THE
WATERWHEEL

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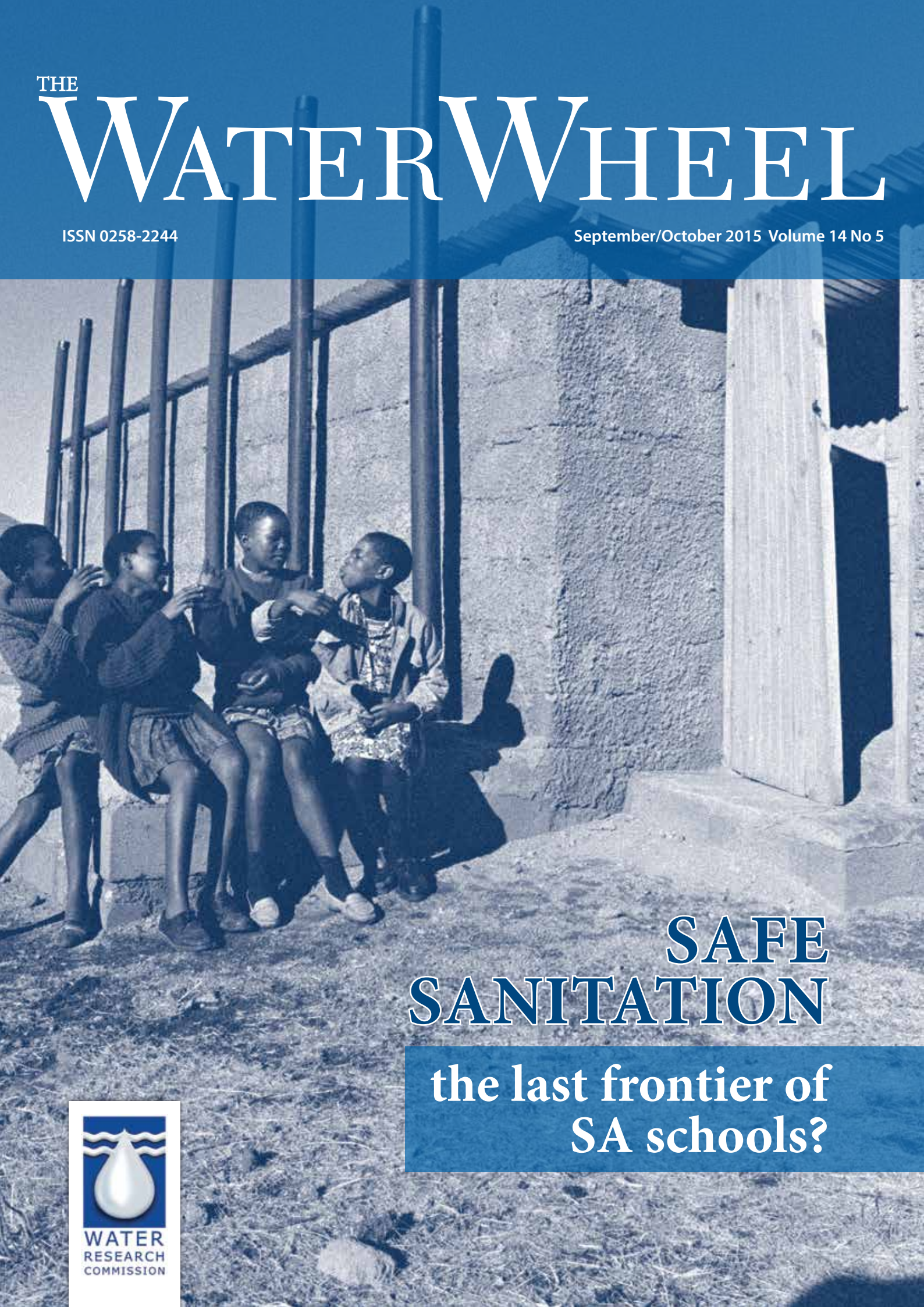

SAFE SANITATION

the last frontier of SA schools?

WATER RESEARCH COMMISSION

GROUND WATER DIVISION

Groundwater: FROM THEORY to Action

14th Biennial Ground Water Division Conference and Exhibition

Conference and Exhibition Groundwater: From Theory to Action
21 - 23 September 2015, Muldersdrift, Gauteng, South Africa

The Ground Water Division of the Geological Society of South Africa is excited to invite Water Wheel readers to its 14th Biennial Conference that will be hosted in Muldersdrift, Gauteng this year. Building on past conferences, this conference aims to highlight the issue of improving the uptake of existing knowledge and experiences to assist in solving environmental and societal problems.

PRE- CONFERENCE WORKSHOPS

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Workshop 2: Aquifer Sustainability
Attend one for R1000 or both for R1700 (incl. vat)

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KEY THEMES

In order to structure discussions on the conference theme, From Theory to Action, certain topics have been identified:

- Groundwater and Water-Energy-Food security
- Groundwater in a Green Economy
- Groundwater and Mining
- Groundwater and Service Delivery
- Groundwater and the Environment
- Monitoring, Data and Information Management
- Resource Economics
- Groundwater Governance
- Knowledge Gaps and Innovations

- *Special sessions on the National Groundwater Strategy and National Groundwater Monitoring Network*

CONTACT FOR MORE INFO:

For more information and updates visit www.gwd.org.za or write to info@gwd.org.za

We are really looking forward to seeing you in Muldersdrift!

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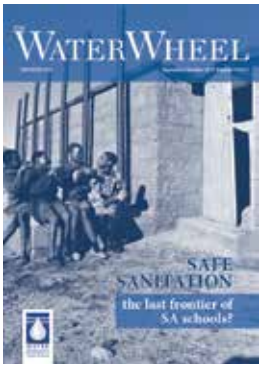


Cover: *A Water Research Commission study is investigating ways to improve the sanitation situation in South African schools. Read the article on page 12. Cover photograph by Guy Stubbs/Africa Media Online.*

WRC CEO, Dhesigen Naidoo

Fluid Thoughts

Investing in the Girl Child – our hope for the future

One of the highlights of the Water and Youth Summit 2015, held in Boksburg earlier this year, was the Schools Water Science competition.

Two shy but confident girls, Kasungasunge Esnath and Thameng Lebogang, from Ennis Thabong School, emerged as the Gold Medal winners. They did excellent scientific work using the Water Research Commission/Ground Truth mini-SASS science kit for evaluating river health and analysed the quality status of their local river, the Swartspruit.

They then went even further and invited the Mayor, as well as the North West Province portfolio committee on water matters, to their school to a discuss the results and the implications for the area's ecological as well as human health. This has resulted in the beginnings of a community-driven effort to clean up the river and improve the status of water in the area.

This story in itself, where a poorly resourced school has supported its learners to win a national science competition, is quite remarkable. It is an accolade to the brave leadership of these very young girl scientists and a tribute to the youth. What makes this even more significant is that these young people come from the Bojanala District in Madibeng, not far from Bloemhof.

Who can forget those spine chilling images of Nomvula Mokoyane in one of her first public engagements as Minister of Water and Sanitation, consoling the mothers who had lost their babies due to exposure to contaminated water. Out of these ashes, from a place that has become in recent times a poster child of the ultimate price to be paid for poor water quality, we now have such promise in the form of these young learners, who together with their teachers have expressed a youth leadership that can only bode well for tomorrow's water security in South Africa. This supreme expression of goodness borne out of adversity is particularly encouraging in that this effort is being led by the girl-child.

The dimensions of discrimination globally dictates that, over and above the racial and gender divides, urban folk are largely better off than their rural counterparts. In addition, the marginalisation of the youth has become increasingly stark world-wide. In effect, the Black, rural girl-child stands at the pinnacle of the most dismal scenarios in the context of the global economic contraction. This also means, on a more positive note, that even the most meagre of interventions to improve the lot of the girl-child can result in a significant upward shift for whole communities and societies.

The World Bank has popularised the concept of the Girl Effect Dividend. Various studies around the world, including South Africa, indicate that the relatively simple measure of investing in girls to the extent that they are able to complete the next level of education, compared to what they are currently able to, would lead to a lifetime earning of today's girl cohort of the equivalent of 68% of annual GDP.

It is estimated that women's incomes increase by 10-20% for each additional year of schooling. Mark Parker, CEO of Nike, endorses this investment adding that…"with targeted investments linked to market demand, adolescent girls will reverse the cycles of poverty with a huge impact on the global economy. The World Bank report *Girls education: designing for success"* talks to the incredible knock-on effects. The analysis indicates that each additional year of education also reduces child mortality by 18/1 000 live births among other markers.

At a broader level, Africa is the continent with the youngest demographic in the world. More than 60% of people in Africa can be classified as youth according to the latest figures from the UN. Of the billion people that were in Africa in 2010, 411 million were 14 years of age or younger.

A further 200 m were between 15 and 24. The African Development Bank says that only 25% of men and, more alarmingly, 10% of women will be working in the formal economy by the time they are 30. The general texture of the dialogue around these statistics is one of burden with talk of higher investments in measures to reduce the African population.

This is quite interesting when considering that the dominant lament in Western Europe, Japan and even China is the economic risk associated with aging populations and very low birth rates. The important question is whether or not we are missing the opportunity of this young African population.

The Black, rural girl-child stands at the pinnacle of the most dismal scenarios in the context of the global economic contraction.

With the right innovative strategy and purposeful and rapid implementation, Africa is poised to realise the largest Demographic Dividend in human history. This is particularly significant in the wake of the declaration of African leaders at the August 2015 SADC Summit that is investing the region's future prosperity through a programme for the rapid industrialisation of Southern Africa. Core to this plan has to be the rapid and sustained development of the youth of the region through education, skills development, training and entrepreneurship development. And the quickest route to success is to ensure a special focus on the girl-child.

It is imperative that we expand our efforts as individual citizens and corporates, to use all our spheres of influence to maximise our investments in improving the lot of women and girls in our country and our region.

It is the shortest route to realising the Demographic Dividend in a sustainable manner. It will also have the important knock-on effect of empowering the youth in general to become full participants in and direct beneficiaries of the economy.

Winners of the mini-SASS Ecoschool challenge, Kasungasunge Esnath and Thameng Lebogang from Ennis Thabong Primary School.

Our ability to enable the next generation to write a much more encouraging story about the girl-child in Africa - depends on what we do today!

Letter

In reference to the Fluid Thoughts column by the WRC CEO titled 'The Cuban engineer conundrum' (*The Water Wheel* July/August 2015) I would like to comment as follows. I must say for a research commission CEO he is treading on rather difficult ground here, and is also adeptly mixing engineering with politics.

The situation as described by Mr Naidoo is really not so simplistic as he makes it out to be. I am a civil engineer (water) with more than 30 years' experience working in Tanzania on a project on capacity building in a small water utility! On the same project with me, but in another town is another highly qualified civil engineer from South Africa doing the same.

If I fly back to South Africa from time to time I meet qualified South Africans who cannot get work in South Africa – the latest one a fitter and turner, the other a farmer developing farms in Tanzania for sisal plantations – people who surely are sorely needed back home. There are MANY such cases.

I came across an article by Stephen Mulholland, which appeared in the *Business Times* in 2013, which indicated what has happened in municipalities in South Africa. I have done projects in Mpumalanga in municipalities in 2013 where EVERYTHING is falling apart. Two large water purification plants in one town being run by one UNTRAINED person? The water from the plants not being neutralised because they do not have lime so they send the acidic water into the system which will corrode everything. It is criminal what is being done. There are no technical capabilities left any more. Why? The previous dispensation were hounded out by what Mr Mulholland said.

In my previous career and already senior I was boxed in by appointments above me (twice) of unqualified people being paid a fat salary who barely lasted six months before hopping to another job – the one was a Zimbabwean citizen. The only things they did with aplomb and alacrity was buy new office furniture all in leather and a new Jeep and Mercedes.

I can go on but think the above will suffice. I do not think it an article that has a place in *the Water Wheel* – the CEO of the SAICE, who is much better placed to comment has already done so and in the mouthpiece of the civil engineers as acknowledged by Mr Naidoo?

Johannes Buckle, Tanzania

Conference unpacks issues around water, energy, food

WWF South Africa's annual Living Planet Conference has explored the ways in which three of the most pressing crises currently facing South Africa – energy, water and food – might be addressed and, in the case of the latter two, averted.

Attended by various sector stakeholders, the conference – held in Johannesburg earlier this year – facilitated three panel discussions, one per issue. From the outset, however, speakers and delegates acknowledged that these are not discrete, siloed fields. Instead, they are so heavily inter-related that any attempt at separating them is not only artificial but, more importantly, indicative of a detrimental blindspot.

