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WATER LOSS – SA needs to do more

WATER RESEARCH COMMISSION

3rd Southern African Regional Biennial YWP Conference

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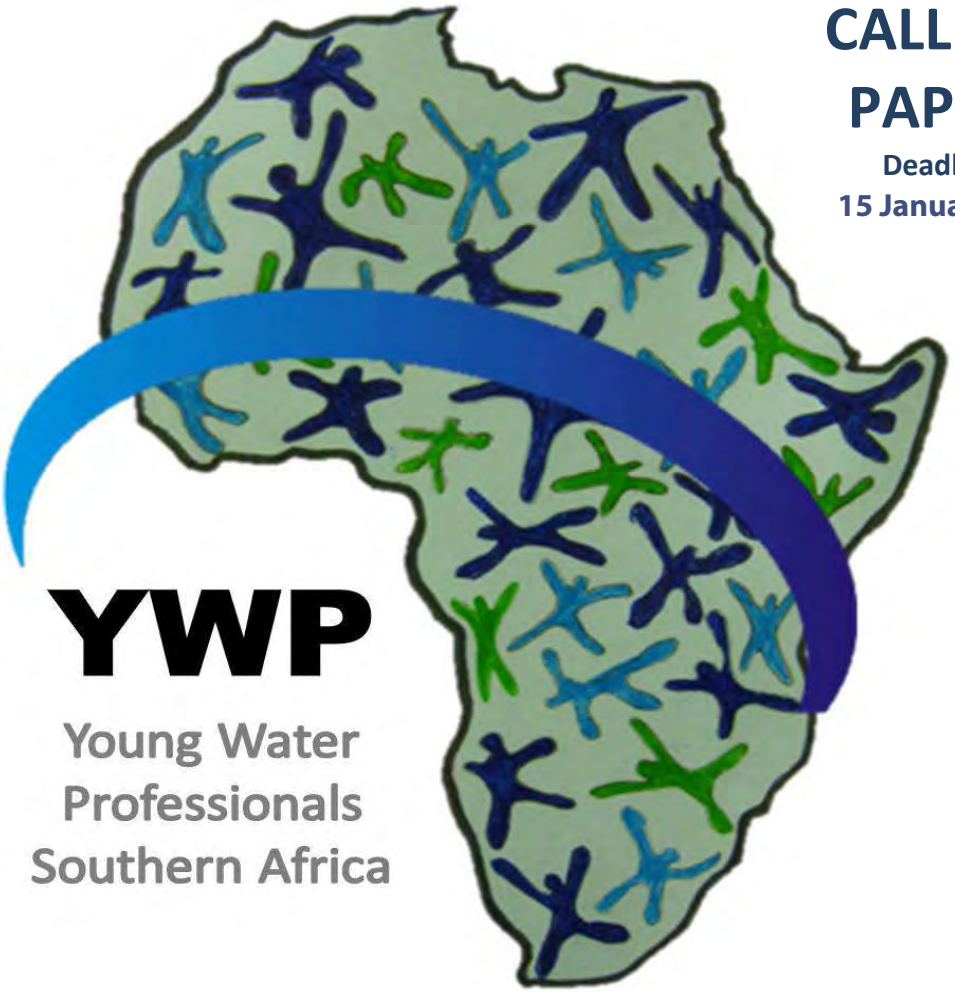

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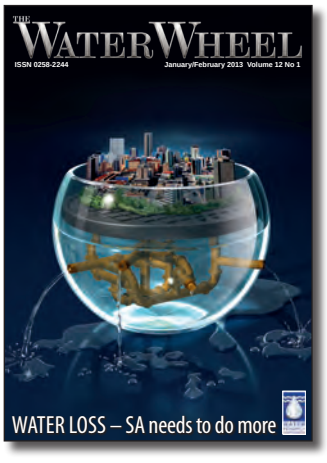


WRC CEO, Dhesigen Naidoo

Gender and Water – moving beyond the thin end of the wedge

The end of 2012 saw the annual 16 days of activism against violence and abuse of South Africa's most vulnerable – women and children.

A few weeks before the start of the 16 days the media ran a seemingly unusual story, The ACLU or American Civil Liberties Union had begun an effort to get the US Army to revisit its policy that currently prevents women from serving in frontline combat zones. While the argument for complete equality is well understood, on the surface it may reflect a well-meaning military establishment that seeks to shield what it considers to be its more vulnerable half. On digging a little deeper, further facts emerge. A primary criterion for promotion in the US military appears to be combat experience. It would appear that the ACLU's case is in fact against a systemic gender discrimination that results in direct disadvantage for women members of the US Army that prevents the further gender diversification of the Army's hierarchy.

What this illustrates is that gender-based violence and abuse, as appalling as the statistics are, remains only the tin end of a very wide wedge (Fig. 1). The key question is this – do we have gender biased systemic fault-lines in our own system? If they exist, where do they express themselves? And of course, in the water sector, how should we deal with them?

An understanding of the wedge is imperative in empowering a systemic response to reverse its impact. In the water domain the impact of gender imbalances are found throughout the system and in all circumstances. However, as with most other discrimination, it is most pronounced in domains of scarcity and hardship. This is therefore a prominent feature in the developing world as a whole and Africa in particular. UNEP estimates that some 400 million Africans live in water scarce countries and 300 million Africans do not have reasonable safe access to water by any international standard.

UNIFEM (UN Women), the United Nations Entity for Gender Equality and Empowerment of Women, claims that women and children around the world travel some 10-15 km every day to collecting some 20 kg of water per trip. In South African alone women walk the equivalent of the journey to the moon and back 16 times every day to collect water. Water.org claims that, world wide, women spend some 200 million hours a day collecting water. The opportunity cost of this is very high. UNIFEM estimates that in India the estimated loss of potential income is 150 million work days a year for women which equates to R1,67 billion.

The WRC in its new five-year strategic plan prioritises Gender and Water and the work-plan is developed in four dimensions (Fig. 2).

The international dialogue that was launched on the African continent under the auspices of AMCOW (African Ministers Council on Water) in 2008 resulted in Water & Environmental Minister Edna Molewa's launch of the Policy and Strategy for Mainstreaming Gender in Africa's Water Sector in 2011. Earlier this year at Rio+20 this was followed up with an international dialogue on Gender and Water, led by Deputy Minister of Water & Environmental Affairs, Rejoice Mabudhafasi, at the UN Conference.

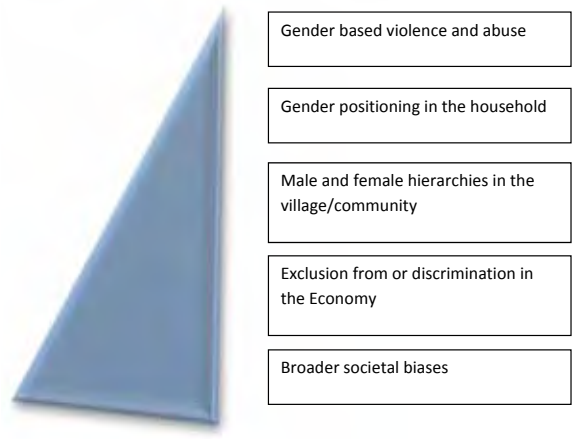


Figure 1

The Wedge of Gender discrimination travels through the trajectories of broader cultural and historical societal biases that impact on deepening the levels of gender imbalances in economic participation of women. These in turn have a tautomeric relationship with household hierarchies that usually result in embedding subservient roles and limited education for the girl-child. All of these, in various ways find expression in gender-based violence and abuse.

Figure 2

The WRC Gender and Water work-plan will operate in four dimensions. The first is an expansion and deepening of the dialogue. This will happen through workshops, seminars and local and international conferences. The second is through a series of mechanisms and studies to inform policy at all levels. The third is through a portfolio of gender specific research projects and Women oriented human capital development measures. Finally, we think that in 5 years, the WRC and its partners would have accumulated sufficient knowledge to produce significant best practice models, manuals and guidelines for gender improvement in the water domain.

The third leg on that journey was the Gender Session at the International Freshwater Governance Conference in November 2012. The lead speaker and renowned academic, Prof Ali Mazrui, reminded us of the traditional role of women as custodians of water in African cultural history. All of these endeavours will culminate in a WRC-partnered international consortium comprising the DWA, the GWP, IWMI and various other players hosting a Gender and Water Summit for Africa in 2013.

The end point of this multi-year journey is to achieve the aspiration that the current Head of UN Women and former President of Chile, Michelle Bachelet, expressed so succinctly: "Gender equality must become a lived reality."

Current WRC-funded women and water-related projects

- **Empowerment of women through water-use and land-use security**: Although the South African Constitution enshrines gender equality, women in rural areas generally experience a lack of water-use security and lack of knowledge to achieve food security. Empowerment of women through secure access to water and land, as well as by obtaining knowledge and developing skills must receive priority attention. This will provide the necessary incentives to take ownership of the process of productive use of water to achieve food security and improve rural livelihoods. This research project is aimed at improving the understanding of social dynamics at the household level that impact on the empowerment of women and attainment of sustainable food production. It includes better understanding of institutional and organisational impediments affecting the decision-making powers of women. The research is currently focusing on selected areas in the Eastern Cape and Limpopo provinces.

