

THE WATER WHEEL

ISSN 0258-2244

May/June 2012 Volume 11 No 3



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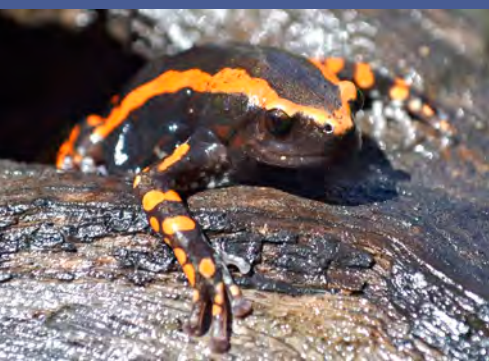
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THE WATER WHEEL is a two-monthly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organisation established in 1971 by Act of Parliament. Subscription is free. Material in this publication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

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New water resources assessment study launched

Cover: Hydrologists working on the latest water resources assessment study of South Africa are having to balance modern technology with a lack of data monitoring on the ground. See story on page 12.

Cover illustration by Ralf Broemer.





Science for change

There is a demand worldwide for a quicker realisation of the benefits of science and research to the real economy.

This demand is increasing exponentially in the wake of the many new challenges that we face globally. These range from climate change to reduced resource availability to an increasing global population to the global economic downturn. Society wants a quick return on its scientific investment.

The same is true in South Africa, and there have been several interventions to enable this realisation. This includes the development of a new Innovation Policy supported by a new law governing intellectual property from publicly funded research as well as the establishment of a public agency to support these endeavours in the form of the Technology Innovation Agency.

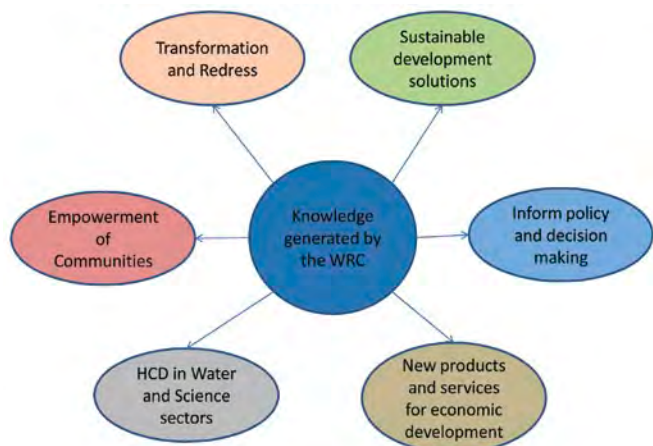
The WRC in its new five-year strategy is building on a

forty-year legacy of addressing this challenge. The Commission's goal is to provide new and innovative solutions to address the challenges of the South African water sector through research and development.

An important concept in this strategy is the WRC Knowledge Tree.

The WRC has already developed a strong track record in this domain in all areas of its operation. There are several examples in the agricultural, ecosystem, industrial, urban water and governance areas. A potpourri of examples are included in the box on the right.

The WRC in the next five years will with its various partners continue and accelerate the efforts to take advantage of the various opportunities and address the many water challenges in South Africa to elevate water to realising the important goal of water being a tool for development, empowerment and growth in a sustainable development paradigm.



The WRC Knowledge Tree

This is an important set of secondary outcomes that will govern the design and implementation of all WRC research and development projects. Every WRC project will be oriented towards being able to achieve at least one and in many cases several of these desired outcomes. In all cases a direct contribution to sustainable development solutions is an important goal.

EXAMPLES OF R&D PROJECTS IN THE WRC PORTFOLIO ILLUSTRATING HOW SCIENCE HAS LED DIRECTLY TO ECONOMIC DEVELOPMENT IN A SUSTAINABLE MANNER

- The international award-winning Water Administration System (WAS) is now applied on all the major irrigation schemes in South Africa, including the largest, the Vaalharts irrigation scheme, which reported savings of 17,5 million m³ of water in the first year it applied the system.
- The WRC has been supporting in-field rainwater harvesting-related research for the past 15 years. Through WRC research, this technology has been successfully transferred to members of 42 villages surrounding Thaba Nchu.
- Decades ago WRC research led directly to the first-time application of dry-cooled power generation in South Africa. Matimba Power Station, outside Lephalale, is the largest dry-cooling power station in the world which has led to significant water savings. Dry cooling uses less water than conventional power generation. The new Medupi Power Station, currently being constructed, will also be dry-cooled.
- The new Sanitation Technology Demonstration Centre located at the CSIR is a joint WRC/CSIR venture. The centre provides practical and visual information on various sanitation technologies that support sustainable human settlements.
- The Butterworth Schools Sanitation & Water Pilot Project has been successfully initiated by the WRC, with partners Irish Aid, the Eastern Cape Department of Education, CSIR and Amanz'abantu. Through this project, emergent locally-based micro-entrepreneurs have been trained and mentored to undertake the routine servicing of water and sanitation facilities at all schools of the Butterworth Education District. The project made use of the 'Social Franchising System' concept developed through WRC projects. Around 400 schools have been serviced and 6 emergent franchisee micro-entrepreneurs have been established and nurtured, with around 25 sustainable jobs created.
- The WRC funded the development of the Building Block Methodology (BBM) for the determination of the 'Reserve' in rivers. The BBM was developed after it was found that international methodologies did not entirely meet South Africa's needs. The methodology has now been developed to the point where it is one of the few advanced environmental flow methodologies in the world with a formal manual.
- Waste minimisation clubs (or WasteMin clubs) have been found to be a good way of improving local industries' environmental performance by promoting cleaner production. Previous WRC-sponsored research led to the establishment of two WasteMin clubs – one in the metal finishing sector in the greater Durban Metropolitan area, and the second one, a cross-sectoral club in the Hammarsdale region, both in KwaZulu-Natal. These clubs proved to be a success, with open sharing of information and ideas among club members, financial benefits to the companies and a reduction in their environmental impact.





Letters to the Editor

'New' algae treatment technology not so new

I receive the *Water Wheel* on a regular basis and really enjoy your articles regarding development and successes pertaining to water treatment.

Some (many?) years ago I worked at the (then) National Institute for Water Research (1980). At the time Dr LRJ van Vuuren was the Head of Department and Dr Cillié was Director.

Reading the article on the Rietvlei Dam and the Rietvlei Water Treatment Works ('The changing face of Rietvlei Dam' in the *Water Wheel* January/February 2012) I noted that the process of dissolved air flotation is used to concentrate and recover the activated sludge produced in the water treatment works.

I noticed some similarities between the introduction of the water circulation machines (SolarBees) to circulate the water to the extent of having an aerobic as well as an anaerobic phase, to optimise algal growth.

My project at the time was to construct an algal pond canal system (similar to the design developed in Israel) and to use the pond to grow and produce algae from raw sewage. This dual purpose pond was intended as a water treatment process as well as a source for animal and fish food.

In place of dissolved air flotation of algae, it was found that dissolved oxygen flotation was as effective, and was also much more cost-effective using solar power. Greater detail can be given should there be interest in this regard. At the time the Zeta potential was established of the algae in order to be able to optimise flocculation and flotation.

After leaving the NIWR for Pelindaba, I lost contact with the process of algae production. Perhaps there is a possibility of some information being exposed that has become redundant.

John Viviers, Laboratory Manager, Kyalami

Water Wheel reaches kids in Limpopo



I would like to thank you for the information we received for our rural water schools project. Your Water Kidz special edition was given to grade seven pupils at Mabje-a-kgoro Primary School, in Limpopo. This project will be taking place every year and we will appreciate any learning information that you can supply us with to encourage learning and reading in rural schools.

Nakampe Modike, Rand Water

International toilet summit comes to SA

South Africa will host the 12th Annual World Toilet Summit at the Durban International Convention Centre in December.

This year's theme is 'African Sanitation: Scaling Up – Dignity for All'. The event, hosted by the South African Toilet Organisation (SATO), is expected to attract more than a 1 000 delegates and exhibitors.

SATO and its international equivalent, the World Toilet Organisation, aim to improve the quality of human life and to ensure dignity through the provision of adequate sanitation solutions to all. It is estimated that up to 2,6 billion people throughout the world do not have access to proper sanitation. This contributes to the spreading of diseases and, in many cases, death, especially children under the age of five years.

"Every 15 seconds a child under the age of five dies from diarrhoea-related illness. In a modern society this would be deemed unacceptable, yet millions of African children face these diseases every day," said Alfie Heeger, SATO founder.

While the World Toilet Summit is being held in South Africa, the summit will focus on the sanitation-related challenges faced by Africa, especially the plight of the 600 million people, mostly women and children, who do not have access to proper toilet facilities.

Among others, the summit organisers have launched an African Toilet Design Competition. The competition criteria have been designed to attract toilet designs that promote safety, reliability, affordability and dignity. The winning designs should be able of mass production and rapid implementation.

For more information about the summit and the competition, Visit: www.satoilet.org or www.world-toilet-summit-2012.co.za

Water by numbers

- **R25-billion** – The funds government is hoping to attract from foreign investors to help revive its ageing water infrastructure, according to Minister of Water & Environmental Affairs, Edna Molewa. A total of R75-billion has been earmarked in the national budget to build new and revamp old water and sanitation infrastructure over the next three years.
- **12** – The number of women who are set to benefit financially from the Adopt-a-River project in Limpopo where they are help to regularly clean two springs in Mphagane and Sheshe villages outside Thohoyandou. Vhembe District Mayor, Florence Dzhombere, announced that the municipality would seek funding for the women, who have been volunteering.
- **179 793** – The number of students studying in the fields of engineering and science at South Africa's universities this year, according to the Department of Higher Education and Training. The figure is up 6,8% from 2011.
- **R2,8-billion** – The funds budgeted for infrastructure projects by the Mpumalanga Provincial Government in the coming financial year. Among others, the provincial government is planning seven new clinics, bulk water infrastructure and the upgrading of roads and classrooms.
- **198** – The estimated number of invasive alien plant species in South Africa, according to the Department of Environmental Affairs. These plants cover about 10% of the country.
- **R1,1-billion** – The estimated annual budget of Working for Water. Since its inception in 1995, the programme has cleared more than 2 million ha of invasive alien plants and provided training for more than 25 000 people a year, mostly women.



Low impact, energy-saving water scheme for PE

An innovative design will minimise the energy needs and bio-physical impact of the low-level water supply scheme from the Nooitgedagt Water Treatment Works to the Motherwell Reservoir in the Nelson Mandela Bay Municipality.

Construction of the pipeline began in May last year, and addresses the growing demand for water by residential developments within the metropolitan area and by the Coega Industrial Development Zone. Consulting engineering firm, SRK Consulting conducted the environmental impact assessment (EIA) and is responsible for monitoring the implementation of the environmental management plan (EMP) on behalf of the municipality.

The project's lead engineering consultant, AfriCoast, identified several alternatives for the pipeline route and narrowed these down to two options, namely a high-level scheme, which would have involved a parallel alignment along the existing pipeline route, over a distance of 32 km and with top water level of 235 m above mean sea level at the Grassridge Reservoir; and a new, low-level scheme pipeline route of 38 km, with a top water level of 156 m

above mean sea level at the Olifantskop Reservoir.

The latter option was chosen, routing the pipeline along contour lines, and as far as possible along existing roads, cut lines and property boundaries. Despite being some six kilometres longer, it had the advantage of using less electricity, according to Robyn Thomson, environmental scientist at SRK's East London office; this saved on costs and reduced the project's carbon footprint.

The EIA also revealed that the low-level route would have less botanical impact, according to Rob Gardiner, principal environmental scientist at SRK's Port Elizabeth office. In particular, it would be better for the species of special concern in the area (aloes and carportrotums) for the endangered ecosystems and for the many endoreic pans in the area (these have no outlets to rivers or sea). It would also be better for the visual impact that would result from clearing vegetation in the servitude – especially as the pipeline crosses the main route from Port Elizabeth to the Addo Elephant National Park.

The project will be vital in boosting the municipality's current water supply. **Source: SRK Consulting**



Water on the Web

<http://iresearch.worldbank.org/PovcalNet>

PovcalNet is a new interactive Open Data tool from the World Bank for poverty and inequality measurement. Through this tool, users get access to the data and can replicate the bank's estimates or calculate poverty rates using any poverty line or country groupings they like. The World Bank's methodology is based on consumption and income, adjusted for inflation within countries and for purchasing power differences across countries.

<http://www.wrc.org.za/Pages/KnowledgeHub.aspx>

The Water Research Commission has started a process to make electronically available all of its annual reports from the start of the Commission forty years ago. Visit the above website and click

on the 'Annual Report' button on the left-hand side of the page.

http://www.whymap.org/why-map/EN/Downloads/Global_maps/globalmaps_node_en.html

A new map of River and Groundwater Basins has been prepared to help water resource policymakers and planners visualise, at the broad scale and in general terms, the potential interaction between surface water systems and the underlying groundwater resources for their conjunction uses. It aims to promote the fact that groundwater has to play an equal part in the management of water resources, since aquifers are a major source for drinking water supply, agricultural irrigation and industrial production, and are vital for sustaining the natural environment.

National hearings on water and sanitation start – lack of proper services 'startling'

The South African Human Rights Commission has launched the first phase of its national hearings on water and sanitation.

This is after the Commission's recent investigations into two complaints on the right to water and sanitation. Both matters concerned the construction of unenclosed toilets – the first in the Makhaza area, Cape Town, and the second in the Rammolutsi Township, Viljoenskroon. In both cases, the Commission found that the municipalities responsible had violated residents' right to human dignity, privacy and a clean environment by installing toilets without enclosures.

Further investigations into the state of sanitation in South Africa by the Commission found that around 11% of households still have no access to basic safe sanitation, while another 28% of households have sanitation services which do not meet the standards due

to lack of maintenance, inadequate water supply or lack of emptying of pit emptying services. At the current rate of delivery (around 300 000 households a year) the country will not achieve its target of providing universal access to sanitation services by 2014.

"The startling finding is that, while access to sanitation is increasing (albeit at less than an optimal pace) from a functionality and adequacy point of view, up to 28% of households are at risk of service failure and/or are experience service delivery breakdowns," the Commission said in a report, released in March. The majority of the unserved population is resident in the rural settlements of KwaZulu-Natal, North West and Eastern Cape. The Commission also expressed its concern over the general state of the sanitation bulk infrastructure in the country, for example the general poor state of wastewater treatment plants.

Government recognises importance of aquaculture



Agriculture, Forestry and Fisheries Minister, Tina Joemat-Pettersson, says government recognises the importance of aquaculture and the role it will play in sustaining production of food fish.

"The South African government recognises the importance of aquaculture and the role it will play in sustaining production of food fish, as the natural fish resources become further challenged and [put] wild stocks under pressure," she said. Joemat-Pettersson was speaking at the sixth session of the Food and Agriculture Organisation (FAO) on Fisheries sub-committee in March.

The Minister said adapting to the effects of climate change will be the hallmarks of Smart Aquaculture in the next decades. "Using resources efficiently and adapting to the effects of climatic and other shocks will be the

hallmarks of Smart Aquaculture in the coming decades. We are all aware that aquaculture is the fastest growing food production sector in the world, and as it continues to grow, a decreasing percentage of food fish and other aquatic animals will be provided from the already heavily exploited natural resources."

According to the Minister, the fast growth of aquaculture worldwide is a result of intensification of production methods, and the improvement of the efficiency of breeding and growing fish, lobsters, molluscs, and other highly-valued aquatic food species.

She said the aquaculture sector finds itself confronted with problems similar to those known from the intensive and growing agricultural sector. "As is the case with terrestrial farming, intensification of animal production and specifically fish farming leads to the emergence of different challenges that we have to confront and overcome. It is at platforms like these that such challenges are discussed and solutions shared and adopted by different stakeholders, be it best management practices, new technologies and/or general governance issues."

Source: BuaNews

Kruger hosts world scientists

The Kruger National Park recently hosted 230 delegates representing 75 different institutions from ten countries at the 10th annual Savanna Science Network Meeting.

The programme explored about 111 presentations covering a wide range of topics and research conducted in all Savanna national parks and protected areas. "This meeting has grown from one encouraging scientific dialogue around biological research in the Kruger National Park to one now encouraging a broader social-ecological savanna focus," explained Scientific Services Head of Department, Dr Danie Pienaar.

Many topical issues in ecological science were covered, including tourism

related issues, biodiversity, land use and land use change effects, the human interface with parks, rivers, wetlands, and freshwater management, climate change effects and anticipated ecosystem responses as well as large mammal ecosystem drivers and their mechanisms of change.