The proceedings were opened by Deon Nel, conservation director at WWF International, who contextualised these issues on a continental and regional level. He discussed discrepancies and opportunities, indicating that while South Africa has maxed out its water resources, only 7% of the continent's hydropower potential has been tapped.

"The choices that Africa makes in the next five to ten years [in terms of energy, water and food] will lock us into a development pathway far into the future," said Nel. "It is a very critical time in Africa's development."

In the panel discussion on water, speakers unpacked the fundamentals that need to be changed in rethinking water security for South Africa. Conversations explored the mismanagement of wastewater and effluent, and the role currently being played by local municipalities and governmental entities.

Shanaaz Majiet, of the Department of Cooperative Governance and Traditional Affairs, emphasised the need for collaboration between different departments and the introduction of ingenuity. "We need to make innovation our mantra in government," she said, "all of government."

Throughout discussions, the points of intersection between energy, water and food were continually addressed: the ways in which water can contribute to solving the energy crisis, for example, as well as the ways in which the maintenance of food security has inevitable repercussions on energy and water resources.

In his wrap-up, head of WWF-SA's Living Plant Unit, Saliem Fakir, commented: "We don't want to think about the environment in isolation of the economy. We want to think about what is needed by society across all walks of life."

The conference also saw the award of the WWF-SAs annual Living Planet Award, this year won by Andrew Zaloumis, CEO of iSimangaliso Wetland Park. Zaloumis's work has resulted in the economic turnaround of the park, with meaningful empowerment and benefits to local communities, and the introduction of more sustainable conservation practices.

DWS working towards integrated water and sanitation policy

The Department of Water and Sanitation (DWS) has convened with other water sector stakeholders and government departments around the National Sanitation Policy Review.

Delegates attending the meeting agreed on the notion that both water and sanitation policies should be consolidated and linked to create one user-friendly policy framework as the issues surrounding both services are intertwined. Such a link, which is already under construction, will further ensure that the inter-connectedness between the two is more understandable to both communities and individuals.

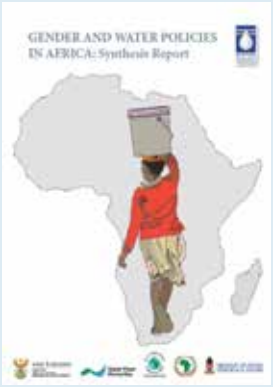
The main purpose of the gathering was to locate the gaps that exist in the current policy in order to augment and strengthen it.

Free basic sanitation, the provision of sanitation services for backyard dwellers and bulk sanitation infrastructure, as well as the establishment and functions of regional sanitation utilities are some of the vital issues that formed part of the caucus around the draft policy.

South Africa's current sanitation policies are transformational and thus focused on addressing sanitation backlogs in the country, with the concepts of reduction, recycling and recovery in the sanitation not entire addressed, the DWS said in a statement.

The new policy will seek to highlight and emphasise the role of sanitation provision in water conservation through the use of appropriate technologies which are environmentally sustainable.

Women still left out of water decision-making in many African countries



Countries across the African continent are endeavouring to make gender a key aspect of water governance and policy implementation with uneven results.

This is one of the conclusions of a new publication, *Gender and water policies in Africa: Synthesis report*, which was launched during World Water Week in Stockholm by the Water Research Commission. The publication was compiled with partners the Department of Water and Sanitation, the Global Water Partnership, African Ministers' Council on Water, and the University of Pretoria.

According to the publication, the incorporation of gender mainstreaming as a cross-cutting policy and implementation process within a cross-sectoral water management area is complex. Commendable progress has been made in gender mainstreaming in the water sector in West, Southern and East Africa, but more needs to be done in this regard in North and Central Africa.

"Harmonisation of the gender machinery with mainstreaming processes across the associated water sectors and through levels of governance scales is key to ensuring the success of gender mainstreaming in the water sector. Political and economic stability are further important prerequisite factors that provide the supportive structural environment for the initiation of and progress in gender mainstreaming in the water sector."

Finally the publication calls for political commitment to find the necessary resources for gender mainstreaming and to work collaboratively with international and regional partners who support gender mainstreaming to ensure that this process is institutionalised across the continent.

SA hot water springs may reveal genetic secrets

Most people visit the Western Cape's hot water springs for health and relaxation, but a recent trip had a more serious scientific purpose: to grow international understanding of complex microbial systems.

Representatives of local and overseas universities visited hot springs and thermal artesian boreholes in areas such as Montagu, Citrusdal and Calitzdorp earlier this year. They were on a metagenomics sampling tour, to study genetic material recovered directly from environmental samples.

"Metagenomics is the genomic (full set of chromosomes) analysis of microorganisms by direct extraction and cloning of DNA from an assemblage of microbes," explained Umvoto Africa technical director, Dr Chris Hartnady, one of the participants. "What strange and novel life-forms may inhabit deep groundwater systems and flow paths in the Table Mountain Group, we still hope to discover."

The overall project goal is to characterise the microbial, geochemical and isotopic properties of thermal spring sources and artesian wells in South Africa. Said Dr Hartnady: "These will be compared with the extensive South African sub-surface dataset derived from the deep mines, to construct a regional picture of the deep continental biosphere."

The trip was sponsored by a grant from the Deep Carbon Observatory in the USA, to the project's main investigator, Prof Memory Tekere of UNISA.

Other participants included Prof Tom Kieft (New Mexico Tech), Prof Esta van Heerden (University of the Free State), Dr Maggie Lau and Rachel Harris (Princeton), Dr Ramganesh Selvarajan (UNISA), Prof Steve Richardson (University of Cape Town) and Umvoto trainee geologist, Michael Hartnady.

The investigators have already collected microbiological, water and gas samples from several sites in the Limpopo and Western Cape provinces.

Now the first step will be describing the composition of the microbial community, then secondly, analysing the geochemical and isotopic compositions of spring source water and groundwater. This will place them in a regional hydrogeological framework.

Thirdly, the hot-spring microbial community composition will be compared with what is already been found from South African deep mines. Finally, the researchers will construct a continental-scale picture of carbon cycling by deep subsurface communities.

Global News

Meat food waste has greater negative environmental impact than vegetable waste

University of Missouri researchers have found that the type of food wasted has a significant impact on the environment.

Although less meat is wasted (on average) compared to fruits and vegetables, the researchers found that significantly more energy is used in the production of meat compared to the production of vegetables. This wasted energy is usually in the form of resources that can have negative impacts on the surrounding environment, such as diesel fuel or fertilizer being released into the environment.

"While many of us are concerned about food waste, we also need to consider the resources that are wasted when we throw away edible food," said Christine Costello, assistant research professor at the College of Agriculture, Food and Natural Resources and co-author of the study.

"Farm equipment used to feed and maintain livestock and plant and harvest crops uses a lot of diesel fuel and other utilities from fossil fuels. When people waste meat, these fuels, as well as fertilizers, are also wasted. Based on our study, we recommend that people and institutions be more conscious of not only the amount but the types of food being wasted."

During the study, pre- and post-consumer food waste was collected from four all-you-care-to-eat dining facilities over three months in 2014. Costello and her research team created a detailed inventory of the specific types of food waste: meat, vegetables or starches. The food waste also was categorised as either edible or inedible (peels and ends of fruits and vegetables).

Once the food waste was categorised, Costello and her research team analysed greenhouse gas (GHG) emissions resulting from fertilizer use, vehicle transportation, and utility use on the farm. GHG emission estimates were measured from cradle (land preparation or animal birth) to farm gate (when the grain or animal was sent to a processing facility). Previous studies have shown that the majority of GHG emissions occur in the production stages prior to the farm products' leaving the farm.

"Based on the findings, we recommend consumers pay special attention to avoiding waste when purchasing and preparing meat; if consumers choose to prepare extra food 'just in case', they should use plant-based foods," said co-author Ronald G. McGarvey, assistant professor at the Harry S Truman School of Public Affairs and Department of Industrial and Manufacturing Systems Engineering.

Grant could bring improved water, sanitation to millions in DRC

The African Water Facility (AWF) of the African Development Bank (AfDB) has announced the approval of a €1.9-million grant in favour of the Government of the Democratic Republic of Congo (DRC) to support the improvement of drinking water and sanitation services in Kinshasa, as well as for the expansion of water supply services towards Kinshasa-West.

The project should benefit over 3.5 million people.

More specifically, this pilot should significantly increase the city's capacity for strategic planning and for investment mobilisation and management to bring forth the effective expansion of Kinshasa's drinking water and sanitation services. The AWF will fund the development of a masterplan for the integrated urban water management in Kinshasha, and a feasibility study on drinking water supply and sanitation services in the western part of the city.

According to the AfDB, the project will be guided by integrated urban water management principles to promote the coordinated management of natural resources and urban water derivatives as a way to maximise social and economic benefits.

"This approach will have the advantage of turning the management of liquid and solid waste into income-generating activities," the bank said in a statement. "Once the project is completed, it is hoped the results and lessons learned from this experience will inspire other cities in the region, which are also looking to develop their drinking water supply and sanitation services."

Irrigation risks spreading invasive pests across Africa

The use of irrigation across sub-Saharan Africa creates conditions that attract devastating foreign plant pests, such as the tomato leaf miner, a Kenyan study has found.

East Africa is at particular risk of infestations from the moth, as temperatures and seasonal rainfall in the region increase due to climate change, the researchers warn. They discovered that the increasingly frequent watering of fields turns more areas into suitable habitats for the destructive insect.

As well as tomatoes, the tomato leaf miner attacks crops such as potatoes, peppers, eggplants (brinjal) and tobacco.

Although native to South America, the pest reached Europe in 2006 and has since spread across the Middle East into Africa.

"In Sudan, one of our project target countries, more than 1 000 ha of tomatoes were destroyed completely due to infestation by this pest," notes Samira Mohamed, an author of the study and a researcher at the International Maize and Wheat Improvement Center in Kenya. "It was estimated that one million tonnes of fruits were destroyed in one year." After the invasion, the price of tomatoes rose tenfold, Mohamed adds.

The study, published in *PLOS One* earlier this year, describes how rainfall in Africa is likely to increase by 10% over the next two decades under the latest climate change predictions, while temperatures are set to rise by 1.5 °C. Coupled with rising irrigation, this will create a warm and moist environment in which crop-eating insects from other tropical countries and continents can thrive.

For example, the climate of the tomato leaf miner's original habitat in South America is similar to the climate developing across large parts of Africa.

The study is the first time irrigation has been included as an indicator for pest spread, the researchers say. Including it gives a more realistic picture of their expected spread, they say.

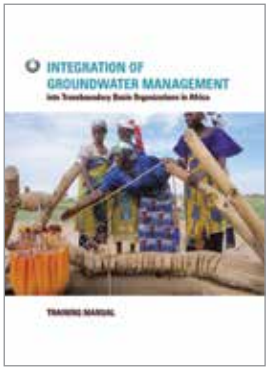
According to Dan Bebber, a biologist at the University of Exeter in the UK, the ability of certain pests to spread to similar environments makes them dangerous for food production.

"Irrigation could trigger changing pest distributions by allowing a host plant to grow where it would not otherwise grow and by producing conditions for the pest or pathogen to grow," he says. "Also, pathogens can be spread around in irrigation water on a small scale."

The Kenyan researchers are now trying to help affected farmers by training them to manage the pest by introducing natural predators.

Source: SciDev.net

New training manual support groundwater management across African borders



For 75% of Africans, groundwater is the main source – and sometimes the only source – of drinking water.

It also has the potential to lift millions of smallholder farmers out of poverty by enabling them to develop irrigation systems that do not depend on unpredictable rainfall. As such, it is expected to play an increasingly important role in development.

By groundwater does not follow national borders: if one country over-pumps, it can negatively affect its neighbour, who also depends on that water source.

While river basin organisations have progressed in managing surface water (such as rivers and lakes) shared across national borders, groundwater is all too often forgotten.

A new training manual hopes to change this. The manual, *Integration of Groundwater Management into Transboundary Basin Organisations* in Africa, is unique because, for the first time, river basin organisations were directly involved in helping assess their own needs and in developing training materials.

The manual focuses on integrating sustainable groundwater management into international policy, improving the technical skills of water managers engaged in national and transboundary water management, and strengthening communication and stakeholder relations across sectors.

In a video interview, manual co-author Karen Villholth of the International Water Mangement Institute (IWMI) says: "It is time for transboundary groundwater issues to be taken seriously… and have commensurate importance to surface water."

Villholth and other IWMI researchers have been collecting satellite data and mapping groundwater in Africa for the last decade. While the continent has significant reserves, the accessibility, quantity and quality of groundwater varies significantly from region to region.