- **Decision-support guidelines for vulnerability assessments**: Climate change is already starting to affect some of the poor and most vulnerable communities around the world. Understanding sensitivities and vulnerabilities (including gender issues) of systems and communities is necessary to inform adaptation action. This research project is aimed at developing decision-support guidelines for vulnerability assessments and adaptation requirements around water and climate among rural economies and communities. This will allow decision makers to manage the vulnerability of communities, particularly women, and make the necessary adaptations within the larger context of planning and development.

- **Water allocation reform to achieve equity and gender balance**: This recently completed project focused on the achievement of redress of race and gender inequalities as water allocation reform is implemented. Lessons were interrogated from international experience and from initial implementation of various processes. This information is to be made available for improving immediate interventions. Existing studies on water allocation reform and trading of water rights in relation to economic development were also considered. Existing processes and instruments, some of which have been implemented in some catchments, and their contribution to redress race and gender inequities, were interrogated. Bottlenecks and hindrances were identified, and solutions suggested to improve the achievement of redress.

- **Improving nutrition in women and children**: Women and children are especially vulnerable to malnutrition. African leafy vegetables are commonly perceived to provide a host of health benefits, particularly nutritional benefits. A recently-completed WRC study showed that these plants can indeed contribute substantially to intake of Vitamin A and iron in both young children and women. The plants also provide a varying amount of other important nutrients which supports the use of a variety to address the nutritional health of vulnerable people.

- **Assessing basic services related to HIV/AIDS care**: A substantial burden of the care of people with HIV/AIDS has been placed on the elderly, school-going children, family members, friends and different care organisations within the community. These volunteer care-givers are mostly women and girls. The aims of this WRC project was to investigate home-based care practices with regards to the experiences of carers and to perform a health risk assessment of the water used for domestic purposes in households caring for people living with HIV/AIDS. The study confirmed that the burden of home-based care has disproportionately become the responsibility of women. Elderly women and young girls spend many of their personal and study hours looking after the sick. The lack of safe water in many areas of the country, the availability of water and the quantity of water have been highlighted as some of the most important aspects that prevent adequate home-based care.

Upfront Diary

Earth sciences
January 8-14
The 24th Colloquium of African Geology will take place in Addis Ababa, Ethiopia. The event is being held together with the 14th Congress of the Geological Society of Africa, which is celebrating its 40th anniversary. The theme of the conference is 'Earth Sciences solutions to African development challenges'. *Enquiries: Conference Secretariat; Tel: + 251-1-6554176; Email: egmea4geoscience@gmail.com; Visit: www.cag24.org.net.*

Wetlands
February 2
World Wetlands Day will be celebrated the world over with the theme 'Wetlands and Water Management'. *Visit: www.ramsar.org.*

Transboundary water
March 16-20
The International Conference on Transboundary Water Management 2013 will take place in Aveiro, Portugal. The theme of the event is 'Transboundary water resources management across borders and interfaces'. Topics to be discussed include water resources modelling, technical and natural solutions, environmental impacts, economic incentives, water governance and much more. *Visit: http://ibtwm.web.ua.pt/congress/*

Water storage & hydropower
April 16-18
An international conference on Water Storage and Hydropower Development for Africa will be held in Addis Abeba, Ethiopia. The conference is being organised by Hydropower & Dams, the International Commission on Large Dams and the Ethiopian Electric Power Corporation. *Enquiries: Margaret Bourke; Tel: +44 20 8773 7244; Email: africa2013@hydropower-dams.com; Visit: www.hydropower-dams.com*

More work needed to curb spread of invasive species – expert

South Africans need to think more innovatively about how they manage 'novel ecosystems' that are being created through the impact of human-mediated factors, including invasive organisms.

So says Prof Dave Richardson, Director of the Centre for Invasion Biology (CIB) at Stellenbosch University. He was speaking at the award ceremony during which he received the John F Herschel Medal from the Royal Society of South Africa late last year.

The medal recognises Prof Richardson's multidisciplinary contribution to science in South Africa and his internationally recognised work on the ecology and management of invasive species.

Prof Richardson was recently appointed as director of the CIB, a centre of excellence that aims to provide the scientific information and human capital needed to inform policy and management guidelines needed to reduce the number of invasive species and their impacts.

For Prof Richardson invasive species very often form part of a cocktail of factors that contribute to environmental problems. "They are both drivers and passengers of degradation."

He believes that the input of invasion biologists, who study how and why certain species are able to expand and flourish beyond their natural range, must be considered before decisions are made regarding issues such as the planting of new crops for the emerging biofuels industry, or the import of reptile species for the pet trade. "Strategies for dealing with invasive species need to give much more attention to the complex human dimensions of introductions and invasions. Humans cause invasions, humans perceive invasions, and humans decide why, when and how to manage invasions."

According to Prof Richardson, biological invasions are already costing South Africa several billion rand per year, and put huge pressure on our ecosystems. "Our rural communities are taking the brunt of such impacts."

Prof Richardson questioned aspects of the current approach to clearing invasive plants in South Africa." South Africa's strategy on a national scale, to clear invasive alien plants, needs to be substantially modified if impacts on our biodiversity are to be meaningfully mitigated," he stated. He highlighted the successful invasion of fynbos by woody plants, which has led to the transformation of natural ecosystems and has had severe impacts on, among other things, water catchments and fire regimes.

New WRC Knowledge Review shows growing support for water research

The latest Water Research Commission (WRC) Knowledge Review is now available.

The Knowledge Review, published every year, provides an overview of the Commission's investment in the creation and sharing of water-centred knowledge over the past financial year.

During the last year alone the WRC managed 332 research projects at various stages of the project lifecycle, of which about 79% were active projects. Research is aimed at addressing challenges within the sectors of water resource management, water-linked ecosystems, water use and waste management, as well as water utilisation in agriculture.

"The WRC supports the water sector with research products aimed at informed decision-making, improving monitoring and assessment tools, and making available a range of new and improved technologies related to water resource management, improved use of water in agriculture and the provision of water and sanitation services," writes WRC CEO, Dhesigen Naidoo. "The WRC continues to support the development of adaptive and mitigating strategies which will ensure the future sustainability of the country's water resources and services, in order to continue the economic growth trajectory and the improvement of quality of life within a sustainable development paradigm."

Total investment in the support of knowledge creation, sharing and dissemination amounted to R140,9-million. This represents an increase of 27% from the previous year. This investment includes about R3,2-million for the Water Information Network (WIN-SA), R1,7-million for the Framework for Education and Training in Water (FETWater), as well as other income leveraged for projects during the year under review. The investment in research projects expressed as a percentage of total expenditure was 67%.

Building capacity remains an important outcome of all WRC research as it strives to provide South Africa with future researchers as well as a source of skilled capital for other institutions within the water sector. Project leaders are encouraged to include students on their projects, enabling them to participate in water research through various projects supported by the WRC.

A total of 506 students were involved in WRC projects in the last financial year, 268 of which are previously disadvantaged. In many areas of research support by the WRC it is evident that students who participated in earlier WRC projects are now leading Commission-funded research projects and serving as members of steering committees as well as reviewers of new research project proposals.

In addition to its support for the training of students, the WRC initiated and supported a number of national capacity-building initiatives. These included support to national and local government as well as the development of new training material for different levels of learners and for academic institutions.

Water on the Web

www.iucnredlist.org
The IUCN Red List of Threatened Species is widely recognised as the most comprehensive, objective global approach for evaluating the conservation status of plant and animal species. The website offers latest data of endangered species around the world, but also facts and information on each species, from frogs, fish to trees and birds.

www.wateractionhub.org
The Water Action Hub is an online platform designed to assist stakeholders to efficiently identify potential collaborators and engage with them in water-related collective action to improve water management in regions of critical strategic interest. The Orange-Senqu basin is one of the strategic basins appearing on the website.

www.techtransfer.csir.co.za
The CSIR has launched a technology transfer portal. The portal is dedicated to the council's technologies transfer activities. It serves as a repository of relevant information on how the CSIR performs technology transfer, what its technology transfer preferences are, who the relevant contact persons are, and what technologies it currently has available for licensing.

WRC to receive R1-million as part of mine prosecution

The Water Research Commission (WRC) was to receive the first instalment in December of a total of R1-million to be paid to the Commission by Golfview Mining.

This follows the mining company's conviction in an Ermelo court in October last year for various contraventions of the National Environmental Management Act and the National Water Act. The mining firm was found guilty after illegally mining in a wetland; the diversion of water resources (i.e. the Holbankspruit, part of the Upper Vaal catchment); inadequate pollution control; and the unauthorised transformation of three hectares of indigenous vegetation.

