THE
WATER WHEEL

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Cover: Research is exploring the value of indigenous knowledge in the sustainable exploitation of aquatic ecosystems. Read story on page 14. (Cover photograph courtesy Barbara Tapela)

Fluid Thoughts


WRC CEO, Dhesigen Naidoo

The twenty year warning

We are slowly emerging from what has been described as the highest impact El Niño event in twenty years.

The associated drought has had a devastating impact locally and regionally in southern Africa, with our neighbour Zimbabwe in the third year of a drought event and Ethiopia facing the prospect of her worst famine in 50 years. The World Economic Forum pegged water crisis as the highest risk to the global economy in 2015, and Sub-Saharan Africa has realised that risk in a reality bite that will take us years to recover.

What of the future? We have been reminded that the El Niño – La Niña cycles are regular, although the levels of severity are less predictable. The recent El Niño being of a much higher impact than its relatively mild predecessors after 1992.

As a country, water security has become increasingly important in recent times and is a major focus of national policy. There are various planning and forecasting models in development, including the data-rich Water Resources 2012 (WRC) project as partnership between the WRC and the Department of Water and Sanitation to very soon become the premier water balance tool to be used in water planning at the quinary catchment scale. This is being developed in a Wikipedia format that will allow the users to firstly engage the tool on-line for access to real-time data as well as having the option for the user community to update the data sets via an administrator firewall to ensure accuracy and data quality.

In parallel, the WRC has invested in a cluster of forecasting projects to look at the possibilities of the next twenty years. The Commission, in partnership with the Institute for Security Studies' Africa Futures programme and the Pardee Centre based at the University of Denver, have developed a 2035 outlook utilising a combination of available planning data as well as a collection of sentiments of thought leaders in the South African water environment.

The study determined that through supply-side measures of new dams and transfer schemes, we will be able to increase water supply by 16.3% or 2.5 Km^3 to 17.8 km^3 (1 km^3 = 1 billion m^3). Unfortunately, at the same time, the forecast of the water demand combining our current use patterns as well as our developmental ambitions as contained in the National Development Plan, our water demand in 2035 will be 18.9 km^3. This will result in a deficit of 6.1% or 1.1 billion km^3.

This is the twenty-year early warning. Our current use patterns are not sustainable. We are the 30th driest nation in the world, and yet our water consumption at 235 ℓ/person/day. That is 32.7% above the global average. Embedded within this lies the core elements of the solution. If we consider our water futures as illustrated in figure 1, our options become clearer.

The path to the higher water security future already enjoys a baseline investment in South Africa today. Minister of Water and Sanitation, Nomvula Mokonyane, has been clear in her 2016 Budget Speech for Water and Sanitation that innovation and creativity will be the drivers both in our water supply diversification as well as increasing our water wise status as a country.

Our efficiency envelope or potential lies in our current use patterns. If we simply reduce our usage to the global average, we will on today's figures avail 1,185 billion m^3 of water into the system, thereby offsetting the projected twenty-year deficit.

The pathway to our water prosperous future rests on three drivetrains. The first is the need for higher investment in new and innovative supply options like higher efficiency, low cost, renewable energy driven, low carbon desalination and point of use systems. The second is a switch to 'fit for purpose' regimes for water quality, core to which is the purple pipe revolution enabling water recycling at scale in every household and production line including agriculture in the country. The third is moving to water use efficiency.

The WRC will, through its new initiatives, combine the national surveys of water use for different industrial sectors with international benchmarks to both define and enable the efficiency gains possible and together with industry partners developing a National Water Benchmarking Initiative similar to the Municipal Benchmarking Initiative that is already demonstrating important successes in this domain.

A combination of these actions makes a for a more water secure future. A water secure future that is achievable long before 2035. And if we manage to attain this in every quinary catchment in the country, then we shall have one of the most robust drought mitigation strategies in the world, regardless of the severity of the next El Niño event.

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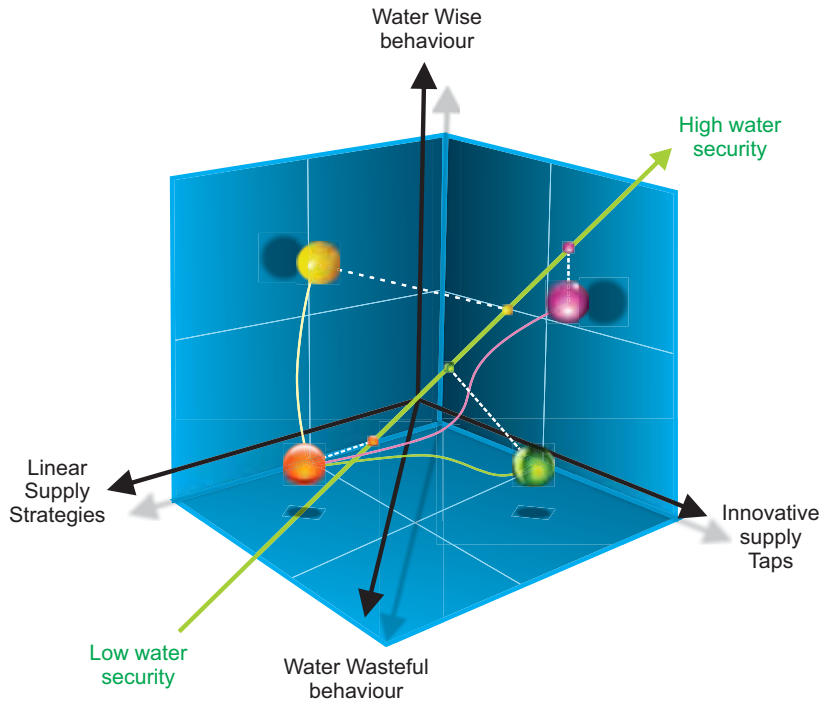

Figure 1.

An illustration of three possible water futures for South Africa. The axes in three dimensions are the levels of water efficiency of use on the one axis; linear to innovative water solutions on the second; and the extent of water security on the third. The current water status (orange) indicates a level of reasonable but vulnerable water security. If our efforts over the next twenty years continue to be predominantly linear solutions to increase supply options while partially tackling the crucial matter of moving to higher water levels of water wise use will definitely improve our water security status (yellow). The best scenario for South Africa is to move to a higher efficiency of use while investing in game-changer creative and innovative water supply diversification. This will enable us to reach much higher and more sustainable levels of water security (purple) moving toward 2035.

Diary

Wastewater technologies
June 13-16
The 13th IWA Leading Edge Conference on Water and Wastewater Technologies will take place in Spain with the theme, 'Evaluating impacts of innovation'.
Visit: http://www.let2016.org/

Water history
June 23-25
The International Conference of the Historical Association of South Africa (HASA) will take place at the Riverside Sun Hotel, Vanderbijlpark, under the theme 'Bridging the disciplinary divide: New routes to understanding the Southern African past?'The conference promises a strong focus on specifically water history.
Enquiries: Petra Lawson (conference administrator);
Email: conferencepl@gmail.com;
Tel: 083 231 6538.

Aquatic science
June 26-30
The annual conference of the Southern African Society of Aquatic Scientists (SASAQS) is taking place in Skukuza, Kruger National Park.
Contact Petrie Vogel, Tel: (012) 346 1674, Fax: (012) 346 2929
Email: petrie@savetcon.co.za;
Visit: http://www.riv.co.za/sasaqs/pdf/1st_SASAQS_11Jan2016s.pdf

Geology
August 27 to September 4
South Africa is hosting the 35th International Geological Congress in Cape Town. The event is aimed at, among others, contributing to the advancement of fundamental and applied research in the geological sciences and to provide a space where ideas and information can be exchanged across the geoscience disciplines. Visit: www.35igc.org

World water
October 9-13, 2016
The IWA World Water Congress will take place in Brisbane, Australia with the theme 'Shaping our water future'.
Visit: http://www.iwa-network.org/event/world-water-congress-exhibition-2016/

Municipal engineering
October 26-28
The annual conference of the Institute of Municipal Engineering of Southern Africa (IMESA) will be held at the East London Convention Centre. The theme is 'Siyaphambili – Engineering for the future'.
Enquiries: Debbie Anderson,
Tel: (031) 266-3263;
Email: conference@imesa.org.za;
www.imesa.org.za

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Letters and Opinion

Dam safety not an issue to be taken lightly

My compliments once again to *the Water Wheel* on very informative reporting, particularly in the November/December 2015 issue. One article, in particular, raised my attention, namely Dam Safety – ensuring integrity of SA's 5 000+ registered dams.

I would like to express a few, I hope, relevant comments adding to your well-structured and informative article. My professional interest and gained expertise evolved over more than 45 years from the involvement in the planning, design, construction and particularly the maintenance as well as the refurbishment/hydropower retrofit of the dams in the Southern Africa sub-region. The growth in the procurement of new dams during 1970s and 1980s reached almost the exponential proportions resulting that more than 5 100 dams of all types and sizes are in existence in SA (somewhere it has been stated that South Africa is the eleventh country with most existing dams on the planet).

However, such sizeable and important infrastructure requests a fair amount of attention and investments for its operation and the upkeep. However, most of South Africa's existing dams are visibly ageing, losing the impoundment capacities due to the sedimentation and many are becoming seriously polluted from only partially controlled urban and mining effluent river releases. The surface runoff from the agricultural land is to the large extent also polluted, contributing to the gradual reduction in the water quality of the South Africa's dam impoundments without any significant remedial correction, thus imposing higher water treatment costs on the downstream users.

The biological, toxicological, financial and other factors (some of them not necessarily easily noticeable) are inevitably accentuating focus not only on the integrity of a dam structure (i.e. particularly the dam wall and associated infrastructure as e.g. is a spillway) but also on the diminishing capacity and particularly on the quality of the water stored behind the dam wall, dictating the overall replacement value of the whole primary water supply scheme.

The urgent importance of the financial constraints of the South Africa's primary water supply infrastructure surfaced in its true reality during 2007 when the Department of Water and Sanitation (than DWAF) introduced the programme on the verification and valuation of major water infrastructure assets (known outside the department as the SAKHILE Project). A consortium of private sector consultancies helped the DWS to develop and establish the Asset Management Project Tool (AMPT) for evaluating immovable national assets.

This tool (and associated processes conducted in the field) enabled the DWS in the condition grade valuating over 320 primary raw water supply schemes (mainly Category III and II national dams) during the 2007/08 financial year. The AMPT is designed to enable the DWS in annual update providing outcomes allowing for relevant budgeting and allocation of funds for the refurbishment and integrity support of the national dams (municipal and private dams are not included in this annual valuation exercise).

The AMPT is also important in providing the background updates allowing for determining appropriate raw water pricing charges (e.g. the Return on Asset and the Future Infrastructure Build charges). The DWS is selling, in most instances, the raw water to other users (e.g. metros, water boards and mining enterprises, etc.). To date ,the vital inputs to the AMPT are based on the Dam Safety Reports (DSRs) produced and approved by the DWS's Dam Safety Office. These reports are compiled by the Approved Professional Persons (APPs) together with the assistance of the DWS's regional office staff. A typical DSR (as structured according to the ICOLD and endorsed by the SANCOLD methods and requirements) may comprise several spheres of information, including statistics, hydrology, geology, dam wall details, spillway details, outlet works details, monitoring and performance observations, risks and Impacts, site inspection report by the APPs with the DWS's assistance, overview of previous recommendations, and conclusion and recommendations.

In general terms an outcome from each DSR is referring and contributing to the Condition Grade Evaluation exercise with regard to the changes in a status at each dam during a period of time between 5 and 10 years. No particular information on the changes in the capacity size due to sedimentation and water quality stored are available from the DSRs. This type and quality of such information are drawn from the other sources within the DWS. However, the frequency of surveys on the sedimentation and water quality is not necessarily matching the frequency in the evaluation of current status of a dam as recorded in the DSRs. The experience gained during a few recent years analysing and utilising the DWS's Dam Safety Reports allows me to suggest that some kind of an alignment between the valuable outcomes of the DSRs and the Condition Grade Valuation exercise (differing in the main objectives) of a dam impoundment scheme is inevitable, if the AMTP has to be supplied with the relevant and qualitative inputs reflecting the reality.

It is obvious from your article that the DWS's Dam Safety Office is facing serious constraints with regard to the competency and numbers of the APPs in the coming years, inevitably jeopardising future valuations of integrity of our dams. There are a few ways how this urgent problems can be mitigated and eventually even eliminated, providing that the stakeholders will be inclined to discuss the way forward. I have some useful ideas and I am prepared to discuss these with the WRC and the DWS's Dam Safety Office.

Bo Barta, Pretoria
(Letter has been shortened - Ed)

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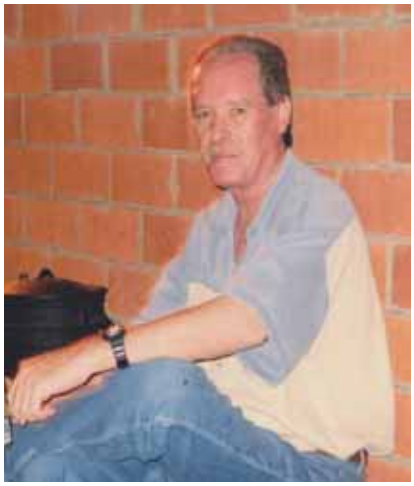
SA water treatment legend honoured



The South African water sector has been hit by another blow with the death of water treatment stalwart, Charles Walters, on 7 April, following a struggle with cancer.

According to colleagues and customers at Rheochem, Charles was a legend. Barry Ludolf of Chemanzi, another long time and well-known water treatment expert, recently had this to say "during the days of SA Cyanamid, Charles was the cornerstone of our Sasol 2 and 3 business. He had an exceptional technical ability."

Charles started his career in water treatment in 1982. The many years he spent with Eskom Technical Department stood him in good stead with future positions. He was one of the pioneers in terms of work on polyamines to replace the traditional use of aluminium sulphate at that time, as well as on Streaming Current Detectors, now commonly used but at the time state-of-the-art technology.

Charles worked at Rheochem until January 2015, fulfilling the role of Inland Region Area Manager for nearly 18 years. During that time he provided customers with an exceptional service. His ability to problem solve was unquestionable and the commitment Charles constantly displayed left customers with the confidence of knowing that he was always available to assist. From Senior Managers to Plant Operators Charles was known to be the person to call when polymer optimisation help was needed.