To access the manual, visit: www.agw-net.org/literature.htm

New from the WRC

Report No. 2162/1/14

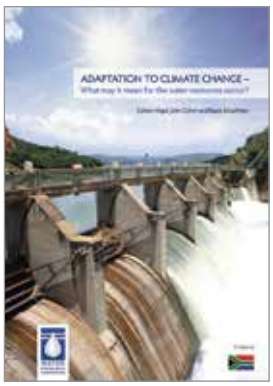
WRF Rainfall Parameterisation and Verification (M Weston & P Kagoda)

The Weather Research and Forecast (WRF) model is a numerical weather prediction model that simulates grid scale saturation and convective rainfall, which is a sub-grid scale process. Several parameterisation schemes are available for each of these processes, which perform with varying degrees of success. Thus, when running a forecast which may cover a large area such as the whole of South Africa that experiences both rainfall types, only a single combination of schemes is applied. This may then favour one rainfall type, such as convective rainfall, to the detriment of non-convective rainfall forecasts. The main aim of this project was to determine the most suitable parameterisation of WRF to represent observed rainfall events in both convective and non-convective rainfall areas in South Africa.

Report No. 1965/1/15

Developing Water Related Climate Change Adaptation Options to Support Implementation of Policy and Strategies for 'Water for Growth and Development' (SI Stuart-Hill & RE Schulze – eds)

The main aim of this WRC project was to develop a framework that reflects an integrative adaptive management approach in order to facilitate strategy development that takes into account vulnerabilities and impacts of climate change in relation to water planning management. Furthermore, the study reflected on the analysis of climate-change related uncertainties and risks in the context of techniques for integrating long-term climate risks into sort- to medium-term development policy decisions and projects.



Report No. TT 630/15

Adaptation to climate change – What may it mean for the water resources sector? (C Vogel; J Colvin and B Scharfetter)

Water managers and water users are used to dealing with change. Anthropogenic climate change, both in its variability from year to year and in terms of change over the longer term, is now an 'additional factor' that they have to contend with. In this short booklet, the authors illustrate some of the thinking and research that has been undertaken both internationally and locally to enable people to better live with climate risks in the water resources sector in South Africa. The booklet is intended for a range of readers, but with a primary focus on those who broker innovation in the water resources sector.

Report No. 2190/1/14

The hatching success of egg banks of selected endorheic wetland (pan) fauna and a suggested water quality classification of pans (A Henri; M Ferreira; W Malherbe; L de Necker; V Wepener & JHJ Vuren)

Pans (endorheic wetlands) are more vulnerable to anthropogenic stress because of their isolated nature and hydrological regime. There are constant fluctuations in the duration and frequency of the inundation period. Small changes in the natural hydrology can have significant impacts on the ecology of these wetlands. The main aims of this research project were to develop methods to assess the hatching success of egg banks in pans; to determine the impact of acid mine drainage (AMD) on the hatching of egg banks; to determine whether pans affected by AMD can still sustain egg banks; to study the applicability of a trophic state based classification system for pans; and to study the applicability of this classification system in selecting reference conditions.

Report No. 2264/1/15

Towards assessing impacts of alien plant infestations on river systems in the Southern Cape using cost-benefit analyses (N Rivers-Moore; H Dallas; J Barendse & F de Moor)

Alien vegetation in the riparian zone can impact on water temperatures, flow patterns, degres of shading, channel modification, and changes to natural sediment loads. This WRC project examines information on the costs of clearing alien riparian vegetation relative to the ecological benefits, as assessed by convergence of water temperatures to target values.

Report No. 2262/1/15

Pollution mapping in freshwater systems: Using aquatic plants to trace N-loading (JM Hill, SN Motitsoe & MP Hill)

The primary aim of this study was to evaluate the potential of sewage plume mapping for the monitoring of water quality in natural systems. Long-term field testing on the New Years-Bushmans River in the Eastern Cape, allowed the mapping of in-situ nitrogen dynamics over a period of 13 months, to assess its applicability for the assessment of ecosystem health, the monitoring of temporal variability in nitrogen loading, and the identification of incipient eutrophication.

Report No. 2105/1/14

Integrated photo-catalytic and anaerobic treatment of industrial wastewater for biogas production (O Aoyi; SO Apollo; J Akach; KY Pete)

Anaerobic treatment of high strength wastewater is a widely accepted practice in the industry to the fact that it converts the organic pollutants into biogas, which is a mixture of methane and carbon dioxide. As a result, this process leads to the reduction in chemical oxygen demand (COD) of industrial wastewater. The aim of this project was to analyse the performance of the anaerobic digester and advanced oxidation process systems separately in degrading high strength wastes and to develop an integrated system to improve biogas production rate and methane yield.

Report No. 2182/1/15

Adaptability and vulnerability of riverine biota to climate change – developing tools for assessing biological effects (H Dallas; N Rivers-Moore; V Ross-Gillespie; P Ramulifho and J-L Reizenberg)

Freshwater ecosystems are among the most vulnerable in the world with respect to global climate change. Southern Africa has been identified as a 'critical region' of water stress. This study focuses on the development of biological temperature thresholds for one ecological component of freshwater ecosystems, the aquatic macroinvertebrates.

Report No. 2070/1/14

Preventing production borehole clogging by in-situ removal of South African aquifer systems (K Robey; G Tredoux and L Chevallier)

The development of groundwater supply schemes is one the increase in South Africa. However, the sustainability of many of these schemes is threatened due to the presence of soluble iron and manganese ions in the groundwater. This risk manifests from the problems caused in the water quality and supply to consumers. Production borehole clogging is of greatest concern in the operation of groundwater supply schemes as it jeopardises their sustainability. This research project investigated the use of *in-situ* iron removal as a possible way to prevent borehole clogging.

Report No. KV 333/15

WRC/DWA framework document for the revision of water quality guidelines: Facilitation of workshops for the risk-based water quality guidelines update (L Boyd, P Moodley, S Jooste)

In 2007, a number of specific issues came to the fore that made it necessary to re-examine the philosophical basis used for determining and using the South African water quality guidelines (SAWQG) published in 1996. Three phases were planned, namely project delineation and development of philosophy (phase 1); application of philosophy and development of prototype guidelines (phase 2) and development of tools for higher-tier site-specific guidelines (phase 3). Unfortunately only the first phase was implemented. The WRC therefore commissioned a short-term research project focused on interactive workshops to get a common understanding of the risk-based guideline theory and to align the approved irrigation water quality guideline project with the future guideline review and update projects.

Report No. 1980/1/14

National wetland vegetation database: Classification and analysis of wetland vegetation types for conservation planning and monitoring (EJJ Sieben; H Mtshali and M Janks)

Wetlands are important ecosystems in the South African context as the country is likely to face a water crisis and only by means of careful planning for water resource management can the government guarantee safe drinking water for all of its citizens. Wetlands provide many different ecosystem services, but they also play an important role as habitats for biodiversity. Plant species occurring in wetlands are useful in terms of their indicator value, as they can help an ecologist to interpret the environmental conditions and changes therein in the wetlands. This project aimed to develop a database with specific species composition data for vascular plants as well as basic environmental information that can be queried and by which wetland communities across the country can be compared in a standardised way.

Report No. KV 339/15

Assessment of groundwater availability from recession flows and instream flow requirements of rivers in South Africa (GY Ebrahim and KG Villhoth)

Groundwater is an important resource of multiple uses in South Africa. However, setting limits to its sustainable abstraction while assuring basic human needs is a must. Due to prevalent data scarcity related to groundwater replenishment, which is the traditional basis for estimating groundwater availability, this report presents a novel method for determining allocatable groundwater in quarternary catchments through information on streamflows.

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Sanitation

The crusade for sufficient school sanitation

A current Water Research Commission (WRC) study is exploring the status of sanitation in rural schools, and reviews best practice for infrastructure design.

Article by Sue Matthews.

All photographs courtesy PID

"Six-year-old Michael Komape drowned in excrement in a pit latrine at his school in Limpopo in January 2014, just a week after he had started his school career."

This is the opening sentence of a WRC report entitled *Exploring the Issues around Rural On-Site School Sanitation in South Africa*, and its shock value is unquestionable. Michael's tragic death came less than two months after the first legally binding norms and standards for school infrastructure were published under the South African Schools Act. These regulations outlawed so-called 'unimproved' pit latrines, but the provincial education departments have been given a three-year grace period to replace them.

Sickening accounts of school toilets are not confined to pit latrines though. Earlier this year, the *Sowetan* ran a front-page article headlined 'School toilets of shame', reporting on the newspaper's three-week investigation of the state of toilets at 25 schools in nine townships in the vicinity of Johannesburg. It described appallingly filthy conditions, with surfaces smeared with faeces and blood, and toilets often blocked and overflowing.

Other news outlets picked up the story after Equal Education, which had marked World Toilet Day on 19 November 2013 by launching its Gauteng Sanitation Campaign, released its findings from a social audit of township schools conducted in March and April. The NGO had been instrumental in getting the infrastructure norms and standards published as regulations, resorting to court action when Minister of Basic Education, Angie Motshekga, dragged her heels. The audit revealed that, of approximately 150 schools surveyed, nearly 70% had no soap in the bathrooms and 40% had no toilet paper, while 18% had more than 100 students sharing a single working toilet.

Yet these are schools in urban settings, and the situation at rural schools – the subject of the WRC report – is generally far worse. The report represents a preliminary exploration for the WRC-funded project *Evaluating the design*

of existing rural school sanitation infrastructure and developing a model and guidelines for optimal design, which is being conducted by Partners in Development, a Pietermaritzburg-based research and engineering company working primarily in the water and sanitation field, particularly in rural areas.

The report focuses on rural schools in the Eastern Cape, Limpopo and KwaZulu-Natal because the National Education Infrastructure Management System (NEIMS) Report, published by the Department of Basic Education in May 2011, showed that these provinces had the highest percentages of schools with inadequate sanitation. About 73% of schools in Limpopo had unimproved pit latrines, while more than 500 Eastern Cape schools – mostly in the former Ciskei and Transkei homelands – had no toilet at all.

The WRC report includes case studies from the three provinces that make for uncomfortable reading. The Limpopo case studies were from 10 schools visited in 2013 by the public interest law centre, Section27, while the Eastern Cape examples were provided by Impilo Yabantu Services, which provides operation and maintenance services for sanitation blocks in four of the province's educational districts. Partners in Development visited a small number of peri-urban schools in KwaZulu-Natal in 2013, but is conducting a more comprehensive assessment of rural schools in all three provinces for the broader WRC study.

The case studies document toilets that looked like they had never been cleaned, toilet stalls with no doors, full pit latrines and schools with no hand-washing facilities. In one example, the superstructure around the boys' latrines had been destroyed in a storm. In another, a primary school with 520 learners, there were only two pit latrines for girls and two for boys, giving a ratio of 1 toilet to 130 learners. Recommendations for the number of children to be served per toilet typically range from 1:20 to 1:50. According to the norms and standards, a school of this size should have eight toilets for girls and four toilets plus four urinals for boys.

Toilets with missing doors offer learners no privacy when using the toilet.

Too few toilets mean that learners queue to use the toilet at break time and may be forced to miss lessons if they don't get their turn. Filthy, smelly facilities and full pit latrines prompt learners to walk home if they live nearby, or relieve themselves in the veld, where they may be vulnerable to rape. Missing doors on toilet stalls result in a lack of privacy that is an affront to human dignity. And, of course, contact with faecal matter and the absence of hand-washing facilities is a serious health threat.

Diarrhoeal diseases from bacteria, viruses or protozoa – which in South Africa account for 3% of deaths and are the third largest cause of death among children under five – are almost always transmitted via improper sanitation and hygiene, while parasitic worm infections cause nutritional deficiencies and impaired physical and mental development in children.

Government is aware of such problems, and has taken steps to address them. Minister of Finance, Nhlanhla Nene, announced in his Budget Speech in February that R29.6-billion had been allocated to the Education Infrastructure Grant for the next three years to help schools meet the minimum norms and standards, and a further R7.4-billion to the school infrastructure backlogs programme, which funds the Accelerated Schools Infrastructure Delivery Initiative (ASIDI).

ASIDI aims to replace 510 sub-standard schools, including so-called mud schools and other 'inappropriate structures', and provide sanitation, water and electricity to schools that don't have access to these services. In August, the Department of Basic Education reported that – as of 30 June 2015 – 116 schools had been completed, 439 of 741 targeted schools had been provided with sanitation facilities, 518 of 1120 schools provided with water and 295 of 914 schools provided with electricity.