As part of a plea agreement, Golfview was fined a total of R4-million (of which R1-million was suspended for five years). The remaining R3-million is to be paid to the WRC, Mpumalanga Department of Economic Development; and the Mpumalanga Tourism & Parks Agency.

The court also imposed an order that forces the mining company to rehabilitate the wetland according to an approved rehabilitation report. The potential cost of the rehabilitation has been estimated at between R50-million and R100-million. This penalty is said to be the largest imposed for environmental offences in South Africa.

WRC Research Manager, Bonani Madikizela, welcomed the conviction. "As a leading funder of wetlands research in South Africa for a number of years, it is very encouraging to receive acknowledgement for this effort. We hope that non-compliance with sustainable mining procedures will soon be a thing of the past. Hopefully this case will serve as a warning and reminder to developers to stay within the ambits of policy."

The court ordered that the monies received from Golfview may only be used for environmental research, awareness, protection and training within Mpumalanga. "This money will go a long way towards development refinement of water resource management methods," noted Madikizela.

Still time to submit papers to groundwater conference

The closing date to submit abstracts to the 13th Biennial Groundwater Division of the Geological Society of South Africa Conference & Exhibition, to take place in Durban from 17 to 19 September, is 10 March.

With the theme 'Groundwater: A New Paradigm', this conference aims to bring together students, academics, specialists and decision-makers to discuss and showcase groundwater and related activities.

The National Development Plan sets out bold plans and interventions to be achieved by 2030. Water plays a key role in most developmental plans. "With a large proportion of the country being served by groundwater it makes sense to take stock of our achievements within the groundwater sector as well as to frame the future role of groundwater within this developmental agenda, say the organisers."

According to the Groundwater Division, the role of the groundwater professional is likely to increase and the groundwater community should be prepared to engage society on the efficient management of this finite resource to ensure social, economic and environmental security. "The way groundwater is perceived by society and specifically decision-makers needs to drastically change to effect positive change. Key lessons from international experiences through international contributions will form part of this new groundwater sector roadmap.

Among the topics to be covered at the conference include groundwater and water-energy-food security; groundwater in a green economy; groundwater and infrastructure; groundwater and mining; groundwater as a catalyst for social development; groundwater and the environment; capacity development; resource economics; and knowledge gaps and innovations, among others.

For more information Email: *info@gwd.org.za* or Visit: *www.gwd.org.za*

Out with the old, in with the new as Swakopmund sewage works approaches finish line

The new Swakopmund Wastewater Treatment Works, in Namibia, is on track to begin treating up to 12 Mℓ/day of sewage by early this year.

The plant will replace the town's old wastewater treatment plant, which is overloaded and no longer complies with legislated discharge standards. The original plant was built in 1957, however, the town has since enveloped it, posing a health risk to residents.

According to mechanical contractor, Aqua Services & Engineering (ASE), a subsidiary of Veolia Water Solutions & Technologies, the sewage reticulation system will still drain and pump wastewater from various stations into a balancing tank at the existing works in town. However, once the new plant is operational, sewage will be pumped 9,8 km in a pipeline to the new plant, where it will be treated. ASE won the contract to supply and install the mechanical works for the new plant.

The new plant is designed for biological treatment by means of the activated sludge process. It includes biological nitrogen and phosphate removal. Final water treatment processes will include gravity sand filtration and disinfection with chlorine. "The new plant's discharge water will be of high quality for re-use in gardening and irrigation throughout the town," notes ASE MD, Christian Stöck. "Our firm considered the odour and vector-related problems, especially in the collection pump station still located in the centre of town, and employed specific technologies to ensure smells are eliminated."

ASE is responsible for all mechanical equipment, including the inlet works, biological reactors (with mixers and surface aerators), clarifiers, rapid gravity sand filters, chlorination and ferric chloride dosing equipment, sludge thickening, and the anaerobic digester equipment.

ASE started installing the mechanical equipment for the plant's activated sludge system in June last year. "The civil works are approximately 80% complete, which means, for us to meet deadlines, we needed to begin our installation, despite the civil works not yet being complete," concludes Stöck.

Conference proves there's value in your poo

Biodiesel, fertiliser, hydrophobic coatings, charcoal – these are all beneficial products that can be created from what we currently flush down our own toilets.

Sustainable sludge management is a growing concern worldwide, and was the centre of discussions among scientists, decision-makers and innovators at the International Faecal Sludge Management Conference, held in Durban towards the end of last year. The conference was hosted by the Water Research Commission (WRC) in partnership with the Melinda and Bill Gates Foundation and eThekwini Municipality.

Increasingly, faecal sludge was being seen as a resource rather than a waste," said WRC Executive Manager for Water Use and Waste Management, Jay Bhagwan. "After 200 years of wasteful flushing the science sector is now pushing the boundaries of sanitation, seeking sustainable ways of beneficiation."

More than 300 delegates from all over the world attended the conference, which showcased 50 innovative technologies and processes. It is hoped that these innovations could lead to the emergence of new businesses while addressing the sanitation crisis that exists in many developing countries.

According to Bhagwan, in most African countries (including South Africa) the focus is on the provision of new toilets while the maintenance of those already built still remains a challenge. South Africa, for example, has more than 1,7 million dry on-site sanitation systems, mostly in the form of ventilated improved pit toilets. Yet, many municipalities do not have any policies, budgets or procedures for the ongoing or emptying of these sanitation systems. "A rough estimate suggests that in the rest of southern Africa there may be another five million urban latrines, many of which will require emptying within five years," said Bhagwan.

The critical challenge for the reuse of faecal sludge is always going to be acceptance, said WRC CEO, Dhesigen Naidoo. "This is why we are investing in the cultural, social and psychological factors that will eventually make non-water dependent sanitation solutions the mechanism of choice for communities."

To view video clips of the conference, Visit: www.youtube.com/watch?v=PKh4ixNKO8o

Department commits more to Harties cleanup

Following the conclusion of the first phase of the Harties Metsi-a-Me programme at the Hartbeespoort Dam, the Department of Water Affairs (DWA) has allocated a further R258-million for operation and maintenance, as well full-scale implementation and extension on remediation of the dam.

DWA reports that it also intends to conduct an independent review of the programme. At the time of writing, the procurement to appoint the Water Research Commission as implementing agent to undertake the review was underway.

The remediation of the dam started in 2008. According to DWA, this had led to "significant improvement of the state of the dam and overall quality of the water." Through the programme some 98 t of dead fish were removed along with debris and hyacinth.

The effectiveness of interventions will continue to be reviewed on an ongoing basis by the Hartbeespoort Dam Inter-governmental Steering Committee.

Serious effort needed to prevent severe water shortages

While South Africa has no crisis in terms of water security, the country had to put in the necessary effort to prevent severe shortages that could lead to serious social and economic challenges, said the Department of Water Affairs (DWA).

"We don't have a crisis; we have a lot of options but those options require effort and money so the more we manage our water effectively, the better for all of us," said the department's Director for National Water Resource Strategy, Fred Van Zyl. He was speaking on the sidelines of a conference to explain the country's water resource strategy approved by Cabinet last year. The gathering was attended by representatives from the private sector, civil society, government officials and the agricultural sector.

The draft second national water resource strategy, released recently by Minister of Water and Environmental Affairs Edna Molewa, warns that South Africa is "at risk" if water is not taken seriously and interventions not applied timeously. It points to the need to protect freshwater sources, while improving the management of water across key economic development centres like Gauteng, Cape Town and KwaZulu-Natal.

Van Zyl said part of the solution was to impose restrictions on irrigation, tighten laws that govern water management and explore the possibility of sea water desalination. The latter, however, proved too expensive but it was something that South Africa needed to explore.

There was a need to invest strongly in water infrastructure in Gauteng, the major economic activities and mining. Evidence showed that if something was not done to improve the management of water, South Africa could experience serious water shortages as early as 2020. "We have to reuse where we can, we can do desalination...we can do a lot of things and research shows that we have to move in that direction and the most important thing is we need money," added Van Zyl.

The department would be urging stakeholders attending the conference to place water management at the centre of their water plans.

Source: SA News

New WRC project to help farmers squeeze more out of tight margins

Staying ahead of rising input costs while still maintaining profitable production has become a tightrope irrigation farmers in South Africa have had to master in order to stay in business. To contribute to the sustainable management of irrigation farming systems the Water Research Commission (WRC) is launching a new project this year focusing on the optimisation of electricity and water use.

The general objective of the project is to develop appropriate management approaches for reducing electricity cost, improving water use productivity and increasing profitability of irrigation farming for selected irrigation areas in South Africa. Among others, the project will review design norms and standards for irrigation systems, available methods to calculate electricity cost for irrigation and changes in electricity tariff structures over the last ten years along with current irrigation practice on farms. Furthermore, the key decision variables for reducing electricity cost of current and alternative irrigation systems will be determined.