According to Dr Pienaar, the meeting provided an opportunity for scientists to share their latest findings conducted in national parks and other conservation areas within the savanna vegetation.

"It is an important forum for dialogue and debate about ecological science and conservation matters as well as a pivotal point for future research collaborations."

Source: SanParks

WISA past president appointed Golder MD and Vice President

Former President of the Water Institute of Southern Africa (WISA) and well known figure in the water sector, Dr Ralph Heath, has been appointed the new MD and Regional Vice-President for Africa of Golder Associates.

This is after former post-holder, Dr Fred Sutherland, was appointed to global Vice-President: Corporate Development, following 12 years of successful leadership in Africa.

Welcoming the appointments, Dr André van Niekerk, a Director of Golder's global board, said that Fred had brought strong leadership to the employee-



owned company which led to significant growth in Africa. "He aggressively pursued the integration of Golder in Africa with the rest of the firm globally. I am confident that Ralph will continue strengthening Golder's record of technical and client service distinction and enable us to continue to attract quality people."

Water diary

ECOTECHNOLOGIES

JUNE 25-27

The IWA Conference on Ecotechnologies for Wastewater Treatment will be held in Santiago de Compostela, Spain. In this conference wastewater treatment will be faced from a global approach meaning that issues about new processes and technologies will be considered along with those related to emissions, economy and environmental analyses in an integrated perspective. *Email: ecostp@novedar.com or Visit: www.novedar.com/ecostp*

Hydroinformatics, 'Understanding changing climate and environment and finding solutions', will take place in Hamburg, Germany. A special focus of this conference will be the assessment of the impact of climate and environmental changes on our aquatic environment as well as the development of suitable adaptation and mitigation measures. *Enquiries: Conference Secretariat; Gerlinde Löbkens; Email: loebkens@tutech.de; Visit: www.hic2012.org/*

FAECAL SLUDGE MANAGEMENT

OCTOBER 29-31

The Second International Faecal Sludge Management Conference will take place in Durban. The call is open for papers or workshops dealing with innovations and experiences with all aspects relating to the accumulation, treatment, removal, beneficial usage, transport, pit emptying, new sanitation technologies, management arrangements, economics and disposal of faecal sludge derived from on-site sanitation systems. Expressions of interests and abstracts not exceeding 500 words should be submitted to fsm2@pid.co.za before 31 May, 2012. *Enquiries: Jay Bhagwan, Email: jayb@wrc.org.za*

YOUNG WATER PROFESSIONALS

JULY 7-13

The International Young Water Professionals Conference 2012 will take place in Budapest, Hungary. The conference will provide a forum for young researchers and professionals working in water and wastewater research, technology and management to present their work and meet their peers from all over the world. *Email: ywpc2012@iwahq.org or Visit: www.iwa-ywpc.org*

HYDROINFORMATICS

JULY 14-18

The International Conference on



New frog species discovered in New York and New Jersey



US scientists have proven that even among city skyscrapers new things can be discovered when they found a new frog species in the ponds and marshes of Staten Island, mainland New York and New Jersey.

The discovery was made by researchers from Rutgers University working together with colleagues from UCLA, UC Davis and the University of Alabama.

The yet unnamed frog – which biologists historically mistook for a more widespread variety of the leopard frog – may even extend into parts of Connecticut and extreme north-eastern Pennsylvania. Researchers believe that

these are likely the same leopard frogs that completely disappeared from Long Island and other parts of the area over the last few decades.

“It is very surprising for a new species like this to have been unrecognised in this area until now,” said Rutgers doctoral candidate Jeremy Feinberg, who made the initial discovery. “Their natural limited range coupled with recent unexplained disappearances from places such as Long Island underscores the importance of this discovery and the value that conservation efforts might have in the long-term survival of this urban species.”

Source: Rutgers University

Online tool helps companies address water risks

World environmental organisation WWF and German development finance institution DEG have launched a global online tool that enables companies and investors to address their water-related risks.

The practical online questionnaire not only identifies water risk in supply chains and investment portfolios, but also provides practical steps to mitigate risk.

Population growth and climate change are set to increase pressure on vital freshwater resources, with serious consequences for nature, people and economies. “Water scarcity is a concern for conservationists, communities and companies alike. But simply competing for every last drop will do no good to anyone. If water users become aware of their water risks – and work together to find solutions – we can ensure that

people, nature and businesses have the water they need,” said Jim Leape, WWF International DG.

Virtually every business sector relies on water. Yet many executives remain unaware of how water flows through their supply chains, or how the health of the environment where their facilities are located could affect long-term profitability. “Water availability is the most underestimated critical issue for the companies we are financing, but we believe that financial institutions can help make the companies more sustainable in their performance. Our work with WWF looks beyond the risks and shows practical ways how to change them into business opportunities,” said Bruno Wenn, Chairman of DEG.

To access the tool, Visit: <http://water-riskfilter.panda.org/>

Value ecosystems when managing water use, UN study urges

Recognising the valuable services provided by ecosystems such as wetlands and forests – and not only focusing on water productivity in agriculture – can improve livelihoods and help meet the rising demands on the world’s water resources in a sustainable way, according to a new report from the United Nations Environment Programme (UNEP).

Increasing water productivity and efficiency is a key concern for policymakers in many parts of the world, especially as rising incomes and changing diets are set to increase the demand on water resources that are already under pressure.

The report, *Releasing the Pressure: Water Resource Efficiencies and Gains to Ecosystem Services*, which was produced by researchers at the Stockholm Environment Institute, urges policymakers and resource managers to shift from the traditional focus on water productivity per unit of agricultural yield (‘more crop per drop’), to a broader view of the concept, which would include ecosystem services.

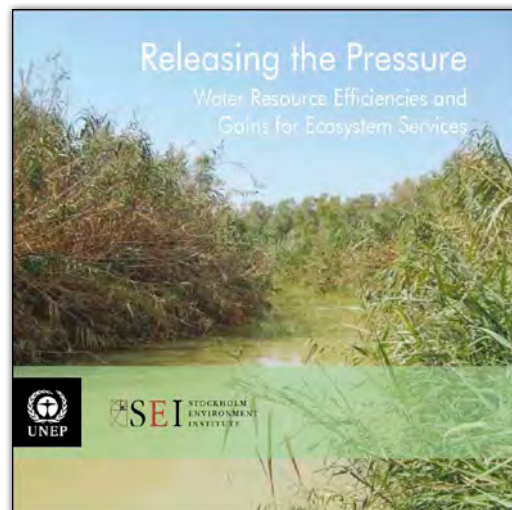
Such an approach would take into account water regulation and purification, pollination, erosion control and other ecosystem services performed by wetlands and forests. These water-dependent services, and the communities that rely on them, can be adversely affected when water is siphoned off from rivers or streams, or drained from marshes, for agricultural use.

Balancing the goals of agricultural land (agro-ecosystems) with these kinds of ecosystem services – using some of the techniques outlined in the UNEP report – can serve to improve human well-being, increase crop yields in a sustainable way and support the transition to a low-carbon, resource-efficient and equitable Green Economy.

“Assessing water productivity narrowly, for example, by simply looking at crop, fodder and forest products – will continue to under-value the role of water for wider society and the economy,” said UNEP Executive Director, Achim Steiner.

“Recognising the wider benefits generated by water, for example nutrient flows, cooling, providing habitats, and other supporting and regulating ecosystem services, is the aim of our work. Water may soon be a critically restricted resource for a growing number of people. In a few months, world governments will meet for the UN Conference on Sustainable Development (Rio+20). This report addresses an important issue for future sustainable development: how to enhance the productive and equitable use of water for multiple needs.”

• **To access the report, Visit: www.sei-international.org/mediamanager/documents/Publications/Air-land-water-resources/sei-unep-releasing-the-pressure.pdf**



New UN agreement seeks to protect environment from hazardous electronic waste

A new United Nations agreement seeks to diminish the damage caused by electronic waste through the collection and recycling of hazardous materials, as well as by introducing measures to improve the ways in which this equipment is managed.

According to the UN Telecommunications Union (ITU), electronic waste is expected to grow exponentially, particularly in developing countries, yet only 13% of electronic waste is recycled, many times without safety procedures in place. The agreement, which was signed between ITU and the Secretariat of the Basel Convention (SBC), intends to strengthen collaboration between information and communications technology (ICT) and environmental policymakers to address this issue.

"The ICT sector is already making significant progress in improving its environmental performance and reducing e-waste through improved best practices and standards," said ITU Secretary-General Hamadoun Touré. "The collaboration with the Secretariat of the Basel Convention will allow the global community to address this ever-increasing problem through a holistic approach, involving the recycling industry as well as environmental policy makers."

Electronic waste, which contains toxic materials used in the manufacturing process, can cause widespread damage to the environment and human health. Through the agreement, which was signed in March, ITU and SBC will exchange information and practices and will work on joint programmes and projects to set ICT standards and raise awareness among countries about electronic waste management.

Source: UN News



Australian scientists develop new salt-tolerant wheat variety

Australian scientists have introduced a salt-tolerant gene into a commercial durum wheat, which has produced spectacular results in field trials.

"Salinity already affects more than 20% of the world's agricultural soils and is an increasing threat to food production due to climate change," noted CSIRO scientist, Dr Rana Munns. In close collaboration with researchers at the University of Adelaide, Dr Munns and the team now understand how the gene delivers salinity tolerance to the plants.

The research is said to be the first of its kind in the world to fully describe the development of a salt-tolerant agricultural crop – from understanding the function of the salt-tolerant gene in the lab to demonstrating increased grain yields in the field.

"Under salty conditions, the new salt tolerant breeding line has outperformed



normal commercial durum wheat, with increased yields of up to 25%," CSIRO research Dr Richard James, who led the successful field trials. "Farmers now have additional options for maximising profits by growing premium wheat in those more saline paddocks which they may

typically avoid or reserve for less valuable crops."

The results have been published in the journal, *Nature Biotechnology*. In the photograph, Drs James and Munns examine a salt-tolerant wheat trial near Canberra.

International Water Management Institute wins international prize

The International Water Management Institute (IWMI) has been named the 2012 Stockholm Water Prize Laureate. Headquartered in Colombo, Sri Lanka, the organisation won as a result of its pioneering research that has served to improve agriculture water management, enhance food security, protect environment health and alleviate poverty in developing countries. The prize will be presented at World Water Week in Stockholm on 30 August.

IWMI has been a driving force promoting policies and techniques to help farmers produce 'more crop per drop', and to implement solutions that enable agriculture to cultivate enough food to feed the planet's growing population with limited water resources. In its citation, the Stockholm Prize Nominating Committee states: "IWMI is the foremost organisation in agricultural water management. Their work has

led to new policies and investments in agriculture that have not only enabled more productive use of water, but have enhanced food security, economic development and environmental health around the world."

On receiving the news, Dr Colin Chartres, IWMI DG said: "It is an incredible honour for our organisation.

The real winners, of course, are IWMI's dedicated staff who, for just over a quarter of a century, has consistently delivered research of the highest quality. Their work has led to new profound influence on water management policy throughout the globe, delivering real benefits for some of the poorest people on earth."



Top SA companies not yet ready to face SA water challenges – Report

While evidence is mounting that South Africa is facing a water crisis of ‘substantial proportions’, the country’s largest companies still have much work to do in order to mitigate any water-related risk to their operations. This is according to the first *Water Disclosure Report* involving the country’s largest companies.

The report, released by the National Business Initiative (NBI) earlier this year, forms part of a global initiative and allows companies the opportunity to publicly report on ‘how they are managing their water risks, leveraging opportunities, and contributing to the overall management of the planet’s fresh-water resources’. A total of 56 companies from the 100 largest companies listed on the Johannesburg Stock Exchange (JSE) were invited to participate in the survey on which the report is based. Of these, 26 responses were received.

According to NBI CEO, Joanne Yawitch, the relatively low response received is an indication that a significant number of large South African companies are not yet ready to disclose information on water-related issues due to lack of adequate or reliable data, or perceive themselves to have low exposure to water-related risk. “This raises the question of whether companies are sufficiently aware of the multiple uses surrounding water with particular reference to water scarcity, projections of the impacts on water availability due to climate change, energy requirements and rapid urbanisation. It also begs the question of whether companies are able to assess the value of water to their business.”

Naturally water scarce, South Africa’s water resources are increasingly threatened by population growth, growing demand and concomitant human-induced pollution. While the role of business in mitigating and adapting the country’s emerging water crisis is still being debated, the JSE 100 companies will need to show leadership in sustainably managing the water resources on which they rely for their day-to-day business operations, according to the NBI.



For the vast majority of companies who responded to the survey the water risks are clear – 85% identified at least one water risk at the direct operational level. These risks pertain mainly to physical water scarcity, declining water quality and inadequate infrastructure and reputational damage.

However, the report also showed a clear mismatch between the magnitude of identified risk and the governance of the risks. Despite the level of substantive risks and opportunities reported, only 65% of the company respondents reported having board oversight of the water risks and opportunities. Furthermore, less than 70% have a water management policy, strategy or plan in place. “Due to the nature of water risks, the number of stakeholders involved, the technological and capital requirements for solutions and the timeframes involved, companies need to act now in support of a consistent and stable supply of water,” the report states.

The report identified a need to improve target setting as well as verification of accounting data as only 65% of respondents reported some form of water-related goal or target setting. “The majority of these targets are quantitative efficiency (or intensity) targets. Only two respondents reported on setting absolute reduction targets while four reported on setting explicit water quality discharge targets...The low level of explicit targets

reported for water quality overall is particularly concerning in light of the acute water quality predicament facing South Africa,” the report stated.

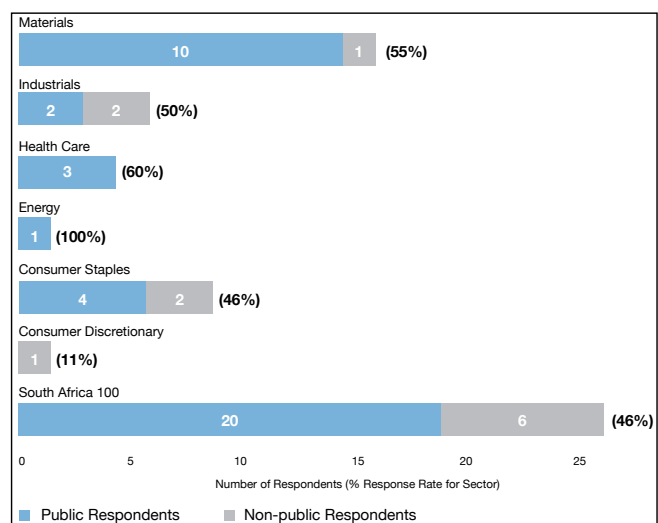
“It is in the long-term interest of business that it plays a leading role in finding and driving solutions to South Africa’s water management challenges,” the report concluded. “Key to this will be the extent to which business can successfully and transparently engage in collaborative efforts and management initiatives – with other businesses, government regulators and policy makers, non-governmental organisations, local communities and other stakeholders at the catchment management level.”

Main recommendations for companies to mitigate against water-related risks

- Board level oversight needs to be improved. Governance systems that are appropriate to the severity and immediacy of the risk should be implemented
- Companies need to understand better the potential for risk through their supply chains by asking key suppliers to report on their water-related risk
- Companies need to set quantitative targets to reduce absolute water usage and improve water quality
- Companies need to act now. Risk and opportunity timelines are near term (0-5 years), so the need to act is immediate.
- Finding solutions requires a multi-stakeholder effort.

Source: NBI

• To view the report, Visit: www.nbi.org.za/Lists/Publications/Attachments/218/CDP%20Water%20Report_Mar2012.pdf



Responding companies by sector

New from the WRC

1841/1/11 (Technical Report) & TT 514/11 (Scenarios)

Water Scenarios – The Water Sector Institutional Landscape by 2025 (M Claassen; N Funke & S Nienaber)



The research project set out to build knowledge about key drivers and uncertainties related to the future of the South African water sector institutional landscape. The project team made use of a broad range of methods, such as interactive workshops, semi-structured interviews and a Web-based survey to get inputs from rural- and urban-based stakeholders from different cultures and with different educational backgrounds. Scenarios are offered to provide perspectives on possible future conditions by identifying important and uncertain drivers of change and describing plausible but diverse future conditions.