Jacqui Swart, who worked with him during the last 18 years of his career, said that with Charles one always knew that things were under control and results would be accurate – he had a unique understanding of the art and science of water treatment and she will always not only be grateful for the contribution he made to growing Rheochem through the early years but for being so dependable as both a friend and colleague.

Charles was an application specialist rather than a sales person and loved his job. He was one in a million and always himself. Charles had an indomitable spirit. He reached across cultural divides without even trying to or being anyone other than who he was – just by being genuine and committed to water treatment.

He will be sorely missed.

UP horticulture student scoops up awards

Mathew Banda, an MSc student in Horticulture in the Department of Integrated Plant and Soil Sciences at the University of Pretoria (UP) has been awarded two prizes from the South African Society for Horticultural Sciences.

He was co-recipient of these two prizes with a student from Stellenbosch. The first prize was awarded to the best oral presentation by a Masters student in Horticulture and the second prize is a travel grant worth R10 000 for the best overall student presentation in Horticulture at the Joint Congress of the Weed, Crop, Soil and Horticultural Societies.

The travel grant is towards payment to attend any international horticultural congress. Banda's research is focused on citrus water use. The increase in demand for irrigation water has prompted research to determine the specific water needs of citrus, which enable farmers to accurately schedule irrigation as per daily plant water use.

This results in saving water and alleviating problems of nutrient leaching, which results in eutrophication, making citrus production more sustainable.

Source: UP

New study investigating drought shocks on industries

The Water Research Commission (WRC) has launched a study to quantify the impacts of drought on South African industries.

This short-term project will investigate the impacts of drought on production, cost of raw materials, export earnings, unemployment, profits, real non-indexed wages, as well as consumption of products, investments and other related factors.

"The primary aim of the project is to produce a set of fact sheets which will provide compelling arguments for early action in the event of a future meteorological drought warning, by describing what the societal impacts of a drought will be," explains WRC Research Manager, Dr Jo Burgess.

Drought historically has caused direct and indirect economic, social and environmental problems. Some of these problems are difficult to avoid, even with early preparation. However, other effects are avoidable, especially those stemming from poor economic planning and delayed drought response.

This WRC project is intended to establish a baseline of typical economic consequences of drought. The specific impacts of the 1991/92 and, if possible, 2015/16 droughts in southern Africa can be measured against this baseline to

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assess reducible, if not avoidable, costs.

According to Dr Burgess, drought-induced economic losses include those resulting from impaired dairy and beef, crop, timber and fishery production; lack of power for industrial use; decline in agricultural-dependent industries; increased unemployment in agriculture and other drought-affected industries; strain on financial institutions (capital shortfalls, credit risks); loss of revenue to state and local governments (from reduced tax base); reduced navigability of waterways; and increased costs for transport of water and development of new sources. Such effects are felt by municipalities, business and industry, agricultural enterprises, households, individuals and government.

WRC Research Manager, Dr Sylvester Mpandeli, who is co-manging the project with Dr Burgess, noted that one way to measure the impact of disasters such as drought is by measuring changes to the gross national product (GNP) or gross domestic product (GDP). Over the last three decades, droughts have reduced GNP by at least 1% in East Africa, North America, South America and Southern Asia, among others.

As part of the study, the research team will hold expert stakeholder workshops and interact with selected industries in South Africa.

Hopping new frog app developed by NWU researcher

North-West University Zoology professor, Louis du Preez, has developed a new application (app) about the frogs of southern Africa.

Prof Du Preez, or the 'frog man' as he is known, has become synonymous with frogs and their well-being to which he has dedicated most of his academic career. An established researcher with a C1 rating of the National Research Foundation, Prof Du Preez has authored 102 scientific articles and seven books. He heads the African Amphibian Conservation Research Group, and his research focuses on the well-being of amphibians and in particular on the conservation of endangered species, as well as the systematics and ecology of amphibian parasite diversity.

The Complete Guide to the Frogs of Southern Africa has been launched on the Apple App Store and Google Play. It was developed by Prof Du Preez in collaboration with Vincent Carruthers.

It is excepted that the app will be especially popular with nature lovers, students and scientists. The app contains all 160 familiar species of southern Africa and elucidates them with more than 1 600 photographs, videos, sound bytes of frog calls, details about their habitat and where each species can be found.

The app is interactive, and enables the user to upload a sighting of the different species, with GPS coordinated or location where they were sighted, notes and commentary. It also contains a user-friendly identification key that makes the identification of a specific frog species easier.

To watch a video on the app, Visit: https://www.youtube.com/watch?v=wwNjYPHRVTg&feature=youtu.be

Source: NWU

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DWS DG calls for groundwater's profile to be raised

Groundwater can go a long way to supplement the surface water to alleviate water challenges.

This is according to the Director-General of the Department of Water and Sanitation (DWS), Margaret-Ann Diedricks.

Speaking at a five-day conference of the Water Resources Group (WRG), Diedricks said that there was an over-reliance on surface water in South Africa at the expense of groundwater. Surface water currently makes up over 70% of total water use in the country.

"There has to be a definite change in mindset with regards to the general over-reliance on surface water while there is an over-abundance of groundwater that can be used for basic needs," noted the DG.

The department was also looking to promote the reuse of water for industrial and agricultural use.

According to Water Research Commission Executive Manager, Dr Shafick Adams, South Africa has an estimated 7 500 million m^3/year of groundwater available under drought conditions. This while current use is estimated at between 2 000 and 4 000 million m^3/year.

"Groundwater, if managed correctly, has the potential to significantly add to the country's water supply mix," noted Dr Adams. Moreover, compared to large bulk water development projects, such as the building of dams, groundwater was fairly cheap and fast to develop, he added. It could serve either as a sole source of water or augment existing surface water supplies.

At the time of writing, DWS was in the process of supporting drought relief efforts by selectively refurbishing existing boreholes, supporting the maintenance of existing boreholes, as well as supporting the drilling of new boreholes.
Source: DWS

Judge orders study into climate change impacts of new power station

For the first time in South Africa, the Minister of Environmental Affairs has required a climate impact assessment for an environmental approval for a coal-fired power station.

This is after Minister of Environmental Affairs, Edna Molewa, gave Thabametsi Power Project – developer of the proposed 1 200 MW Thabametsi coal-fired power station near Lephalale, in Limpopo – six months to conduct a climate change impact assessment and a palaeontological impact assessment before the project can start.

The order comes after environmental justice organisation, Earthlife Africa (ELA), represented by attorneys at the Centre for Environmental Rights (CER), asked the Minister to set aside the approval of the proposed power station. ELA, together with partner organisation Groundwork and community networks in the Vaal, the Highveld and KwaZulu-Natal, argue that energy from renewable sources should be prioritised over coal-fired power because of coal's detrimental impact on the environment and human health.

As a result, the Minister amended the authorisation, adding the order to conduct the climate change assessment.

In a statement CER said that, while the Minister's acknowledgement that the climate change impacts of coal-fired power generation is seen as a victory for the organisation, it has a number of concerns about the decision.

"The Minister has not prescribed the scope of the climate impact assessment or the palaeontological impact assessment. [In addition], the Minster has required the reports of both assessments to be submitted to the Department of Environmental Affairs to review, but did not require interested and affected parties to have an opportunity to comment on the assessments."

CER was of the opinion that, by requiring these additional impact assessments, the Minister had conceded that material impacts were not assessed before the approval was granted, which is contrary to the requirements of the National Environmental Management Act. "We believe that the Minister's decision to uphold the authorisation, despite these deficiencies, makes it subject to review by the High Court."

The Thabametsi power station is one of 11 proposed privately-owned coal-fired power plants which have, or are expected to, submit bids to sell electricity to Eskom under the Coal Baseload Independent Power Producer Procurement Programme.

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Projects in Progress

Water flowing along with wine at Vergelegen

Vergelegen middle dam at 100% capacity in late summer, proof of the increase in water availability.

All photographs supplied

Somerset West wine estate, Vergelegen, is globally recognised for its award-winning vintages, but this past World Water Day, celebrated every year on 22 March, farm management, staff and visitors raised a glass to the abundant water permeating land once densely packed with invasive alien vegetation.

In what is believed to be the largest private conservation undertaking in South Africa, 2 000 ha (of a planned total of 2 200 ha on the farm) have been cleared and rehabilitated to indigenous vegetation. In the process, the programme has unleashed water resources and generated over 230 jobs for previously unemployed and untrained people, in areas such as bush cutting and hand-picking alien seedlings.

Anglo American acquired the farm in 1987, and the investment in this clearing programme (and other interventions) have made it a leader in the Biodiversity and Wine Initiative, a partnership between the South African wine industry and conservation groups. The estate, which is open to the public, is considered a national treasure and has been nominated as a World Heritage Site.

"Before the implementation of the invasive alien clearing project, activities such as the planting of pine plantations, Acacia and Eucalyptus woodlots and agricultural development opened pathways for alien plant invasion, said Vergelegen environmental project manager Jacques van Rensburg. "More than 80% of the farm's natural veld was invaded by pine on the higher slopes, with Acacia and Eucalyptus species in the low-land area."

As alien vegetation uses up to 60% more water than fynbos, its clearing has boosted water flow. The farm's environmental treasures now include 80 ha of rehabilitated wetlands, fed by the Hottentots Holland mountain range catchment area. These offer a thriving habitat for numerous species of birds, amphibians, invertebrates and wetland-associated mammals such as otters, mongooses and small buck.

While the slightly acidic nature of the farm's wetlands limits the number of plants, numbered among them are floral jewels such as Wachendorfia, Watsonia and Aristea. There are also varieties of Ericas and endemic Leucodendrons, many of which are on the International Union for Conservation of Nature's Red Data List. The farm's wetland areas also contain a pristine Palmiet bed that helps remove excess nutrients from the water and improves its quality.

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Lourens River

The return of indigenous vegetation (which acts as a natural filter) and other conservation initiatives have also contributed to mopping up pollution and encouraging diversity in the Lourens River. This is the only South African river that is a Protected Natural Environment, and the 10 km running through the estate (of a total 20 km) are managed by Vergelegen, the Lourens River Conservation Society, the City of Cape Town and CapeNature.

The river has indigenous fish such as *Sandelia capensis* and *Galaxia spp.* Shy Cape clawless otters can be seen at night, while water mongoose, large grey mongoose and small grey mongoose live off the fish. Large-spotted genets also thrive, while resident bird life includes malachite and giant kingfishers.

On the entire farm, the number of bird species has soared from 80 to at least 142 since the alien vegetation clearing began. The animal population now includes numerous antelope species, leopard, caracal, honey badgers, snake weasels, silver foxes, Cape hares and spotted genet. There are at least 500 different plant species in total.

Local and international scientific research at the farm is coordinated by Vergelegen's Centre of Learning Excellence. For example, Hamburg University of Technology scientists researched the Lourens River water quality, while a Stellenbosch University group undertook research at the estate's vast Rooiland Dam, which stores 2.72 million m^3 of water. The dam was used as a negative control in an investigation of the impact of small-scale aquaculture on the water quality of irrigation dams in the Western Cape.

"Improving the quantity and quality of water at Vergelegen has been one of the many successful outcomes of the alien vegetation clearing programme," said MD Don Tooth. "Our achievements have been a team effort and we are happy to share our conservation research and learnings with other interested parties that could benefit."

Water researchers at Vergelegen have included Nelia du Buisson and Kora Holm from Stellenbosch University, seen here at the farm's Rooiland Dam.

Newly rehabilitated wetland, showing the growth of various restio species.

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Global

Dragonfly smashes insect migration records

A dragonfly barely an inch-and-a-half long appears to have shattered the long-distance record for insect flight – travelling thousands of miles as it migrates from continent to continent.

Biologists say the evidence is in the genes. Populations of the dragonfly, called *Pantala falvescens*, in locations as far apart as Texas, eastern Canada, Japan, Korea, India and South America, have genetic profiles so similar that there is only one likely explanation.

Apparently somehow – the insects are travelling distances that are extraordinarily long for their small size, breeding with each other, and creating a common worldwide gene pool that would be impossible if they didn't intermingle.

"This is the first time anyone has looked at genes to see how far these insects have travelled," notes Jessica Ware, an assistant professor of biology at Rutgers University and senior author of the study that has been published in *PLOS ONE*.

"If North American Pantala only bred with North American Pantala, and Japanese Pantala only bred with Japanese Pantala, we would expect to see that in genetic results that different from one another. Because we don't see that, it suggests the mixing of genes across vast geographic expanses."

According to Ware, these dragonflies have adaptations such as increased surface areas on their wings that enable them to use the wind to carry them. They glide for long periods, expending minimal amounts of energy as they do so.

Dragonflies have already been observed crossing the Indian Ocean from Asia to Africa. "They are following the weather," notes Daniel Troast, who analysed the DNA samples in Ware's lab while working towards is Masters Degree in Biology, which he earned in 2015.

"They are going from India where it is the dry season to Africa where it is moist season, and apparently they do it once a year."

Moisture is a must for Pantala to reproduce, which is why these insects would be driven to even attempt such a perilous trip. "The species depends on it. While many will die en route, as long as enough make it, the species survives" says Ware.

Flight patterns appear to vary. The hardiest of the dragonflies might make the trip nonstop, catching robust air currents or even hurricane winds and gliding all the way. Others may literally be puddle jumpers.

Pantala need freshwater to mate and lay their eggs – and if while riding a weather current they spot a freshwater pool created by a rainstorm – even on an island in the middle of a vast ocean – it is likely they will dive earthward and use those pools to mate.

After the eggs hatch and the babies are mature enough to fly (which takes only a few weeks) the new dragonflies join the swarm's intercontinental and now multi-generational trek right where their parents left off.

For now, details of this extraordinary insect itinerary are an educated best guess, as are specific routes these migrations might take. Much more work is needed to bring may loose ends together.

To access the PLOS ONE article, Visit: http://journals.plos.org/plosone/article?id=info%3Adoi%2F10.1371%2Fjournal.pone.0148949

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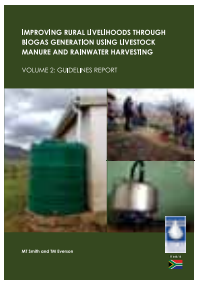
WRC New reports



Report No. TT 645/15

Improving rural livelihoods through biogas generation using livestock manure and rainwater harvesting (Guidelines report)

Increasing fodder production has become essential to solve the problem of diminishing natural grazing veld for livestock in rangeland systems. These guidelines were developed to assist livestock owners with biodigesters to implement sustainable grazing management practices. This was achieved through determining methods for improving grazing capacity and livestock production in three communal areas in the Eastern Cape, KwaZulu-Natal and Limpopo provinces.
The main research report (*Report No. 1955/1/15*) is also available.