The project will also seek to develop methods and models for calculating electricity cost, providing decision support for capital investment, operating cost and irrigation water management, as well as quantify the reduced system and lifecycle cost for increased profitability. One of the main products of the research will be a guidance report for optimisation of electricity and water use for sustainable management of irrigation farming systems.

Explaining the reasoning behind the project, WRC Executive Manager for Water Utilisation in Agriculture, Dr Gerhard Backeberg, says that electricity tariff structures have changed over the years. In addition, electricity rates have escalated considerably, with more increases expected in the near future. "This requires a change in design norms and standards as well as a shift in emphasis to lifecycle cost evaluation."

It has been ten years since the WRC has funded electricity and water use optimisation studies in the agricultural sector. This research output clearly needs to be revised and guidelines must be updated.

"Over the intervening years, new technologies have become available such as variable speed drive and energy efficient motors," notes Dr Backeberg. "Better engineering practices for pumps, including auto restart and remote control, have led to increased accuracy and energy efficiency. It is therefore essential to evaluate and compare different technologies on the basis of efficient energy/power use and operating cost over the lifecycle of the irrigation system."

"Farmers need advice and extension based on user-friendly guidelines in order to respond to pressures and incentives by changing irrigation practices."

In addition, better automatic weather stations are accessible and convenient irrigation scheduling techniques, such as continuous logging probes with telemetry, can be applied. This enables more efficient use of water, reduced electricity consumption and higher food production.

At the same time there are pressures to reduce the carbon and water footprint, especially for export food markets. "In so doing, costs must be lowered, profitability and competitiveness increased and water use productivity improved," notes Dr Backeberg. "However, farmers need advice and extension based on user-friendly guidelines in order to respond to these pressures and incentives by changing irrigation practices."

These practices that influence electricity power use include determining water use of crops, monitoring soil water content, applying the correct volume of water at the correct time of the crop growth stage, pumping water efficiently from the river or storage dam to the field, installing energy efficient motors, selecting correct pipe sizes and regular maintenance of equipment, among others. Measurement and verification therefore requires determining the baseline and implementing an information system for management of reduced energy/electricity consumption and optimisation of water use on irrigation farms.

The WRC project is expected to be completed in 2017.

A new project funded by the WRC aims to help farmers stay ahead of soaring water and electricity cost.

No need to grow economy at cost of biodiversity, says UN

A new global strategy to combat unprecedented levels of biodiversity loss calls for 'significant' increases in biodiversity investments in 100 countries – while at the same time aiming to foster economic growth and create jobs in addition to protecting endangered species and habitats.

Launched late last year, the report 'The Future We Want: Biodiversity and Ecosystems – Driving Sustainable Development – the Strategy' will see the UN Development Programme (UNDP) work with national governments to protect biodiversity and manage ecosystems across 1,4 billion hectares of land and bodies of water.

According to UNDP, it will also help governments find new ways to finance biodiversity management through "domestic revenue, innovative financial mechanisms, and donor funding from a range of sources."

"Human survival depends heavily on biodiversity and healthy ecosystems, yet in recent decades, the world has experienced unprecedented biodiversity loss and ecosystem degradation, undermining the very foundations of life on earth," said UNDP's Associate Administrator, Rebeca Grynspan. "As 1,2 billion people living in severe poverty depend directly on nature for their basic needs and livelihoods, this needs urgent international attention."

UNDP unveiled the strategy at the 11th Conference of the Parties to the UN Convention on Biological Diversity, Hyderabad, India. The Conference adopted the new strategy, which UNDP said is designed to help countries integrate biodiversity management with development planning, enable protected areas to contribute to sustainable development, and ensure that management and rehabilitation of ecosystems mitigate the effects of climate change.
Source: UN News

Collapse of Classic Maya civilisation linked to drought

The Classic Maya culture thrived in rainy times and then collapsed as the climate became dry, according to new research.

The Classic Mayan region covers portions of Mexico, Belize, Guatemala and Honduras. An international project led by researchers from Pennsylvania State University, in the US, and ETH Zurich, Switzerland, has created a precisely-dated record of rainfall from cave deposits in the Classic Maya region, and compared it to a 'war index' of hostile events recorded on stone monuments. The research has enabled the team to create a unique historical timeline linking climate and culture in unprecedented detail.

The war index is based on how often certain keywords occurred in Mayan inscriptions on carved stone monuments. The researchers were then able to chart how increases in war and unrest were associated with periods of drought.

The new datasets provide a unique insight into how a civilisation prospered and developed, expanding into large cities during a period of favourable climate and then collapsed following climate change between AD 660 and 1100. Maya rulers commissioned monuments to record events and the research team found the frequency of texts carved on stone monuments pointing to status rivalry, war and strategic alliances increased significantly between AD 660 and 900, during the drying trend.

The role of climate change in the fall of the Classic Maya civilisation had previously been suggested, but remained controversial due to dating uncertainties in previous climate records. The research team constructed rainfall for the last 2 000 years using the chemistry of stalagmites from Yok Balum cave in Belize. The cave is located 1,5 km from the Classic Period Maya site of Uxbenká and is close to other major Maya centres, all influenced by the same climate systems.

According to Dr James Baldini of Durham University, who led the cave monitoring portion of the study, the rise and fall of the Mayan civilisation is an example of a sophisticated civilisation failing to adapt successfully to climate change. "Periods of high rainfall increased the productivity of Maya agricultural systems and led to a population boom and resource overexploitation. The progressively drier climate then led to political destabilisation and warfare as resources were depleted. After years of hardship, a nearly century-long drought from 1020 sealed the fate of the Classic Maya."

The findings of the study have been published in *Science*.

Cleanup of most challenging US contaminated groundwater sites 'unlikely for decades'

Around 10% of the US's 126 000 contaminated groundwater sites are considered so complex that restoration is unlikely to be achieved within the next 50 to 100 years due to technological limitations.

This is according to a new report from the US National Research Council. According to the report, the estimated cost of complete cleanup at these sites ranges from US$110-billion to US$127-billion.

Several national and state groundwater cleanup programmes developed over the last three decades under various federal and state agencies aim to mitigate the human health and ecological risks posed by underground contamination. The US Department of Defence, for example, has already spent around US$30-billion in hazardous waste remediation to address past legacies of its industrial operations.

"The complete removal of contaminants from groundwater at possibly thousands of complex sites in the US is unlikely, and no technology innovations appear in the near time horizon that could overcome the challenges of restoring contaminated groundwater to drinking water standards," said Michael Kavanaugh, chair of the committee that wrote the report. "At many of these complex sites, a point of diminishing returns will often occur as contaminants in groundwater remain stalled at levels above drinking water standards despite continued active remedial efforts."

The international year of water cooperation starts

In 2010, the United Nations Generable Assembly declared 2013 as the UN International Year of Water Cooperation. World Water Day, celebrated on 22 March, will also be devoted to the theme of water cooperation, and various events are planned around the world.

The year is aimed at emphasising that water is critical for sustainable development, including environmental integrity and the eradication of poverty

and hunger. It is hoped that the year will serve as a platform to unify all efforts to increase people's awareness of water-related problems and ways to resolve them, thus creating a favourable environment for generating new ideas and searching for the most efficient ways to address challenges.

For more information, Visit: www.unwater.org/watercooperation2013/

Study offers tool for incorporating water impacts into policy decisions

How valuable is water to society exactly?

This is the question researchers at the University of Minnesota's Institute on the Environment hope to answer with their new policy-making framework.

The framework, published late last year in the *Proceedings of the National Academy of Sciences*, provides a tool for assessing and valuing the many services clean water provides – from recreation and beauty to navigation and hydropower – and incorporating them into policy decisions.

"After repeated requests for information on the value of water quality, we realised that there was a huge gap between the demand for economic values of water quality and our ability to provide tools to estimate those values. This gap limits our ability to make informed decisions," explained project leader, Prof Bonnie Keeler. "We provide a framework that describes the numerous pathways in which changes in water quality affect our health, recreation and livelihoods and the economic value of those changes. This yields a far more accurate picture of the costs and benefits of decisions."

The decision-making template developed links actions, changes in water quality, changes in a spectrum of ecosystem goods and services, and changes in the economic value that accrues from the changes in ecosystem goods and services. The researchers then outlined a five-step plan policy makers can use to apply the template to on-the-ground decisions around water issues.

"There will never be a single number that describes the value of clean water in all places and contexts," noted Prof Keeler. "What our paper proposes is a way for users to link tools from ecology and economics to get value estimates that are specific to their location and sets of alternative actions. Ideally these values can then factor into incentive programmes, cost-benefit studies and payment programmes for ecosystem services."

Sustainable cities must look beyond city limits

City leaders aspiring to transform their cities into models of sustainability must look beyond city limits and include in their calculation the global flow of goods and materials into their realm, argue researchers in the Royal Swedish Academy of Sciences journal, *Ambio*.

Many cities are now developing sustainable strategies to reduce pollution and congestion, improve the quality of life of their citizens and respond to growing concern about human impact on climate and the environment. But sustainable city initiatives often ignore the environmental footprint from imported goods and services such as food, water, energy to cities.