1886/1/11

Assessment of Handwashing and Hand Hygiene Behaviour (M Wilkinson; A du Toit; D Mashimbye and S Collignon)

Hands are one of the chief vehicles of transmission of diarrhoeal disease, especially the hands of mothers and caregivers. Good hand hygiene thus plays a significant role in preventing and minimising these diseases. The main aim of this project was to assess handwashing and hand hygiene behaviours of South Africa. This report includes the framework, which formed the basis of the method of the hand-hygiene assessment, and the result from the assessment of hand hygiene at three sites, an urban, peri-urban and rural site in Tshwane Metro Municipality.

KV 279/11

The Influence of Social Welfare Grants on the Dependency on and Valuation of

Wetland Ecosystem Services (F Lewis; J McCosh & Z Nxele)

The primary objective of this study was to qualitatively explore whether the introduction of social welfare grants has resulted in a change in the perceived value of, and associated behavioural responses to, wetland ecosystem services by local households. The Mbongolwane Wetland (in KwaZulu-Natal) was used as a case study. This wetland is well known for its importance to local households and small-scale farmers through providing services such as water provision, resource harvesting and crop production. A livelihoods-system approach was used to explore the cause and effect relationships between the condition of the environment and local livelihoods. The body of the report focuses on the key findings, conclusions and recommendations from the study.

KV 1807/1/11

Influence of Unpaved Access Roads of Surface Runoff within Forest Plantations (M Moodley; TR Hill & H Beckedahl)

This study was aligned towards understanding the influence of forestry access roads on runoff, sediment production and soil water movement. In the presence of only a few local past studies much of the work has been exploratory in nature and strong reliance had to be made on past international studies for guidance. Techniques and systems had to be refined or adapted to local site conditions and equipment had to be customised to meet the objectives of the study, much of which has been met although perhaps not fully realised from the two years of field monitoring. The study was conducted under natural rainfall over two full summer seasons.

1901/1/11

Interactive Risk Approach: An Approach to Reducing Risks from Informal Settlement Waste Streams: Community-based Risk Assessment with Municipal Partnerships (A Lagardien; D Cousins & A Benjamin)

Informal settlements continue to be a feature of South African urbanisation. Municipalities of cities and towns continue to be confronted by mounting backlog realities while national and provincial human settlement strategies seek alternative approaches. A major challenge in this context is that inadequate waste management within informal settlements produces downstream flows of human waste that either bypass overburdened infrastructure networks or contribute to their dysfunction. As a result, increasing pollution of deteriorating river systems poses a public health threat that goes beyond individual rights to basic services to the collective interests of broader society. An interactive approach to risk reduction was developed and then field-tested in different case study settings. Based on field research in two differing municipal regions with eight informal settlement case studies, the tools were refined.

Report No: 1797/1/11

Implementation of Strategic Adaptive Management for Freshwater Protection under the South African National Water Policy (C McLoughlin; J McKenzie; M Rountree & R Grant)

There is increasing awareness of the complexity of systems, and a trend in different fields that envisage management as learning, rather than control. Managing complex systems characterised by uncertainty requires an adaptive, learning-by-doing approach. The conventional tools of risk assessment, planning and design, and the methodological and explanatory reductionism of conventional science have proven inadequate for managing large ecosystems sustainably. The focus of this study was to implement and test emerging principles of strategic adaptive management, in connection with freshwater protection – an important component of the South African national water policy.

Report No: 1707/1/11

The South African Diatom Index (SADI) – A Preliminary Index for Indicating Water Quality in Rivers and Streams in Southern Africa (WR Harding & JC Taylor)


The core aim of this project was to provide a water quality index, informed by diatom species and abundance, which would encompass South African river and stream conditions and, at the same time, incorporate ecologically relevant characteristics of endemic species – i.e. supporting the derivation of ecological inferences from diatom assemblages. Creation of the first version of the South African Index has been achieved through the collection, processing, examination and analysis of 768 individual samples – together with their associated water quality information.

Report No: TT 486/11

Mine Water Research Impact Assessment (Frost & Sullivan)

Formal mining has been in existence for about 120 years in South Africa. The Water Research Commission (WRC) has been extensively involved in mine-water research since 1989. To date, the Commission has produced around 39 research studies focusing on mine-water management, which typically considers water requirements and the pollution potential of South African mines. In an effort to retain and strengthen its position as a 'value for money' institution delivering research and innovations that contribute to socio-cultural, economic, political, technical and environmental aspects in South Africa, the WRC has embarked on a number of studies to assess and portray the impact of its research programmes and resulting products and benefits to the country. Overall, the report concludes that the WRC research on mine-water management has had a positive impact across economic, environmental, social and health aspects of South African society.

To order any of these reports, contact Publications at Tel: (012) 330-0340; Fax (012) 331-2565; E-mail: orders@wrc.org.za or Visit: www.wrc.org.za



Taking on the challenges of water resource assessment

What promises to be the most accurate assessment of South Africa's water resources to date has just been launched by the Water Research Commission (WRC). Lani van Vuuren investigates the challenges – and the opportunities – offered by the new Water Resources 2012 (WR2012) study.

It is well known that water is South Africa's scarcest resource, and that the country counts among the world's 30 most parched. With an average annual rainfall of only around 465 mm a year (about half the world's average) and a concomitant high evaporation rate, South Africa has a total mean annual runoff of less than 50 000 million m³/a – only 50% of the mean flow of the Zambezi River.

As water will always be in short supply in South Africa, it is extremely important to make sure that the water we do have is developed and managed optimally, not only for the country's citizens and industries, but also for the sake of

its aquatic environment. This makes quantifying exactly how much water we have one of the most important tasks to be undertaken in the local water sector.

A COMPLEX TASK

In addition, South Africa's climate is characterised by extremely complex hydrological features, explains Wandile Nomqophu, WRC Research Manager. "Not only is it highly variable in time and space, it is not unusual to experience extreme climatic conditions in different parts of the country at the same time, for example, drought in one part and floods in the other. Undertaking regular water resource assessments, thus not only allows us to quantify our available water resources, it also helps to augment our understanding of how our natural hydrological cycle behaves."

These assessments fall within the realm of hydrology – a science which, according to Prof Denis Hughes, Director of the Institute of

Water Research at Rhodes University, deals with the occurrence, circulation, and distribution of water on and within the Earth's surface. Basically, he writes in the *South African Geographical Journal*, hydrologists are faced with the (often, daunting) task of using a limited number of quantitative and qualitative observations, together with a conceptual understanding of the operation of processes involved in the movement of water through the hydrological cycle, to estimate the occurrence of water at various locations.

This is usually done with the assistance of hydrological models, which not only have to consider the precipitation and runoff at a certain point, but also other variables such as topography, vegetation cover and rooting characteristics, relative geology and drainage density, to name but a few. To complicate matters, hydrology is a 'living' process, adds Nomqophu. "Raindrops do not fall in exactly the same place every time it rains." This makes long-term monitoring all the more important.

PC POWER

The WR2012 study, which kicked off in April, is the sixth comprehensive national water resource assessment to be undertaken in South Africa since the first was completed in 1952. Financed by the WRC, the study is being undertaken by a consortium of consulting engineering firms, led by SSI. The objective of all of these studies has been to assist decision makers at all levels of government to make informed choices about all policies concerning South Africa's water resources.

According to water resource assessment veteran Dr Bill Pitman, now an independent consultant, each water resource assessment study builds on the technology and knowledge gained from the one before. "A huge factor has been the exponential growth in computing power over recent decades – said to double every two years. This has made it possible to develop better tools using increasingly powerful computing power." So with each consequent study there has been more precision and consequently more accuracy and confidence in the results.

Geographical information systems (GIS) and Google Earth, for example, would not have been possible a few decades ago, Dr Pitman points out. "The WRSM2000 catchment model [now used widely in the South African water resource assessment process] contains a wealth of information over and above what was available from earlier studies." Thanks to the growth in computing power, this catchment model now takes into account the impacts of various forms of land use (e.g. afforestation, alien vegetation, urbanisation, dam construction and water transfers) on water resources, and also models the interaction between surface and groundwater. "Added to all this is the ever-growing user-friendliness of computers and the vast storehouse of the Internet," notes Dr Pitman.

An interesting phenomenon has been that, with each consequent

study it has been found that South Africa actually has less water resources available than previously thought. This is not the result of climate change, says Nomqophu, but actually the result of more precise and accurate assessment. The latest calculation of naturalised mean annual runoff for the country, as determined by the WR2005 study (launched in 2009), has been calculated at 49 210 million m³/year – 4% less than the figure of the 1990 study.

Every study takes three to four years to complete, with at least a decade lapsing between studies. However, with constant change occurring in the South African water sector coupled with increased demands and the looming threat of climate change, the WRC has decided to attempt to shrink this gap. "The current study will be completed around 2016, however, even before the launch of the final results we hope to start the next study," reports Nomqophu.

WR2012 will include updating of all hydrological data up to 2010, further enhancements to WRSM2000, revised groundwater data, and a monthly time series of present day flow, to name but a few. The project will also create a publicly-accessible, Web-based and interactive reporting

system to continually quantify both the surface and groundwater resources of South Africa.

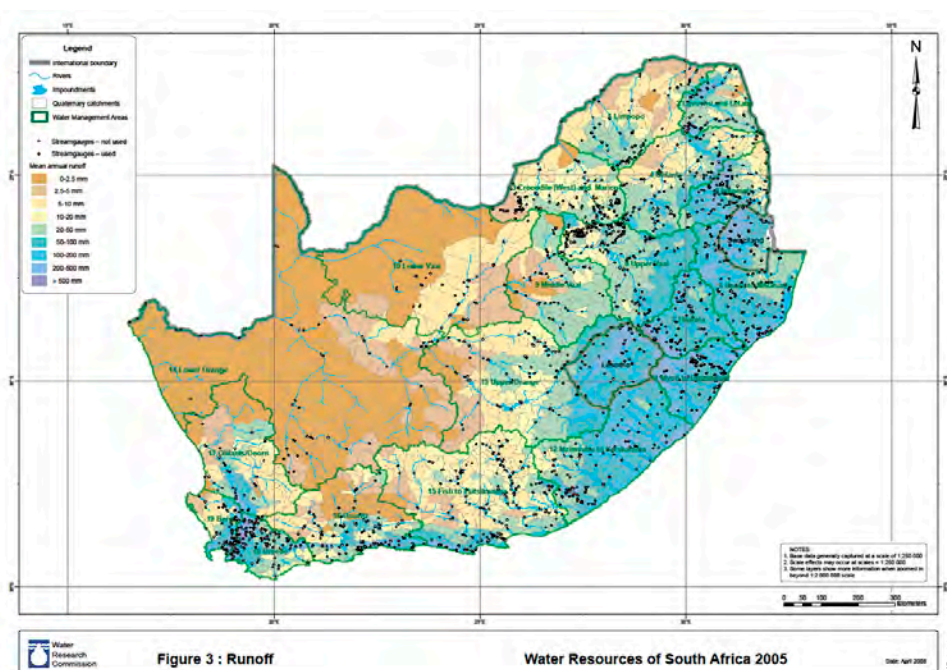
WHERE HAVE ALL THE GAUGES GONE?

All the computing power in the world is useless, however, without the appropriate data to be processed. Spatially representative, long-term consistent records of rainfall and streamflow data are essential for achieving a high level of understanding about water resources.

Dr Pitman explains: "Rainfall is the primary input to hydrological computer models, not only to determine streamflow, but also irrigation requirements and net evaporation from reservoirs (an important factor in the determination of yield). On the other hand, information on streamflow is necessary to calibrate the hydrological models to ensure we get the most accurate determination of our water resources. Thus to undertake water resource assessment without rainfall and streamflow data is a bit like trying to plan for population growth without a proper census."

A gross concern for hydrologists has been the decline of streamflow and rainfall data following the 1990

Mean annual runoff across South Africa.



study. And it is this decline that will by far the greatest challenge to overcome in the WR2012 assessment.

The Department of Water Affairs (DWA) is the responsible body for the collection of streamflow data, part of which is the construction of gauging weirs and the installation of sensitive equipment, which is often the target for vandalism. The main reason for the decline, however, is probably one of insufficient budgets, says Dr Pitman. Nomquphu confirms this.

Another reason is the lack of adequate manpower, which in turn is also budget-related. "Available DWA staff members are dedicated to providing the best service they can, often under very difficult circumstances," notes Dr Pitman. Despite their efforts, however, the number of useful streamflow gauges has decreased from a peak of 450 in the late 1980s to less than 350 in 2004.

The number of useful rain gauges paints a far more serious picture. Most rainfall data is collected by the South African Weather Service (SAWS), who depends largely on private individuals who do the work on a voluntary basis. When the use of time series of flow was first adopted in the 1981 survey, the period prior to 1920 was rejected owing to the relative scarcity of stations open

before that date. "However, we are now in a similar position with the decline in number from a high around 1970 to only about half of that in 2004, which is roughly the same number of stations in 1920," reports Dr Pitman. Some water management areas (WMAs) are worse off, than others. For example, WMAs No. 4 (Olifants) and No. 13 (Upper Orange) now have less than half the number of stations open than was the case in 1920.

Concern over the lack of data points was already highlighted in the WR2005 study and, while several recommendations were made then to responsible authorities, no concrete action has as yet been undertaken to reverse this precarious situation. However, the WRC hopes to stimulate change in the right direction soon. "We have already had informal talks with SAWS and DWA, and workshops are planned for later this year which will involve a wider range of stakeholders to see how we can reverse this downward trend," Nomquphu tells *the Water Wheel*.

In addition, WR2012 team members are working towards recommending the minimum monitoring requirements that the country cannot do without in order to understand and effectively manage its water resources. This information

will be made available within the next two years.

After the WR2012 study is completed South Africa will have a good database covering 90 years, so all is not lost, notes Dr Pitman. "However, if the future is characterised by more severe droughts than we have experienced in the past – either through climate change or other factors – our diminishing network will leave us with ever-increasing gaps in our knowledge of the country's water resources."

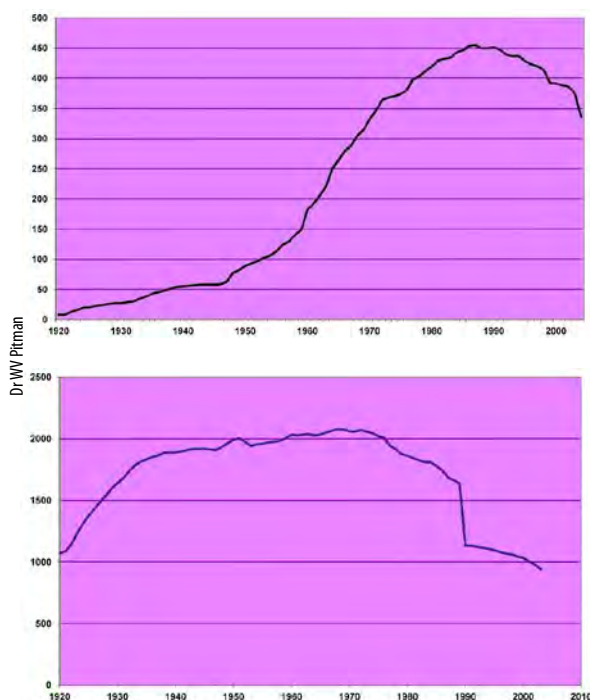
Another challenge to water resource assessment is increased land use and the effect this has on our water resources. The WR2005 study calculated that around 98% of the country's surface water resources were already allocated, which means that many catchments are also over-allocated. Actual monitoring of water use, however, is sorely lacking. "Abstractions and return flows have grown considerably through the decades, but these records are in the hands of individual concerns and local authorities, whose enthusiasm for monitoring usually falls way behind that of DWA," says Dr Pitman.

With surface water resources almost over-allocated, the understanding of the country's groundwater resources is of critical importance, notes Nomquphu. "Efforts are underway to develop a



Land use, such as irrigation, has a huge effect on water resources, yet monitoring of water use on the ground is sorely lacking.

RGBStock



Top: Number of useful flow gauges open in each year.

Above: Number of rainfall stations open in each year.

consistent approach to assess this strategic resource as part of the integrated water resource assessment for the country. However, sustained groundwater monitoring is alarmingly patchy, and this lack of reliable and continuous groundwater records data is a major concern.”

The worsening of water quality is another factor that will be generally addressed in the WR2012 study. After all, water that is too heavily polluted for use is as bad as having no water at all. Nomqophu also bemoans the lack of young hydrologists entering the sector. “Government departments, such as DWA, used to be the premier training ground for young hydrologists and hydrological engineers, however, this fell by the wayside in the mid-1990s. It is extremely important for the sustainable use and management of our water resources that we retain and grow our body of expertise.”