So progress is being made, but unfortunately it's often a case of one step forward, two steps back.

Broken pedestals over pit toilets cause dangerous conditions for learners, especially those in primary school.

Adequate construction and maintenance of toilet facilities is a significant issue at many schools.

"There's a whole lot more that needs to be done around the value of hygiene and sanitation at schools – who looks after it, how it's managed, who is accountable – because otherwise you can spend millions on new facilities and you'll come back in a year and they're either trashed or locked."

"What the findings of our research show is that it doesn't stop with building new toilet blocks," says David Still of Partners in Development. "There's a whole lot more that needs to be done around the value of hygiene and sanitation at schools – who looks after it, how it's managed, who is accountable – because otherwise you can spend millions on new facilities and you'll come back in a year and they're either trashed or locked."

Indeed, follow-up visits to schools provided with new toilet blocks frequently reveal that their condition has reverted to a state little better than before. This is sometimes due to shoddy workmanship, leading the Auditor-General to recommend in the education sector report released in August that provincial education departments cease appointing contractors that don't meet the Construction Industry Development Board's requirements. But – as highlighted by the WRC report – it's also caused by user behaviour, which has an enormous impact on the wear and tear of facilities and their cleanliness, as well as deliberate acts of vandalism and inadequate maintenance.

Roles and responsibilities for school maintenance are spelled out in the South African Schools Act. By default, the education district or provincial department are responsible for maintenance and repairs, and for managing the necessary budget. However, Section 21 of the Act allows provincial education MECs to allocate this responsibility to the school governing body if it is considered capable of performing the role.

For these 'Section 21 schools', a budget allocation is transferred from the provincial department into each school fund. They are expected to pay for municipal and contractual services, conduct day-to-day maintenance and perform repairs in the event of minor emergencies. The Province remains responsible for more complex maintenance projects and major repairs.

In Gauteng, in response to Equal Education's damning audit, the provincial education department identified 472 schools with sanitation problems, and paid for remedial work that was expected to be completed by the end of August. Education MEC, Panyaza Lesufi, reported at a news briefing in July that he had converted all schools in Gauteng to Section 21 schools and made R750-million available to them so that they would be able to buy their own toilet paper, soap and cleaning material. He also said he was in discussions with the Department of Correctional Services to use prisoners to clean school toilets!

Of course, the MEC could be accused of simply passing the buck, because converting under-capacitated schools to 'Section 21s' is unlikely to solve the litany of problems. And judging by the comments on news websites, the concept of having convicted criminals on school property does not enjoy wide support.

Besides, neither of these solutions would be suitable for rural schools in the Eastern Cape, Limpopo and KwaZulu-Natal. In striving to develop a model for improved sanitation management, the WRC project team is in the process of doing an assessment of sanitation at 100 rural schools in the three provinces. The assessment involves an inventory of sanitation stock and its condition, interviews with the principal and cleaner (where there is one), and a focus group with learners allowing some triangulation of viewpoints between different stakeholders.

Following dialogue with the Department of Basic Education, the research findings will be used to develop guidelines on management issues, which the project team hopes can be tested in future projects. Another set of guidelines will focus on the design of sanitation facilities and the choice of systems and technologies. The preliminary document explores these aspects, which are important in ensuring that the sanitation options selected will be safe, suitable and sustainable.

For example, providing gender-segregated toilets helps prevent harassment of girls by boys, but since younger children may be bullied by older children in single-sex toilet blocks, facilities may need to be provided for different age groups too.

With regard to technology, standard flush toilets are not possible in many rural settings because – apart from using more water than is sustainable in our water-scarce country – installing sewage pipelines and pump stations is prohibitively costly, and may pose a threat to health and the environment if leaks are not readily detected. At the other end of the scale, Ventilated Improved Pit (VIP) latrines comply with the minimum norms and standards, but are regarded by many as inferior, smelly and sometimes unsafe.

Pour-flush or low-flush toilets potentially offer the best of both worlds, bridging the gap between the convenience of flush systems and the sustainability of VIP systems. With a pour-flush toilet, one to three litres of water is poured into the bowl to flush the toilet, pushing the excreta through the water-seal and into the collection chamber. With a low-flush toilet, a cistern dispenses three litres of water around the pan with each flush. Both types cost significantly less than a full-flush toilet, although about 20% more than a VIP, and greywater can be used for flushing.

With WRC funding, Partners in Development developed a pour-flush prototype in 2010, which was modified into a low-flush system in 2013. Both types terminate in a simple soakaway or leach pit, which is relatively small compared to a septic tank. Ideally, twin pits should be installed, so that when one becomes full the other can be used instead. The full pit is allowed to dry out for two to four years and then emptied, ready to be used again once the operational pit reaches its capacity.

The toilets were successfully tested in townships in KwaZulu-Natal and the Western Cape, and by June 2015, more than 80 pour-flush and six low-flush units were in operation in 14 schools.

The project team is under no illusion that rectifying the woes of rural sanitation will be a simple task, because they recognise the multi-faceted nature of the problems. Summing up their findings from their initial investigation of the issues, they state in the WRC report:

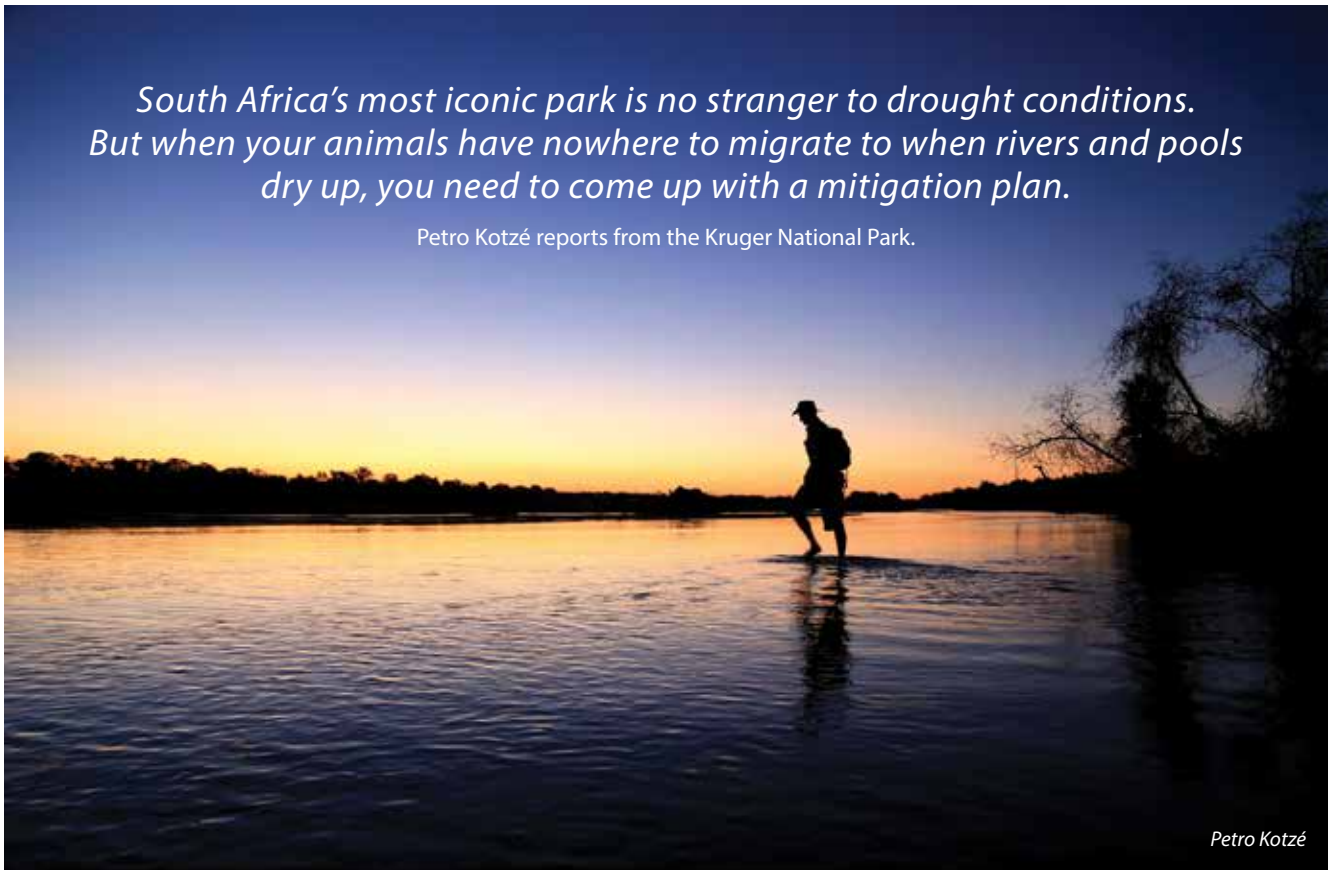
"What this exploration revealed was the fact that the failure or success of infrastructure is fundamentally linked to the needs, resources, attitudes and beliefs of management and the users of school sanitation, and that any attempt to improve the status quo must come from a perspective of a 'total solution' which addresses all of these elements coherently."

"While this document touches on how infrastructure interfaces with user needs and the implications for management, a careful review of models for management and user education is planned as the study progresses. It is clear that addressing these three elements – infrastructure, management and education – together is vital in order to expect that any intervention might succeed."

The WRC is funding a project to construct pour flush toilets at six Limpopo primary and secondary schools. The toilets are housed in timber frame units, with the timber coming from removed alien invasive vegetation.

Water and the environment

Kruger getting house in order for severe drought



South Africa's most iconic park is no stranger to drought conditions. But when your animals have nowhere to migrate to when rivers and pools dry up, you need to come up with a mitigation plan.

Petro Kotzé reports from the Kruger National Park.

Petro Kotzé

Across the central and eastern Pacific, there is a constant interplay between the temperature of the ocean and the atmosphere. It is referred to as the El Niño-Southern Oscilation (ENSO) cycle. Sometimes, the temperature fluctuates higher or lower than the norm, affecting weather and climate across the globe. Simply put, a cold ocean water phase is referred to as La Niña. Currently, we are in a warm phase, better known as El Niño, which typically reaches its peak from December to February.

In one corner of South Africa, conservationists are keeping an interested eye on El Niño. The most recent data from the National Oceanic and Atmospheric Administration (NOAA) in the United States indicates that this phase is likely to continue into our summer rainfall months. Should this be the case, it could hold far-reaching consequences for South Africa's most famous conservation area – the Kruger National Park (KNP). Climatic conditions such as these indicate a strong possibility of severe drought.

Already, the rainfall of the summer of 2014/15 was below normal across large parts of the park and catchment areas of the five perennial rivers that run through it. The Luvuvhu, Letaba, Olifants, Sabie and Crocodile rivers all originate outside the park, flowing from west to east through the protected area, then Mozambique, and eventually drain into the Indian Ocean.

The impact, should this happen, is unknown. The previous time that the park experienced severe drought was during the 1991/92 cycle, and the consequences still ripple through policy and management plans more than 20 years later. And, should a severe drought take place, it would be in an environment where conservation principles have changed considerably.

The consequences this time around will only be clear in retrospect. In preparation, South African National Parks (SANParks) and KNP management are bracing themselves for the worst while keeping a window of opportunity wide open for the knowledge they are expecting to gain from the event.

Times of plenty, times of need

The mean annual rainfall (MAR) in the KNP varies from approximately 740 mm at Pretoriuskop in the south to about 440 mm at Pafuri in the north, but during droughts or floods rainfall can vary from 50% below or 50% above the long-term average respectively.

Naturally, there are cycles of high and low rainfall, seen as drivers to healthy ecosystem functioning such as weaker animals dying off, leaving a genetically stronger population. However, Large Infrequent Disturbance Events (LIDE) such as extreme droughts or floods, are different altogether. It could cause severe or longer term ecosystem changes, especially since the ecosystem of a conservation area like the KNP is curbed by fences, and the rivers that run through it are heavily utilised before they enter the park. Therefore, should a LIDE be on the cards, management steps in and a number of provisions are already being made in the park.

Park management have had a number of severe droughts in the park's existence to learn from; in the 1960s and early 1970s and then again predominant droughts from about 1982 to 1997.

According to Dr Eddie Riddell, the park's manager for freshwater resources, "the most recent and well documented drought in the Kruger National Park is that of 1991-1992 when the park received only 44% of the long-term average rainfall from a 100-year record."

The El Niño-related droughts of 1982/83 and 1991/92 were the most severe droughts on record in the KNP and large parts of the rest of southern Africa. Both these events were characterised by below normal rainfall for two consecutive years – a situation predicted for this year, says Dr Freek Venter, Kruger National Park conservation general manager.