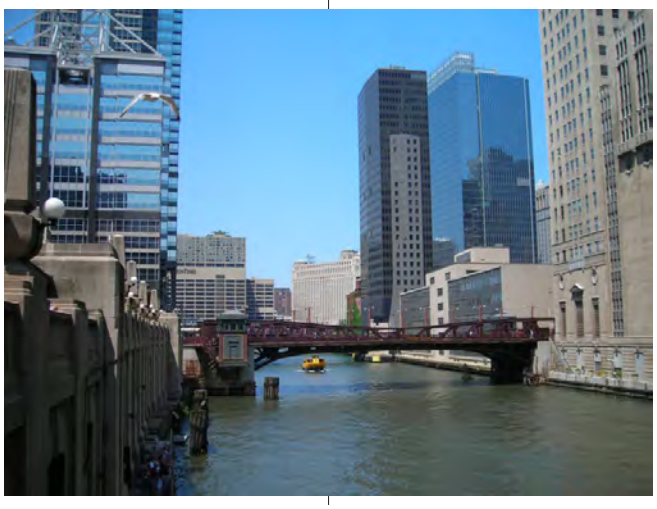
"The sustainability of a city can no longer be thought of in isolation from the combined resource use and impact of cities globally. Urbanisation is no longer a local issue," say Earth-system researchers in their paper, 'Planetary stewardship in an urbanising world: beyond city limits', published in October.

"Urban areas drive much of the global changes we see, whether in energy use, food supply, resource depletion or land-use change," says lead author Dr Sybil Seitzinger, Executive Director of the International Geosphere-Biosphere Programme in Sweden.

The world has urbanised rapidly, and continues at an unprecedented pace. Today, over half of all people live in urban areas, with most growth taking place in Africa and Asia. "Humankind is expected to build more urban areas during the first 30 years of this century than all of history combined," notes co-author, Prof Karen Seto, from Yale University.

A system of sustainable cities will require adequate information on resource flows and their impacts, preferably in near-real-time and on a global scale. "Digital technologies are now putting this kind of information within grasp," says Dr Seitzinger.

To access the paper, Visit: www.springerlink.com/content/t06251122wp126p3/fulltext.pdf



Water by numbers

5 000 – The estimated number of Durban residents who have openly objected to the city's sewage-to-drinking water plan, the Independent Online Reports. The plan involves recycling around 116 million litres of wastewater a day from the KwaMashu and Northern wastewater treatment works and then blending it with conventionally treated drinking water.

57% – The percentage of South Africa's population that have flush toilets connected to the sewerage system, up from 55% in 2007, according to Census 2011. According to the latest census statistics, only 5,2% of the country's households do not have any toilet facility.

89,4% – The percentage of households in Gauteng which have access to piped water inside their house or yard, according to Census 2011 – the highest in the country. Households in the Free State have the second-highest access to piped water in the house of yard (89,1%) followed by the Western Cape (88,4%).

4 000 – The estimated number of artisans and technicians required to overcome the crippling challenges of poor operation and maintenance of water-related infrastructure, according Water & Environmental Affairs Minister, Edna Molewa.

10 – The number of water meters being stolen a day from some areas of Johannesburg, according to Johannesburg Water. The water and sanitation service provider has reported an increase in water meter theft, especially from its Central region, which includes areas such as Berea, Hillbrow, Doornfontein, Yeoville, Observatory and Kensington.

260 – The number of critically endangered wattled cranes left in South Africa. The Endangered Wildlife Trust has created awareness of the plight of this bird – and all crane species – as well as their wetland habitats first annual Chrissiesmeer Crane Festival, in Mpumalanga.

New from the WRC

Report No. 1756/1/11

Investigation into the effects of water quality (organic vs. inorganic) on the immune system (E Pool; P Bouic; H du Preez; C Malan & R Hendricks)

Factors that modulate the immune system can have serious consequences for animals and humans because the normal defences against microbes, pathogens and cancers do not function properly. This can result in increased incidences of infections, cancers and allergies. Several chemicals found in the environment, such a oestrogens, polychlorinated biphenyls (PCBs) and the pesticide lindane have immunotoxic properties which affect specific immune defences. The objectives of this study were to validate and implement an assay to monitor the effects of hydrophobic extracts of water on the immune cell populations; validate and implement an assay to monitor the effects of environmental water extracts on inflammatory, Th1 (cell-mediated immunity) and Th2 (humoral immunity) cytokine synthesis and on antibody production. Furthermore, a seasonal study was undertaken on the immune and microbiological quality of the water from the Eerste and Plankenbrug rivers, Stellenbosch.

Report No. 1700/1/12

The impacts of rural small-community water supply interventions in rural South Africa (P Jagals)

Much evidence exists to show that, where communities use poor quality water, improving water supply services such as access, availability and portability generally leads to a significant reduction in morbidity as well as premature mortality from water-related infectious disease. The purpose of this work was to develop an understanding of the socio-economic value of improving water supply services and ultimately produce a framework from which to develop a tool for assessing and monitoring the extent of these benefits.

Report No. TT 534/12

Tool to measure impacts and operations of rural small-community water supplies in rural South Africa (P Jagals)

This report contains descriptions and contents of two rapid assessment tools. Tool 1 is used to measure impacts of rural small-community water supply interventions in rural South Africa, while Tool 2 is used for rapid technical assessment of rural water-supply systems. Water service providers and other interest groups can use these tools to evaluate whether the small-community water-supply systems that they are providing are beneficial for their recipients and, if not, where there will be areas that require improvement.

Report No. 1799/1/12

Water temperatures and the Ecological Reserve (H Dallas & N Rivers-Moore)

Freshwater systems, both globally and within South Africa, are under pressure, and are among the most deteriorated and worst off systems, due in part to water abstraction, flow regulation and pollution. Successful implementation of environmental flow management requires taking cognisance of the full spectrum of flows together with thermal regimes, including their temporal and spatial variability. Water temperature is recognised as an important abiotic driver of aquatic ecosystems, and understanding the role that temperature plays in driving ecosystem change is important if effective management of thermal stress on aquatic ecosystems is to be achieved. Therefore, the main aims of this research project were, among others, to collect baseline water temperature data in a range of rivers in the Western and Eastern Cape; develop a generic water temperature model for South Africa; and to develop an understanding of the response of aquatic organisms to water temperature regimes in South African rivers.

Report No. 1745/1/12 to 1745/3/12

Tackling the challenges of full pit latrines (D Still & K Foxon)

The South African government has constructed over two million ventilated improved pit (VIP) toilets and other on-site sanitation systems since 1994. But with a remaining three million households still without basic sanitation, many water services authorities (WSAs) in South Africa are still focused on addressing backlogs and have not given serious thought to the maintenance of the systems they have already built. Many of the toilets that were first provided in the push to provide basic sanitation for all are expected to reach capacity in

WRC throws open its storeroom doors

After more than 40 years of serving as South Africa's premier hub for water-centred knowledge, in which 100 research reports are printed a year, on average, the Water Research Commission (WRC) storeroom is throwing open its doors to the public.

The bulk of the WRC's reports are free of charge, however, for a limited time period bulk orders for these reports – for which postage is normally charged – will be distributed for free. Institutions are encouraged to place their orders now to avoid disappointment. Orders of ten reports or more are strongly encouraged. The WRC will also be consulting with public and school libraries to receive some of the reports which are of a less technical nature. Prospective recipients can browse the WRC website for all reports titles. All of the WRC's reports also remain freely available for download on its website (www.wrc.org.za)

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the next few years, which will result in an overwhelming demand for pits to be emptied. Without funds, policies, tools or procedures in place to manage the emptying of pits and disposal of sludge when this happens, many WSAs around the country may soon be facing a crisis. The goal of this project was to investigate existing management practices with regard to VIP toilets, identify challenges and develop strategies and tools for more effective management. Existing literature and current practice was explored to consolidate knowledge on pit filling, strategies and methodologies for pit emptying and the economic aspects of successful on-site sanitation management. New technologies and methods were developed for pit emptying and sustainable alternatives for the beneficial use of sludge were explored. The findings of this research have been published in three volumes, namely *Understanding Sludge Accumulation in VIPs and Strategies for Emptying Full Pits (Volume 1)*; *How Fast do Pit Toilets Fill Up? A Scientific Understanding of Sludge Build Up and Accumulation in Pit Latrines (Volume 2);* and *The Development of Pit Emptying Technologies (Volume 3)*.

Report No. 1887/1/12

Piloting and testing the pour flush latrine technology for its applicability in South Africa (D Still & B Louton)

This project investigated the potential for modifying the pour flush design, which is used widely in Asia, to meet the needs of the South African context. The development and application of pour flush systems in Asia was studied. Three case studies were conducted to investigate the experience of South Africans with low flush systems in the past and related technologies were surveyed. A prototype was developed and tested after which the technology was piloted in 20 homes for usage periods of up to 18 months. The systems were monitored over the course of the project and performance and user experience were assessed at the end of the project.