Report No. 2009/1/15

A tunable lignocellulosic enzyme system for treatment of industrial wastewaters

The fruit industry is a multibillion dollar industry that is growing rapidly in all regions of the world. The production of juice consumes a large amount of fresh fruit and water, while generating large quantities of recalcitrant material called pomace. Up to 25% by wet mass of citrus fruit production is pomace. The industry does not have a particular use for the pomace and, as a result, it is considered waste. Fruit wastewater has a poor water quality with a chemical oxygen demand (COD) of up to 10 000 mg/L. Fruit wastewater is normally released into the sewerage system, which can result in clogging. If it is introduced directly into rivers it and lead to eutrophication of water bodies. Most fruits wastes are lignocellulosic in nature, which pose specific problems for hydrolysis as an enzymatic treatment, as such substrates are particularly recalcitrant.
The proposed process was postulated as a successful and cost-effective solution to the treatment of these wastes and involved the enzymatic treatment of agricultural wastes using suitable combinations of cellulases and oxidases (ligninases) in an effective ratio. The major aim of the Tunable Immobilised Lignocellulosic Enzyme (TILE) system was to treat agri-industrial wastewater using enzymatic processes in order to generate clean water, and at the same time, produce value-added products from such waste. The study focused on apple pomace and apple derived wastes from industries in the Western Cape.

Report No. 2246/1/15

The use of GIS and remote sensing techniques to evaluate the impact of land use and land cover change on the hydrology of Luvuvhu River catchment in Limpopo Province

Land use and land cover changes in a catchment can impact water supply by altering hydrological processes such as infiltration, groundwater recharge, baseflow and runoff. Studies that link anthropogenic factors and land cover to hydrology and water resources have not been widely conducted in the Luvuvhu River catchment. This WRC study was conducted to evaluate the impact of land cover and land use change on the hydrology of Luvuvhu River catchment. The information derived will help prevent the potential for human conflict over diminishing resources and disease outbreaks related to waterborne vectors. Remotely sensed data and ground survey methods were used to evaluate the changes. A combination of multi-date fine, medium and coarse resolution remotely sensed imagery was used to detect and quantify changes.

Report No. 2163/1/15

Radiative forcing of southern African climate variability and change

This report is concerned with exploring the effects of various forms of tropospheric and stratospheric radiative forcing on southern African climate variability and change. A large set of sensitivity tests, following the experimental design of the Atmospheric Model Intercomparison Project was performed for this purpose. An ensemble of projections of future climate change has also been analysed, to investigate the relative importance of enhanced carbon dioxide concentrations and recovering stratospheric ozone in forming southern African climate during the twenty-first century.

Report No. KV 341/15

A comparison of the South African approach to water resources management and planning with four international countries

This report compares the South African approach to water resources management with four international countries, namely Australia, Brazil, England and the USA. The over objective of the study was to determine whether or not South African can learn from other countries with similar water resources issues and improve the current methodologies, approaches and techniques based on their experiences. This was carried out using the following areas of comparison: legislative framework; required documentation and typical studies carried out; institutional arrangements; and modelling techniques.

Report No. 2238/1/15

Key interventions to improve local groundwater governance

There is a growing perception that groundwater governance is simply not working, especially at the local scale, in South Africa. This perception is increasingly being supported by research. The purpose of this investigation was to address known weaknesses in groundwater governance by identifying and prioritising key interventions that can improve local groundwater governance in South Africa.

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Ecosystem services

Worth their salt – Determining the value of Limpopo's water ecosystems

A Water Research Commission (WRC) funded project is exploring whether indigenous knowledge is properly valued when natural products from water-linked ecosystems are commercialised, and how this issue can be addressed in planning and policy.

Article by Sue Matthews.

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

Barbara Tapela

The rich variety of ecosystem services provided by wetlands are often highlighted as a reason to protect these natural habitats. Provisioning services – according to the Millennium Ecosystem Assessment's definition – include food and medicinal products, freshwater for domestic and agricultural use, and reeds and grasses for roof thatching, floor mats and handicrafts.

The focus is generally on subsistence use of these goods, or even limited trade that allows members of the surrounding community to make a small livelihood at local markets or roadside stalls along tourism routes. But there are also 'success stories' of , for example, traditional baskets and bowls being offered for sale at top retail outlets, both within South Africa and abroad.

Since these ventures require consistent product quantities and quality, small-scale producers are often encouraged to enter into contractual arrangements, and there may be a number of middlemen between them and the 'end seller' if the market value chain – encompassing the full range of activities required to bring a product from conception to its end use and beyond – is very long.

Do the producers at grassroots level receive a fair share of the benefits of such trade, or are they being exploited and their indigenous knowledge not fully recognised? And what are the implications for the sustainability of the natural resource? Could the increasing demand for the products – coupled with rural population growth, poverty,

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unemployment and the added pressure of climate change – threaten the resilience of ecosystems?

These are the kind of questions being explored in a project conducted for the WRC by the Institute of Poverty, Land and Agrarian Studies (PLAAS) at the University of the Western Cape. The ultimate aim of the research is to ensure that indigenous knowledge is incorporated into natural resource management planning and policy, specifically that associated with water-linked ecosystems.

South Africa already has some legislation addressing the issue. In 2004, Cabinet adopted an Indigenous Knowledge Systems (IKS) Policy, which is essentially an enabling framework to stimulate and strengthen the contribution of IKS to social and economic development in South Africa. More than a decade later, in March 2015, the Minister of Science and Technology, Naledi Pandor, published the Protection, Promotion, Development and Management of Indigenous Knowledge Systems Bill, 2014, for public comment.

Also in 2004, the National Environmental Management Biodiversity Act (NEMBA) was promulgated, with a chapter on bioprospecting, access and benefit-sharing to regulate bioprospecting involving indigenous biological resources and ensure the fair and equitable sharing of benefits arising from it. The NEMBA Bioprospecting, Access and Benefit-sharing Regulations subsequently entered into force in 2008, and in 2012 the guideline document 'Bioprospecting, Access and Benefit Sharing Regulatory Framework' was published to help different stakeholders understand the legal requirements and their rights in terms of the law.

"We're looking at the existing policies, but emphasising that the water sector must also exercise due diligence," says project leader, Dr Barbara Tapela.

"When indigenous resources from water-linked ecosystems enter the market value chain, we need to ensure that a fair and just portion of the value generated goes back into uplifting the livelihoods of the people who produce the resource, and improve conditions for communities where the wetlands are located."

The field research component of the project is focusing on a case study of the traditional salt makers at the Soutini-Baleni wetland, which encompasses the Mahumani vlei and the hot springs that help sustain it. The wetland, on the southern bank of the Klein Letaba River, approximately 40 km south-east of Giyani in Limpopo, was declared a Natural Heritage Site on World Wetlands Day in 1999 because the salt-making practices here are believed to date back 2000 years. The site's name reflects the terms used by the local Tsonga people, Soutini meaning 'place of salt' and Baleni 'wide open vlei'.

"When indigenous resources from water-linked ecosystems enter the market value chain, we need to ensure that a fair and just portion of the value generated goes back into uplifting the livelihoods of the people who produce the resource."

Salt-making is practised only by women – nowadays from the surrounding villages – although in times past they came from as far afield as Mozambique. It typically takes place only during the dry winter months, although there is emerging evidence that some of the women have begun entering the salt mine at other times too. Traditionally, salt-making is governed by customs that include formal rituals

Transfrontier Parks Destinations

The brine is boiled until most of the liquid evaporates, leaving behind a salt residue that can be dried in the sun.

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The salt is sold in Giyani's informal market.

and specific terminology to pay tribute to ancestral spirits. For example, access to the salt mine is only granted by the presiding priestesses after performance of an appeasement ritual that involves laying twigs and sticks at the base of an old leadwood tree, and reciting incantations to introduce new arrivals. The priestesses act on behalf of visitors who do not know the correct terminology, alerting the spirits to this fact and requesting their leniency.

Once admitted, the women stay for seven days, sleeping under the trees and eating food they have brought with them from home. Salt-making begins with the filling of buckets with salt crust scraped from the edge of the vlei. For each bucket of salt crust, one is filled with soil and another with river sand, and all of this material is deposited into a raised filter-basket called a xinzhava, which is made from twigs, grass and clay. River water is then poured over the mixture, dissolving the salt and allowing the brine to drip down into a container below. Next the brine is boiled over a fire to evaporate the fluid, after which the salt residue left behind is spread onto sacks and dried in the sun.

By the end of the seven days, the women return home with about 50-80 kg of salt each. Some of this may be bartered within the community – salt being exchanged for chicken or vegetables, for example – but it is also sold at local village markets, to informal traders in nearby Giyani and to traditional healers from further afield.

Recently, a few of the women have sold their salt through a private company that operates an ecotourism venture at the hot springs under a lease agreement with the provincial tourism agency. The company, Transfrontier Parks Destinations, runs Baleni Camp as part of its African Ivory Route in Limpopo, and has arranged for the salt to be marketed by Oryx Desert Salt, which is based in Cape Town but sells salt harvested from a remote part of the Kalahari Desert.

While the women earn R1 800 for 50 kg of salt, the final packaged product is advertised on the Oryx website at R650 for just 3kg! Smaller quantities may have even more of a mark-up, particularly when sold overseas under the banner of the burgeoning Slow Food movement.

"In the past, with commercialised indigenous products such as buchu, Hoodia and devil's claw, the contentious issue was around sharing of the financial benefits – basically, the people who grew the buchu ended up getting the short end of the stick," notes Dr Tapela. "In the case of Baleni salt, the surrounding communities have maintained the wetland by using its resources in ways that have not damaged them, so they have effectively paid the cost of ensuring those resources still exist. Are those costs, as well as the value of indigenous knowledge, being factored into the sharing of financial benefits?"

One way of assessing this is to construct a value chain map, which enables the tracing and tracking of relationships between different actors, such as producers, intermediaries, processors and exporters, as well as the flow of inputs, services, and credit through the chain. This was one of the first tasks of the field research, which entailed group discussions with the women who mine the salt, as well as meetings with the traditional leadership and the ecotourism company.

"In light of our findings we'll now be doing an action research process, whereby we'll be using this as a test case to see how we can improve this value chain so that it can work to benefit the local woman. The key stakeholders involved are quite keen for us to work together – they wanted to help the women by getting the salt into the market, but when you get into traditional rural communities, you need to have your finger on the pulse of the socio-political dynamics."

Dr Tapela explains that the traditional leadership was marginalised in the process of negotiating the ecotourism and salt-marketing arrangements, which meant there was a risk that these initiatives would not be tenable in the long term.

"The WRC is emphasising and channelling more research resources towards the business of ecosystems as a way of centralising marginalised communities as beneficiaries, especially those from rural and peri-urban areas."

So they have an interest in working with all the key stakeholders to find a way forward," she says. "The companies therefore have an interest, but they also have some ethical considerations, without which they would not have market credibility."

The learning achieved from this test case will be used to propose recommendations for critical interventions towards pro-poor, equitable, gender-sensitive and IKS-cognisant value chains, with the hope that the commercialisation of natural products could yet prove to be a valuable tool for addressing poverty, unemployment and inequality.

"It is for this reason that the WRC is emphasising and channelling more research resources towards the business of ecosystems as a way of centralising marginalised communities as beneficiaries, especially those from rural and peri-urban areas," says WRC Research Manager, Bonani Madikizela. "There is an urgent need to improve the quality of marginalised communities' lifestyles through unlocking wealth in aquatic ecosystems, without compromising the integrity of the ecological infrastructure or natural ecosystem health conditions. This is the essence of green economy."

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Municipal services

Urban consumers give water services the thumbs up

Though water is a topic that sometimes reaches headlines for negative reasons in South Africa, the country's water has a lot going for it. Our drinking water is generally good, with standards that compare well globally. Petro Kotzé reports on the results of a survey on urban South Africans' perceptions of their municipal water and sanitation services.

As with any other goods and services, customer satisfaction is closely aligned to the users' perception of the product and service. Independent researcher, Dr Sarah Slabbert (of Sarah Slabbert Associates), points out that users have no choice of water service providers in South Africa, so they cannot 'shop around' for alternatives. However, she says, customer satisfaction is still the basic principle of service delivery. The simple question whether you are delivering a good service still applies.

So, what then are South Africans' perception of their drinking water quality and related service provision? National feedback on the topic from the perspective of the customer is limited. In 2004/5, the then Department of Water Affairs and Forestry (now the Department of Water and Sanitation), in collaboration with the UK's Department of International Development (DiFD), commissioned a study into water services customer care and protection. The study included a survey among adult South Africans on their perceptions of the water services they receive from municipalities.

Then in 2011, Sarah Slabbert Associates led a Water Research Commission (WRC) survey on drinking water quality perceptions and the variables that influence these. This survey has now been repeated in 2015 in association with the South African Local Government Association (SALGA). The latter study covers a broader scope than the one in 2011. Instead of focusing on drinking water quality only, it investigated the general public's perspective on aspects of water services that SALGA has identified as relevant to investigate.

The study, published earlier this year, found that 88% of urban South Africans (7% more than in 2011) perceive their tap water to be safe to drink. This concurs with international studies, which found that most people in countries with a reliable water supply perceive tap water as having a low safety risk to drink.

"We are still able to produce world class quality services, and the people have confirmed that," says WRC Executive Manager for Water Use and Waste

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Management, Jay Bhagwan. "As a survey is a quick way to get an understanding of where people's satisfaction is, it is important to do this on a regular basis to see how the sector is delivering."

According to Dr Slabbert, the survey was completed in September 2015, before the brunt of the current drought started to be felt, which is good as it could have affected perceptions and skewed a comparison with the 2011 results.

South African's perception of their drinking water quality

As mentioned, results have indicated that most urban South Africans are still confident that their tap water is safe to drink.

Furthermore, the survey found that consumers in the metropolitan (metro) municipalities perceive their tap water to be significantly safer to drink than consumers in the other urban municipalities. For metro municipalities, the study found a 15% gap between the metros with the highest consumer confidence in drinking water quality and those with the lowest consumer confidence. These were the City of Cape Town (98%) and eThekwini (97%), and at the lowest end, Buffalo City (83%) and Nelson Mandela Bay (82%).