A severe drought such as that experienced in 1991/92 holds many consequences – near inconceivable to those that have not experienced it before. In March 1992, the Sabie River, generally regarded as the most biodiverse in South Africa, was near to losing its status as a perennial river for the first time in recorded history.

Major water users in the catchment came together, eventually forming the Sabie River Working Group (SRWG), consisting of irrigation farmers and forestry and State departments. Farmers voluntarily restricted irrigation up to 60% and forestry ring-barked hundreds of stray trees along the banks of the river, preventing the Sabie from drying up.

Inside the park, the 30 000 strong buffalo population shrank by about 60% to 14 000 and many other herbivore population numbers declined, including hippo, warthog, common reedbuck, kudu and giraffe. Rare antelope such as roan, sable, eland and tsessebe also declined significantly. According to Dr Venter, many of these animal populations rebounded in the wet years that followed, though rare antelope numbers remain low.

Catering for the park's people

The management of the Kruger National Park have got another aspect to keep in mind when the water levels get low: people. In particular, those that call the park home and the thousands of tourists who enters through its gates every year.

To offset the potentially detrimental effects of drought, the KNP has a number of water efficient policies in place. These include the introduction of a hydro-zoning programme in its tourist camps so that their gardens are water-wise, and a water use restrictions policy of its own which is applied to staff and tourist areas. It hosts the national Working for Water programme, through which beneficiaries tirelessly remove often water guzzling alien invasive plant species from the landscape. In addition, some camps have had additional boreholes drilled for low level emergency water provision should the need arise to use groundwater to augment supplies.

If the drought continues then there will be additional cost in terms of the time the park personnel have to allocate to drought management, for instance servicing water supply infrastructure and liaising with upstream stakeholders and water management institutions to ensure that water uses are equitably restricted and commensurate with legislation to ensure that the ecological reserve flows are maintained.

Additionally, the droughts were characterised by significant human migrant movement from neighbouring countries through the park, and many accidental veld fires flared up as a result. Tourists also encountered migrants on the road from time to time.

Looking back, moving forward

Since then, a number of changes have taken place in the park. The 1991/92 drought was one of the most researched and documented, says Dr Riddell. "We know that these dry periods change the balance in favour of the plains game such as zebra and blue wildebeest who utilise the shorter grasses, while not favouring those long grass feeders such as buffalo and the rare roan, tsessebe and reedbuck." This, in turn, leads to a switch in the grass species composition of the veld due to the resulting grazing pressure dynamics, he says.

"We also know that the larger predators, such as lion, leopard and hyenas, did well during these times, at the expense of the smaller predators, including wild dog, cheetah and jackal by out-competing them for resources." Furthermore, the surviving buffalo were the strongest and most resilient, and thus only the 'best' re-populated the park.

Significantly, management started looking differently at the water provision strategy in the park.

In the past, waterholes were steadily increased from 1911 until the 1990s to provide reliable water in an environment that was perceived to be 'drying out'. They reached a peak of about of 300 and included catchment dams in seasonal streams.

Current guidelines include that water should not be provided in areas that are naturally dry, or be provided too evenly across the landscape. Water provision is still condoned in certain areas to cater for tourist expectations and because of remaining fences (inhibiting a complete return to natural water availability). However, for the most part, artificial water points are being closed down, certain dams breached and rehabilitated and in a few relevant cases water points opened up again. In effect, vegetation and animal distribution patterns are allowed to recover so that seasonal variation between times of water availability and drought can fulfil their natural function.

A common misconception is that animals die of thirst during prolonged droughts when, in fact, most starve to death after grazing has been depleted, explains Dr Riddell. Some animal

During the previous drought experienced in the Kruger National Park the 30 000 strong buffalo population shrank by about 60% to 14 000.

The Sabie River Working Group, which prevented the river from drying up during the 1991-92 by applying voluntary water restrictions.

(Photograph courtesy KNP)

Another sight during the previous drought: The Black Heron Dam in Letaba River ran dry and filled with slime. Since then, the dam wall has been removed and reverted to a measuring weir.

(Photograph courtesy KNP)

and plant species flourish when plenty of water is provided, while others do not. It is therefore important to provide water in a way that creates conditions suitable for sustaining a wide range of biodiversity, and not only for those species that do better in close proximity to water (like zebra and blue wildebeest).

Thus those species that prefer to occupy drier areas further from water where there are fewer predators, less competition for food and less trampling (like sable and roan antelope) also need to be catered for. The KNP's new water provision policy creates refuge areas for grass further away from permanent water.

The aim is for seasonal variation in water availability and drought episodes to again fulfill their natural function in the system. Research already suggests some recovery of the vegetation and animal distribution patterns since waterpoint closures.

KNP will have a number of other weapons in its arsenal to offset potentially catastrophic effects of a severe drought, this time around. Following the 1991/92 drought, the SRWG successfully lobbied the then-Minister of Water Affairs, Kader Asmal, for additional storage capacity in the catchment, which led to the construction of the Inyaka Dam on the Marite river tributary of the Sabie. "The Inyaka Dam is currently almost full and it will be interesting to see how it maintains its level if another dry summer occurs," notes Dr Venter.

He adds that this process created an outstanding relationship with and awareness amongst water users in the Sabie River catchment that lasted for more than a decade. "From these droughts also flowed the 12-year long WRC-funded KNP Rivers Research Programme, involving many scientists from several universities, that was designed to inform minimum in-stream flows and water quality for KNP rivers. Knowledge gained from this programme eventually cascaded into the Environmental Reserve clause of the National Water Act."

This does not mean that substantial challenges do not remain.

"There have been some challenges of late to meet the ecological Reserve in the catchments of the Letaba, Crocodile and Sabie rivers," says Dr Riddell. These issues have been resolved through collaboration with upstream institutions particularly Catchment Management Agencies and Water User Associations as well as the Department of Water and Sanitation. As a result, the ecological reserve could be met due to water releases from dams (the Tzaneen, Kwena and Inyaka dams respectively).

"Should a severe drought take place, it would be in an environment where conservation principles have changed considerably."

However, he adds that if the dry period continues for another year or two, reconciling the rivers' ecological reserve requirements with those of upstream users will become more challenging.

Dr Venter adds that census numbers of large herbivores in the KNP indicate that the biomass of these animals has more than doubled during the past decade. This increased animal biomass (most of it due to an increasing elephant population) may have compounding effects on the influence of the next major drought.

Still more questions than answers

While ENSO can be forecast with good skill up to nine months ahead, it is critical to keep in mind that an El Niño/La Niña forecast is not a rainfall forecast. Though most El Niño years have been associated with below-normal rainfall, this impact is often reduced by sufficient groundwater and soil moisture content that have remained in the system from previous season.

Dry periods favour game such as zebra and blue wildebeest.

The Luvuvhu River with normal winter flow (1986) and during the drought of 1992. (Photographs courtesy KNP)

It is complicated further by the fact that the numerous rainfall regions in southern Africa correlate differently with ENSO. It cannot be accepted as a rule that the southern part of Africa will receive below-normal rainfall during El Niño years and above-normal rainfall during La Niña. For example, according to Weather SA, "The 1997-98 El Niño was the strongest on record, but not all of South Africa received below-normal rainfall. Some regions had an abundance of rain because of moist air that was imported from the Indian Ocean."

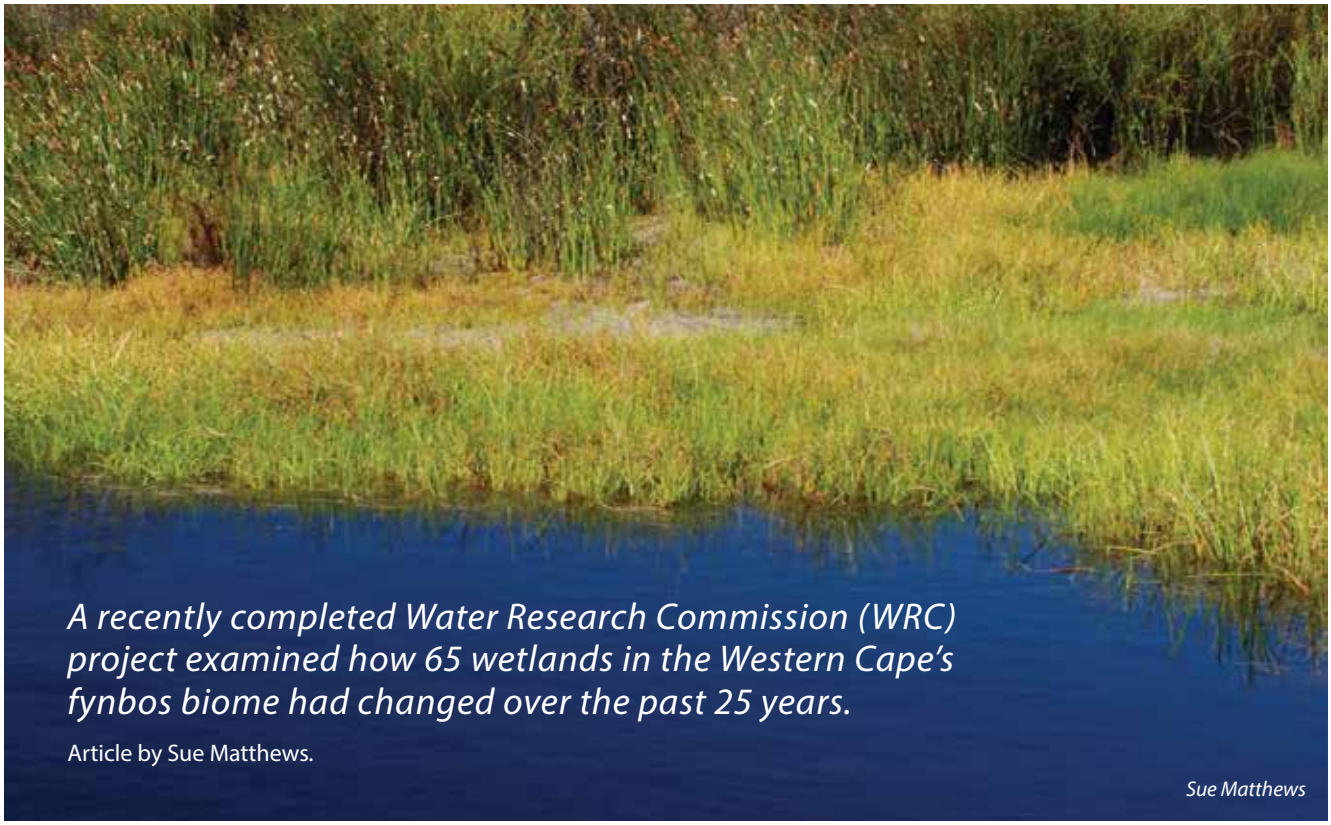
For KNP management, this implies that they will have to wait for the rain or the lack thereof, to make any concrete conclusions.

If severe drought does occur, says Dr Venter, it will allow them to answer a number of pertinent questions: Will the perennial rivers flowing through the KNP dry up or will the changed strategy to build larger dams in the upper catchments rather than in the KNP itself bear fruit? Will water quality problems currently experienced in some rivers be compounded? Will the more natural distribution of water lessen the drought impact on the vegetation some distance away from permanent water? Will the more natural water distribution pattern (due to the closure of many man-made waterholes) favour roan antelope so that they survive better, or will they decline further or disappear from the KNP ecosystem? What will happen to other rare antelope such as sable, tsessebe, eland and reedbuck? Will the KNP's elephant population continue to increase, will it stabilise or will it decline? Will a serious drought present the park with opportunities to work closer with its neighbouring communities, or assist to provide them with lifesaving natural resources?

For any answers, we will have to wait for something as fickle as the weather.

Wetlands

The Cape's fynbos wetlands – then and now



A recently completed Water Research Commission (WRC) project examined how 65 wetlands in the Western Cape's fynbos biome had changed over the past 25 years.

Article by Sue Matthews.

Sue Matthews

"We were chatting one day about the wetlands work that Mike Silberbauer and Jackie King [both formerly of the University of Cape Town (UCT)] had done in the late 1980s, and we thought 'wouldn't it be interesting to see what's happened to those wetlands?' " says project leader, Dr Heather Malan. "Once we knew that our project proposal to the WRC had been approved, the first task was to get hold of all that original material, which meant trawling in the depths of the building that I didn't know existed!"

A set of historical field notes was even found hidden behind some water pipes while clearing out the laboratory of the Freshwater Research Unit! Having been based in UCT's Zoology Department since its inception in 1984, the Freshwater Research Unit closed in 2012, but some of its staff and former students regrouped off-campus as the independent Freshwater Research Centre.