Report No. 1988/1/12

Bridging the policy divide: Women in rural villages and the Water for Growth and Development Framework (L Loate; V Molose; S Motloung; V Munnik; I Wilson & K Zuma)

This study was focused on the implementation of water legislation and policies on the ground, evaluating whether the intentions of the Water for Growth & Development Framework to bring water services and water resources together in support of women as strategic users of water and, in particular, rural women's use of water for their emerging productive activities, are met in reality. Among others, the study examined the extent to which local authorities meet their developmental mandate to promote local economic development by supporting rural women multiple uses of water. The study demonstrates rural women's strategies for multiple uses of water and ways in which policies and their implementation at national and, in particular, at local level, better support them.

Report No. 1926/1/12

Water use of the dominant natural vegetation types of the Eastern Shores area, Maputaland (AD Clulow; CS Everson; C Jarmain & M Mengistu)

In South Africa much of the focus on total evaporation (ET) related work in water research has been on alien vegetation due to its high water use and impact on the environment. There is a dearth of information on ET from natural vegetation and, in particular, indigenous trees. This is compounded by variable climate and there is a poor understanding of how far previous research results can be extrapolated to other climatic regions. During the course of two previous WRC-funded projects a need was identified to determine the water balance of the Eastern Shores area of the iSimangaliso Wetland Park. It was, however, apparent that there was little or no information on the actual ET from the different vegetation types of the area. Because ET is such a dominant component of the water balance, there was therefore a critical need to determine and better understand the ET of this vulnerable and protected area in order to improve the management of the system.

Report No. 2016/1/12

Evaluation of sanitation upgrading programmes – The case of the bucket eradication programme (NP Mjoli)

The majority of municipalities used the conventional waterborne sanitation system to replace buckets in urban formal settlements. This presented a challenge for municipalities servicing areas with bulk sewers and inadequate wastewater treatment capacity and, in some cases, the available water supply could not support the new waterborne sanitation systems. This study was initiated to assess what worked and what did not work, to evaluate the extent of compliance of the bucket eradication programme with sanitation policy principles and to assess the impact of the programme on the quality of life for the beneficiary communities.

Report Nr. KV 297/12

Silver/zeolite nano composite-based clay filters for water disinfection (L Petrik; R Missengue; O Fatoba; M Tuffin; J Sachs)

People who do not receive a supply of treated potable water rely on natural groundwater or surface water resources which in the absence of sanitation systems are often contaminated with pathogenic microorganisms of faecal or other origin. Point-of-use (i.e. household) treatment devices offer the most potential to minimise the risks of waterborne disease in such situations. Clay or ceramic filters for household water treatment have been available since the 1980s and their efficacy has been investigated. However, such studies usually assess filters that are produced commercially and are beyond the budget of the intended end users, prompting other workers (e.g. the Potters for Peace organisation) to investigate filters which employ local people and locally available materials in their fabrication. This project investigated the possibility of enhancing the Potters for Peace innovation with the addition of silver/zeolite for added disinfection.

Report Nr. 1647/1/12

Managing salinity associated with irrigation at Orange-Riet and Vaalharts irrigation schemes (LD van Rensburg; JH Barnard; ATP Bennie; JB Sparrow & CC du Preez)

Salinity associated with irrigation has in the past, and continues to be arguably the most important factor threatening agricultural production under irrigation. Unfortunately the problem extends beyond the confines of irrigated fields, degrading water resources and resulting in extensive areas of land becoming waterlogged and saline. Poor planning and ineffective water and salt management practices by farmers and managers of irrigation schemes therefore strongly affect the sustainability of irrigation. Researchers are in agreement about the fact that sustainable irrigation is technically possible with the proper design and operation of irrigation and drainage systems, with the implementation of suitable crop and soil management practices, provided that acceptable political and social structures are in place. The general opinion is that irrigated agriculture will not only survive, but will indeed thrive under realistic circumstances and appropriate management practices. The estimated fraction of salt-affected irrigated land in South Africa is only 9%, which is much lower compared to countries such as Argentina, Egypt, Iran, Pakistan and the USA where percentages as high as 34% are experienced. Despite the fact that salt-related problems are not at present a significant factor threatening production under irrigation in South Africa, increasing evidence of deterioration of physical resources suggests that the problem cannot be ignored. A solicited research project on managing salinity associated with irrigation in selected areas of South Africa was therefore introduced by the Water Research Commission.

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COUNTING THE LOST DROPS –

Study into non-revenue water shows we can do more

www.sxc.hu

While South Africa's non-revenue water levels compare well internationally as a water scarce country we need to do all we can to prevent the unnecessary loss of water. This is one of the main recommendations of a recent study into the state of non-revenue water in South Africa commissioned by the Water Research Commission (WRC). Lani van Vuuren reports.

The Draft Second National Water Resources Strategy (NWRS2) has identified the implementation of water use efficiency, conservation and water demand management as a core strategy to ensure sufficient water to meet South Africa's needs going into the future. This, 'non-negotiable performance area', it says, must be implemented immediately in all water use sectors, specifically municipalities. "In view of water scarcity, it is essential that such water losses must be curtailed, especially in terms of the need to provide for the growing water demands of new socio-economic development," the strategy points out.

In order to improve the current situation, the water sector must have a clear indication of the current status of non-revenue water in South African municipalities, more specifically what the actual water losses are and how they are split between physical leakage (real losses) and commercial losses (apparent losses). It is for this reason that the WRC, in collaboration with the Department of Water Affairs (DWA), launched the latest investigation into the state of non-revenue water in South Africa, which has now been published.

In the most comprehensive and detailed study of its kind, to date, data were gathered from 132 municipalities throughout South Africa representing over 75% of the total volume of municipal water supply. The study follows on from similar WRC assessments undertaken in 2001, 2005 and 2007. This is the first time the country has a single, representative estimate of non-revenue water as opposed to various estimates in previous years.

According to project leader and MD of WRP Consulting Engineers, Ronnie Mckenzie, speaking on behalf of the key team members, which included Willem Wegelin and Zama Siqalaba who gathered most of the information, many of the country's municipalities are realising the value of undertaking a proper and reliable water balance. They were therefore happy to cooperate with the project team as it also helped them to formalise their water balance, a requirement of DWA.

"Unfortunately we also have several municipalities operating in crisis mode, who had no energy to deal with requests for information," adds Mckenzie. More than half of municipalities were unable to provide any data on non-revenue water, and many lacked even the most basic bulk meter readings, which means they do not know how much water they are consuming let alone how much is being lost through physical leakage or commercial losses. This was of great concern to the project team.

MAIN RESULTS

South Africa's present level of non-revenue water is estimated to be in the order of 37%, which is virtually at the world average of 36,6%. Of this, a quarter is considered to be losses through physical leakage. According to Mckenzie, while South Africa compares well to the world average we do not compare well to other developed water scarce countries, such as Australia, whose non-revenue water levels are often less than 10%. "There is still much scope for improvement. As a water scarce country we cannot afford to waste so much water."

The study also indicates that South Africa still has a relatively high per capita water use (around 273 litres per person per day) which is an indication that the average citizen still does not realise the scarcity of this resource. The current volume of non-revenue water is around 1 580 million m^3/annum of water per annum – roughly equal to the annual supply of Africa's largest water utility, Rand Water. At a nominal production cost of R4,5/m^3, this loss represents about R7,2-billion a year.

It is heartening to note that the issue of non-revenue water – ignored by many municipalities in the past – is now receiving increasing attention at municipal level. "All of the large metros and most of the large cities and towns are now monitoring their water use and trying to establish a proper and reliable water balance in line with international recommendations," notes Mckenzie. "Progress in this regard is certainly being made and both the DWA and the WRC are creating awareness and encouraging proper water auditing at the municipal level."

WHAT IS NON-REVENUE WATER?

Non-revenue water refers to all the water that is lost through physical leakage or commercial losses (meter under-registration, billing errors, theft etc) as well as any unbilled authorised consumption (fire-fighting, mains flushing etc).

Physical leakage as a result of damaged or unmaintained water supply pipelines are a real headache in most municipalities.

Lani van Vuuren

So-called category A municipalities (metros) achieved non-revenue water levels of around 34,3% compared to the water losses of 72,5% (on average) achieved by B4 (small) municipalities. Non-revenue water levels of mid-sized municipalities range from 30,5% to 41,3% on average. Mckenzie does stress that expressing the losses in terms of percentages, while normal practice at the political level, can be very misleading and care should be exercised when comparing percentage losses between different municipalities or from one year to the next.

In many municipalities throughout South Africa there is a dedicated effort to provide safe potable water to outlying communities that have previously had no access to a formal water supply indicating a shift in focus from improving efficiency to the installation of new pipelines and supplies in line with government policy. As the report points out, such measures can inadvertently lead to an increase in the levels of non-revenue water, particularly in percentage terms, when, in fact, significant improvements are often being made.