Consumers in the North West and Mpumalanga provinces have the lowest confidence in their drinking water quality. These two provinces also have the least reliable water supply in terms of consumer experience and perception. In the survey 60% of consumers in North West said that they suffered water interruptions at least once a month, or more frequently.

Though it is tempting to relate these findings with the municipalities' Blue Drop status, Bhagwan warns that this would be incorrect, as perception is based on service delivery, while the Blue Drop reports on technical functionality. Though there are subtle correlations, the two processes are not seamless, he says.

According to Dr Slabbert, It was not the purpose of the study to compare perceptions with municipalities' water quality compliance results. "However, in broad terms we can say that perceptions in the Metros correlate with the findings of the Blue Drop report."

In concurrence with international studies, a very small percentage of the population (4%) base their perception of the quality of tap water on what they have heard or read in the media.

Instead, the top six reasons why people think tap water is safe to drink are that the water looks clean; nobody gets sick; the water tastes good and smells good; people say the water is safe to drink and the municipality cleans the water. Conversely, the top six reasons why people think tap water is unsafe to drink are that the water looks dirty, tastes bad, smells of chlorine, smells bad, some people got sick from it and other people say the water is unsafe to drink.

"The survey found that 61% of urban consumers do not know how much water their household consumes per month and 48% of paying consumers do not know how much they pay for water per month."

The outward appearance of water as an indicator of quality is a trend that is also picked up internationally, says Dr Slabbert. "Appearance could be deceptive; therefore, it is interesting that people also rely on the fact that nobody gets sick." She points out that results indicate that people will start doubting the quality of their drinking water when there is change in aspects like the appearance or the smell of the water. An example that is relevant locally and internationally is the clearly noticeable presence of chlorine – though people are unsure if it is good or bad for them.

The survey also looked at the use of tap water versus bottled water. The choice seems to be a combination of perceptions of drinking water quality and affluence. The less confident people are about how safe it is to drink tap water, the more likely they are to boil or filter tap water or to use bottled water if they could afford it. In North West, where 56% of consumers are confident that tap water is safe to drink, only 54% of consumers drink water straight from the tap.

On the other hand, consumers in the higher Living Standard Measure (LSM) groups and with high incomes seem to be buying bottled water irrespective of their perception of the quality of tap water. "It is probably a status symbol to drink bottled water when you can afford it," noted Dr Slabbert. In the city of Cape Town, for example, 98% of consumers are confident that tap water is safe to drink, but only 67% drink water straight from the tap. Seven percent say that they never drink water – rather opting for coffee, tea, cool drink or wine.

Service quality

The survey found that 72% of urban consumers believe that their municipality is competent to deliver a good water and sanitation service in normal circumstances, though this confidence decreases for the municipality's ability to deal with extraordinary circumstances. Only 57% believe that their municipality is competent to deal with water scarcity in the event of a drought.

The urban population rates the quality of the water and sanitation service at 6.34 out of a possible 10 (9 to 10 being outstanding; 7 to 9 very good; 6 to 7 good; 5 to 6 adequate and less than 5 being disappointing or requiring urgent improvement). "The average is 6.34 but there are distinct demographic and area differences," says Dr Slabbert.

The service quality index indicated that consumers in the higher LSM groups are more positive about the water and sanitation service that their municipality delivers than consumers in the lower LSM groups. The findings for LSM groups correlate with income: the higher income groups are more positive about their municipal service than lower income groups.

There are no significant gender differences and, age-wise, the age group 35 to 49 has the most negative perception of their municipality's service. Furthermore, the service quality scores are sensitive for province and the size of the

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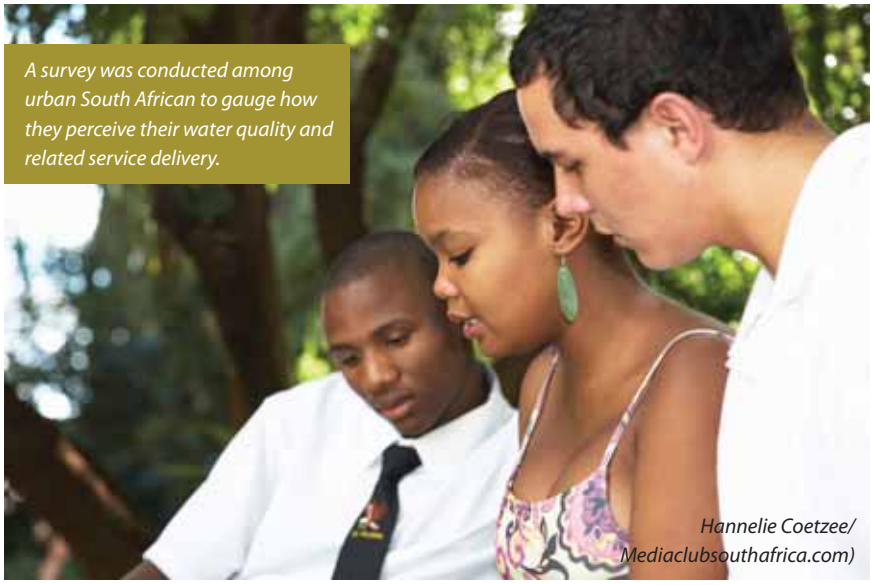

A survey was conducted among urban South African to gauge how they perceive their water quality and related service delivery.

Hannelie Coetzee/ Mediaclubsouthafrica.com)

municipality. Consumers in Gauteng and the Western Cape have the highest index scores, in other words, they have the most positive perception of the water and sanitation service that their municipalities deliver. Consumers in Mpumalanga, the Eastern Cape and North West have the most negative perception.

Consumers in metropolitan areas (with an index score of 6.59) are more positive about their municipality's quality of service than consumers in smaller cities and towns (an index score of 5.93). "We do recognise that in smaller areas there are areas where we can improve," says Bhagwan.

For the Metros, the City of Cape Town (7.01), City of Tshwane (6.97) and City of Johannesburg (6.77) score highest, while Nelson Mandela Bay (5.83) and Buffalo City (5.6) scored lowest.

Awareness of consumption and cost of water

"This is a wakeup call", affirms Dr Slabbert. The survey found that 61% of urban consumers do not know how much water their household consumes per month and 48% of paying consumers do not know how much they pay for water per month. Furthermore, 79% of urban consumers are aware that they should save water and of how they could do it, yet 21% do nothing to save water. Higher LSM groups (LSM 6 to 10) and consumers with a matric or some form of tertiary education are better informed than consumers from the lower LSM groups and consumers without matric.

"It is likely that people would over report water-saving actions, because they know they are expected to save water. Taking that into consideration, a percentage of 21% admitting to doing nothing to save water is high," she notes.

Final thoughts

The WRC has compiled and distributed technical and ministerial briefs that highlight a number of implications that the findings hold for policy and management.

Firstly, sensory aspects such as appearance, taste and odour have the strongest influence on South Africans' perceptions of the safety of tap water. This is an important supplement to the technical parameters in the Blue Drop criteria.

Secondly, municipalities' Water Safety Plans should take the drivers of risk perceptions into consideration when emergency plans are developed.

It also notes that there are several areas of drinking water quality which are insufficiently or ineffectively communicated to the general public. Notably, the Blue Drop status of a municipality is a weak driver of consumer perceptions with regard to drinking water quality. As such, it seems that consumers are unaware of the Blue Drop status of their municipalities.

Furthermore, lower income households' apparent lack of knowledge of water treatment processes can be addressed with educational programmes and visits to municipal water and wastewater treatment plants. Conversely, municipalities with good drinking water quality should use this finding to improve their image and to build consumers' trust in their services.

The top six reasons why people think water is safe to drink:

1. The water looks clean.
2. Nobody gets sick from drinking the water.
3. The water tastes good.
4. The water smells good.
5. People say the water is safe to drink.
6. The municipality cleans the water.

The top reasons why people think water is unsafe to drink:

1. The water looks dirty.
2. The water tastes bad.
3. The water smells of chlorine.
4. The water smells bad.
5. Some people got sick from it.
6. Other people say the water is unsafe to drink.

Lastly, as few South African consumers know how much water they use, and what the associated cost is, it is likely that consumers are wasting water. A multiple strategy, including school and media campaigns, is recommended for communicating information about water conservation and water demand management.

In conclusion, Bhagwan notes that "against many of the challenges that the country is going through we are still able to maintain a good level of service."

To order the report, Perceptions of municipal water and sanitation services (Report No. TT 647/15), contact Publications at Tel: (012) 330-0340; Email: orders@wrc.org; or Visit: www.wrc.org.za to download a free copy.

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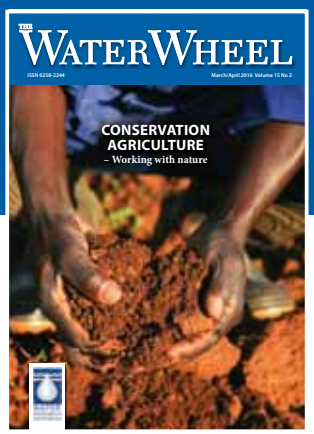

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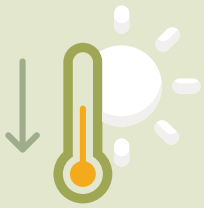
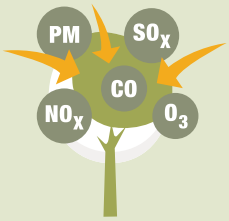
Benefits of Urban Trees

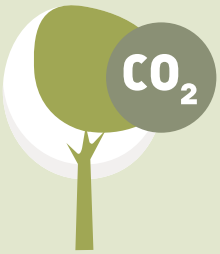


Strategic placement of trees in urban areas can **cool the air** by between 2 °C and 8 °C.



Large urban trees are excellent **filters for urban pollutants** and fine particulates.

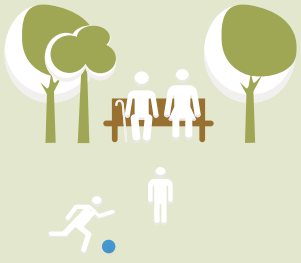
Mature trees **regulate water flow** and **improve water quality.**



1 car = 1000 km

One tree can **remove 12 kg of CO_2** from the atmosphere annually, the **equivalent of 18 000 km** of car emissions.

Wood can be used for **cooking and heating.**

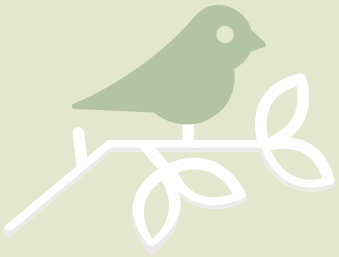


Spending time near trees **improves physical and mental health** by increasing energy level and speed of recovery, while decreasing blood pressure and stress.

Trees can **provide food,** such as fruits, nuts and leaves.

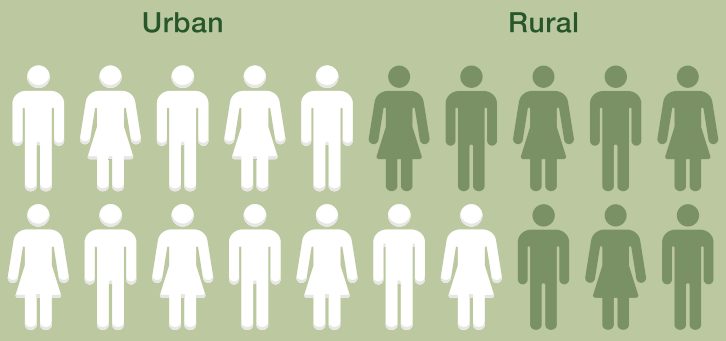
Trees properly placed around buildings can **reduce air conditioning needs** by 30% and **save energy used for heating** by 20–50%.

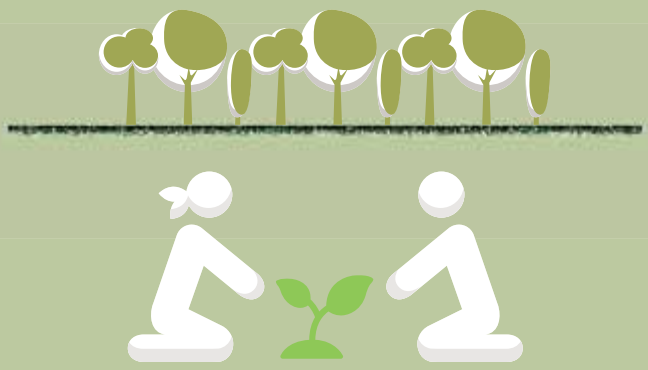
Trees provide habitat, food and protection to plants and animals, **i ncreasing urban biodiversity**



Landscaping, especially with trees, can **increase property values** by 20%.

World urban population is growing fast...





...planting trees today is essential for future generations!

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Ecological infrastructure

Research into ecological infrastructure steps up a gear

While coal-mining in the heartland of South Africa helps to keep our lights on, the polluted water flowing from these operations pose a serious threat to the country's water resources, particularly the wetlands of intensely mined regions, such as Mpumalanga. South Africa's aquatic scientists are working hard at finding solutions to mitigate these risks.

Article by Arno de Klerk.

All photographs courtesy CSIR

Acid mine drainage (AMD) is one of the largest threats to water resources, often disrupting the functioning of water bodies. By gaining a better understanding of ecological infrastructure – the nature-based equivalent of built or hard infrastructure – the CSIR, Water Research Commission (WRC) and its partners have developed mechanisms to help limit and mitigate the impact of coal-mining on wetlands in Mpumalanga.

Ecological infrastructure refers to naturally-functioning ecosystems that generate and deliver valuable services to people and can be just as important for providing services and underpinning socio-economic development. In 2012, the CSIR and the South African National Biodiversity Institute undertook a cooperatively applied research project funded by the Coaltech Research Association, WRC, as well as the Department of Environmental Affairs' Working for Wetlands programme.

Mpumalanga was selected as the focus area for this study due to the fact that coal has been mined in this area for more than a century. By virtue of their positions in the landscape and relationship to drainage networks, wetlands are frequently impacted by coal-mining activities. While wetlands constitute important ecological infrastructure, coal resources are of strategic importance to the province, as well as the rest of South Africa for, inter alia, economic development. However, regulatory authorities and the public now have an improved understanding of the range of economic, social, ecological and hydrological costs of wetland loss and degradation.