The project, entitled *'Trajectories of change in wetlands of the Fynbos Biome'* was therefore conducted under the auspices of the Freshwater Research Centre, but also involved researchers and students from UCT, North West University and UNISA.

By finding out how wetlands had changed – and why – the project team aimed to improve understanding of the factors leading to wetland degradation, and in so doing facilitate their conservation.

Locating the wetlands previously surveyed by Silberbauer and King was not always a simple task though.

"That was before the days of GIS and Google Earth, so they had recorded the geographical coordinates from 1:50 000 maps, which wasn't very accurate. We had to do a bit of detective work to figure out where some of the wetlands were, and pin-pointing the exact sampling site was often impossible," notes Dr Malan.

Annotated orthophotographs used in the original project were of great help, as were the old field sheets, which often included a description of how to get to a site, valuable insights into the flora and fauna, comments by landowners or other aspects noted during sampling. And thanks to the foresight and diligence of Mike Silberbauer, most of the results – mainly in the form of water chemistry measurements and species lists

of plants and invertebrates – had been collated in an electronic database that was fortunately still accessible.

A sampling programme was drawn up that ensured wetlands were generally visited in the same month of the year as the original project, unless they had been recorded as dry at that time, or where logistics made this impractical. In each case, *in situ* measurements were taken and water samples collected to assess water quality. In addition, diatoms, plants and invertebrates were sampled, and a rapid habitat assessment conducted.

Land use in the surrounding area was noted during field trips and checked using aerial photographs to infer changes in wetland plant species composition since the 1980s. The overall importance of the wetland, in terms of its ecological importance and sensitivity, direct human benefits and ecosystem services, was also scored. All of this information was used to determine each wetland's Present Ecological State, which could be compared to its likely condition at the time of the original survey, although Heather stresses that the historical state was "very much an educated guess, based on what we had in the way of old photos and reports".

Surprisingly, 29% of wetlands were found to be in a better condition – their scores pushing them into a higher ecological health category – than they were 25 years ago, and 24% were in much the same condition. By contrast, 23% of wetlands had deteriorated significantly, and 8% showed a slight deterioration. For the remaining 16% of wetlands, the change in ecological health either could not be determined or the wetland no longer exists. But even if all of those wetlands had deteriorated to some degree, the total percentage of wetlands in an improved or similar condition would still be in the majority.

The research showed that the main reason for improved ecological health is the protection of wetlands within new conservation areas, including the Table Mountain and Agulhas national parks, municipal reserves such as Kenilworth Racecourse Conservation Area and Witzands Aquifer Nature Reserve, and even private landowner initiatives like the Nuwejaars Special Wetland Management Area. Indeed, 51% of the wetlands have a better conservation status than they did in the late 1980s.

City of Cape Town

Khayelitsha Pool

The Khayelitsha Pool may originally have been a depression that filled as the water table rose in winter, but it was probably deepened at some stage to accommodate flow from the Kuils River, which was diverted south of the N2 road. The once seasonal river is now a perennial system as it receives a high volume of stormwater runoff and treated sewage effluent from the extensively developed catchment. Not surprisingly, perhaps, the Khayelitsha Pool was found to have the highest phosphate levels of all the wetlands surveyed in the project, and the second highest ammonium levels. Nevertheless, since the original survey it has become the centrepiece of the Khayelitsha Wetlands Park, an urban green space and recreational area managed by the the City of Cape Town's parks department. The pool, its reed beds and the surrounding wetlands provide habitat for a variety of birds, while the landscaped area includes a playground, skate park, picnic sites and footpaths. The site is also important for flood control and nutrient attenuation.


Matthew Buckland

Lake Michelle

Today Lake Michelle is a permanently inundated freshwater body, but it was once a seasonal saline wetland known as the Noordhoek Salt Pan. Although it has been completely transformed from its natural state, its condition is arguably better than it was 25 years ago. The pan was mined for salt until the 1920s, and in the 1930s it was used as a motor-racing track. During the 1970s it was excavated for a marina development that was never built, and subsequently used for the storage of treated sewage effluent. By the late 1980s, the land was heavily infested with alien acacias, but much of this was cleared when construction of the current residential development began in 2000. The eastern shore is now fringed with exotic garden plants, but the western and southern shores form part of an eco-estate, where restios and other indigenous species have been planted as a protective buffer, and the use of pesticides and fertilisers is strongly discouraged. Artificial wetlands have been created to 'cleanse' polluted stormwater runoff from the surrounding catchment, and water quality monitoring shows nutrient levels to be in the acceptable range. Regular sightings of otters on the estate are considered indicative of the good water quality and ecological condition. Lake Michelle therefore forms an effective buffer protecting the downstream Noordhoek Wetlands, which lie within the Table Mountain National Park, from water quality impacts arising in the catchment.

Wetland deterioration was usually caused by invasion by alien plants – chiefly acacias, pines and eucalypts – and urban or agricultural development. It manifested as poor water quality, with high nitrogen and/or phosphorus levels, and a proliferation of reeds such as *Phragmites australis* or *Typha capensis* in response to this nutrient enrichment, sedimentation and more constant water levels.

"We found that the condition of the wetland can be predicted fairly well from the land use in the area," says Dr Malan, "so looking at changes in land use via remote-sensing methods, for example, is a good broad-based way of monitoring wetlands."

These are the kind of practical considerations that can inform the National Wetlands Monitoring Programme, to be developed under a recently initiated WRC-funded project.

"Doing fieldwork is very expensive, although of course there is information you can only get when you go out into the field," she explains. "In fact, the results from this project show that diatoms have quite a lot of potential as water quality indicators for wetlands."

"Surprisingly, 29% of wetlands were found to be in a better condition – their scores pushing them into a higher ecological health category – than they were 25 years ago."

This finding warrants further exploration, especially since other studies have recently demonstrated that aquatic invertebrates are less reliable for inferring water quality in wetlands, unlike in rivers, where the macroinvertebrate assemblage is the basis for the rapid biomonitoring tool, SASS – the South African Scoring System.

"If you think of invertebrates living in a seasonal pan, they have to be very tough to exist in a system that changes from fresh when the wetland is inundated during winter, to quite saline when much of the water evaporates in summer. They tend to be generalists, able to tolerate a wide range of conditions, while SASS works for rivers because those invertebrates have a narrow tolerance range."

For the National Wetlands Monitoring Programme, the project team believe that it would be best for each wetland to be subject to an initial in-depth assessment to prepare baseline information and to identify any issues or threats specific to that wetland,

after which a tailor-made monitoring strategy should be prepared. This would include sampling for selected water quality parameters and monitoring basic aspects like land-use change, as well as any specific issues – such as reed encroachment or pollution inputs – relevant for that particular wetland and likely to pose a threat to its future ecological health.

One realisation brought home to the project team, however, was that even highly degraded wetlands can have important benefits for people. This was well illustrated by Khayelitsha Pool on the Cape Flats, which is heavily impacted by development upstream and surrounded by low-cost housing. On the other hand, residential development does not necessarily mean that a wetland will be in poor condition, as demonstrated by Lake Michelle on the South Peninsula. At the opposite extreme, the wetland at the inflow of the Silvermine Dam is protected from development as it lies within the Table Mountain National Park.

While these three wetlands all fall within the Greater Cape Town Area, in rural areas further afield the condition of a wetland may by entirely dependent on the actions of just one or two of the surrounding landowners.

"As an academic researcher, realising how essential it is to work with the landowners was quite an eye opener for me," says Dr Malan. "We need to do more to incentivise people to protect wetlands, whether it's through education or tools such as tax breaks, because you can't conserve everything in a national park!"

To order the report, *Trajectories of change in wetlands of the Fynbos Biome from the late 1980s to 2014* (**Report No. 2183/1/14**) contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; or Email: orders@wrc.org.za.

Silvermine Dam Inflow

The Silvermine River rises in the Constantiaberg on the Peninsula mountain chain and flows into the sea at Fish Hoek, about 12 km downstream. A dam was built close to its source in 1898, but has not been used as a municipal water supply for some decades. The area formed part of the local authority Silvermine Nature Reserve until it was incorporated into the Table Mountain National Park in 1998. Since then, pine trees and other invasive alien vegetation in the catchment have been removed, and paths and a gravel road crossing the river upstream of the dam have been closed to restore natural habitat and prevent erosion. The environmental condition of the wetland at the dam's inflow is therefore likely to have improved since 1988, and it is in a near-pristine condition, with the low nutrients levels and pH typical of fynbos streams.

Sue Matthews

Opinion

Confronting inequitable power dynamics of global knowledge production and exchange

The research environment in the global South faces many pressing challenges given resource inequality. Technical and financial issues aside, Laura Czerniewicz asserts it is the values and practices shaped by the Northern research agenda which contribute just as much to the imbalance. In order to confront these inequities, perceptions of "science" and research outputs must be broadened, and the open access movement needs to also broaden its focus from access to knowledge to full participation in knowledge creation and in scholarly communication.

Showing 'the world of science', the maps accompanying this article portrays global research production as expressed through science journals' publishing in the early 2000s as well as the growth in science output between 1990 and 2001. It makes a dramatic point about the complexities of global inequalities in knowledge production and exchange. What would it take to redraw the knowledge production map to realise a vision of a more equitable and accurate world of knowledge?

Disparities

Knowledge creation and dissemination are, of course, crucially shaped by the practicalities of money and technology. It is significant that the average research and development (R&D) intensity (R&D as a percentage of GDP) for OECD countries was 2.4% in 2009, while few developing countries had reached 1%.

These percentages of national funds are important differentiators in what is possible; without comparable levels of support researchers in resource-poor environments must spend inordinate amounts of time fundraising and dealing with external grant-giving organisations, are limited in their ability to participate in scholarly community activities, and so are often constrained in the research they can undertake. Infrastructure also shapes what is possible; for example maps of internet cable clearly show how collaboration between those in the global north is enabled by substantial bandwidth while north-south and south-south connections are not.

Values and practices

These technical, financial and even mechanical issues are easy to identify, and so it is tempting to put one's faith in the idea that more money and machines will solve the problems of knowledge production inequality. Values and practices – which legitimate certain interests and not others – contribute just as much to global imbalances as material disparities do. The positioning of these science journals is not neutral: engagement with them is characterised by several levels of uneven participation.

They operate within a discourse in which 'international' really means 'global north'. This paradigm is reinforced by the strong reliance on the ISI Impact Factor, leading to an anomalous situation in which researchers from the global South must tailor their research to be of interest to high impact journals serving a Northern research agenda.

For example, a study of four high impact journals in the management social sciences found that they attracted authors from many countries but their empirical sites of investigation were significantly located in Europe and North America (Hamman, R. *Balancing the academic terms of trade: The paradox of*

publishing in top-tier journals from the periphery. unpublished, available from author).

This indicates the extent to which local researchers will use their scarce resources to achieve publication in the high impact journals, supposedly international. Given the overall constrained research environments in which these researchers operate, these resources are lost to local research needs, and may in effect subsidise the research of the global north. Ironically, at the same time, relatively well resourced researchers from the global north undertake research in developing countries and publish in those same 'international' journals. In the worst cases, the global south simply provides novel empirical sites, and local academics may not become equal partners in these projects about their own contexts.

Researchers in the global south are caught in a double bind. They are rewarded for publishing in international journals in several ways: through promotions, and sometimes even financially (in South Africa, for example, universities receive about US$13 000 from the National Department of Higher Education and Training for every article published on accredited lists (and in 21 of the 23 universities a percentage of this 'reward' goes directly to the authors).

At the same time, development imperatives and government policies pressurise researchers to undertake research relevant to pressing social and related problems which may not be appealing enough (or even 'academic' enough) to interest the international journals. One scholar thus noted wryly that, "African scholars face a critical choice between sacrificing relevance for recognition, or recognition for relevance."

Another problem not captured by the journals map is that it measures science journal articles as the sole representation of scientific research output, whereas there are other valid forms of outputs which also report research findings. Obvious examples in the scholarly community are monographs and edited collections.

While the map portrays science research, it interprets this narrowly, and fails to include the social sciences and humanities which continue to value books in all forms, both digital and in hard copy. Also, in many contexts valid research is undertaken and published with the unfortunate name of 'grey literature'- in the form of working papers, technical reports, policy reports, etc.

These genres of research output are often prevalent in research areas focused on pressing development issues. In South Africa it is instructive to consider, for example, the outputs of research organisations such as PLAAS (Programme for Land and Agrarian Studies) and SALDRU (South African Labour Development Research Unit), whose prolific, robust and internationally- recognised output would be poorly reflected on the map above.