"Many of the interventions needed to reduce non-revenue water can be implemented at relatively modest cost compared to those of a new water supply project."

THE CHALLENGES REMAIN

Unfortunately, despite the progress being made, it seems that South Africa's non-revenue water levels have remained stagnant at best over the past five to ten years. "It appears that the overall level of non-revenue water throughout South Africa is not reducing, with indications that it may in fact be increasing," says Mckenzie. "Unfortunately, it is currently not clear whether the slight increase is due to more reliable data from a larger data set or due to a real increase in the non-revenue water. We require another year or two of reliable data to establish if the trend is really increasing or not."

The investigation confirmed that non-revenue water remains the product of many factors, including poor planning, limited financial resources to implement the necessary programmes, poor infrastructure asset maintenance and lack of capacity. However, several additional key problem areas were also identified. One of the greatest inhibitors to the introduction of successful water demand management in many municipalities is the proper auditing and documentation of the various interventions.

"If the various interventions are properly ring-fenced and audited, the results will speak for themselves and the funding needed to implement new projects will easily be approved," notes Mckenzie. "Such auditing will also deter many companies from undertaken non-revenue water reduction projects under the misconception that they are an easy source of income and can be

NEW COMPENDIUM ON WC/WDM INTERVENTIONS NOW AVAILABLE

A new compendium of water conservation and water demand management (WC/WDM) interventions and measures in municipalities is now available from the Water Research Commission (WRC).

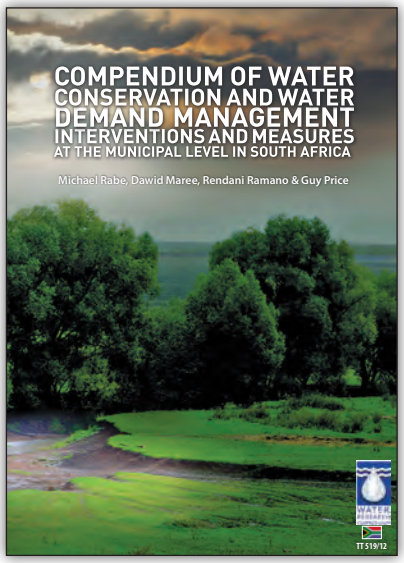
As a result of the infrastructure-intensive supply systems needed at a national, regional and local level to deliver water to end-users, many municipalities across the country are struggling to sustainably meet consumer demand. The dichotomy is that while municipalities are struggling to meet demand, water losses remain high. Much of this loss can be attributed to leakage and losses in both the network and on consumer properties which, in many areas, are not unaccounted for and represent a revenue loss to the municipality.

At the same time, the need for demand-side interventions that effectively reduce physical losses in water networks, artificial demand at the end-user level created through leakage, as well as apparent losses due to metering and billing deficiencies is abundantly clear.

In response to this need, municipalities across the country have initiated interventions, programmes and projects to reduce the demand for water with varying levels of success. Aimed at identifying, documenting and disseminating the experiences of municipalities in water demand management, the WRC directed the development of a compendium of case studies relating to WDM at municipal level. A total of 40 case studies are presented in an anecdotal, easy-to-read format. The presented case studies highlight not only best practice in the industry, but also less effective approaches that can potentially achieve greater effectiveness through improved management and implementation.

The document notes that a key challenge in planning for future economic growth and social upliftment in South Africa is ensuring efficient use of water supplies and reducing water consumption through improved management of demand for water. This notion also recognises that the eradication of poverty cannot take place without water.

"Historical demand for water continues to grow across the country and unless steps are taken to reduce demand, especially given that South Africa faces scarcity in the near future, water shortages will become the order of the day. The case studies documented in this compendium abundantly demonstrate that it is possible to reduce water demand of municipal customers through carefully managed interventions, and in so doing also achieve greater financial efficiency, reduce non-revenue water and improve operation and maintenance procedures."



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completed by anyone with a spade and a shovel."

Another important aspect of non-revenue water reduction is effective billing and metering. Revenue recovery is essential in order for municipalities to provide a sustainable good quality service and as such should be decisively implemented across the country where practicable, the report points out. Ultimately, local authorities have a mandate to generate revenue and to operate in a self-sustaining manner and this can only be achieved through proper monitoring of water-supply systems in the form of metering and creating a culture of payment for services to enable sound maintenance activities and a high standard of consumer service. Furthermore, the importance of proper planning, budgeting and maintenance of water infrastructure cannot be over-emphasised and is essential in reducing water losses and averting a potential water crisis.

WHAT SHOULD OUR TARGETS BE?

Non-revenue water can potentially have a significant impact on water supply, and in some areas high levels of lost water have already forced the commissioning of new transfer schemes. According to Mckenzie, non-revenue water should be seen as a source of water as it actually represents a significant opportunity for municipalities to save water. "The added bonus is that many of the interventions needed to reduce non-revenue water can be implemented at relatively modest cost compared to those of a new water-supply project."

Moreover, in areas that typically experience high levels of unemployment, the water demand management measures can create useful and long-term employment. In many cases, such interventions not only save water but can also create significant energy savings, particularly in systems where water is pumped at some point in the supply cycle.

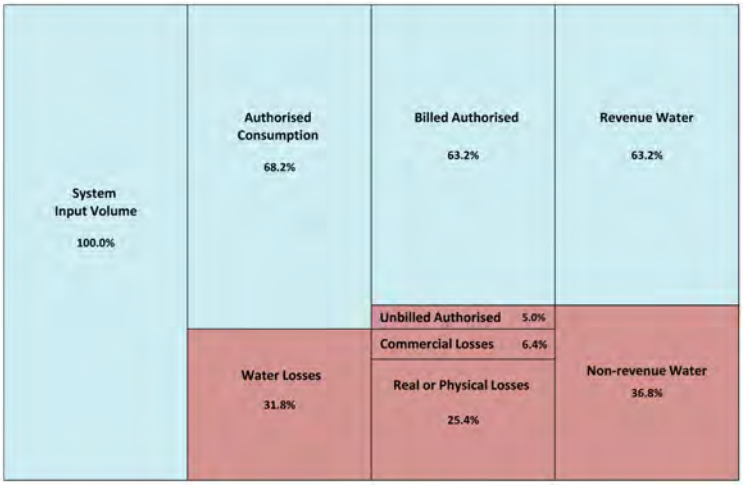


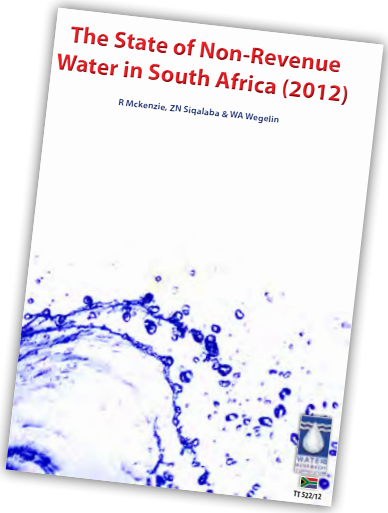
Figure 1
The national water balance

While the NWRS2 sets a target to reduce non-revenue water in municipalities to 15% by 2014, Mckenzie suggests that this may be difficult to achieve without the injection of many billions of Rand into the necessary water demand management interventions countrywide within the next two years. Without such a massive financial investment he believes that a target of 25% within ten years is achievable, especially considering muncipalities' current resources. Mckenzie also recommends that targets be defined in terms of volumes rather than percentages, as the latter can be misleading.

"While it may still be possible to achieve significant savings within only a few years this will require huge investment which may simply not be viable in the current economic climate in which many countries across the globe are struggling just to survive. We know that it takes ten to twenty years to implement a new water resource project and water loss reduction projects are likely to need the same time period for proper and sustainable implementation." Adds Mckenzie: "There will always be some water demand management interventions that can be implemented quickly and cost-effectively. Such interventions should be prioritised and implemented without delay."

While some municipalities have made great strides in conserving water much still has to be done in other areas to ensure water is not wasted unnecessarily. It is hoped that water loss reduction will receive the attention it deserves before the next large drought hits the country.

- To order the report, *The State of Non-Revenue Water in South Africa* (**Report No. TT 512/12**), contact Publications at Tel: (012) 330-340; Fax (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.