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With this in mind, the main focus of the project was to develop mechanisms that could help to limit and mitigate the impact of coal mining on wetlands and to provide guidelines to the coal mining industry and regulators in this regard.

Some of the key outcomes of this study included:

1. A review of what is currently known about pans in South Africa;
2. A case study on the impact of rehabilitation measures on wetlands impacted by AMD;
3. An introductory guide to wetland rehabilitation in mining landscapes; and
4. A high risk wetlands atlas for Mpumalanga.

Pans in South Africa

South Africa lacks sufficient natural lakes resulting in a high dependence on dams for water supply. However, many people do rely on numerous endorheic wetlands, namely pans that are distributed throughout the country. Pans are usually regarded as relatively insignificant in respect of the total surface area that they occupy, but they are quite unique in form, function, sensitivity, as well as in the types of biota they attract and harbour.

It is based on this uniqueness that these systems are not well understood. Currently, these systems are highly vulnerable to activities such as mining and other land use practices, because often buffer zones are unable to provide sufficient protection.

Some pans may be entirely reliant on rainfall to sustain them, while others may have linkages to groundwater that are vulnerable to disruption when mining activities affect the water table. Unlike rivers that have some self-purifying capability, pans generally retain whatever drains from its immediate catchment or enters the waterbody through atmospheric deposition.

Currently, there are also no major monitoring programmes in place to deal with pans in South Africa, possibly due to the limited understanding of their functioning and associated value. Thus, with limited research to properly understand these systems, and with current information being fragmented and difficult to access, the true functioning and importance of these systems may never be realised. With this in mind, researchers from the CSIR, together with other partners have started an initiative to develop best practice guidelines for pans in South Africa.

Rehabilitation case study

The impact of surface mining on ecological infrastructure has been well studied and relates closely to the decrease in ecosystem services provided (directly and indirectly) by these systems. Generally, it is agreed that there are various benefits derived from investing in the maintenance and rehabilitation of ecological infrastructure. However, very little data exits on the impact that these measures have on ecological integrity. For this reason, the project intended to measure the extent to which rehabilitation of a degraded wetland could improve its ability to treat water impacted by mining-related pollutants.

The study entailed a number of assessments over the course of the project period which pointed to a significant improvement in the water quality flowing out of the wetland after rehabilitation. Combined with this, a reduction in toxicity and improvement in the diversity of the biological communities were observed.

From these results it was evident that the rehabilitation measures had a positive impact on the ecological integrity of the wetland system, resulting in improved ecosystem services that significantly reduced the downstream impacts. These rehabilitation efforts promoted integrated water resource management principles of coordinated development and management of water resources to maximize economic and social benefit, whilst contributing to the sustainability of vital ecosystems.

While the initial results are promising, further work remains to be done in monitoring the condition and performance of the wetland in the longer term. It is unclear, for example, whether the water purification function will improve as the wetland adjusts to its new post-rehabilitation state.

It will also be important to determine the thresholds at which pollution loads will start to have a serious impact on the sustainable functioning of the wetland. However, building on the firm foundation created during this study, a new three-year Coaltech funded project has been initiated to focus on these key elements.

This will provide useful information with regard to the assimilative capacity of the wetland, as well as an indication of its sustainability in continuing the water treatment function and its value to the mining sector. To our knowledge no such study has investigated this.

Rehabilitation in mining landscapes

The rehabilitation case study conducted during this project was evidence of the benefits of investing in the maintenance and rehabilitation of ecological infrastructure such as wetlands. Wetland rehabilitation can thus be successful if it is well planned and implemented.

Globally, various approaches have been used to rehabilitate wetlands. The introductory guide that has been developed towards wetland rehabilitation in mining landscapes is aimed at being a user-friendly guidance to specialists, mining houses and regulators. The guideline document builds on existing information to provide a consolidated approach towards wetland rehabilitation within the specific constraints and opportunities presented by mining landscapes.

"This project was a unique and excellent example of how government, academia and industry can work together for the greater good."

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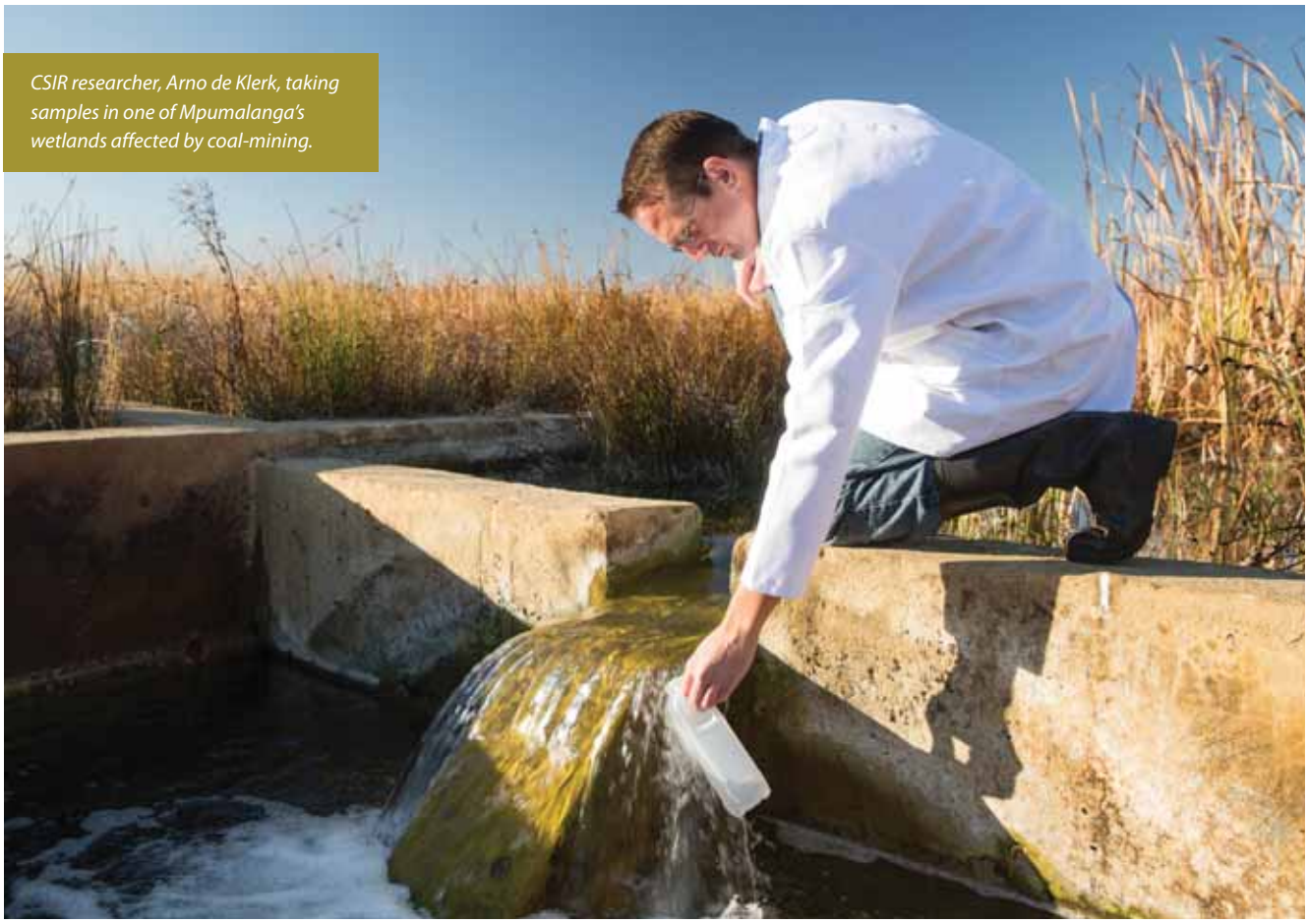

CSIR researcher, Arno de Klerk, taking samples in one of Mpumalanga's wetlands affected by coal-mining.

This document provides users with insights into key principles during the various phases in the mining lifecycle so as to assist in planning and decision-making. Reference checklists, as well as an overview of legal considerations pertaining to wetland rehabilitation have been included to assist users throughout the process of wetland rehabilitation.

SANBI Director: Ecological Infrastructure, John Dinie, Coaltech Director, Henk Lodewijks, Arno de Klerk and Dr Paul Oberholster of the CSIR discussing the improved functioning of the Zaalklap wetland, which was rehabilitated following extensive impact by coal-mining.

The document aims to promote a standardised approach concerning wetland rehabilitation so as to provide a uniform approach with respect to wetland rehabilitation planning, design and implementation in mining landscapes. In this way a range of risks for various stakeholders can be minimised and managed through proper wetland rehabilitation planning and implementation, thus ensuring compliance with environmental legislative provisions and authorisation requirements. Through the use of this guideline wetland rehabilitation activities may have the potential to leave a meaningful and lasting legacy that may, to some extent, compensate for the negative impacts that mining activities have.

High risk wetlands atlas

A key aim of the project was to improve the knowledge and use of appropriate spatial information so that both mining companies and regulators may be better informed during their planning and decision-making processes. A High Risk Wetlands Atlas was developed that identifies key wetland landscapes in the grassland biome of Mpumalanga that are particularly important or irreplaceable in terms of biodiversity, water resource management and other ecosystem services.

Thus, through this atlas we were able to bring together the confusing array of biodiversity data that regulators expect mining houses to consider when they are planning and implementing a mine. This atlas will improve planning and decision-making by providing a single and easily accessible access point to the most appropriate spatial information. This

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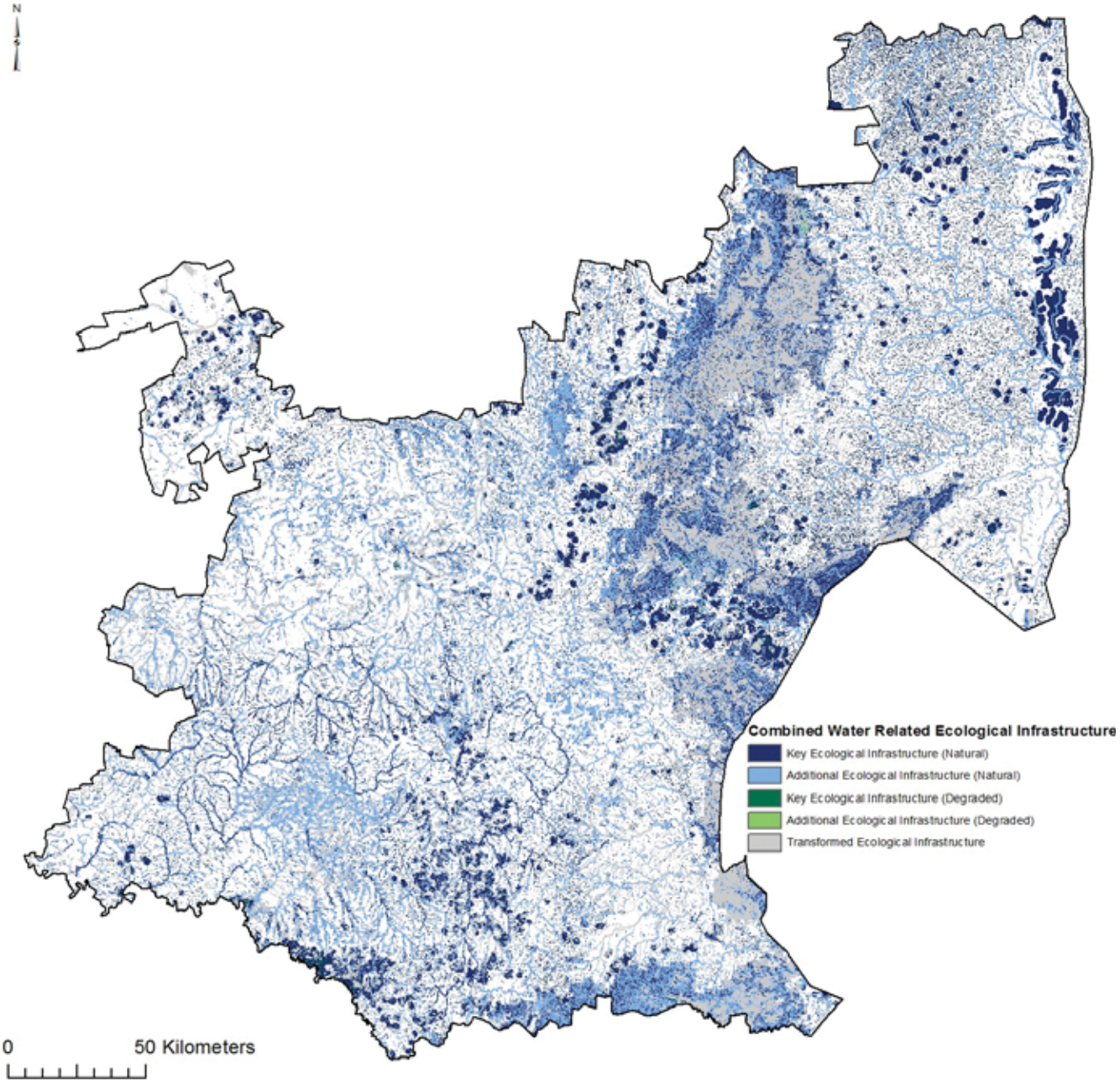
includes data on threatened habitats, special wetland types, threatened species, protected areas, etc. and also includes key spatial data that has recently been developed or revised.
A very important outcome of this work was that we were able to produce new and unique maps of water related ecological infrastructure in Mpumalanga. These maps provide useful information in the following areas, namely:

- Combined ecological infrastructure for water;
- Ecological infrastructure for water production and flow augmentation;
- Ecological infrastructure for flood attenuation;
- Ecological infrastructure for water quality; and
- Ecological infrastructure for erosion control.

In conclusion, this project was a unique and excellent example of how government, academia and industry can work together for the greater good. The products developed during the project will be officially launched at the 2016 conference of the Southern African Society of Aquatic Scientists (SASAqs), to be held in the Kruger National Park, in June.



Areas of ecological infrastructure important for water production and streamflow augmentation.