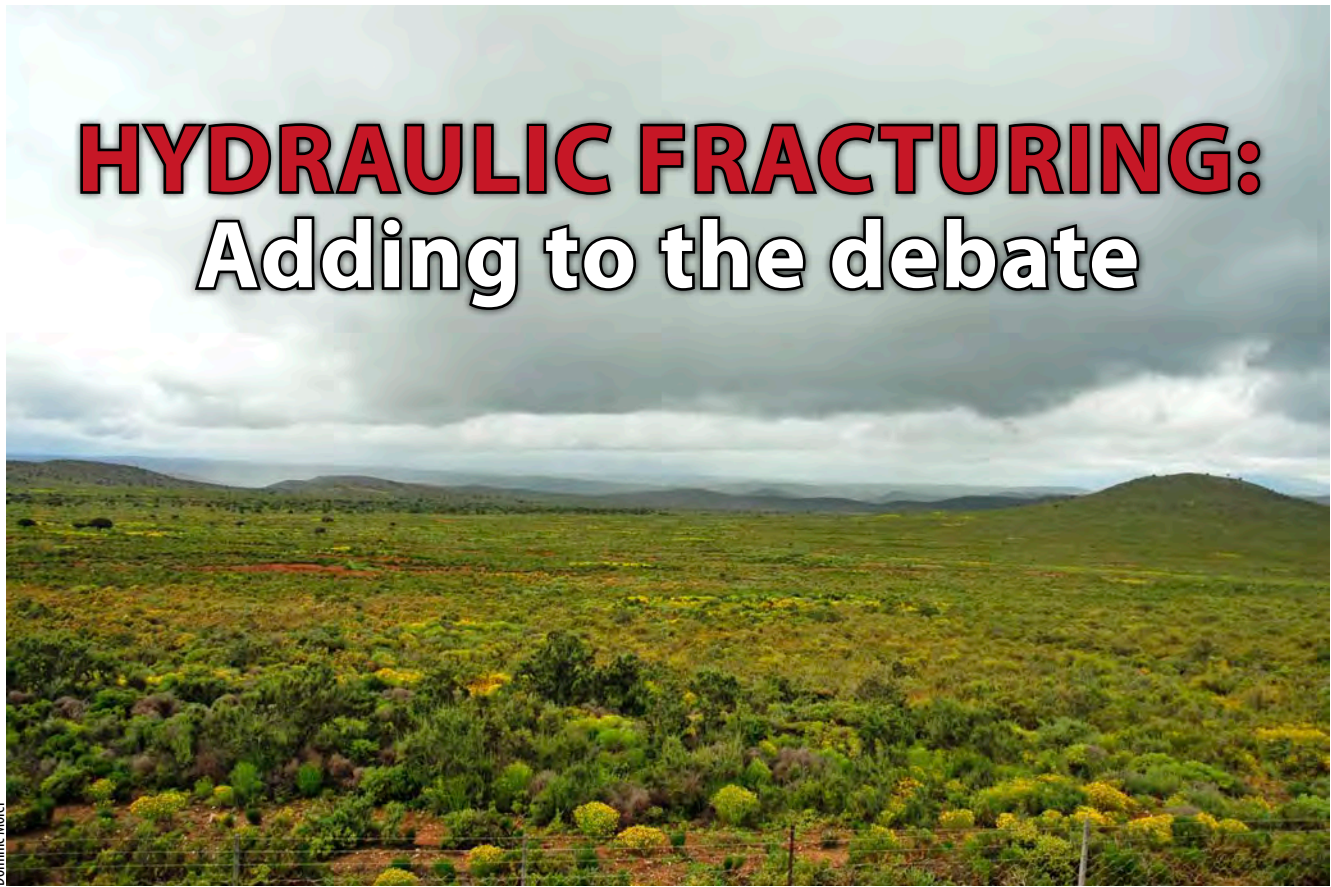
South Africa has come a long way in water resource assessment since that first study by Prof Des Midgley 60 years ago. It will be up to all stakeholders to work together to ensure that this extremely important body of knowledge remains intact for generations to come. □

WATER RESOURCE ASSESSMENT THROUGH THE DECADES

- **1952 study** – The first national water resource assessment study in South Africa was undertaken by Prof Des Midgley, former head of the Witwatersrand Hydrological Research Unit. Back then, Prof Midgley was in the employ of the Department of Irrigation (as it was then known). He collected all the available data and built up consolidated national and regional files, which, up until that time, had been scattered among various authorities in the country. The study was undertaken prior to the advent of the computer age in South Africa, and all calculations were done manually or with the aid of adding machine or slide rule. While Prof Midgley was working on the study he was called to the construction site of the Albasini Dam, in Limpopo. It is said that he took all of his work with him, working late into the night to complete the first comprehensive survey of the surface water resources of South Africa. His efforts earned him his PhD and established him firmly as the leader in water resource hydrology in the country.
- **1969 study** – This study was undertaken by Prof Midgley and Dr Bill Pitman with the benefit of a mainframe computer (single user). The standard means of communication with the computer was via punch card.
- **1981 study** – The study, again led by Prof Midgley and his team at Wits, was undertaken prior to the advent of the personal computer in South Africa. The computing environment was now one of large, mainframe computers linked to a number of remote terminals. This was the first study which made use of the now internationally-recognised Pitman deterministic rainfall-runoff model, which Dr Pitman developed in 1973. Not only could the model be used to extend flow records (as dictated by the availability of suitable rainfall records), but it could also be used to facilitate the process whereby records affected by land use could be ‘naturalised’ by removing the effects of irrigation, afforestation and all water transfers.
- **WR90** – By this time the personal computer had become a useful and versatile analysis tool. In addition, the consulting engineers who undertook this study could take advantage of geographical information systems (GIS) software, which was already being used for a wide range of applications. Prof Midgley also led this team. The study used an updated, PC-based, version of the Pitman model. The new model, known as WRSM90, was of modular construction with four types of module – runoff, irrigation, reservoir and channel. This survey produced the most comprehensive set of maps issued yet, containing information such as rainfall, evaporation, runoff, land cover and water use, geology, soils, sediment yield and vegetation, to name but a few.
- **WR2005** – This was the first study to include the interaction between surface and groundwater in the modelling process. It was also the first water resources assessment survey to address water quality issues. WRSM90 was upgraded again; this time a Windows version was created (WRSM2000), which included, among others, modelling of the surface-groundwater process, improved modelling of the impacts of afforestation, irrigation, alien vegetation and mining areas, as well as improved modelling of wetlands. Water quality was addressed with a new model, called SALMOD. The main innovation of WR2005 was the issue of a DVD with a ‘dashboard’ (menu system) containing all the models, electronic maps, spreadsheets, time-series data files of point rainfall, catchment rainfall and natural flows, reports, WRSM2000 networks and associated data files.

Source: WV Pitman, 2011. ‘Overview of water resource assessment in South Africa: Current state and future challenges’ in Water SA 37(5), p 659-664

HYDRAULIC FRACTURING: Adding to the debate



Dominic Morel

A recently completed study solicited by the Water Research Commission (WRC) looks at what we know about hydraulic fracturing, and what we should know if this is allowed to go ahead in South Africa.

Article by Petro Kotzé.

Since the announcement that gas exploration might take place in the Karoo, the topic has caused both elation and concern – often placing polarised opinions directly opposite to each other. On the one hand, there is the prospect of job creation and a reduced dependency on coal-generated electricity. On the other, concern has been raised that the process could pollute already scarce water supplies and the pristine way of life in the Karoo.

Lack of scientific proof to back-up claims on any side of the fence has fuelled the confusion. A recent WRC report aims to fill at least some

of these gaps by looking at what we currently know about the process of hydraulic fracturing, and what could happen should the process take place. Led by Prof Gideon Steyl, research fellow at the Institute for Groundwater Studies (IGS) and a Professor in Chemistry, the key issues that the report focuses on are the shale gas reservoir potential in the main Karoo basin as well as other potential areas of interest; the location relative to and relationship between the shale gas reservoirs and the Karoo aquifer systems; and the potential impacts associated with hydraulic fracturing and accompanying processes. The research group also consisted of Prof Gerrit van Tonder, Professor in Geohydrology at the University of the Free State and Dr Luc Chevallier of the Council for Geoscience.

Prof Steyl is careful to point out that the observations and findings made are neither totally

comprehensive nor exhaustive, since little data is available in the public domain on hydraulic fracturing in South Africa. “We are being honest about what we know and don’t, know” he says. To shed some light on the matter Prof Steyl was one of a group of researchers that visited the Marcellus shale area in the USA, where hydraulic fracturing is currently taking place. Sites visited included the Pennsylvania drill rig in Whitneyville, the fracking rig in Grover, the wellfield north of Whitneyville, the Williamsport Municipal Water Authority and the United States Geological Survey (USGS) office in Harrisburg.

WHAT IS IT?

Shale gas is defined as gas generated from organic-rich shale. The target gas is methane, which is an energy source and can be used for the production of fuels or as a power

source for electricity generation. Methane is a dry gas and represents the final stage of hydrocarbon thermal maturation.

Organic-rich shales were originally muds deposited in marine or lacustrine basins, the organic material being derived mostly from algae, spores and pollen. These muds became buried and lithified over millions of years and generated various hydrocarbons with increasing depth of burial. Between two and four kilometres burial depth, oil is produced, between four and five, wet gas is produced and between five and six, dry gas, including methane, is produced. Deeper burial, such as what happened in the Bokkeveld Group (for example) results in low-grade metamorphism, the termination of hydrocarbon generation and the formation of graphite from the organic material. Deep core samples in the main Karoo Basin indicate that the Ecca Group shales have potential to generate dry gas south of approximately latitude 29°S.

Here, the Whitehill Formation contains the highest total organic carbon contents and presumably has the highest potential for generating dry gas. The most promising area to source gas from the Whitehill Formation is south of the southern limit of dolerite intrusion, but north of the Cape Fold Belt. In the region south-east of a line from Ficksburg to north of Laingsburg, where the top of the Lower Ecca Group is deeper than the minimum proposed depth of 1 500 m for hydraulic fracturing, shale with the best potential for dry gas lies in an east-trending zone between 30 km north of the southernmost exposures and 50 km north of the southern limit of dolerite intrusion.

These dolerite intrusions, says Prof Steyl, is what makes the South African geology unique, especially in comparison to areas where shale gas occurs in America. The intrusive dolerites are present over about 390 000 km² of the main Karoo Basin underlain by the Ecca Group (which increases the thermal

maturity leading to the generation of dry gas). This causes gasification of the carbon in the shale that can only lead to gas being vented or being trapped in the sub-surface, potentially making it unavailable for hydraulic fracturing.

It is important to keep in mind that researchers only have a relative idea of the area's geology, "not an absolute" says Prof Steyl. The only way to get a clearer idea is by exploration and, he adds, even though some exploration has taken place in the area, it has not been comprehensive enough to create a clear picture of what exactly is to be found under the surface of the Karoo Basin.

HOW IS IT DONE?

During the hydraulic fracturing process, drilling starts vertically, with casing installed until a depth where all viable aquifer systems (potable water) cannot be affected. Drilling is continued for a few meters and cement pumped into the casing, until the space between the wellbore and the outer casing is entirely filled with cement.

As the vertical drilling is continued intermediate casing is inserted to stabilise the deep borehole. This also serves to isolate and separate brines and hydrocarbons which might be trapped in the sub-surface,



Courtesy Gideon Steyl

preventing borehole interference, natural gas contamination and protection of surface aquifer systems.

At the kick-off point drilling techniques are applied to force the drilling to occur in a horizontal direction through the production zone, which can stretch for as much as three kilometres. Once the horizontal borehole has reached its target extend, production casing is installed and cemented into place to prevent leaking. Subsequently the production

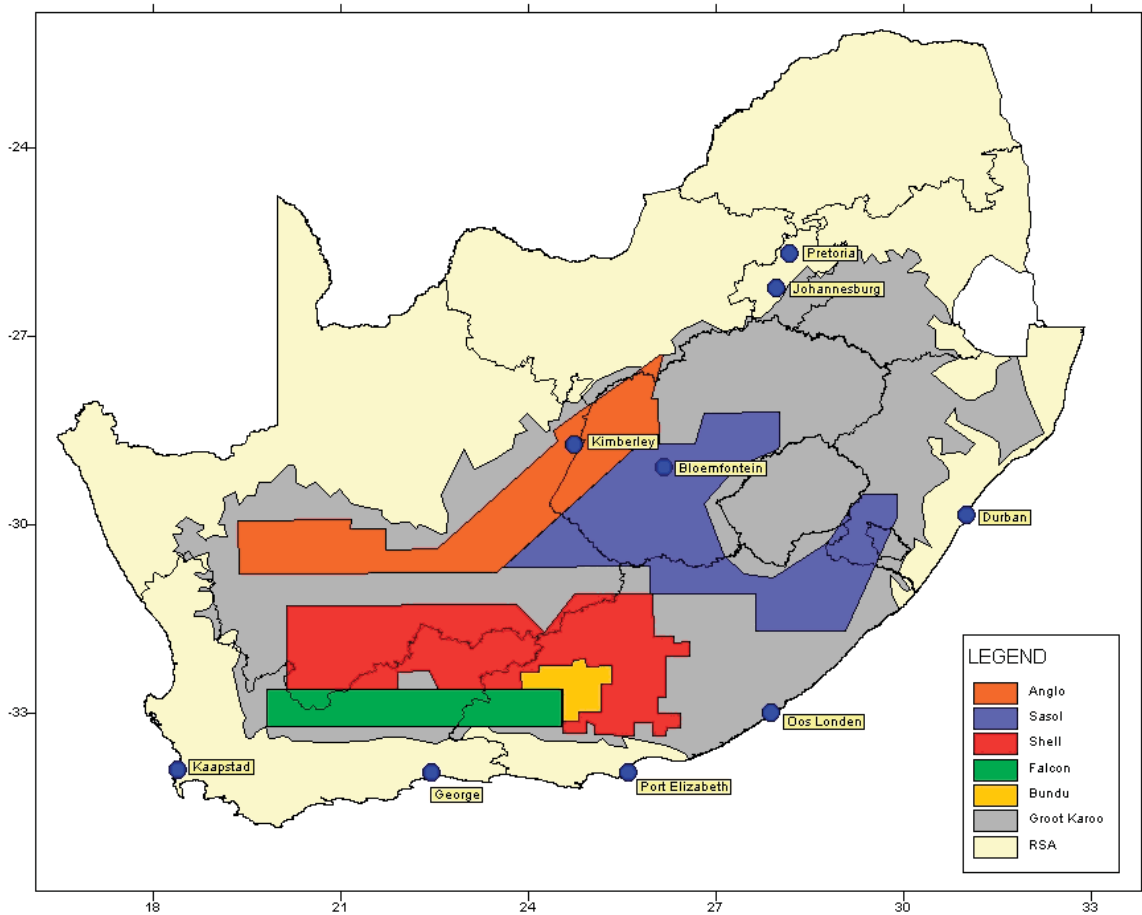
Above: A drilling rig near Whitneyville, which was one of the sites in the USA that researchers visited for the recent WRC research project.

Below: A clearing in the State of Pennsylvania (USA) where the pipeline for the hydraulic fracturing is running.



Courtesy Gideon Steyl

There are currently a number of companies that have exploration rights to investigate natural gas resources in Karoo type formations. The area available for natural gas development is substantially larger than just the Karoo, with exploration areas covering six of the nine provinces in South Africa. A five-spot pumping test in the Waterberg has been operated since 2004 by Anglo Operations and 20 boreholes have been drilled in the main Karoo since the beginning of 2008 to test for coal-bed methane production potential. Most of the exploration rights for natural gas resources have been allocated for shale gas development.



casing is punctured at selected points where fracturing fluid will be pumped through at increased pressures to release the shale gas. This method (hydraulic fracturing) is commonly used to enhance the production of low permeability formations such as tight sands, coal beds, and deep shales.

The chemical composition of the fracturing fluid, as well as the rate and pressure at which it is pumped into the shale, are tailored to the specific properties of each shale formation and, to some extent, each



The main concerns regarding the possible impacts of hydraulic fracturing on the environment (main concerns indicated in red).

'Fracking' can be a confusing term since the term actually implies two very different processes. Hydro fracturing refers to the process of fracturing with water only, while hydraulic fracturing refers to fracturing using water with a chemical mixture.

borehole due to differences in volume. When the pressure increases to a sufficient level, it causes a hydraulic fracture to open in the rock, propagating along a plane more or less perpendicular to the path of the borehole direction.