The usual rejoinder to the inclusion of such research is the question of quality; but the answer lies not in rejecting these forms of outputs but in finding ways to prove their worth whether through new mechanisms of peer review, or through new metrics which measure impact and value through use and re-use, not just citations in the same coterie of journals

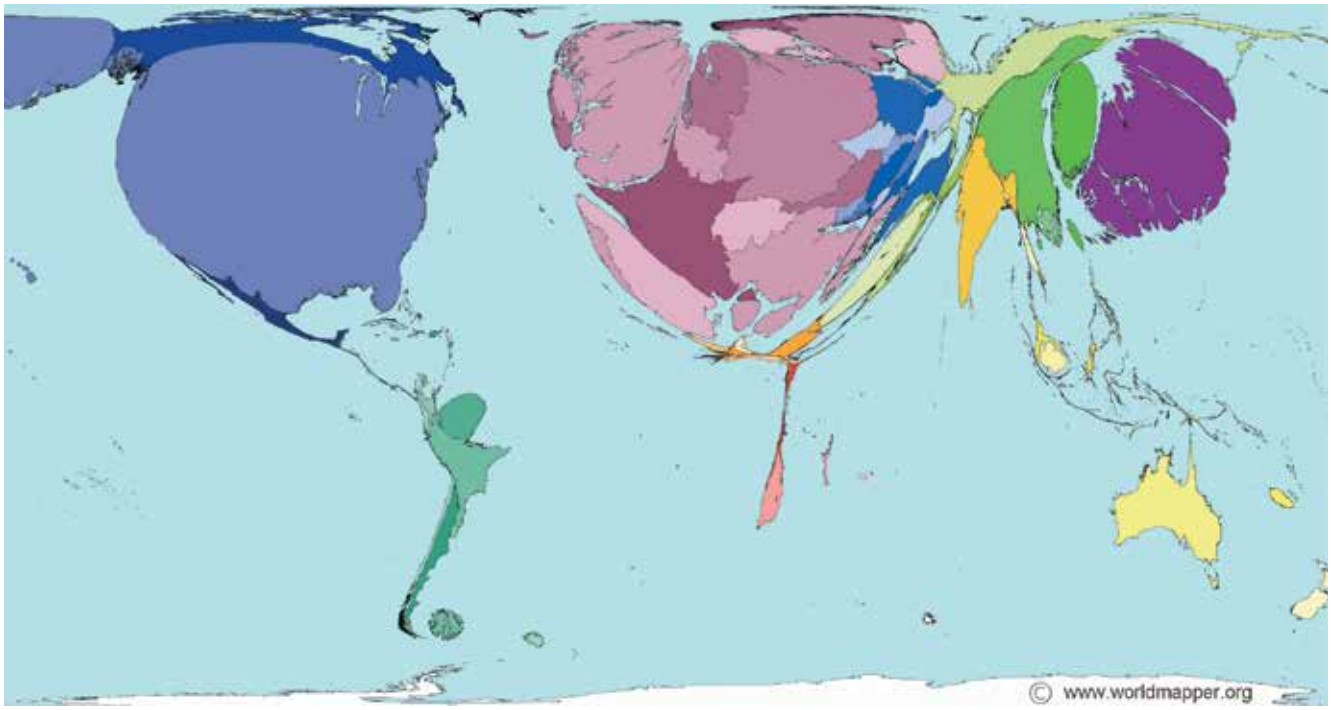


Figure 1: The world according to the production of science. Territory size shows the proportion of all scientific papers published in 2001 written by authors living there.

from which many are excluded in the first place.

Another category of invisible research from the South is the considerable output commissioned by government and undertaken by consultants, many of whom are practising academics. Even when published, this kind of research is often not attributed to its actual authors. It has the added problem of often being embargoed, with researchers even having to sign confidentiality agreements or 'official secrets acts' when they are given grants. This is especially bizarre in an era where the mantra of publically funded research being made available to the public has become increasingly accepted.

From access to participation

Yet another snag that is surfaced in the knowledge outputs represented in the map above is that they generally reside behind paywalls and can only be reached by people with access to expensive academic databases. This excludes those who cannot afford to pay for it, i.e., researchers in resource-constrained environments, and members of the general public who do not have passwords for the electronic facilities of universities and research institutions.

Of course this situation is about to change substantially as the open access policies that are currently percolating in the system in the EU, the UK and other countries are implemented over the next few years. This will substantially increase the volume of research to which scholars and readers all over the world have access, and will undoubtedly be a very important contribution to research.

Ironically, however, the danger of this more ubiquitous availability is that without similar national and regional policies in the developing world, and without resources being made available to actively support open dissemination in these countries, many types of research from the developing world will be rendered even more invisible. This may unwittingly consolidate the erroneous impression that these scholars are undertaking little of value, have little to contribute to global knowledge and are reliant on the intellectual capacity of the global north.

In conclusion, to redraw the map of global knowledge production, the inequitable global power dynamics of global knowledge production and exchange must be confronted head on. Funding and infrastructure must be improved, our perceptions of science must be broadened to encompass the social sciences, research outputs need to be recognised as existing beyond the boundaries of the formal journal article, incentives and reward systems need to be adjusted to encourage the legitimation of the new fairer practices more possible by the affordances of a digitally networked world. And finally, the open access movement needs to broaden its focus from *access* to knowledge to full *participation in* knowledge creation and in scholarly communication.

Laura Czerniewicz is an associate professor with the Centre for Higher Education Development at the University of Cape Town. She leads the university's open scholarship initiative, OpenUCT, and blogs at http://lauraczerniewicz.uct.ac.za.

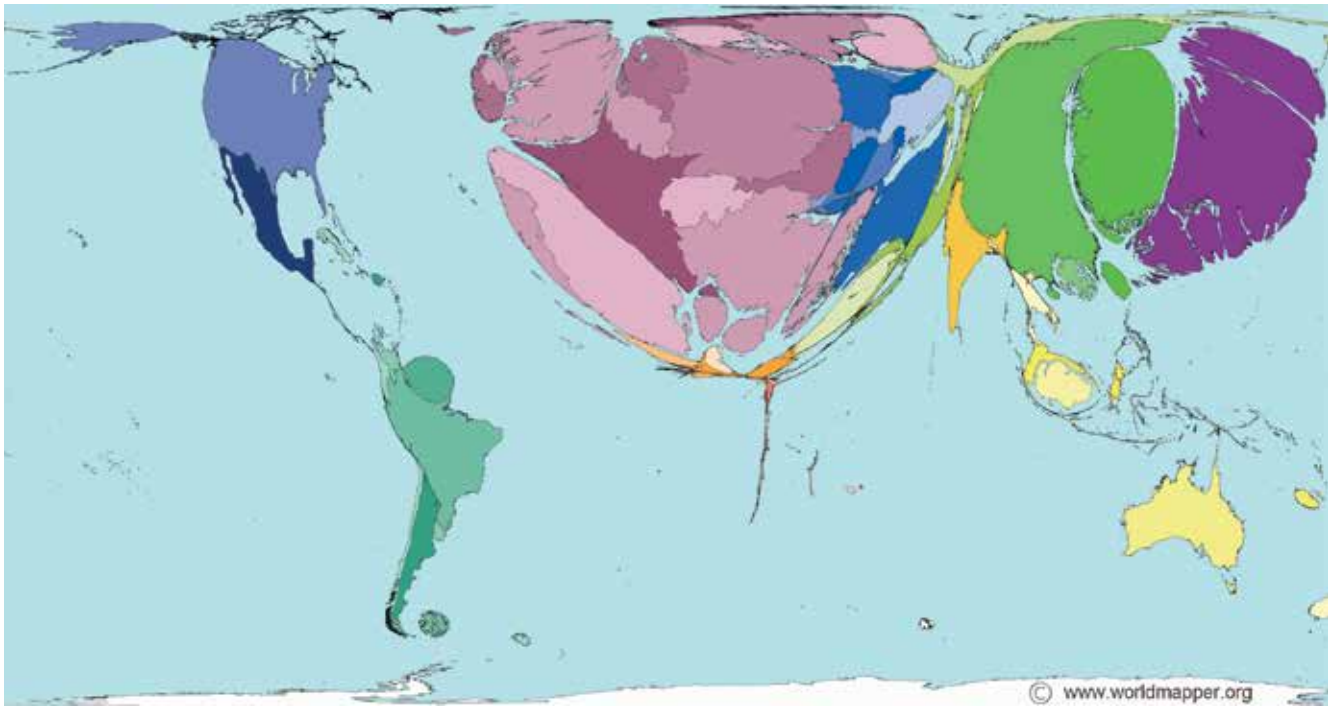


Figure 2: This map shows the growth in scientific research of territories between 1990 and 2001. If there was no increase in scientific publications that territory has no area on the map.

THE WATER WHEEL

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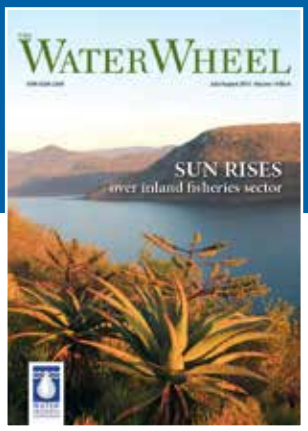

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Aquatic fauna and flora

The incredible platanna and its deadly legacy

Long since indispensable to science, the humble platanna is a remarkable creature, with an incredible instinct for survival.

Article by Dr Jo van As.

The South African clawed toad *Xenopus laevis* commonly referred to as the platanna occurs naturally in water bodies throughout much of southern and central Africa. It has also been introduced all over the world and is now established in natural habitats in large parts of the USA, the UK, most of western Europe, and is invading Chile at an alarming rate. Apart from these feral populations you are also likely to find colonies of these toads in laboratories in many university cities around the world.

The clawed toad is today, together with half a dozen other creatures, the standard laboratory research animal all over the world. From the turn of the twentieth century these toads were cultured in laboratories and after the Second World War become the dominant experimental animal in Developmental Biology and Biochemical studies. During the early thirties discoveries were made that would result in the South African clawed toad *X. laevis* becoming world famous.

Dr Lancelot Hogben a Cambridge-trained physiologist was, unlike many of his contemporaries, not a man of independent means. He actually had to have paying jobs to support him and his family. As a result, he often moved to better paying positions in different institutions in the UK, later to Canada and in 1927 to Cape Town, South Africa. This is where he came into contact with *X. laevis* and was so enthralled with the animal that he named his house in Cape Town after it.

In 1930, Hogben published a paper in which he, in principle, demonstrates that *X. laevis* could be used as an indicator of the presence of gonadotrophins in the urine of pregnant women. He did not mention the possibility of using *X. laevis* in pregnancy testing.

Before he could pursue the matter further, it was again time for Hogben to move on, this time to London, and as a new chair of Social Biology at the London School of Economics. One of the colleagues at the University of Cape Town described Hogben as "arrogant, supercilious with a caustic personality". In addition to finding Hogben difficult and unpleasant, staff and students were incensed by his lack of concern for the animals on which he experimented. His unpopularity and abrasive personality may also have contributed to his frequent relocations.

In October 1933, two former Cape Town colleague, Shapiro and Zwarenstein presented a paper to the Royal Society of South Africa which announced that in the previous month they had successfully used *X. laevis* in 35 pregnancy tests. Their findings were published in *Nature* the next year. This sparked a long public feud between Hogben and his former co-workers as to the claim of the breakthrough.

It was never really satisfactory resolved, but by 1939 the Hogben test, as it became generally known, was established as a rapid diagnosis for pregnancy. Despite the name attached to the test there is no doubt that HA Shapiro should have the credit for developing the test, so writes another colleague JWC Gunn in an article to the *British Medical Journal* in 1939.

The test required just one injection of urine from a woman suspecting that she was pregnant, into the dorsal lymph sac of a female *X. laevis*. If indeed she were pregnant, the urine will contain low levels of gonadotrophic hormone which will induce egg-laying by the *X. laevis* 8-12 h later. This meant that a woman suspecting she may be pregnant could provide a urine sample to pathologist and have the result the next day.

The Hogben tests remained the standard procedure for early pregnancy testing all over the world until the 1970s when it was replaced by immunological methods. It is interesting that this test never ever produced a false positive result. It did sometimes produce a false negative if the level of gonadotrophic hormone were too low at a very early stage of pregnancy. By the 1960s *X. laevis* was firmly established as an experimental animal in biological research and remains so today. Most if not every student of Biology had at some stage in his/her studies dissected a specimen of *Xenopus laevis*.