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Water for food

The art of learning – how science is assisting emerging farmers in Limpopo

The National Research Foundation frequently circulates calls for proposals for collaborative projects involving partners from foreign countries, in line with South Africa's bilateral and multilateral agreements. The extent to which these ultimately benefit 'Joe Public' is sometimes difficult to gauge, but one such project has had a potentially life-changing impact for a group of smallholder farmers in Limpopo.

Sue Matthews reports.

All photographs courtesy EAU4Food

It was a call from the European Union's (EU's) 7th Framework Programme for Research and Technological Development (otherwise known as FP7) in 2010 that spawned the EAU4Food project, coordinated by the Alterra Institute at the Wageningen University and Research Centre in the Netherlands. The project's full name, 'European Union and African Union cooperative research to increase food production in irrigated farming systems in Africa', reflects the fact that it was rolled out in five countries on the African continent – South Africa, Mozambique, Ethiopia, Mali and Tunisia.

The South African partner organisations were Stellenbosch University, represented by Dr Willem de Clercq, and the CSIR, represented by Dr Nebo Jovanovic, also based in Stellenbosch. However, the study site was near Giyani in the Letaba Basin, more than 1 600 km away as the crow flies.

The project's main objectives were to design, test and disseminate effective soil and water management strategies, which would allow African farmers to increase food production and achieve sustainable use of irrigation water, conserve soil

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fertility and reduce pollution of freshwater reserves. In doing so, the project would facilitate the development of socially acceptable, environmentally sustainable and economically profitable production systems.

An innovative transdisciplinary research approach was used, actively involving all stakeholders – from farmers and retailers to policy makers, water managers, agricultural officials and NGOs. With assistance from the UK's Overseas Development Institute, learning and practice alliances (LPAs) were set up as stakeholder platforms at national and regional levels, while farmers at local level were invited to community of practice (COPs) groups. A 'photo safari' was arranged to assist farmers in revealing the problems they face.

"While the scientists involved had a clear idea of problems relating to water use and agriculture, we didn't have planned outcomes at the start of the project because we wanted to get buy-in from all the stakeholders in the region, and ensure that the people on the ground had a say in what they wanted us to do," says Dr de Clercq. "So the project was designed in such a way that it focused on solving the farmers' problems."

Four main problem areas were prioritised by the farmers:

- Limited access to markets – lack of information on pricing, lack of packaging materials and facilities, not producing according to market demand and standards
- No equipment – lack of funds to procure irrigation equipment and farm machinery, limited skills and knowledge to operate such equipment
- Heatwaves – no action plan to counter the effect of heatwaves on crops
- Lack of management information – limited knowledge of best cultivars, irrigation volumes, pest control, financial management.

The researchers recognised that some of these problems could be addressed by increasing irrigation efficiency (dubbed 'more crop per drop') as well as economic water productivity ('more cash per splash'). Field trials were therefore initiated at two cooperative farms where the Limpopo Department of Agriculture already had a number of active projects. The trials were conducted over a two-year period by an MSc student from Stellenbosch University's Department of Soil Science, Cou Pienaar, and focused on tomato because this is one of the most important cash crops grown in the area.

Most of the smallholders were using traditional furrow irrigation, so a drip irrigation system was installed, with irrigation scheduled on the basis of soil moisture monitoring, and the results in terms of crop production compared. While the farmers were generally achieving yields of below 5 t/ha, introducing drip irrigation alone increased this to an average 26.5 t/ha. When additional improved management practices were introduced, such as mulching and soil nutrient management, the yield shot up to 120.9 t/ha!

"The farmers receive granular fertiliser from the government, but they didn't know how much to use," says Dr de Clercq. "So we calculated the fertiliser requirement in terms of Coke bottle caps per plant, and showed them a method whereby they use a broomstick to make a hole in the ground close to the tomato plant, empty one cap in the hole and cover it up again. And the same with pesticides – we trained them on the maximum dilutions they should use."

"The farmers also told us about problems caused by the heatwaves the area experiences. They said it gets too hot to go out into the fields, so all the crops die and they have to start all over again, which is a major stumbling block. But now that we've installed drip irrigation, they don't need to go out into the fields to irrigate, they can just turn on a tap. This has saved their crops and provided a huge amount of security in terms of still being able to deliver to their markets."

"Also, since you don't wet the total surface area with drip irrigation, you get less problems with weeds, so they don't need to be in the field every day like they normally were. We also changed the tomato cultivar to a higher yielding one with a better shelf life."

The manager of two Spar supermarkets in Giyani, Peet Snyman, agreed to buy the farmers' produce, with the result that their net financial income increased from an average of R3 754 to R42 486.

It wasn't only the farmers from the two cooperative farms who benefited from the project, because a number of demonstration days were held, with a good turnout of farmers from the region. And since none of the researchers could speak Tsonga, extension officers from the Limpopo Department of Agriculture were trained in the techniques so they could show the farmers what to do. They have, in turn, shared information with other extension officers working in the region, so the knowledge can be more widely applied.

The success of this project has attracted further funding for a public-private partnership project, called InnoGiyani, to promote agribusiness innovation in the area. The Netherlands' Ministry of Foreign Affairs is contributing half of the €6 million budget via its Facility for Sustainable Entrepreneurship and Food Security (FDOV), while the other half has to be generated by the project. The project aims to develop the Manombe Cooperative Trust in Giyani into a sustainable and profitable institution by facilitating the local production of high-quality maize flour, which will be purchased by the SPAR supermarket.

One of its targets is to rehabilitate Giyani's former irrigation scheme. Dr de Clercq explains that the apartheid government

MSc student, Cou Pienaar, explains his research findings at a Farmers Day held during the project.

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The experimental plot for tomato production with fertiliser treatment but no mulch cover.

operated a vast banana production system here as a way of showing that the Gazankulu homeland 'worked', but after financial and technical aid dried up post-1994 it slowly declined until 2006, when most activity came to a halt.

Some 800 ha of the 1 500 ha of land will now be used to cultivate more water-efficient maize, and a defunct maize mill in Giyani will be refurbished to process the crop. Profits will be re-invested to support the cooperative, tailor-made training and capacity-building will be provided, and an innovation hub will be established to help identify new business opportunities.

"Everything is in place for the project, and we are busy repairing some of the water supply lines and so on, but as a result of the drought we decided not to start as yet," says Dr De Clercq. "We don't want to make use of the water that was allocated to us for irrigation while the rest of the community doesn't have water for their livestock."

He explains that water shortages will be alleviated to some extent once the Department of Water and Sanitation's Nandoni Pipeline Project, which will transfer water from the Nandoni Dam on the Luvuvhu River near Thohoyandau to the Nsami Dam just north of Giyani, is completed.

As part of the EAU4Food project, hydrological modelling was conducted to get a better understanding of water availability in the catchment, and how this might be affected if the smallholder farmers increased their crop production. The SWAT (Soil and Water Assessment Tool) model was initially applied for the entire Limpopo catchment to study the effect of irrigation and fertiliser application on crop yields and hydrology. The results indicated that crop yields increase when both irrigation and fertiliser operations are applied, but so does plant transpiration, causing increased evapotranspiration and hence decreased river flows.

Subsequently, SIMGRO (Simulation of Groundwater and surface water levels) was applied at the subcatchment scale, for the Letaba basin. The model simulates regional transient saturated groundwater flow, unsaturated flow, actual evapotranspiration, sprinkler irrigation, stream flow, and groundwater and surface water levels as a response to rainfall, reference evapotranspiration and groundwater abstraction.

Irrigation is known to account for more than 50% of total water demand in the basin, but most of this is by large-scale commercial farms. They use surface water from the major dams – there are 22 in the basin – while smallholder farmers use mainly groundwater, unless they are located next to a stream. The modelling results showed that, as for the SWAT findings, applying more water and/or nutrients on smallholder farms increases water use by crops. However, since the area occupied by smallholder farming makes up only 0.5% of the basin, even increasing the area by 50% or changing to crops with a larger evapotranspiration would have a very small influence on river flows.

"One of the reasons we did these modelling studies was to make sure we understand the system, so that when we start the InnoGiyani project we will not affect the water supply to the Kruger National Park downstream, nor the water quality," says Dr De Clercq. "And we're now quite certain that we know how to manage irrigation in such a way that we don't negatively influence the water pathways."

Smallholder farmers attend a demonstration day.

The farmers participated in a 'photo safari' to document the challenges they experience.

Mulching did not have a significant effect on yield or water productivity, but resulted in less surface evaporation from the soil, ensuring more sustainable use of water resources when combined with better irrigation management.

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Drought

The Lowveld's worst drought in 33 years? Understanding the long-term impacts

The South African Lowveld tends to experience drought in cycles every few years, with the latest dry spell being one of the worst. Dr Tony Swemmer of the South African Environmental Observation Network (SAEON) sheds some light on what this means for the region in the longer term.

Cattle that have died of starvation are becoming a common sight in the rural areas of the Lowveld.

All photographs courtesy SAEON

As severe drought unfolds across most parts of the country, reports on its impacts on urban and agricultural systems are regularly making their way into the mainstream media… rural villages without water, maize fields bare and unplanted, images of dead livestock…

Impacts to natural areas – from protected areas to rural rangelands – have not received as much attention. But in these areas the long-term impact of the drought may turn out to have equally important repercussions for both people and nature in rural areas.

The Lowveld region of South Africa is currently experiencing as severe a drought as any other part of the country, and provides a microcosm for recording and researching the impacts of the drought in many parts of southern Africa.

Climatological data for Phalaborwa provides an example of the severity of the current drought. The 2014-15 rainfall year was one of the driest on record, with just 255 mm of rain recorded compared to the long-term average of 533 mm. So far, the 2015-16 summer is turning out to be even drier, with all months except one receiving below-average rainfall. Over the past 12

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months, only two have received average or above-average rainfall.

Two consecutive years of such low rainfall is extremely rare in the highly erratic rainfall history of Phalaborwa. The last time this occurred was in the severe drought of 1982 to 1984. The combined rainfall for those two years was 602 mm, while the current two-year total is just 404 mm.

Given that the long-range forecasts are for continued below-average rainfall for the next few months, it is unlikely that the current two-year total will catch up to the 662 mm of 1982-1984, meaning that this drought will go down as the most severe in Phalaborwa since record keeping began in 1954.

Extreme heat is also contributing to the severity of the drought this year, with an unusually large number of very hot days that result in greater evaporation of the little rain that has fallen. Figure 2 shows the number of days that maximum temperatures have exceeded 40 °C for each summer since 1960-61. This summer (red bar) still has a few months to go, but eleven 40+ °C days have already been recorded, far more than any summer in the past.

Impact on vegetation

The most obvious impact of the drought in and around Phalaborwa, so far, is the pitiful grass production in both protected areas and rural rangeland. Normally by this time of the year, grasses are reaching their maximum sizes and consist of tufts of bright green foliage.

Currently, throughout the Lowveld, most grasses, such as Themeda triandra, have no or few green leaves and many may have already died. The re-establishment of large, productive tufts of grasses such as these will take many years, resulting in increased soil erosion, altered water and nutrient cycles, and reduced forage for grazing herbivores for many years after the drought ends.

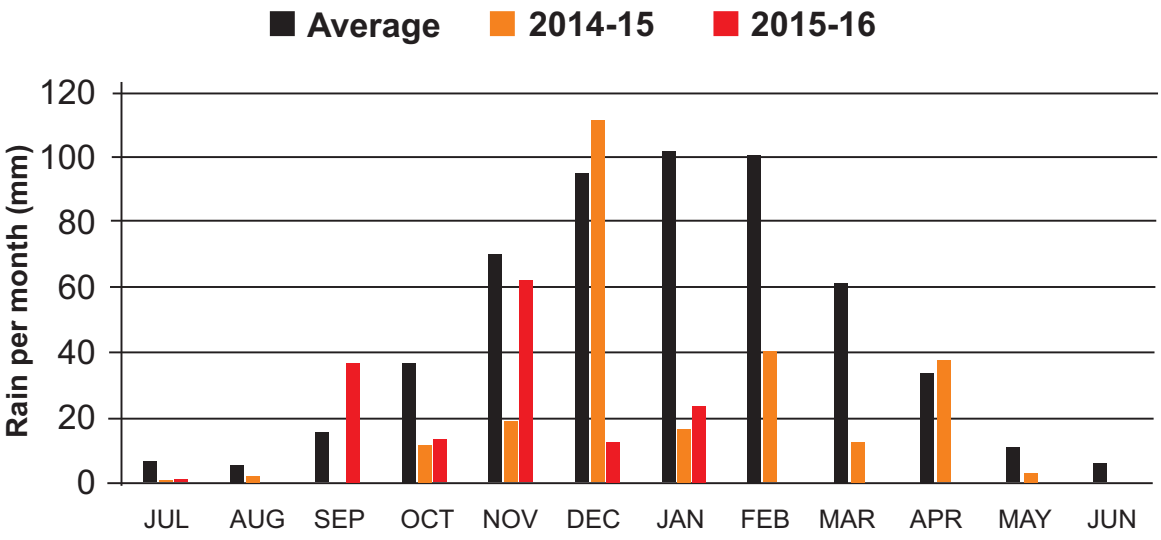

Figure 1 – Rainfall patterns for Phalaborwa for the years 2014/15 and 2015/16.

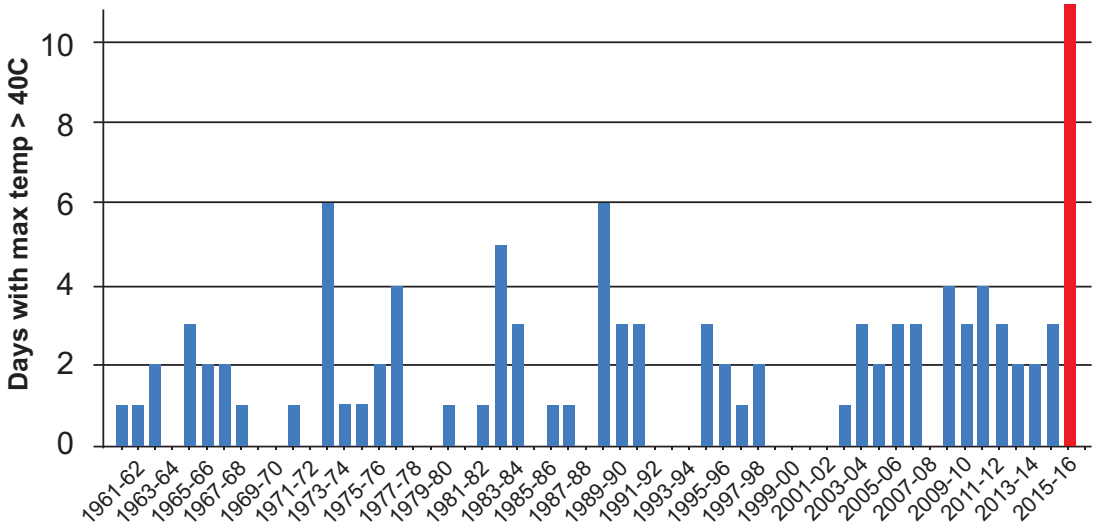

Figure 2. Number of days that maximum temperatures have exceeded 40 oC.