There are a number of concerns regarding hydraulic fracturing, of which eleven were identified in the report. Should the process be approved, regulation to prevent environmental damage is the most important success factor, says Prof Steyl. A major concern in natural gas development is the prevention of migration of gas or other fluids out of the reservoir and into overlying strata, particularly fresh water aquifers. In cases where this has occurred, according to the report, it has been the result of well construction problems and not of hydraulic fracturing itself.

Water use, especially in a water-scarce area like the Karoo, is another major distress factor. A fracture treatment of a typical Antrim gas well, as located in Antrim, Michigan requires about 50 000 gallons (189 m³) of water. This amount can increase to as much as 5 000 000 gallons (18 927 m³) or more, the same amount typically used by eight to ten acres of corn during a growing season.

Proper management of produced water is particularly essential in protecting public health and the environment, says Prof Steyl. In Michigan, for example, produced water must be managed and disposed of according to strict rules.

Accept for these three concerns, identified as the most probable points of impact, other main issues include the migration of gas, the management of produced water and the identification of chemical additives. Spills of chemical additives or flowback water can have adverse environmental or public health impacts.

The application of good management practices would significantly reduce these events from occurring. Additionally, monitoring by the regulatory body would ensure a

continuation of good practices and, notes Prof Steyl, the monitoring team must be independent from the State, even though fines would be paid to the State. Ideally, such a team must consist of water, terrain and drilling specialists.

RECOMMENDATIONS

The most important conclusion from this report is regulation,” stipulates Prof Steyl. “What is pumped in and out, the remediation and handling of the terrain and even water purification should be closely monitored.”

For example, Michigan’s laws and rules effectively protect water and other natural resources as well as public health and safety from potential adverse effects of hydraulic fracturing. Their Department of Environmental Quality has more than 50 staff employed in enforcing these state requirements and is taking a proactive approach in

Below: A hydraulic fracturing operation with a Christmas tree blow-out preventer system in the middle of the picture, while the chemical components delivery system is on the right-hand side and one perforation transport truck is stationed on the left-hand side.



Courtesy Gideon Steyl



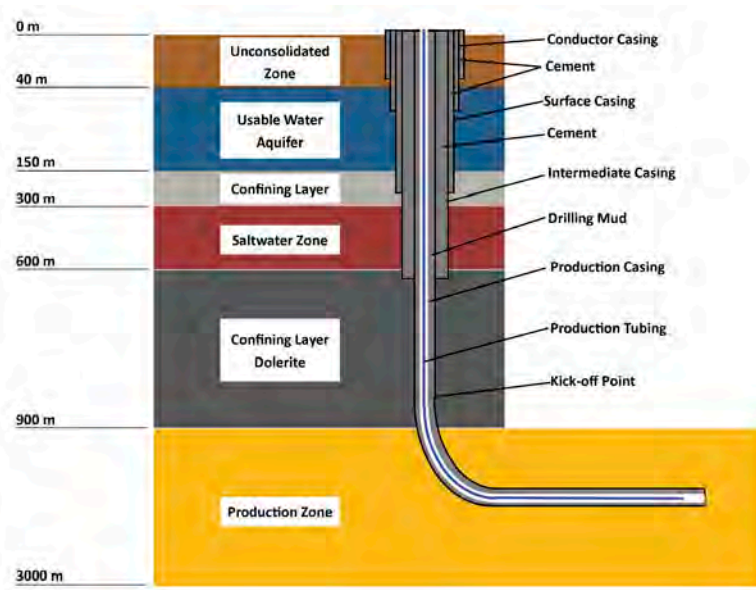
Courtesy Gideon Steyl



Courtesy Gideon Steyl

Top: Hydraulic fracturing drilling operations taking place at Whitneyville.

Above: The water containment facility on a hydraulic fracturing site consisting of 56 large containment vessels.



Left: A conceptual model of borehole drilling arrangement for gas exploration.

Bottom left: The production facilities during the remediation of the site. Additional water containment facilities are shown in the background which will be removed before full production commences.

Below: A pond facility on site with geotextile liner and moundings. The research report recommends that these facilities should not be used in the South African environment.

atmospheric, soil, surface water and groundwater (isotopes, macro, micro and metal species) environments. It should be filed at the DWA and the DEA, the results verified by an independent body and the data be made available to the public (this is one of the greatest drawbacks in the international arena).

- All associated drilling footprints, including return water containment structures should be fully remediated to natural levels before the contractor is allowed to leave the site.
- Wastewater containers should be used to store and transport wastewater from the site to a suitable water treatment plant that can correctly purify the water.
- Strict legal licensing restrictions should be applied by the government in which the licence for drilling is leased to the drilling company.

Nevertheless, many questions remain. It is still unknown what the potential for shale gas extraction is or what the effect of our unique geology will be on such a project. A pilot study which involves exploration and drilling by an independent body of researchers could be an answer, concludes Prof Steyl.

The final WRC report, *State of the art: Fracking for shale gas exploration in South Africa and the impact on water resources* (Report No. KV 294/11) will become available later this year.



Courtesy Gideon Steyl

addressing large-scale hydraulic fracturing as well as other issues associated with deep shale gas development.

Should the hydraulic fracturing process be used and allowed by the government of South Africa, the most critical recommendations to be followed are:

- No chemicals should be injected into the boreholes without full disclosure of the type of compound used.
- Waste pits should be avoided as far as possible.
- Drilling should be conducted at least 10 km from any residential areas.
- Drilling logs should be filed at the Department of Water Affairs (DWA) and Department of Environmental Affairs (DEA), and should be publicly available within six months of drilling completion.
- Only best-practice guidelines should be implemented.
- A pilot study should be done a year in advance in which a monitoring network of boreholes (both shallow and deep) is installed to monitor the impact of hydraulic fracturing on the area.
- A baseline should be constructed before any drilling is done in an area, and should include



Courtesy Gideon Steyl



iSimangaliso Authority

Tropical storm brings much needed relief to iSimangaliso

While other parts of southern Africa cursed its destructive power, Tropical Storm Irina has brought much needed water to one of southern Africa's premier water heritage locations, iSimangaliso Wetland Park.



Leigh-Ann Morrison

Above: Establishment of a spillway to join the uMfolozi River and Lake St Lucia estuary began in March, and was helped along by heavy seas and rain.

Left: The uMpathe River flooded its banks on the Western Shores.

Encompassing 9% of the country's coastline, iSimangaliso has, until recently, been weighed down heavily by the burden of a decade-long drought. However, five years to the day after Cyclone Gamede thrashed the coast and broke open the Lake St Lucia estuary, Tropical Storm Irina brought similar heavy rainfall and high waves to the country's first World Heritage Site. Classified as a 'moderate storm' by the South African Weather Service, Irina crashed into the eastern coast of southern Africa at the end of February and during the start of March.

The previously parched pans on the eastern and western shores of

Right: The 2 km-long sand berm between the estuary and Maphelane before Irina's arrival.

Below right: The 2 km-long sand berm between the estuary and Maphelane after Irina's arrival.



iSimangaliso Authority



iSimangaliso Authority

Lake St Lucia have been recharged, with lake levels rising significantly. As winter approaches, this is good news for the park's 800 hippopotami and 1 200 adult crocodiles, as well as the resident herds of buffalo and elephant.

Over a 48-hour weekend period at the start of March, the highest rainfall figures in iSimangaliso were

recorded at Cape Vidal (375 mm), Charters Creek (350 mm), Mission Rocks (Eastern Shores section) (346 mm), and Sodwana Bay (304 mm). Thankfully, no significant damage was reported to infrastructure.

Meanwhile, management expressed its satisfaction at the way nature had advanced the park's efforts towards rejoining the Lake

St Lucia system with the uMfolozi River. The park has been working actively since 2011 to rejoin the latter river to Lake St Lucia, from which it has been artificially separated since 1952. This has greatly reduced fresh-water inflow to the lake.

Combined with drought conditions, the St Lucia estuary mouth has remained closed to the sea for the



Heather Fitchet

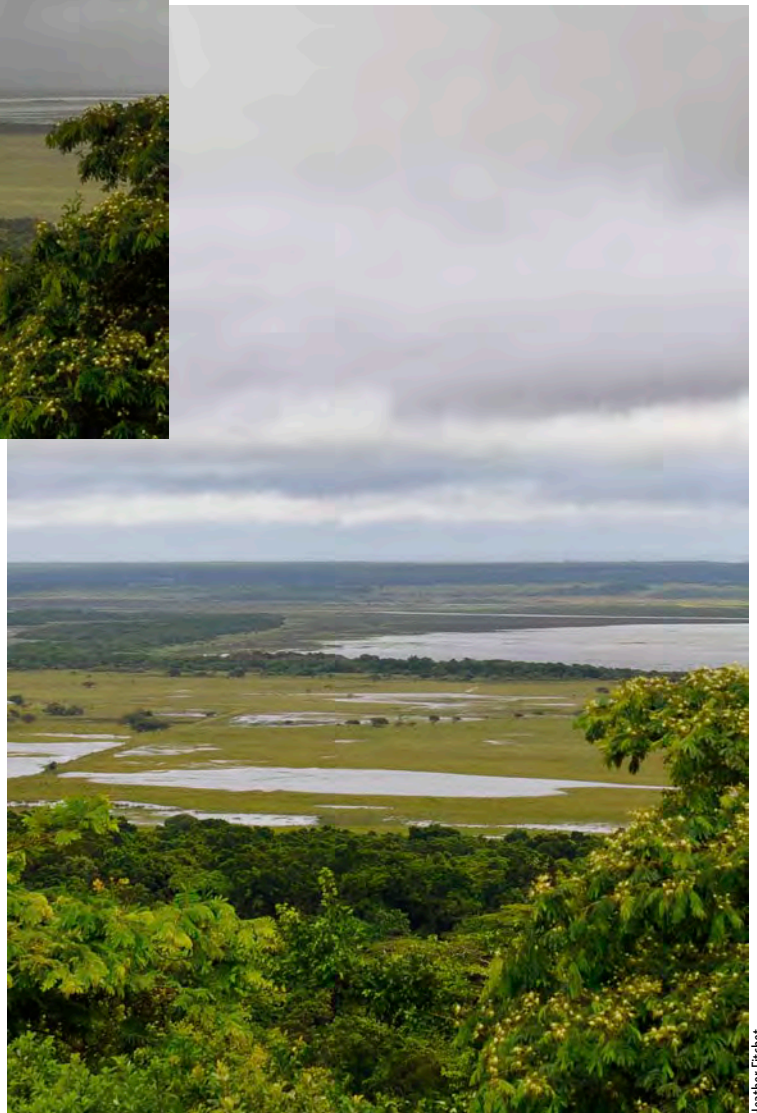
Left and below: A view over the Eastern Shores before and after Tropical Storm Irina, taken on 2 and 4 March, 2012, respectively.

St Lucia estuary and uMfolozi River had not joined yet and the estuary mouth had not opened to the sea. However, the situation remained dynamic and was being closely monitored by staff.

“The uMfolozi River mouth has continued to ‘eat’ its way north towards the estuary, taking with it the thousands of tons of unwanted dredger spoil and marine sediments creating the artificial berm,” noted iSimangaliso CEO, Andrew Zaloumis. “The management strategy of iSimangaliso to allow the uMfolozi and Lake St Lucia estuary to re-join, in line with new scientific work, is rapidly being brought closer by the extreme weather currently being experienced.” □

best part of the last decade. This has resulted in St Lucia being unable to function as an estuary. In November 2011, the processing of breaching the uMfolozi River started. The process was facilitated through the assistance of a tracked excavator and wheeled dozer. Among others, the work entailed the removal of old dredger spoil and marine sediments that had been deposited on the breach creating an artificial berm deflecting the river away from St Lucia.

Following Tropical Storm Irina, the uMfolozi River flowed from bank to bank while the 2 km-long sand bar at the uMfolozi River mouth was overtopped as a result of the high swell. At the time of writing, the



Heather Fitchet

FROG COUNT –

Study confirms rich bio- diversity of amphibians in Kruger



Hyperolius marmoratus

They may not count among the traditional big five, but this does not make the conservation of frogs in the Kruger National Park (KNP) any less important. Lani van Vuuren reports on a current project to assess the biodiversity of frogs in the park.

Like many freshwater species, frog populations are declining globally. There are many factors that threaten their survival, among them habitat destruction and pollution. Even animals living within the confines of national parks are not safe from these influences, as the death of hundreds of crocodiles in the KNP a few years ago demonstrated.

However, while the increasing degradation of catchments feeding the KNP's rivers are well known the potential effect of this on the park's amphibian population has not been studied in depth – until now. A current study, funded by the Water Research Commission and led by independent researcher, Dr Wynand Vlok, is assessing the biodiversity of frogs associated with the major pans and rivers of the KNP as well as the physical and chemical factors affecting their distribution.

The study, which kicked off in 2009, has surveyed 45 wetlands (different types of pans) throughout the park as these are associated with the greatest biodiversity of frogs. In addition, the Luvuvhu, Shingwedzi, Letaba, Olifants, Sabie and Crocodile river systems have been sampled. Frogs are either physically identified and counted or identified through their calls.

SPECIES RICH

The study has confirmed the high biodiversity of frog species in the KNP. During the last survey, 33 frog species were recorded (the current record is 35 species). This included several new records and voucher specimens collected for several species, including the Sharp-nosed Grass Frog (*Ptychadena oxyrhynchus*), Southern Ornate Frog (*Hildebrandtia ornate*) and African Bullfrog (*Pyxicephalus edulis*).

A new record of a tadpole of the East African Puddle Frog (*Phrynobatrachus achruidoides*) was also recorded from Hapi East Pan. “This is the first confirmed record of the

species within the KNP,” reports Dr Vlok. Another incidental observation was made of calling Tinker Reed Frogs (*Hyperolius tuberilinguis*) from the Lower Sabie rest camp – an area out of their normal range. “The species is possibly expanding its range northwards along the river and pan systems,” notes Dr Vlok.

“Without adequate baseline data, such as species contribution within all regions of the park and population trends of species, it is impossible to determine a conservation strategy for the frogs of the Kruger.”

It is no surprise that water is the main factor influencing amphibian biodiversity in the park. Rainfall is critical for the survival of the majority of frog species in the KNP as most frogs breed in shallow seasonal water bodies, such as temporary and seasonal pans, inundated grasslands and seasonal pools within rivers and streams.

Without adequate rainfall the majority of frog species cannot initiate or complete their reproductive events. This was experienced during the last field survey in December 2011. “Insufficient rains resulted in the majority of pans being completely dry resulting in little or no breeding activity,” notes Dr Vlok. Thankfully, the rains arrived in late January and February, creating additional breeding habitats and inundation of the majority of larger and smaller pans within the park. “This would have resulted in the creation of additional breeding habitats and foraging areas for tadpoles.”

So, while causing significant damage to roads and bridges in the KNP and inconvenience for the humans that use them, the frogs would have welcomed the floods experienced earlier this year. “The frogs certainly benefited from the good rains. The

heavy rainfall would have resulted in the emergence and breeding of the majority of frog species, and especially the explosive breeders such as the African Bullfrog, Toads, Grass Frogs, and Sand Frogs,” Dr Vlok tells the *Water Wheel*.

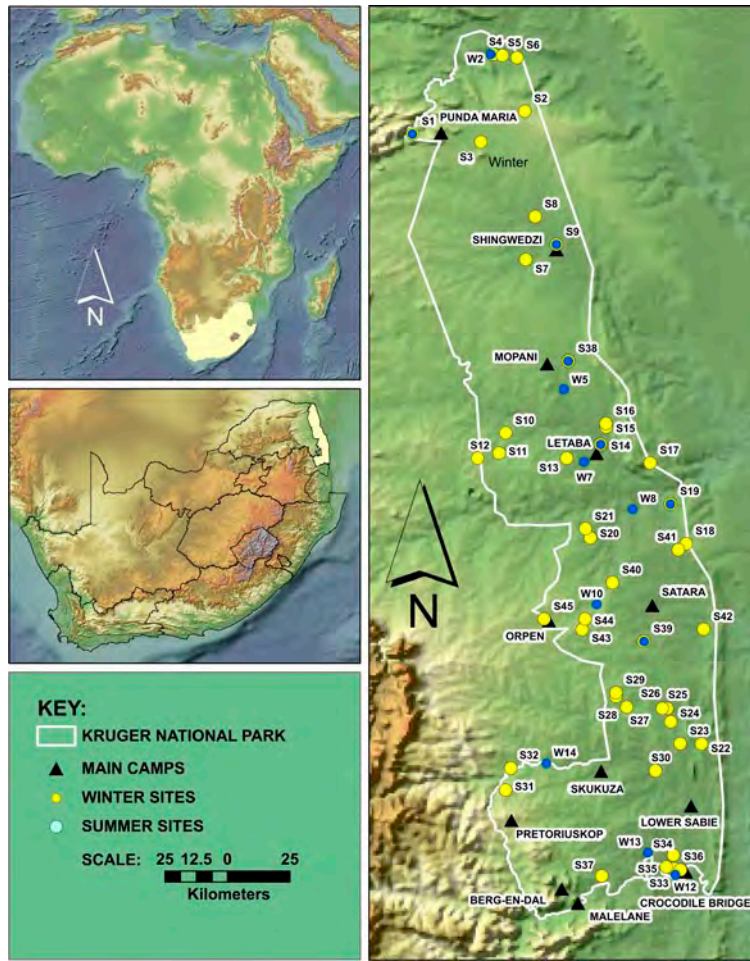
Right: The foam nest of the Southern Foam Nest Frog (*Chiromantis xerampelina*).