The platanna is a truly remarkable creature. It is an opportunistic omnivore feeding on almost anything available, taking live prey as well as scavenging on dead animals. Adult *X. laevis* do not feed directly on plankton but utilise plankton blooms in a bizarre way.

X. laevis tadpoles are filter feeders of plankton, which they convert to biomass. The adults then cannibalise their own tadpoles and in so doing also utilising seasonal plankton blooms.

These toads are also very resilient creatures, and are known to survive for extended periods without food. *Xenopus laevis* can live up to 20 years, but has a generation time of only eight months under ideal conditions, and has a very long breeding season, which extends from early spring to late summer making them very prolific breeders.

Although it spends its whole lifecycle in water, this toad can survive without water for long periods and move overland when its habitat dries up. This usually happens at night or in the early morning hours when the vegetation is moist. It can also survive in mud for months on end, in a process known as aestivation, where it metabolism slows down to a state of suspended animation. It is an air breather and needs to surface to gasp for air, but it also acquires oxygen through its skin directly from the water.

Females deposits thousands of sticky small eggs underwater which attach to plants. The tadpoles, when they hatch, are gregarious and remain in a large group. This behaviour confuses bird predators which do not identify the large moving mass as potential prey. When a tadpole strays away from the tadpole mass it becomes vulnerable for predators.

Xenopus laevis is the epitome of perfect adaptation, and it is no wonder that it was as successful in non-native environment as it is pre-adapted to survive in almost any freshwater habitat. This may be wonderful for the toads but bad news for the environment and ecology in its new non-native habitat. It often becomes invasive out competing local species resulting in a decline in the biodiversity.

An animal as successful as *X. laevis* and being repeatedly introduced into so many different countries is an environmental hazard. With even the best security measures you cannot contain *Xenopus laevis* in captivity. It can and will escape though the drainage system and in many other ways but, is most often distributed by people with misguided but never the less good intentions.

Its hardiness and ease to culture that made *X. laevis* the super successful laboratory animal also made it an ideal candidate for the pet trade. It is of no surprise that it could establish viable feral populations in so many parts of the world. Many of these populations the result of misguided ethical considerations, often also ignorance by releasing pet toads into the nearest pond or stream, after the owner lost interest, or flushed them down a toilet. They will disappear out of sight, but will most likely survive the ordeal.

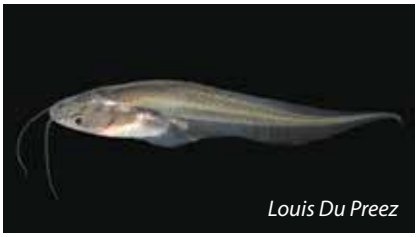
From an evolutionary view, *X. laevis* presents a perfect example to illustrates adaptation and the concept of pre-adaptation. It celebrates its success as an international laboratory animal and to top it all *X. laevis* is a supreme host for a wide range of incredible unique parasites and symbionts.

Platannas have a rich assembly of symbionts, more so than most other frogs and toads. The reason for this phenomenon is that the platannas are different from most frogs and toads. All stages of their lifecycle are aquatic, where as in most toads and frogs the adults are land dwellers.

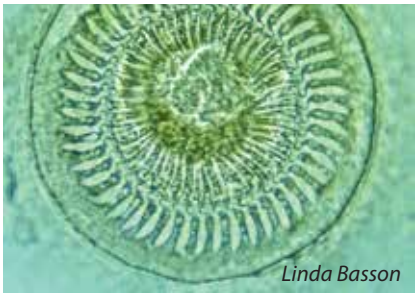
X. laevis are therefore not only exposed to symbionts that evolving together with their own linage over a period of almost 150 million years, but also to symbionts evolving together with the fish linage dating even further back. In many respects the platannas way of life overlaps with that of fishes and it is inevitable that they will be exposed to the same symbionts. *X. laevis* symbionts from fish origin such as *Trichodina xenopodos* have evolved to become unique symbionts and specific to their *X. laevis* host.

The spectrum of *X. laevis* symbionts is truly remarkable. They include representatives of at least 30 genera from seven invertebrate groups inhabiting different parts of the body. This includes on the skin, under the skin, lateral line (sense organ on body), nostril, Eustachian Passage (the bony passage connecting the middle ear to the nasopharynx), eyelid, mouth, oesophagus, intestine, stomach, rectum, urinary bladder, in the blood and even in the pericardium (sack enclosing the heart). These parasites and symbionts have been well studied due to the high profile of this popular laboratory animal. With all its extraordinary characteristics the platanna has a horrifying legacy. Although none of its parasites, which are all specific to their only host *X. laevis* have so far not been reported to be transferred to any other aquatic host throughout its worldwide distribution. That is except the deadly Chytridiomycota fungus generally known as chytrid-fungus. This fungus has little or no effect on its vector the platanna but is deadly to any other amphibian it comes into contact with. It has now been confirmed that the drastic decline and in some cases extinction of amphibians is the result, amongst others, of the chytrid-fungus. And the origin of the vector and the chytrid is from South Africa.

An adult platanna, Xenopus laevis.



The tadpole of the platanna.



A micrograph of silver impregnated specimen of the adhesive disc, about 0.08 mm in diameter, of a ciliophoran urinary bladder parasite, Trichodina xenopodos.

Water KIDZ

Northern Cape pupils scoop first prize in water network competition

CF le Roux, member of the SAICE Kimberley Branch and Malcolm Pautz, 2015 SAICE president, with Aqualibrium winners Lourens van Niekerk, Frans Jacobs, Lohann Burger (Hoërskool Diamantveld) and Gaillard Rossouw, Business Unit Lead, Civil Infrastructure at AECOM.

A team from the Northern Cape town of Kimberley scooped first prize in this year's Aqualibrium-competition, hosted by the Southern African Institution of Civil Engineering (SAICE).

Water distribution systems are important to supply safe and clean drinking water to communities. In order to educate learners about the importance of water networks and expose them to the day-to-day challenges faced by water engineers in ensuring equal access to water by all, SAICE, introduced the annual Aqualibrium competition in 2003, in its hundredth year of existence.

The aim of the competition is to distribute three litres of water equally between three reservoirs (containers) placed randomly on a grid of 16 points. Participants build a pipe network between a water source and the three reservoirs using plastic pipes of different diameters. Teams are judged on how well they can achieve this task within a set period of time. To determine the winner the volume of water in each reservoir is measured and penalty points are calculated (teams are penalised for supplying less than or more than a litre per container).

The competition exposes learners to the practical application of processes that influence their daily lives, which is how water gets to their homes. They are made aware of the intricacies involved in the design of water distribution networks and the actual water delivery to households.

The grid used for the water distribution network is on a background that depicts the entire water cycle. This grid

The team from Winnie Mandela Secondary School, in Tembisa, hard at work building their water network.

intrigues learners, as well as educators, who find it a helpful educational tool. The competition creates awareness regarding the issues surrounding water in South Africa. It spreads the message that water is a precious commodity that should be recycled, reused, and respected, while the use of water should be reduced.

The group with the lowest number of penalty points wins the competition. Competition rules test the creativity of the teams,

for example, the main supply pipe has to be connected at point 1 on the competition sheet; pipes must align with the grid on the sheet, and where two or more pipes meet at a junction they must all be connected to each other. A maximum of eight lines on the sheet grid may be left without a pipe.

SAICE organise regional competitions through their branches across the country, and the regional winners are flown up to the first national finals held at the Pretoria Show. Following the success of the first event, the Aqualibrium competition has become an annual event on the institution's calendar.

It is interesting to note that all three winners of the 2014 competition are currently studying civil engineering, underpinning the value of continuing with these kinds of projects in order to make a difference to the priority scarce skills situation in South Africa.

This year's competition was co-sponsored by AECOM. Other sponsors included Bosch Stemele, Marley Pipe Systems and DPI Plastics. For the first time, the competition also included regional teams from Swaziland and Zimbabwe.

But it was the team from Hoërskool Diamantveld that turned out victorious, conceding only 45 penalty points. Representing their school was Frans Jacobs, Lourens van Niekerk and Lohann Burger. In the second place was the team from Merrifeld College from East London, represented by Kiam Venter, James Gibson and Dominique Plaatjes. The team from Mzilikazi High School in Zimbabwe achieved third place. This team was represented by Anita Dube, Vusumuzi Ngwenya and Freedom Mhondiwa.

A penalty score below 100 is considered excellent. Interestingly the minimum number of penalty points (and therefore the highest score) ever achieved was 30. This has been achieved twice in the national finals – the first time in 2008 by Brackenfell High School from Cape Town and the second time in 2012 by Port Rex Technical High School from East London.

Learners experience the competition as great fun and a valuable learning activity. A simple and fun activity, it doesn't matter what your age or level of learning. However, while the competition is simple to understand and fun to do, the underlying problem is highly complex: the three small reservoirs can be placed in more than 3 000 combinations, and potentially there are 280 billion possible pipe networks for each one of these combinations.

An important factor of the competition is the fact that it attracts entries from both privileged and under-privileged schools. Everybody stands a chance at winning and, through the years, about one third of national competitions over the years have been won by very underprivileged schools. The competition has also seen an increasing number of entries by mixed and all-girl teams – an indication perhaps that engineering is no longer seen as an exclusively male career choice.

For two consequence years, the Aqualbrium competition has been selected as a finalist of the National Science and Technology Forum-BHP Billiton Awards in the science communication and science awareness category. According to SAICE, the competition strengthens government's initiatives aimed at encouraging learners to take Mathematics and Science at school and to follow a career in engineering.

The team from Lenyora la Thutho Comprehensive School carefully selecting their network parts.

The competition has seen an increase in mixed girl-boy teams and all-girl teams competing through the years.

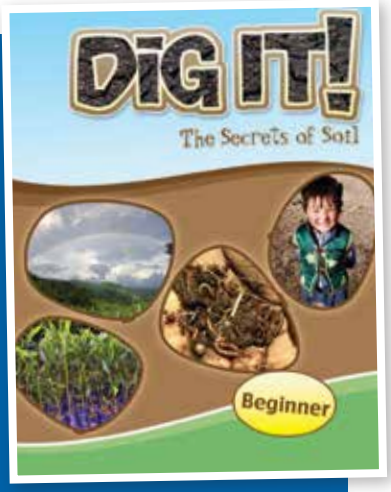
New educational tools help kids dig into soil science

A new series of educational materials is teaching children the importance of healthy soils for our food, environment, livelihoods and well-being.

Developed by the Food and Agriculture Organisation of the United Nations (FAO) as part of the 2015 International Year of Soils, the materials target children aged 5 to 14, using word games, puzzles, drawing activities and other interactive elements.

The four educational booklets are separately designed for beginner, intermediate, advanced and young adult students, with an accompanying educator's guide for teachers. Available in English, all of the booklets are available for download on the FAO International Year of Soils website (www.fao.org/soils-2015/resources/educational/en).

FAO is now collaborating with government who wish to translate the materials into additional languages to be used in primary and secondary school curricula. Once finalised, all of the materials will be available online for free use by member countries, teachers and students.



WRC at the forefront of emerging contaminants research

Despite considerable progress in water research undertaken over the past decade, there is increasing concern over the presence of the so called "emerging contaminants" (ECs) in the environment as well as their potential human health risks. The Water Research Commission (WRC) has realised that more needs to be done in order to understand, assess and manage the risks associated with emerging contaminants in the environment, to advance the science, as well as to communicate with the authorities and the public. The Commission, together with stakeholders in the water sector, met earlier this year to discuss the issue at length and share new research developments, as well as formulate a research strategy on how to tackle the problem in hand in order to improve our understanding on the full potential human and ecosystem health effects of these contaminants in our water resources. All stakeholders were in agreement that more needs to be done on this issue, particularly towards hazardous waste collections and more should be done to raise awareness among consumers on the proper disposal of pharmaceutical products, in order to safeguard against the entry of these contaminants into our water systems.

WRC CEO, Dhesigen Naidoo, emphasised the importance of engaging in such talks a as transformation of the current water treatment system through technology is fast growing.

Delegates at the dialogue.

Leanne Coetzee presented information on the latest research funded by the WRC on persistent organic pollutants and contaminants of emerging concern.

Prof Henk Bouwman of North-West University noted that increasingly, emerging contaminants were being detected at various concentrations in the environment.

The special guest speaker at the event was Dr Audrey Levine, a Fulbright Fellow and Programme Director at the National Research Council, in the USA.

4th YWP-ZA Biennial and 1st African YWP Conference

16 – 18 November 2015, Pretoria, South Africa

STOP TALKING, START DOING

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

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