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Herbivore mortalities

The inevitable impact of reduced grass growth is the death of grazing herbivores, such as cattle in rural rangelands and many of the large species of antelope in protected areas. Cattle that have died of starvation are now becoming a common sight in many rural areas in the central Lowveld, with reports of thousands of animals already lost in the Giyani area.

Cattle have been maintained at high numbers in the region for many years, due to good rains in the first part of the millennium, a multitude of dams and the increasing tendency of cattle owners to buy feed for their cattle in the winter.

However, this year feed was exceptionally expensive and is already in short supply. In addition, many of the dams scattered through the rural rangelands have dried up, and cattle need to be moved to other areas to survive, at great expense to local cattle owners. A dramatic decline in cattle numbers now seems inevitable.

While cattle owners constitute a relatively small part of the rural population, the drought impacts rural livelihoods in other ways. For example, Mopane worms make an important contribution to the diets of thousands of rural households during late December or early January when the adult worms are harvested, dried, sold and eaten. This year, very few worms emerged and most of those that did, perished before reaching their adult size.

This is the first summer that no worms have been recorded on Mopane trees, since surveys began in 2009 at a benchmark site in the Kruger National Park.

The death of wildlife in private game reserves and the Kruger National Park has also begun, with reports of hippo dying in the Kruger Park as the smaller dams and rivers dry up. Other grazing animals which depend on a high quantity or quality of grass, such as buffalo and impala, are already emaciated in numerous parts of the park, and many are likely to perish during the coming winter.

Rivers and freshwater ecosystems

The effects of the drought on the rivers and freshwater ecosystems in the Lowveld are now developing rapidly, with low rainfall in the catchment areas to the west contributing both directly and indirectly to low flows at a time when river flows normally begin to peak (the indirect effects stem from reduced outflows from dams upstream, as dam managers attempt to maintain as much water as possible for the coming dry season).

The Olifants River, the largest of the region, is close to drying up and flow for the month of January was the lowest it has been for at least 18 years. Figure 3 shows the average and minimum monthly flows for the river (in blue), as recorded at Mamba Weir where the river enters the Kruger National Park, as well as the monthly flows for the 2015-2016 rainfall year (in red).

"The death of wildlife in private game reserves and the Kruger National Park has also begun, with reports of hippo dying in the Kruger Park as the smaller dams and rivers dry up."

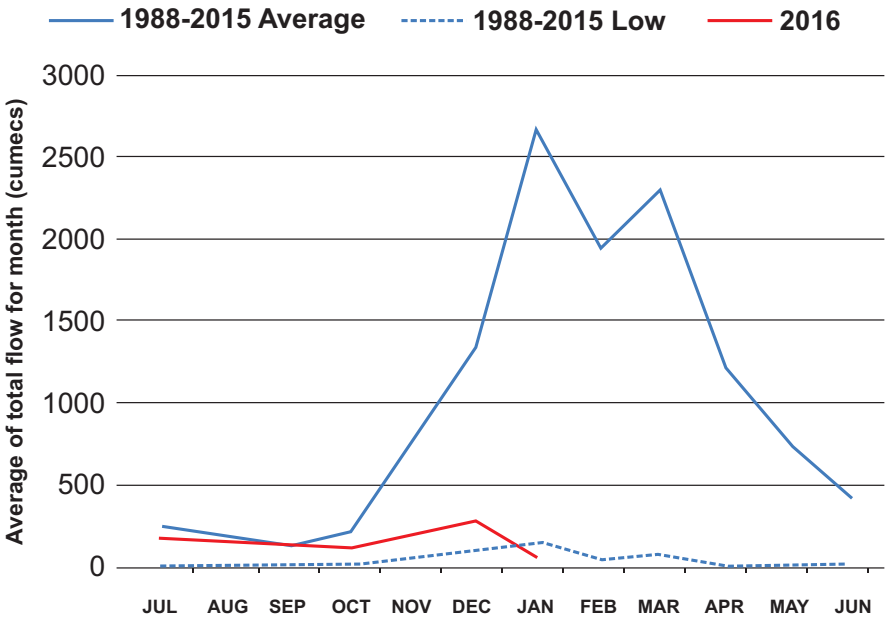

Figure 3. Average and minimum monthly flows for the Olifants River.

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The carcasses of a variety of fish species that died when the Letaba River ceased flowing upstream of the Kruger National Park in early January of this year.

"The long-term impact of the drought may turn out to have equally important repercussions for both people and nature in rural areas."

The Letaba River, another major perennial river of the Lowveld, has run dry within the Kruger National Park. By December 2015 the flow had already reduced to a trickle within the wide expanse of the floodplain of this normally expansive river. Fish deaths are an inevitable consequence of the prolonged low flows experienced.

The positives of droughts

In the field of ecology, theories have been developed as to the positive role of droughts in ecosystems, savannas in particular. Droughts can regulate populations of herbivores, thus preventing overgrazing and degradation of the vegetation in the long term. In addition, severe droughts may kill off many trees in savannas, thus helping to maintain a favourable balance between trees and grasses.

Few mopane worms have emerged this year due to the drought.

The widespread death of trees and shrubs such as Mopane trees seems tragic, but is actually a positive effect of the drought, counteracting decades of bush encroachment throughout the region, and promoting the re-establishment of a vigorous grass layer.

Due to the rarity of droughts that are severe enough to have such impacts, there is little data to test these ideas. SAEON is now well positioned to document the impacts of a severe drought and provide the type of data needed to understand the long-term role of climate - and climate change - in controlling natural and semi-natural ecosystems.

This article originally appeared in the February 2016 newsletter of SAEON. Visit. www.saeon.ac.za

Large sections of vegetation, such as these tufts of Themeda triandra in the Kruger National Park, have died off due to the drought conditions.

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Water services

Corruption costing global water sector billions

Water supply of Afghan refugees in Western Pakistan is compromised by uncontrolled diverting of water from surrounding host villages, who have no access to save drinking water.

WIN/Joost Butenop

While 32% of the world's population still lacks access to safe water, development efforts are being stifled by corruption and maladministration, with as much as 10% of water sector investment being lost. This is according to a new report by the Water Integrity Network (WIN).

The publication, *Water Integrity Global Outlook 2016,* reports that grand corruption cases plague the water sector worldwide. This while some 663 million people lack access to improved drinking water sources globally. This contributes to 1.6 million deaths annually, most of whom are children under the age of five.

The publication cites several cases where corruption robbed people of services. In 2015, an audit of the €70 million phase II national water programme in Benin, which included €50 million from the Netherlands and €20 million from the European Union, unveiled that €4 million had vanished from the Benin Ministry of Water. Dutch development cooperation with the government of Benin was suspended thereafter to safeguard additional funds from misuse.

In 2013, Malawi's reformed public financial management system was misused to divert US$5 million in public funds to the private accounts of officials.

A lack of transparency, accountability, and participation in water service delivery has also contributed to costly inefficiencies and failures in the West. In the United States, residents of Flint, Michigan, are reeling from recent revelations of high levels of lead contamination in the city's water supply, blamed largely on inaction by the Michigan Department of Environmental Quality, the state agency responsible for ensuring safe drinking water. According to a report by *the Guardian*, the resulting class action lawsuits from Flint residents may cost the state upwards of *US$1* billion in damages.

The WIN report documents cases like these, revealing corruption's costly impact on the world's water resources. It also shows the degree to which poor water governance negatively affects the world's most vulnerable populations – specifically women, children and the landless.

Examples are shared of both corruption and good practices from communities, private sector, civil society and governments. The report demonstrates how improved governance as well as integrity and anti-corruption measures can win back an estimated US$75 billion for global investment in water services and infrastructure annually.

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"The examples such as the Benin case, the Belo Monte Dam in Brazil, and Flint show that outright corruption or the lack of transparency, accountability and participation are enormous obstacles to achieving human rights and the sustainable development goals," noted WIN Executive Director, Frank van der Valk.

More than money

In many countries, public criticism of officials can lead to fines and imprisonment. In other cases, whistleblowers and activists who have sought to reveal cases of corruption have faced intimidation and violence.

Pedro Caché, an independent Mexican journalist, was jailed for ten months and charged with sabotage for filming a demonstration outside the state water commission in August 2014. After Caché's release in May last year, Mexican media reported that allegations of his torture were being investigated the Comisión Ejecutiva de Atención a Víctimas, the federal agency responsible for victims and civil society organisations.

In March in Honduras, Berta Caceres and Nelson Garcia of the indigenous and environmental rights group COPINH were gunned down by unknown assailants in two separate incidents. Both are believed to have been assassinated in retaliation for their campaign against the Agua Zarca project. This is not unlike the murder of anti-mining activist, Sikhosiphi Rhadebe, who led protests against mining in Xolobeni on the Wild Coast in South Africa.

Unsurprising then that the WIN report specifically lists whistleblower protection as a vital element of public accountability and anti-corruption success.

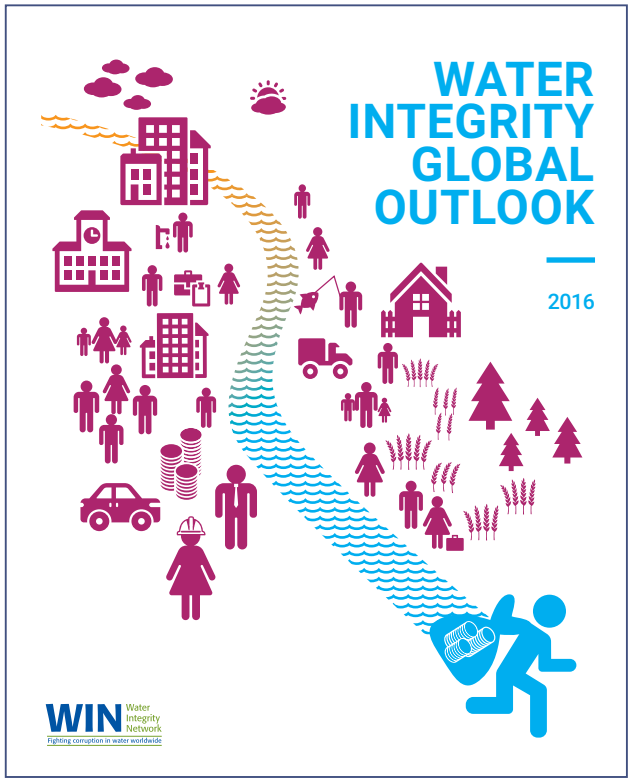
New roads ahead

Demand for water is increasing worldwide. Petty corruption and grand corruption together are threats to water governance internationally and to efforts to meet water service needs and improve water sector performance. The report is a call to action for integrity for all players – governments, private companies, civil society groups, and individual citizens worldwide. It therefore highlights and draws lessons from those examples of where governments, companies, and community groups have won gains for water consumers and environmental protection.

"The examples such as the Benin case, the Belo Monte Dam in Brazil, and Flint show that outright corruption or the lack of transparency, accountability and participation are enormous obstacles to achieving human rights and the sustainable development goals,"

In Indonesia, the Jasa Tirta I Public Corporation, a state-owned but legally independent river basin organisation, became a model for anti-corruption initiatives by adopting international financial accounting standards, quality management systems, and integrity tools for employees.

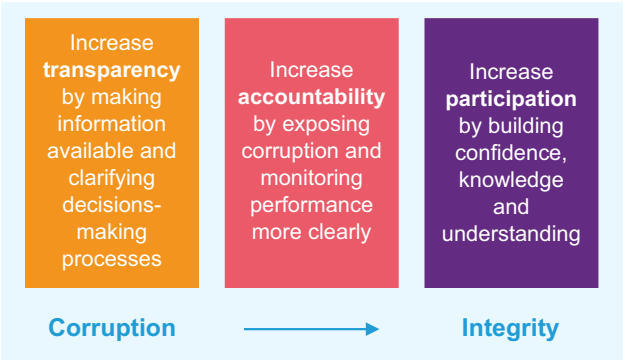
In Sierra Leone, the Guama Valley Water Company's tough anti-corruption reforms brought almost all illegal tampering of customer billing to an end. By 2015, gains in company revenue were enough to cover operations and maintenance.



The Water Integrity Global Outlook 2016 focuses on addressing corruption in the global water sector.

"The report proposes to build 'integrity walls' from building blocks of transparency, accountability, participation and anti-corruption measures," said Van der Valk. "Urgent action by all stakeholders is required to stop the ongoing waste of resources."

To download the full report, Visit www.waterintegritynetwork.net



Strategies and approaches for enhancing integrity in the water sector.

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Water utilities

Digital security: How safe are our water utilities?

Reports of cyber threats against utilities are on the increase. But what do the threats consist of, and how worried should we be?

Article by Görrel Espelund.

In recent years, cyber-attacks against critical infrastructure, such as water utilities, have been on the increase globally. However, growing awareness doesn't necessarily translate into the implementation of better security protocols and safer systems. And, in the developing world, water distributors also face a range of other challenges to maintaining safe water distribution.

When discussing cyber crimes, focus is often on security breaches in the private sector, especially retail and banking. But according to several studies conducted in the last few years, cyber attacks on vital infrastructure such as electrical grids and water distribution systems have escalated.

In a blog in *The Huffington Post Business*, Michael Deane, Executive Director of the National Association of Water Companies in the US explains how the evolution of computer-based management systems has, on the one hand, improved the reliability and quality of water services, but on the other has increased the possibility of targeted or accidental cyber events that could lead to disruption in the water supply.

He concludes: "In the drinking water and wastewater sectors, a cyber attack could hone in on four different threat vectors: chemical contamination, biological contamination, physical disruption and interference with the highly specialised computer systems controlling essential infrastructure known as Supervisory Control and Data Acquisition (SCADA) systems. A successful attack resulting in consequences in any of these areas could cause major damage, resulting in long periods of operational downtime, financial losses and most importantly, a threat to public safety."