Below: The African Bullfrog (*Pyxicephalus edulis*), which has now been recorded in the Kruger National Park.

Bottom: The Red-Banded Rubber Frog (*Phrynomantis bifasciatus*).



Right: The main frog surveying sites.



habitat requirement. Other frog species, such as Sand Frogs (*Tomopterna* spp.) prefer sandy soils to burrow in.”

ACID RAIN

Since water pollution and acid rain are already being experienced by the KNP, another study is being undertaken as part of the larger amphibian biodiversity project to determine factors that may influence amphibian biology, distribution and population sizes. This study is focusing specifically on the possible effect of decreasing pH levels (as a result of acid rain) on frog biology and ecology. It is also determining how the presence of metals and organic pollutants can influence these amphibians. The latter is being determined through histopathological, bioaccumulation and biomarker studies.

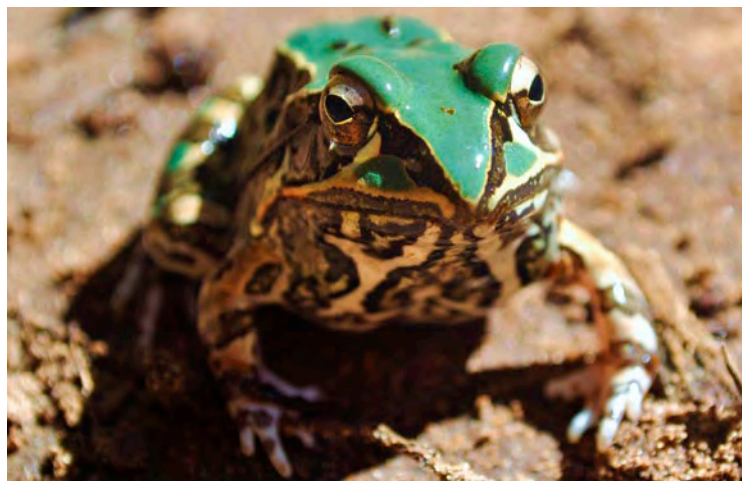
Acid tolerance bioassays have been conducted with eggs as well as tadpoles of four frog species occurring in the KNP, namely the Flat-Tacked toad (*Amietophrynus maculates*), Southern Foam Nest Frog (*Chiromantis xerampelina*), African Bullfrog (*Pyxicephalus edulis*) and Ornate Frog (*Hildebrandtia ornata*), using survival and development as endpoints.

No eggs have developed below a pH of 4 (acid rain with an average pH value of 4.72 has been recorded in the park), with most species requiring a higher pH concentration (value 5 to 6) to develop. Preliminary results regarding chronic exposure of tadpoles to water with low pH have found that tadpoles exposed to pH 4 to 4.5 take much longer to develop; they are also smaller than other tadpoles and differ in colour or pigmentation. Some of the tadpoles have also found to have axial deformities, where the tails are crooked.

“While the overall quality of the water at frog breeding sites is generally good, dry periods do result in a concentration of salts and nutrients. We have noted previous studies on acid rain in the KNP with concern, as

Another important factor for frog biodiversity is temperature. Some frogs are known as more mesic temperature species, e.g. Raucous Toad (*Amietophrynus rangeri*) while others keep to the tropical savanna, e.g. Tropical Platanna (*Xenopus muelleri*), and Golden Leaf Folding Frog (*Afraxalus aureus*). “Together,

temperature and rainfall influence vegetation, another important factor for frog species distribution and diversity,” notes Dr Vlok. “Certain species such as the Brown Backed Tree Frog (*Leptopelis mossambicus*) and Southern Foam Nest Frog (*Chiromantis xerampelina*) are arboreal so trees are an important



Right: A juvenile Ornate Frog (*Hildebrandtia ornata*).

we do not know how long the capacity of the soils to buffer this acidity will continue,” says Dr Vlok. “In the long run, this can have a detrimental impact on the frogs in the park, and even biodiversity in general, as evidence from Europe has shown.”

LONG-TERM MONITORING

This project has highlighted the need for an ongoing frog monitoring project in the KNP to ensure the future of these amphibians in the Kruger. “Without adequate baseline data, such as species contribution within all regions of the park and population trends of species, it is impossible to determine a conservation strategy for the frogs of the Kruger,” Dr Vlok points out. “Monitoring of the complete frog assemblages at pans will provide more pertinent information than surveys on selected flagship species or frog species of conservation concern.”

The research team has noted that several of the sites selected during the current project fulfil the criteria for long-term monitoring sites. They are accessible by vehicle, have a wide diversity of habitats as well as frog species, and have been monitored in the past. It is also important that water quality within selected pans in different regions is monitored through the wet seasons.

“More intensive studies need to focus on the current status of the Raucous Toad (*Amietophrynus rangeri*) within the park as well as the presence of the East African Puddle Frog (*Phrynobatrachus achridoides*) at other pans around Hapi East Pan (Pafuri area). Tadpole specimens of the Russet-backed Sand Frog (*Tomopterna marmorata*) and Knocking Sand Frog (*Tomopterna krugerensis*) need to be collected as they are currently unknown,” adds Dr Vlok.

In the end it is all about ensuring that southern Africa’s most famous national park continues providing a sanctuary for all creatures no matter how great or small.

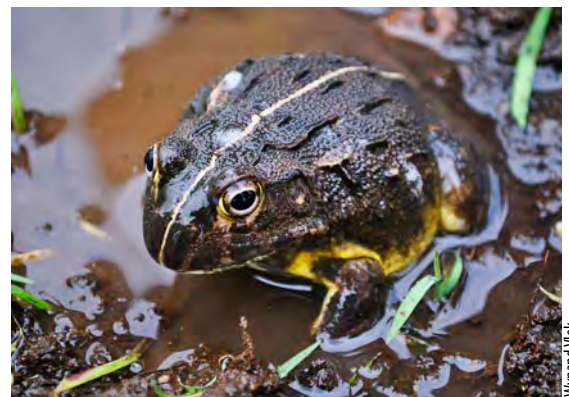


Wynand Vlok

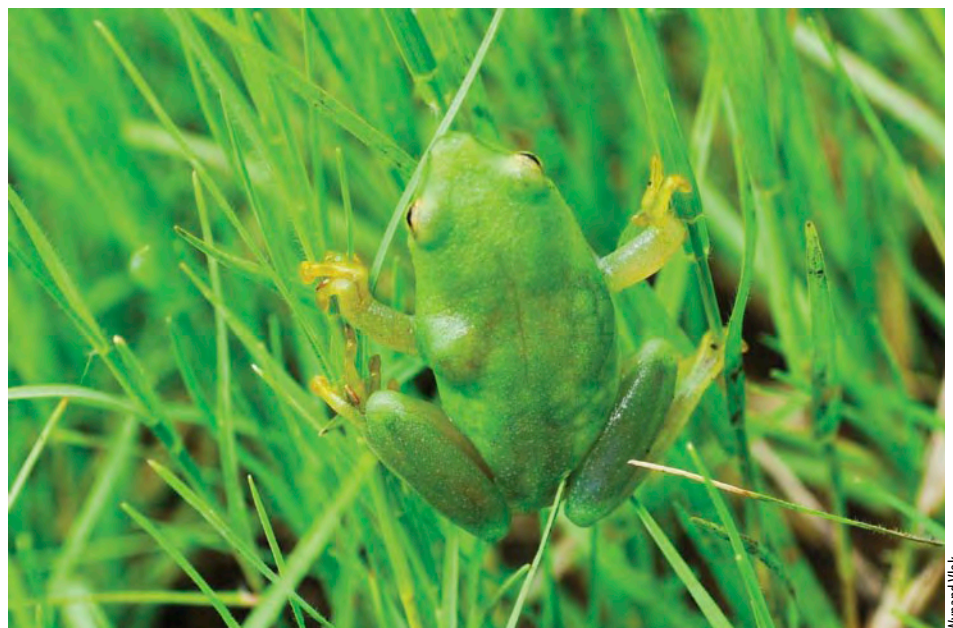
Above: The field laboratory where eggs and tadpoles exposed to waters of differing pH.

Right: Juvenile African Bullfrog (*Pyxicephalus edulis*).

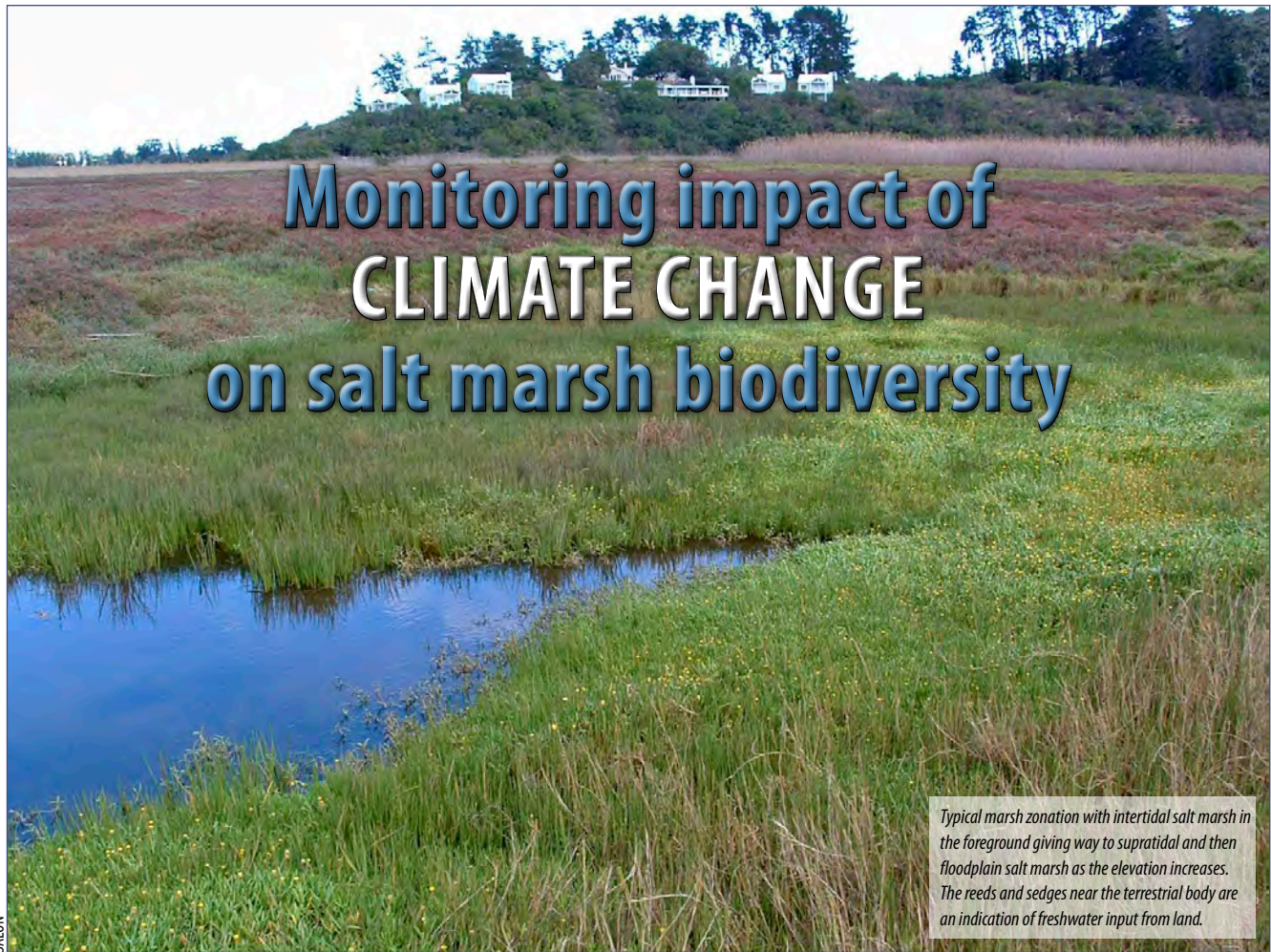
Below: The Water Lilly Frog (*Hyperolius pusilus*).



Wynand Vlok



Wynand Vlok



Typical marsh zonation with intertidal salt marsh in the foreground giving way to supratidal and then floodplain salt marsh as the elevation increases. The reeds and sedges near the terrestrial body are an indication of freshwater input from land.

The South African Environmental Observation Network (SAEON) is the principal investigator in a study to investigate the influence of predicted climate change and sea-level change on the diversity, distribution, abundance and community composition of salt marshes in selected estuaries in South Africa. Article by Tommy Bornman and Jadon Schmidt.

South Africa is likely to experience substantial climate change in the next decades, leading to a dramatic decline in biodiversity. The predicted changes in the rate of sea-level rise, as a result of global warming, will have important impacts on the coastal zone, displacing ecosystems, altering geomorphological configurations and their associated sediment dynamics, and

increasing the vulnerability of social infrastructure.

SEA-LEVEL RISE

Coastal wetlands (collectively comprising salt marshes, mangroves, intertidal and supratidal areas) could experience substantial losses as a result of sea-level rise. These economically valuable ecosystems are highly productive and provide a number of important functions, such as flood and storm protection, waste assimilation, nursery areas for fisheries, supply or organic matter to estuarine and marine environments and nature conservation.

Tide gauge measurements from South Africa indicate that sea levels have risen by around 1,2 mm/year over the last three decades, similar to international estimates, although recent observations from satellites

indicate that the global sea levels have been rising by 3,3 to around 0,4 mm/year from 1994 to 2006. The current trend of sea-level rise is expected to accelerate in the future, with recent estimates indicating a 12,3 cm rise by the year 2020, 24,5 cm rise by 2050 and 40,7 cm rise by 2080.

DECLINE IN RIVER RUNOFF

In addition to sea-level rise, it is estimated that runoff from rivers on the west and south coasts would decline by 11% to 84%, while those on the east coast would change by anything from -21% to +10%, making the percentage runoff change in southern Africa among the highest in the world.

The reduction in freshwater reaching the estuary will have a direct impact on the ecological functioning of the salt marsh because each species has a specific freshwater requirement.

A further impact will be the reduction in sediment input from the catchment, reducing the ability of the salt marsh to accrete at the same rate as eustatic sea level rise.

If salt marshes are to survive rising water levels, they must be able to accrete at a rate such that surface elevations gain is sufficient to offset the rate of water level rise. A number of studies have shown that coastal marshes are able to accrete at a rate equal to the historical rate of eustatic sea-level rise (1-2 mm/year).

UNDERSTANDING SHORELINE RESPONSE IS CRITICAL

Marginal and emergent vegetation such as salt marshes and mangroves contribute significantly to estuarine productivity and any negative effects on these communities could thus feed through to estuarine associated fish and fisheries. In the face of a global rise in sea level, understanding the response of the shoreline, the change in productivity of coastal wetlands and its impacts on faunal populations and other coastal ecosystems, to changes in sea level is a critical scientific goal to inform policy makers and managers.

RSET MONITORING

SAEON is attempting to understand the response of the salt marsh by measuring vegetation cover, soil characteristics, vertical accretion, short-term sedimentation, soil vertical elevation changes, shallow subsistence and horizontal shoreline change at nine sites with varying sediment availability and wave energy in the Swartkops, Kromme and Knysna estuaries. The research was originally funded by the Marine Living Resources Fund, however, it is now supported by the Department of Agriculture, Forestry & Fisheries and Oceans and Coasts, Department of Environment Affairs. Precise measurements (within

1 mm) of sediment elevation in the intertidal salt marsh have been made over a period of three years relative to a fixed subsurface datum using a Rod Sediment Elevation Table (RSET).

SET monitoring provides a time series of the integrated effect of surface and below ground processes on sediment elevation. Measuring sediment elevation with a SET involved the installation of a permanent receiver in a concrete casing in the *Spartina maritima* zone.

The SET provides a non-destructive method for making highly accurate and precise measurements of sediment elevation of intertidal and subtidal wetlands over long periods of time relative to a fixed subsurface datum. This technique overcomes many of the limitations of methods currently used to estimate elevation, such as sedimentation pins, and precision surveying.

Repeated measurements (three sets) of elevation were taken at nine points on eight fixed different orientations at each station, i.e. 5 832 measurements in total every six months. The only significant change in sediment elevation at the 27 stations in the three estuaries was recorded at Station 3 in the Knysna Estuary, located in the Ashmead Channel. This seasonal variance could be related to sediment input and scouring from the Bagai tributary.

BASELINE FOR MEASURING CHANGE

SAEON will continue to monitor the sediment elevations at the 27 stations in the three estuaries on an annual basis. It is expected that a few more years of data collection will be necessary to set a baseline against which change could be measured. Vegetation ($n > 20\ 000$) and sediment data ($n > 1\ 212$) are being analysed at present).

Based on the preliminary data it is hypothesised that the strongest physical variables that determine

vegetation composition and distribution are sediment salinity and elevation. Both variables will be influenced by direct and indirect effects or climate change and sea level rise, and it is further hypothesised that salt marsh community and species distributions and cover abundance will be significantly altered within the next ten years.

Long-term monitoring of the salt marsh sediments in these three estuaries will continue indefinitely to test the following main hypotheses:

1. The Kromme Estuary is starved of fine sediment and a significant portion of the salt marsh will drown with increasing sea levels.
2. The Swartkops Estuary has the largest diversity and area cover and salt marsh habitat that, together with the ample supply of fine and coarse sediment, will ensure the survival of the marsh with rising sea levels.
3. The Knysna Estuary receives sufficient sediment from the catchment, but coastal squeeze will restrict the landward transgressions of salt march, resulting in a significant loss of salt marsh habitat and area with increasing sea levels.

• This article originally appeared in the eNewsletter 1 of 2012 of SAEON, www.saeon.ac.za. □

The levelling arm with the measuring pins.



SAEON

Squeezing water out of fog



Rural women walk passed fog harvesting nets located at Lutshaya near Lusikisiki, in the Eastern Cape.

Christine Nesbit/Africa Media Online

A current study by researchers of the University of Pretoria is investigating if fog harvesting is a valid supply of potable water for small communities, and if so, for how long. Article by Petro Kotzé.

“If you have no water to drink, even just a little is a lot,” says apple farmer Jimmy Zondag. Zondag is owner of the farm, *Belle Vue*, in Avontuur in the Western Cape, an area which receives about 600 mm rain per year. The farm is situated on a mountain, and even though the headwaters of the Kouga and Gourits rivers are close by, the farm has almost no source of potable water. Zondag has drilled 39 bore-holes on his property, pointed out by geologists, water diviners and satellite technology, but not one has yielded water. He is thus dependent on a fountain, which sometimes has to be pumped as much as five times before he gets anything. Recently, Zondag has started turning his eyes skywards for water again, but he is not looking for rain. He is looking for fog.

The idea of harnessing fog as a source of drinking water has been

studied for decades, and it has been implemented with great success in some countries where conventional sources of fresh water, such as wells, lakes, rivers and pipelines are unavailable.

One of the world’s first successful experiments took place in the remote Chilean fishing village of Chungungo located in the Atacama Desert, one of the planet’s driest regions. In 1992, the village’s inhabitants relied on water delivered from distant wells, but after the installation of 80 fog collectors, village residents were enjoying an average of 10 000 l/day of fresh drinking water – an estimated 35 l per individual. Consequently, the quality of life in Chungungo improved dramatically as the freshwater boom led the village to flourish.

In South Africa, the percentage of the population with access to clean drinking water is said to have increased from 62% in 1994 to 93% in 2011, however this still leaves millions of people without this basic human right. Furthermore, South Africa is a semi-arid country with only 35% of its surface areas

receiving more than 500 mm rain per year. Fog harvesting is not an entirely new method of supplying potable water to remote villages in South Africa, but now some researchers, with the help of funding from the Water Research Commission (WRC), are fine-tuning the concept for local conditions and while they are at it, expanding our knowledge about this meteorological condition.

“One of the biggest advantages of such a system,” says project leader Prof Jana Olivier, “is that the water is available as soon as the nets have been erected.” Where other systems might need to be pumped to users, water from fog harvesting is transported with gravitation, uses no electricity and maintenance is minimal. Fog water harvesting is especially suitable for areas where fog occurs frequently and other sources of water are not available. There are a number of places in South Africa that might benefit from such systems.

FOG IN SOUTH AFRICA

In South Africa a number of places record over ninety days of fog per

annum, mostly along the West Coast and in mountainous regions. Along the West Coast, advection sea fog is common. This is formed when moist air from the South Atlantic Ocean passes over the cold Benguela Upwelling region and is cooled down. Along the mountains of the Eastern Escarpment and the Western Cape, the most frequent source of fog is orographic fog and stratus clouds. The first happens when low level onshore flow blows air up the escarpment, adiabatically cooling it as it rises, causing the moisture in it to condense.

Local fog harvesting projects are scattered across these two regions. Prof Olivier, a climatologist and professor extraordinaire at the University of Pretoria (UP), first got involved in the concept in the mid-1990s, when she made a call over an agricultural radio show for farmers to help researchers collect information on fog patterns in the West Coast. Forty farmers replied, she says, wanting to know how much water she thinks she can squeeze out of the fog. This led to a WRC-funded study which investigated the use of fog harvesting to augment domestic water supplies in South Africa. Pilot 1 m² fog collectors were erected in various parts of the country and the water collection rates monitored over a three-year period. Water yields were found to be a function of elevation, wind speed, moisture content of the air and site characteristics.

Along the West Coast yields ranged from 1 to 5 l/m²/day while in the mountainous regions, they exceeded 10 l/m²/day at elevations greater than 1 800 m. For example, says Prof Olivier, they could harvest on average about 12 l/m²/day at Woodbush in the vicinity of Magoebaskloof. At the Groenland Mountains in Grabouw, she says, they harvested just over 10 l/m²/day.

The successes of these projects led to the erection of larger systems, closely following the Chilean designs but adapted to suit South African conditions. These involved two



A young boy quenches his thirst with water collected from fog in Limpopo.

WRC archives

sections of 9 m x 4 m shade cloth netting draped over a top cable and secured to the middle and lower cables and to the poles on either side. This forms a fog collection screen of around 70 m². A gutter is attached to the lower ends of the screen, filling JoJo tanks underground.

Seven of these large fog water collection systems were erected between 2001 and 2008 at two schools in the Soutpansberg Mountains in Limpopo, at five schools in the Eastern Cape and at a small West Coast village, Lepelfontein. These were selected because all the necessary elements were there, says Prof Olivier. Factors include accessibility, need and location (up a hill). Daily water collection rates ranged

from zero on a sunny day to almost 4 000 l during wet and foggy conditions and the water was found to be of an exceptionally high quality, “naturally distilled,” says Prof Olivier.

The researchers then moved on to finding stronger and more stable designs and a more durable mesh to increase the longevity of the nets, especially as some nets were damaged during storms. Current systems consist of nine panels arranged in the shape of four equilateral triangles to form the basic nine panel system of 396 m². Additional nine panel systems can be linked to this, allowing the expansion of the system to the space available.

The individual mesh panels of the system are 11 m x 4 m, suspended

by three individual 6 mm galvanized cables anchored to ground via brackets. According to Prof Olivier, a compulsory element to all their fog harvesting projects is that a trough has to be supplied for animals to drink from. In some cases, she explains, animals have ripped the nets to get to the water, and in this way, not only are thirsty animals catered for, but it ensures the safety of the nets.

An experimental site was established on the Zondachsberg at Avontuur, just outside Uniondale. At this site more than 8 000 ℓ of water were collected from one 38 m² system during October and November 2009, coinciding with one of the most devastating droughts experienced in the region during the last 80 years. The water quality collected at Avontuur is excellent, far surpassing all international and local standards for potable water, notes Prof Olivier. She says that another experimental system will also be erected at Lambertsbaai this year, allowing researchers to compare West Coast and East Coast systems and factors influencing them.

The current four-year WRC research project will also entail a number of other elements. Among others the researchers will investigate the difference between so-called 'wet' and 'dry' fog, as described by

West Coast locals. According to Prof Olivier, it is suspected that dry fog consists of droplets with a dust nucleus, while wet fog has salt as a nucleus, which typically causes bigger droplets to be formed. This means that the wet and dry fog may be associated with different synoptic systems.

The research project also entails an investigation of long-term climate data to ascertain if climate change will have an impact on the frequency of fog and thus on the volume of fog water that can be harvested in the long term.

Prof Hannes Rautenbach, Head of the Department of Geography, Geoinformatics and Meteorology at UP, says they are looking if the weather patterns that cause fog, and especially cold fronts that are important for the formation of fog, could be affected by a change in climate. This will also help establish where it will be most economically feasible to erect large fog harvesting systems.

The search for the perfect material is also still continuing. Five nets made from different materials have been erected; one, for example, with fine hairs, to see which would result in the most water harvested. Further outputs will also include innovative new fog harvesting designs that can

harvest water during times of no wind.

Another result will be the compilation of a set of maps indicating optimal fog harvesting areas in South Africa. This will be combined with information on roads, accessibility and more, eventually indicating not only the areas where fog harvesting would be the most feasible, but also which specific sites would be suitable. "Thorough scientific support like this is essential before the fog harvesting structure is built in order to ensure that scarce resources are not wasted in areas where a project will not be feasible," says Prof Johan van Heerden of the Department of Geography, Geoinformatics and Meteorology at UP, who has been involved with the fog harvesting research since its early days. He adds that another element of integral importance to successful project is buy-in from the community, on who continued maintenance of the structure is dependent.

As with the case in Chile, says Prof Olivier, eventually they would like to incorporate a social responsibility element into their project. Once people have enough water to drink, they want to try and help community members to use the water for food gardening. After that has been supplied, they are exploring the possibilities of creating small-scale projects to generate income. "This is how water can affect communities," she says, "and empower them to create opportunities for themselves."

Zondagh himself, after his experience with the fog nets on his property, is keen to continue the exercise. Even though the start-up cost is a hurdle, he sees "a lot of potential" for their continued use, even though the yield is at times as little as two litres a day, and the distance to the nets from his house is quite far (in future, he would probably have to pipe it closer). Still, if you're thirsty, and you have no water, he says, even two litres of pure drinking water makes a difference. □

One of several fog-harvesting projects found along the West Coast.



Lani van Vuuren

Water harvesting and conservation – TRAINING THE TRAINERS

A comprehensive learning materials package developed for facilitators, resource-poor gardeners and farmers on water harvesting and conservation is now available from the Water Research Commission (WRC).

Lani van Vuuren takes a look at these tools aimed at improving food security in South Africa.

Water harvesting and conservation (WH&C) has supported communities around the world for at least 3 000 years, but in South Africa in modern times its popularity has only started to rise in the last decade or so. WH&C is a highly productive and sustainable practice and, today, it is used by small producers and commercial farmers alike.

The WRC has supported research into WH&C for more than 15 years, however, benefits have mostly accrued to the communities where the research has been undertaken. “The potential of rainwater harvesting to contribute to food security has been well proven, not only in South Africa, but around the world,” reports WRC Research Manager, Dr Andrew Sanewe. “The time has come to roll out these practices in South Africa, and attack hunger on a large scale.”

While many resource poor farmers and gardeners express an interest in learning WH&C practices, facilitators, such as extension officers, are not always equipped to provide the necessary training and support. To fulfil this need the WRC funded the compilation of a comprehensive WH&C learning materials package. The materials were developed by Umhlaba Consulting Group over a period of four years.

COMPREHENSIVE TOOL

The learning materials were developed within a ‘training of trainers’ framework and target



Manxaba Ziphu

three user groups, namely learners and training organisations (including agricultural extension officers and rural development fieldworkers); facilitators at training operations responsible for teaching the WH&C course; and resource poor

gardeners and farmers who are the end users of water conservation techniques.

While the first part of the package is focused specifically on the technical aspects of improving water availability in homesteads,

A healthy garden can lead to a healthy life.

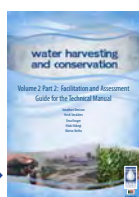
MATERIALS AVAILABLE IN THE COMPREHENSIVE LEARNING PACKAGE

Water Harvesting and Conservation Volume 1: Development of a comprehensive learning package for education and the application of water harvesting and conservation (**Report No. TT 492/11**) ➔



Water Harvesting and Conservation Volume 2, Part 1: Technical manual and farmer handouts (**Report No. TT 493/11**) ←

Water Harvesting and Conservation Volume 2, Part 2: Facilitation and assessment guide for the technical manual (**Report No. TT 494/11**) ➔



Water Harvesting and Conservation Volume 2, Part 3: Facilitation manual (**Report No. TT 495/11**) ←

Water Harvesting and Conservation Volume 2, Part 4: Facilitation and assessment guide for the facilitation manual (**Report No. TT 496/11**) ➔



- To order any of the materials contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565 or Email: orders@wrc.org.za. The materials can also be downloaded for free from the WRC website, www.wrc.org.za

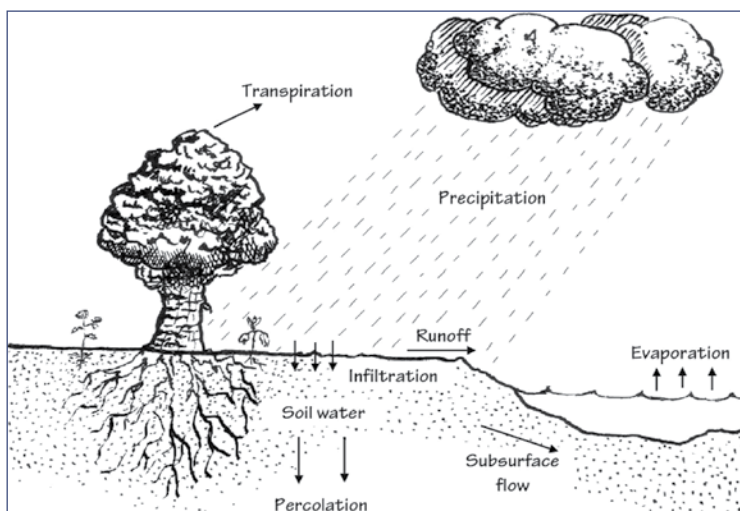
gardens and fields WH&C; the second part aims to equip fieldworkers and extension officers with the facilitation skills needed to transfer the knowledge of these techniques and practices. The latter part includes a technical module covering soils and WH&C methods, a facilitation module covering facilitation techniques, as well as a set of farmer handouts with illustrated steps on how to implement the methods.

The package has been structured as a 30-credit short course. The materials cover, not only rainwater harvesting techniques research by the WRC, but any WH&C method in

“The time has come to roll out these practices in South Africa, and attack hunger on a large scale.”

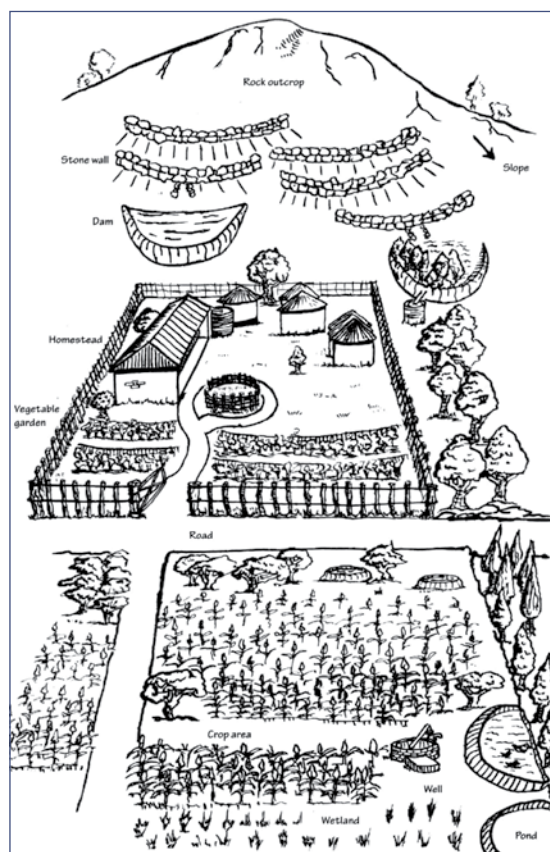
the public domain that was found to be applicable in local circumstances. Once they have completed this course, rural development fieldworkers and agricultural college graduates will be equipped with both the technical and facilitation skills to effectively take water harvesting and conservation technologies and approaches to farmers and food gardeners.