According to Deane, the awareness of possible cyber attacks is steadily growing. Since 2013, November has been designated as "Critical Infrastructure Security and Resilience Month" with the aim of recognising the importance of protecting critical infrastructure in the US.

Even so, last year the US Department of Homeland Security received 159 reports involving "vulnerabilities in control systems components". Most of the vulnerabilities involved systems used in the energy sector, but water utilities and wastewater are also considered at high risk of cyber attacks, according to Water Online.

But cyber attack on vital infrastructure is not a phenomenon occurring in the US alone.

The Ponemon Institute, a research centre that specialises in data protection and information security policy, released a study in 2014 in which two thirds of 599 IT security executives in 13 different countries admitted to having had "at least one security compromise that led to the loss of confidential information or disruption of operations" in the previous year.

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However, there is a large discrepancy between being aware of the risk and protecting the systems from it.

Dr Renier van Heerden, Principal Engineer and Researcher at the CSIR points out that because the risk of cyber attacks on a country's infrastructure is still considered fairly low, companies have yet to take the threat seriously enough to start investing in safer systems.

"Companies' main concern is uptime, to keep the systems running without disruption. To achieve this, they'd like robust and dependable systems. Unfortunately that runs contrary to security," he says.

The reason behind this is simple: if you add a layer of security to systems such as SCADA, used to control dams, power plants and water treatment facilities, it increases the risk of small configuration faults – which, in turn, can cause major problems or lead to down-time.

Firewalls and encryption, the most commonly used industrial cyber security programmes, are complex systems, and their configurations can be difficult to understand and verify.

"So we find that we have two competing mechanisms. Traditionally, because the world wasn't so interconnected, the openness and the robustness of the systems used to be more important than security. But with the technology changing and the world being more interconnected, security has become more important.

Companies – state-owned or private – look at the history when they make risk analyses. And up to now it hasn't been worth it to invest in that extra security measure. In my opinion, it's a mistake," van Heerden says.

The most infamous cyber attack on physical infrastructure in the world is the Stuxnet malware. It is believed to have been built jointly by the US and Israeli governments to sabotage Iran's nuclear programme in 2007/2008. It then accidently spread in 2010 and became widely known.

Malware such as Stuxnet, BlackEnergy and Havex are specifically designed to target industrial control systems – and attacks on vital industries and infrastructure are frequently reported in various Internet and computer magazines. However, when it comes to the developing world, things look a bit different.

Neil Macleod, former head of eThekwini Water and Sanitation who won the 2014 Stockholm Industry Water Award, points out that no matter how secure you try to make your system, it is only as good as your last password and the integrity of your staff.

"You have to be sure that you have a staff of happy workers and that they comply with the very rigorous security protocols in place. Compared to developed countries the issues are slightly different in the developing world. Richer countries have more computer-based solutions and therefore they are more vulnerable to these kinds of attacks. In developing countries we tend to have teams on every site."

"We do our work with limited computer-based systems, limited remote operations and a lot of on-site operations," says Macleod.

It is only large cities like Cape Town, Johannesburg and Durban that have started to move towards a computer-based management of operations, which also makes them more prone to cyber attacks. But Macleod is not worried.

"People can start hacking into the systems of the big cities and cause interruption to the service for a few hours before we notice what is going on. On the sewage side, there is a possibility that hackers could mess up the dosage [of chemicals] and then the river will be polluted, which is unacceptable, but recoverable. In the case of water purification plants, however, the impact could be more severe in terms of public health in that the water may not be safe to drink if the disinfection or coagulation processes are affected," says Macleod.

"The biggest problem for developing countries, where the level of IT and computer-based technology is pretty low, is not cyber attacks but poverty."

Not even the department is safe

Earlier this year the Department of Water and Sanitation became the victim of a hacking sting. Hackers from the Anonymous collective broke into the official website of the department, breached the site's database, stole all its data and dumped it online. This included real names, emails and identification numbers of over 5 800 employees and collaborators. Even personal details such as phone numbers, addresses and passwords were revealed.

eThekwini Water and Sanitation received the Stockholm Industry Water Award as a recognition of its work to provide, within a few years, 1.3 million people in greater Durban (eThekwini) with piped water and 700 000 people with access to toilets.

"The biggest problem for developing countries, where the level of IT and computer-based technology is pretty low, is not cyber attacks but poverty. Poor people who try to tap into the water utilities illegally do most of the damage caused to our systems. Another big problem causing disruption is theft of the metals, valves or copper cables.

That is a constant scourge that we, and most developing countries, face. The people sell the goods to be able to buy bread, but the value of the metal is many times less than the cost of the repairs," concludes Macleod.

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Water cooperation

Cooperating for the sake of water – the Israel experience

In an exclusive interview with Water Wheel Editor, Lani van Vuuren, Israel ambassador to South Africa, Arthur Lenk, shares his thoughts on the drought in South Africa and what the country can learn from the way in which Israel overcame its inherent water scarcity.

When ambassador Lenk first saw the reports on the widespread drought in South Africa, he felt compelled to act. As a son of Israel he is extremely familiar with issues of water scarcity. With its part-Mediterranean, part-desert climate, the lack of water has been an inherent part of Israel's history from Biblical times. The latest significant drought, which lasted from 1998 to 2012 and stretched over the entire eastern Mediterranean, was reported by the US National Aeronautics and Space Administration (NASA) to be the worst to hit the region in 900 years.

Like many others countries in the world, including South Africa, Israel has seen an increase in the demand for water in recent decades due to economic development and population growth. This left the small country with a dilemma – how to grow water supply when natural resources are so scarce and said to become even scarcer in the face of climate change?

Rather than be defeated by this challenge the country chose to act using the most innovative science and technology at its disposal, focusing its attention on curbing demand and increasing water supply from alternative sources. Today, the country operates a sophisticated water infrastructure where more than 50% of the water used is artificially produced.

The *Huffington Post* calls Israel the "unsung hero of water management". The government – which acts as legal guardian over water – has created such an efficient infrastructure of water supply and conservation that the country can now practically function without rain.

This is the first lesson ambassador Lenk believes South African can learn. "South Africa – like Israel – is constrained by the lack of natural water resources. The secret to success is not only to learn to work within these constraints but to make the pie bigger."

Israel has achieved this in three main ways. Firstly, the country has introduced recycling and reuse of wastewater on a massive scale. Israel has become the world leader in wastewater recycling, reclaiming more than two thirds of the 530 million m^3 of sewage and effluent it produces a year. This water is used mainly for agriculture. Over 55% of water used in agriculture in Israel today is reclaimed. (Compare these figures with the world's second-largest water recycler Spain, which reuses only 17% of its wastewater)

Along with water reuse the government has also introduced desalination. Among the country's five desalination plants, the Sorek plant, located about 15 km south of Tel Aviv, is the largest (this desalination plant is also one of the largest in the world). The plant produces about 624 000 m^3 of potable water a day. Plans are afoot to expand desalination further, and seawater and brackish water is expected to make up a third of the total water supply in Israel by 2020.

Ambassador Lenk admits that energy costs are a current hurdle for South Africa in expanding desalination, but adds, "desalination is becoming cheaper, cleaner and more energy efficient as technologies advance." It is interesting to note that cities such as Durban, which has been particularly hard hit by drought, are already exploring the implementation of desalination.

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By replacing the use of freshwater with reclaimed water and desalinated water, the country has addressed inter-annual and inter-seasonal variability while building resilience to climate change.

Israel's third focus has been on teaching its citizens that water is a scarce resource. The Mediterranean country managed to cut down severely on water demand in the last few years. This is largely the result of intense campaigns to reduce consumption and curb waste. *The New York Times* reports how the Israeli government made huge cuts in the annual water quotas for farmers, and encouraged household water saving by fitting willing households with free water efficient devices (such as aerated showerheads). Water prices have been raised – encouraging everyone to use less – and much has been done to reduce leakage. The hard work paid off – between 2008 and 2011 household water reduced by 20% and remained stable.

Ambassador Lenk believes that South Africans do not yet know the true value of water. "In Israel the value of water is akin to the value of oil." Getting people to value water this much takes more than "just a few adverts in the paper," he says. "Rather, it will take a concerted effort by all entities involved to instil in people how important water is to life and that it must be conserved at all cost."

This also means addressing the South Africa's unaccounted-for-water rate of 37%. How can people value water if they see their municipality letting millions of litres just flow down the street?

In the Middle East, successful management of water impacts directly on peace. Ambassador Lenk cites the example of the memorandum of understanding Israel signed with the Palestinian Authority and Jordan in 2013 on water sharing in the region. Part of the agreement is increasing water sales from Israel to the Palestinians. Ambassador Lenk notes that Israel annually supplied the Palestinian Authority with over 20 billion litres of water beyond requirements of agreements between the sides (nearly 52 billion litres in total), giving the Palestinians access to over 248 million m^3 annually.

By replacing the use of freshwater with reclaimed water and desalinated water, the country has addressed inter-annual and inter-seasonal variability while building resilience to climate change.

"Israel and Jordan have also reached an agreement to share water to be produced by a planned desalination plant in Aqaba, from which salty brines will be piped to our shared Dead Sea. In return for its portion of the desalinated water, Israel will double its sale of Sea of Galilee water to Jordan on the countries' north border," the ambassador explains.

The ambassador feels so strongly about addressing issues of drought in South Africa that he has cancelled national day celebrations at the Israeli embassy and instead is using the budget to host three water management seminars in South Africa, to be hosted in Johannesburg on 6 June, in Cape Town in 8 June, and in Durban on 9 June. The aim is for water experts from both Israel and South Africa to exchange intellectual capital.

The embassy has invited Israel's top water experts from government and academia, along with representatives from 15 leading Israeli water tech companies. The 'Israel water week' follows an agreement reached with the South African Department of International Relations and Cooperation that these events will form part of official bilateral cooperation It is the hope that this will be the start of a road to water cooperation between the two countries.

South Africa is already familiar with some of Israel's water companies. One of these is Netafim, a pioneering firm in drip irrigation. The world's largest irrigation company, the firm won the 2013 Stockholm Industry Water Award for the pioneering of drip and micro-irrigation.

Netafim was established in 1965 to respond to a lack of water in Israel – particularly the Negev desert. Today, over 10 million hectares of farmland are irrigated with drip irrigation. Drip irrigation helps growers worldwide increase their yields while minimising utilisation of water, energy and arable land.

Netafim's global presence enables the company to make a significant impact on water usage by growers throughout the world. The company operates 16 manufacturing plants – including one in South Africa – and serves an ever-increasing number of growers in over 100 countries.

The Israel experience has shown that there is no quick fix to water security. "It is only by elevating the water question to that of a national issue of importance that solutions can be found," concludes ambassador Lenk.

To participate in the Israel water week events register via the website, http://israelwater.co.za

The Sorek desalination plant, 15 km south of Tel Aviv, is the largest in Israel.

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New Masters programme to fulfil ideals of National Water Act

A new Masters programme, focusing on developing the skills required for the implementation of the National Water Act, has been launched by the Water Research Commission (WRC), together with the Department of Water and Sanitation (DWS).

According to Margaret-Ann Diedricks: DG of Water and Sanitation, the Masters programme was finalised after evaluating the education and training needs of the DWS and that of other government departments, non-governmental organisations and the private sector. The assessment took into account various imperatives, including South Africa being a country in transition, its affirmative action policy, staff and career development concerns, capacity building required for achieving sustainable development and the need to link and interact with efforts by Southern Africa and the international community.

While South Africa has been hailed internationally for the progressiveness of its water legislation, implementation of concepts such as the Reserve has been hampered by a lack of necessary skills in the sector. The new course, which has already been implemented by North West University, aims to provide training at a professional scientific level that qualifies candidates on a nationally and internationally recognised level to achieve a holistic understanding of the processes, functions and components of inland and estuarine aquatic ecosystems for management purposes.

The Masters programme comprises ten modules, which can also be presented as a series of short courses. These include, among others, an introduction to environmental water requirements; resource economics in integrated water resource management; surface and groundwater hydrology; hydraulics and hydrodynamics; fluvial geomorphology; aquatic ecology, and implementation and management options for water supply.

Diedricks encouraged other universities to start engaging with the programme, and adapt it according to their curriculum architecture.

To access the Masters curriculum (*WRC Report No. TT 653/15*), visit the WRC website, www.wrc.org.za to download a free copy or contact Publications at Tel: (012) 330-0340; Email: orders@wrc.org.za to order a hard copy.

Department of Water and Sanitation DG, Margaret-Ann Diedricks, and Water Research Commission Group Executive, Stanley Liphadzi, with the new Masters curriculum.

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Southern African Society of Aquatic Scientists

SASAQS 2016
26-30 June 2016
Skukuza, Kruger National Park

Dear SASAQS Delegates

Our 2016 congress will be hosted by North West University's Research Unit for Environmental Sciences and Management in the Kruger National Park from 26-30 June 2016.

A panel of international acclaimed researchers will act as keynote speakers with our theme: Aquatic Research, Management and Conservation in a rapid changing world!

This is in the high season school holiday period and therefore we would like to make a special request with you that all registration and accommodation fees will have to be paid by the 1st of March 2016 in order for us to keep the reservation.

We know there are challenges with some of the Academic Institutions and Government Departments and would like to accommodate all of you as far as possible but we will require prepayment as the Society have to pay that over to Sanparks and cannot take the financial risk. The recommendation is that you all make provision for an advance in order to settle your registration and accommodation fees in time. Please note that accommodation cannot be guaranteed in Skukuza.

Please note that purchase orders should also be processed and paid by the 1st of March 2016 to secure your booking, please check the procedure with your financial department to adhere within the timelines. Quotes, Invoices and Statements are available on the online registration system.

- **We can only take reservations for the congress date. (26 June - 30 June) Any pre or post congress bookings should be made directly with Sanparks. www.sanparks.org.**

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Email: petrie@savetcon.co.za
Mrs Erna Klopper - Accommodation Bookings
Email: admin@savetcon.co.za

Abstract deadline: 29 April 2016
Submit abstracts electronically at http://savetcon.conference-services.net/directory.asp

DEEPLY ROOTED IN SOUTH AFRICA WATER SOCIETY

www.wrc.org.za

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

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

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

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THE POWER OF KNOWLEDGE TO THE PEOPLE