All the material was developed in close consultation with key



Above: An illustration is used to explain the movement of water through the soil.

Right: An illustration of the Maseko family homestead in Zimbabwe where rainwater harvesting has been practiced successfully.





Lubabalo Ntsakontoko

with both the Unit Standard and the Quality Council for Trade and Occupations accreditation frameworks. Accreditation has proved to be a lengthy and complicated process, and the WRC remains in talks with the Department of Agriculture, Forestry and Fisheries (DAFF) to ensure the accreditation of the material.

It is now up to the trainer community to ensure the material reaches as many fieldworkers and farmers as possible. “We believe in the potential of this learning package to make a real difference in the lives of people,” notes Dr Sanewe. The materials fit in squarely with the DAFF’s Zero Hunger Campaign, aimed at eradicating hunger and food insecurity in South Africa

through the production of affordable, good quality food.

“The materials will hopefully not only be used in the training courses of agricultural colleges, but also by community and non-governmental organisations,” adds Dr Sanewe. Workshops are being planned for different parts of the country to expand awareness of the learning package among potential disseminators. Extension officers and other fieldworkers will also be taken briefly through the material.

In the end, it is all about ensuring that no-one in South Africa goes to bed hungry at night. If you have the power to make a difference it is your duty to make a difference. ■

stakeholders to ensure its relevance. According to the project team, there was a marked positive interest in water harvesting and general enthusiasm to have this new material embedded in existing curricula at agricultural colleges and higher education organisations. “The agricultural colleges in particular expressed specific and immediate need, such that some were willing to use the draft materials in their curricula.”

During a pilot process lasting six months 14 learners received training at the University of KwaZulu-Natal’s Centre for Adult Education. In a spin-off from the project, 68 students from the Walter Sisulu University Fine Art Department were financially supported through fieldwork exposure and competition funding, to provide illustrations for the course materials.

FROM THEORY TO PRACTICE

The learning materials package has been structured to comply

Above: An artist’s impression of rainwater harvesting.

Top right: Water harvesting gives you food.

Top right: Water is wealth.

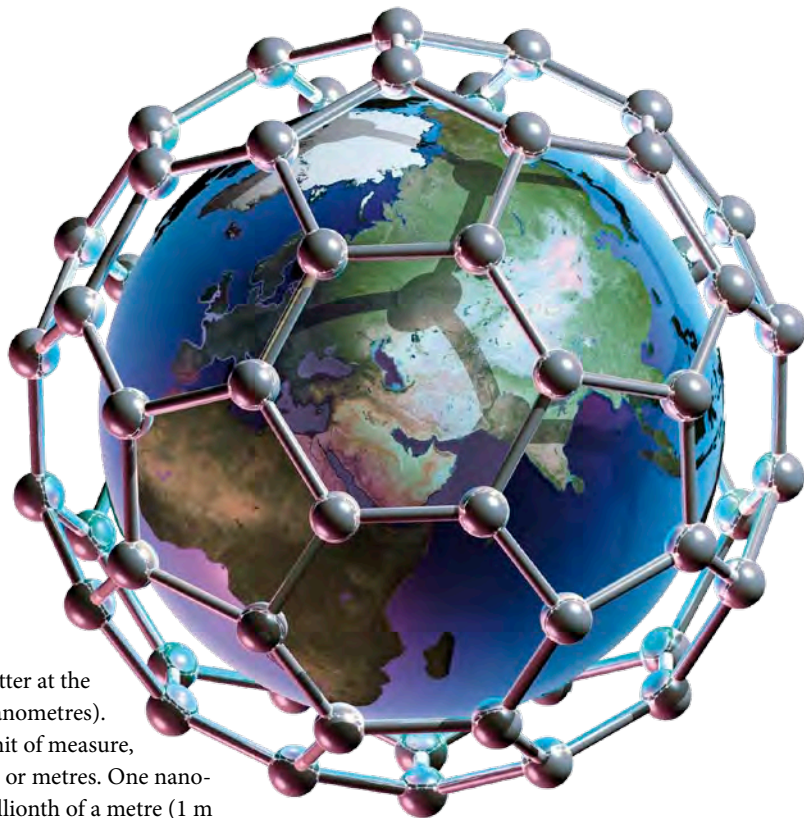


Bonga Sifumba



W Bonkolo

NANO – A small small science with BIG possibilities



Nanotechnology is one of the most exciting developments of the 21st century. These days nanotechnology features in everything from sunscreen and tennis rackets to medicine and even water and wastewater treatment. But what is nanotechnology?

The word 'nano' refers to something that is very small. Nanotechnology deals with materials so small they cannot be seen with even normal microscopes. Basically, nanotechnology is the art and engineering

of manipulating matter at the nanoscale (1-100 nanometres). A nanometre is a unit of measure, just like millimetres or metres. One nanometre equals one billionth of a metre (1 m = 1 000 000 000 nm). That is a lot of zeros!

So what do we measure in nanometres? Well, atoms and molecules – the smallest things around us are measured in nanometres. For example, a water molecule is less than one nanometre. A typical germ is 1 000 nanometres, and a hair is 100 000 nanometres wide. The best way to illustrate it is this: take a ruler and flip it to the centimetre side. See how long 1 centimetre is? Now imagine you can fit a million points into that one centimetre. The space between two of those points will be a nanometre.

At this small size, materials often take on unique and sometimes unexpected properties. The small size affects their physical properties, like their surface area, magnetic properties, melting point and electrical conductivity. Nano-sized gold, for example, can appear red rather than metallic yellow. Nano-sized carbon tubes are many times stronger than the same weight of steel, while bulk carbon can be very brittle.

This means that at the nanoscale, materials can be 'tuned' to build faster, lighter, stronger and more efficient devices and systems, as well as new classes of materials. In the water sector, nanotechnology can be applied to develop more cost-effective and high-performance water treatment systems as well as instant and continuous ways to monitor water quality.

Nanomaterials may also be used to develop new and enhanced sensors which can detect biological and chemical contaminants at very low concentrations in

water. In addition, nano-enhanced materials may be used to remove, reduce or neutralise water contaminants that threaten human health and/or ecosystems. There are already thousands of products on the market benefiting from nanotechnology, and new products incorporating nanotechnology are launched around the world every day.

NANO AND WATER

- **Water treatment:** Nanomaterials can already be harnessed to enhance existing water treatment processes. Replacing existing materials and equipment such as activated carbon and reverse osmosis and nanofiltration membranes by nanotechnology modified or produced materials can lead the way for more advanced nanotechnology processes.
- **Water pollution:** There are several new techniques being investigated for the remediation of water pollution. One of the most promising examples is zero-valent, nano-iron which is being tested for use in removing solvents from pumped groundwater.
- **Diagnostic tools:** Great potential exists for the development of nanotechnology-based diagnostic tools that can be used for real-time drinking water quality assessment. Detection of viruses, bacteria and parasites in real-time is needed rather than culture-based techniques that could provide information in days.



Modern products already making use of nanotechnology.



In the water sector, nanotechnology can be applied to develop more cost-effective and high-performance water treatment systems as well as instant and continuous ways to monitor water quality.

THE SIZE OF NANO

One nanometre = one billionth of a metre

One DNA molecule = 2 nanometres (nm)

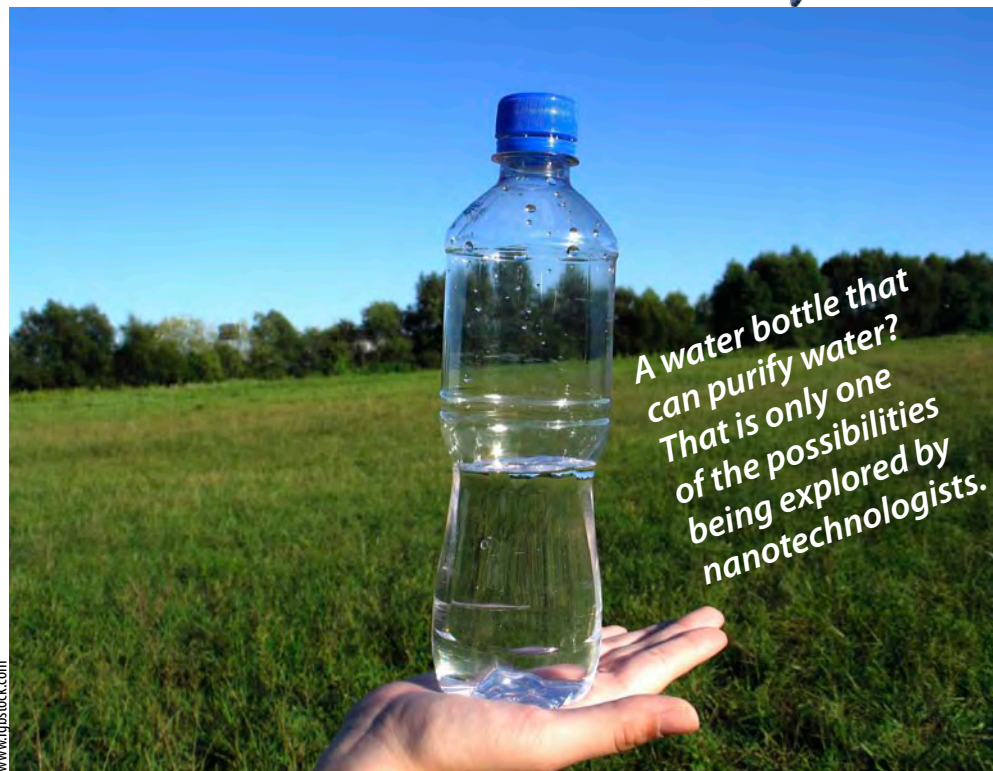
Virus = 50 nm

Visible colour = 400-700 nm

E. coli = 5 000 nm

Hair diameter = 75 000 nm

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A water bottle that can purify water? That is only one of the possibilities being explored by nanotechnologists.

The Water Research Commission is currently funding a number of existing projects in the field of nanotechnology. One of these studies involves the fabrication of nano-fibre membranes to treat water for drinking purposes. Another is looking at the use of polymer beads, containing nano-magnetic particles, to clean (or defoul) membranes used in the desalination process.

Nanotechnology is an interdisciplinary field, which means it involves many people from different sectors working together, such as biologists, chemists, physicists and engineers, to create new and wonderful things. South Africa is one of the first countries in the world to have an official nanotechnology strategy, focusing on water, energy, chemical and bioprocessing mining and minerals and advanced materials and manufacturing.

Modern nanotechnology is still a very new science, and researchers are discovering new things every day. This means we do not know nearly enough as we want to about what nanomaterials can and cannot do. Like all chemicals and materials, scientists have to be sure they know all there is to know (i.e. benefits

and disadvantages) about these products before they can be used safely. There are still a lot of unanswered questions about the health and safety aspects of nanomaterials to humans and the environment, and scientists are working hard to answer all of these questions.

In the end, it is all about creating exciting new products and technologies to make the world a better, safer world to live in.

USEFUL WEBSITES

- <http://science.howstuffworks.com/nanotechnology.htm/>
- <http://en.wikipedia.org/wiki/Nanotechnology>
- http://en.wikipedia.org/wiki/Nanotechnology_in_water_treatment
- http://wrcwww/Knowledge%20Hub%20Documents/Water%20Wheel/Articles/2008/01/WaterWheel_2008_01_Nanotechnol%20p%2010-13.pdf
- www.trynano.org
- www.crnano.org/whatis.htm
- www.nanoandme.org/home/



New water resources assessment study launched

The Water Resources 2012 (WR2012) study was launched at Emperors Palace, on the East Rand, in March. It is the sixth national study to be undertaken in the country to assess South Africa's

national water resources since 1950. The main purpose of the new study, which started in April, is to update the previous assessment (WR2005). It will also create a Web-based and interactive reporting system

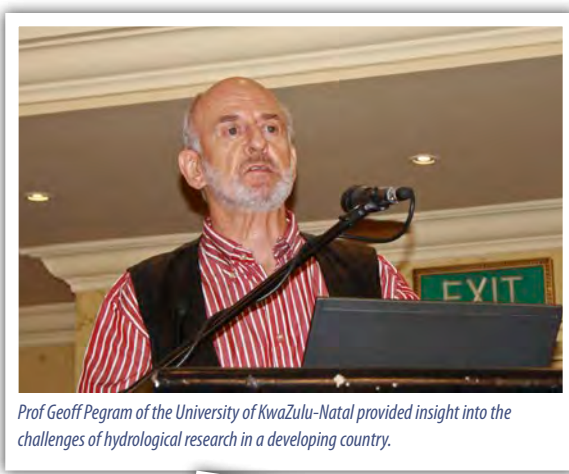
to continually quantify both surface and groundwater resources of South Africa. Such a system will be essential in the continuous update of the National Water Resource Strategy. Also read the article on page 12.



Prof Andras Bardossy of the University of Stuttgart, in Germany, provided the keynote address on the future of hydrological research globally.



The main guests at the WR2012 launch (front left to right), Dhesigen Naidoo, Prof Andras Bardossy, Prof Geoff Pegram, Prof Roland Schulze, Mbangiseni Nepfumbada, Prof Denis Hughes, Wandile Nomqophu and Allan Bailey.



Prof Geoff Pegram of the University of KwaZulu-Natal provided insight into the challenges of hydrological research in a developing country.



DWA Acting Deputy Director-General Mbangiseni Nepfumbada signing a certificate of endorsement as a token of the department's support for the project while WRC CEO, Dhesigen Naidoo, looks on.



WR2012 project leader Allan Bailey; WRC CEO Dhesigen Naidoo; DWA Acting Deputy Director-General Mbangiseni Nepfumbada, and WRC Research Manager Wandile Nomqophu.

(All photographs by Lani van Vuuren)

Monash South Africa – Preparing Water Leaders for the Future

Monash South Africa is a campus of Monash University, Australia; a leading global, research-intensive university, which has been ranked in the top one percent of universities in the world by the Times Higher Education - World University Rankings.

Monash South Africa offers students the opportunity to obtain an internationally-recognised degree on our attractive, secure, state-of-the-art campus in Ruimsig, Johannesburg.

International WaterCentre Africa: Water Research Node

The vision of the International WaterCentre (IWC) Africa: Water Research Node is to build water leadership and research for a sustainable African future. It aims to do this by providing innovative water leadership and governance education and training in a research-intensive and collaborative environment. The Node also offers water leadership expertise through consultancy and contract research.

The Water Research Node at Monash South Africa was created by Monash University through its strategic partnership with the IWC. The IWC specialises in education and training, applied research and expert services to promote a whole-of-water cycle

approach and develop capacity in integrated water management around the world.

Postgraduate education

The Master of Philosophy in Integrated Water Management is a research-based degree designed to prepare the next generation of research leaders to address complex and interlinked water leadership and governance issues.

It is offered full time over two years or part time over four years. It comprises an interdisciplinary coursework component (consisting of four compulsory coursework units) and a full research thesis. The coursework units are: Science of water; Project management and research design; Water sustainability and development; and Water governance and policy.

This degree is ideal for professionals with an interest in water leadership and governance from a variety of water-related backgrounds such as

engineering, social sciences, service provision, environment, conservation, health and many others.

Short courses

To address the growing need for skilled and experienced water professionals in South Africa and Africa, the Water Research Node will soon be offering a suite of weeklong water leadership and governance short courses. These courses are ideal for people working full time, living outside of Johannesburg or professionals wanting to expand their leadership capacity in the water sector.

More information

Contact the IWC Africa: Water Research Node

Tel: 011 950 4130/ 4453

E-mail: linda.downsborough@monash.edu

Web: <http://www.monash.ac.za/research/water-research-node/>



MONASH South Africa

A campus of Monash University Australia



Water Research Commission



The Water Research Commission (WRC) is South Africa's dynamic hub for water-centred knowledge, innovation and intellectual capital. The WRC provides leadership for water research development in:

- Water Resource Management
- Water-Linked Ecosystems
- Water Use and Waste Management
- Water Utilisation in Agriculture
- Water-Centred Knowledge

Impact areas address the following key issues:

- Water and Society
- Water and Economy
- Water and the Environment
- Water and Health

www.wrc.org.za