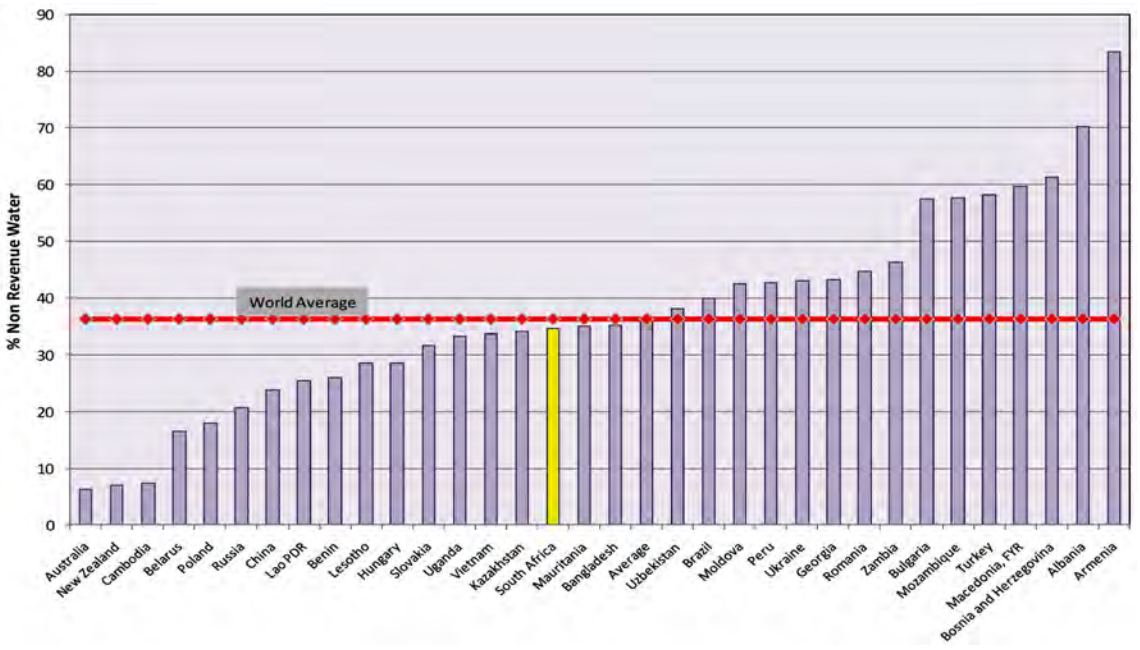
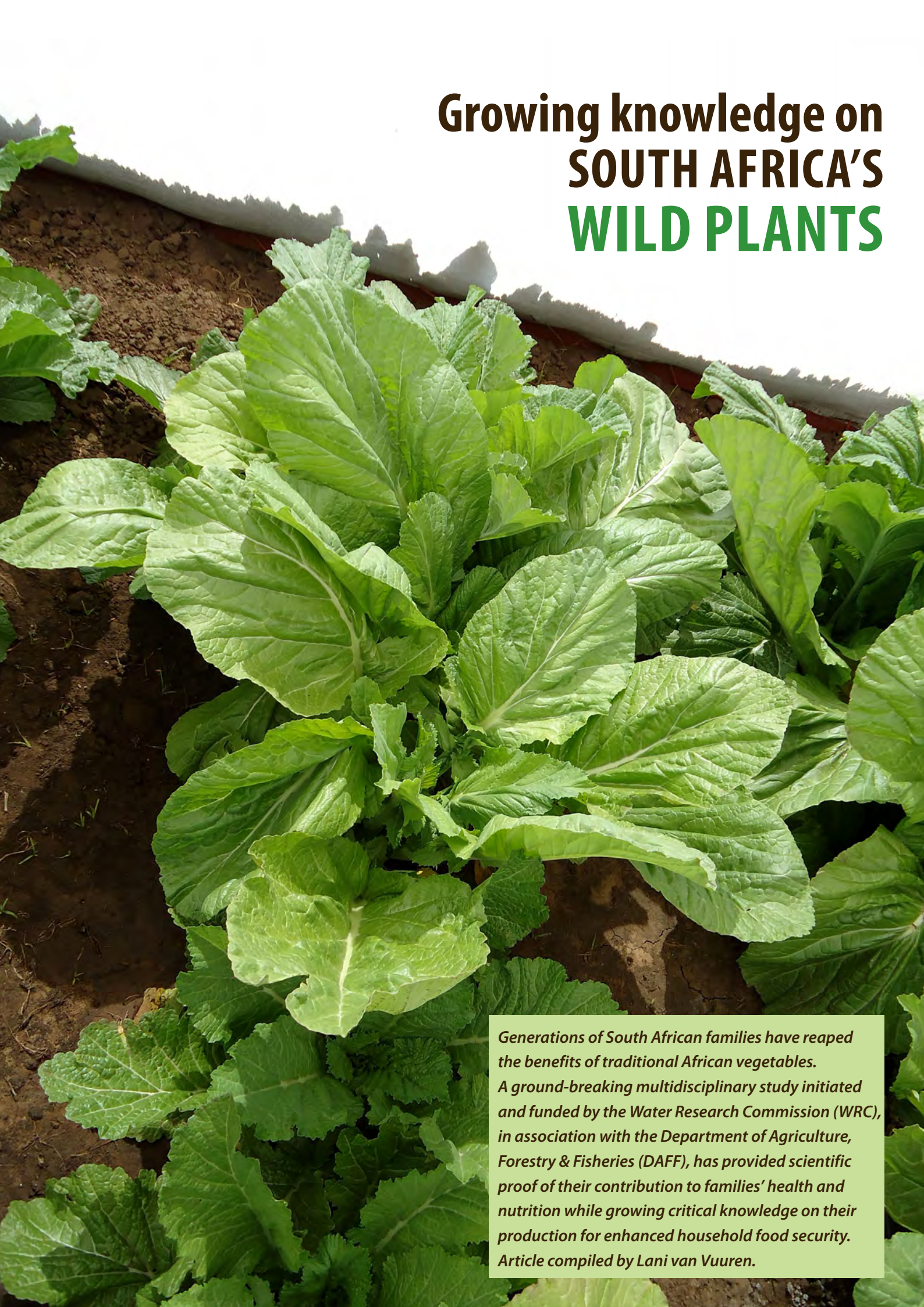


Figure 2
International percentage of non-revenue water

Growing knowledge on SOUTH AFRICA'S WILD PLANTS



Generations of South African families have reaped the benefits of traditional African vegetables. A ground-breaking multidisciplinary study initiated and funded by the Water Research Commission (WRC), in association with the Department of Agriculture, Forestry & Fisheries (DAFF), has provided scientific proof of their contribution to families' health and nutrition while growing critical knowledge on their production for enhanced household food security.

Article compiled by Lani van Vuuren.

Left: *Traditional African vegetables can be found in modern urban markets, such as this one in Soshanguve, Pretoria.*

Whether you refer to it as *morogo*, *imifino* or African leafy vegetables, traditional leafy food plants continue to play an important role in the contemporary food systems of people in South Africa, particularly in poor, rural areas. In South Africa, traditional African leafy vegetables are mostly gathered, with only selected species being cultivated, usually as part of a mixed cropping system in home gardens or smallholder plots.

Traditional African leafy vegetables have important advantages over exotic vegetable species, for example, they are generally easier to produce and usually require less resources (such as water) while being rich sources of micronutrients, such as iron and Vitamin A. Some of the most important traditional vegetable species, such as amaranth and spider flower, are pioneer plants, which emerge naturally when soils are disturbed following cultivation. Commercial farming systems may regard them as weeds, but in African smallholder cropping systems they are often left to grow for later harvesting.

The popularity of specific species depends on a variety of factors, including availability, ease of preparation, taste, consistency and appearance. While still a niche market, traditional African leafy vegetables are not only gathered for home use but also sold in fresh or dried form at both informal and formal markets.

TURNING INDIGENOUS KNOWLEDGE INTO DOCUMENTED KNOWLEDGE

The potential value for food security and rural development of gathering wild foods, growing locally adapted varieties and eating from the local ecosystem is recognised internationally. Despite significant advances, one in five South African families still experience difficulty in accessing food, with research indicating that local households are becoming increasingly dependent on social grants – a situation which is not sustainable in the long term (for more information on the latest food access statistics, read 'Growing Currency rather than Carrots' in *the Water Wheel* November/December, 2012).

Despite their significance in staving of hunger agronomic research on traditional African leafy vegetables has been neglected in the past. Generally, the utilisation, water use and agronomy of these crops are not well documented, contributing to the underutilisation of these food plants. A need has also been identified to document indigenous knowledge regarding these food plants.

To improve this state of affairs, the WRC has invested steadily in research into traditional African leafy vegetables since 1998. The latest multi-year study, which focused on the nutritional value and water use of indigenous crops, was the most intensive yet. The project placed particular emphasis on African leafy vegetables, such as amaranth, Jew's mallow, Chinese cabbage, nightshade, spider flower, pumpkin, tsamma melon and cowpea.

"Previous WRC-funded research confirmed that there is an expanding niche market for fresh traditional vegetables, particularly African leafy vegetables, yet we found little recorded knowledge on important production practices such as seed selection, fertilisation, pest control

Left (top to bottom): *Jew's mallow, nightshade, amaranth and tsamma melon were among the traditional vegetables studied in a recently concluded WRC project.*

and water use in relation to environmental variables at localities where these crops are growing," explains WRC Executive Manager: Water Utilisation in Agriculture, Dr Gerhard Backeberg. "Through this research we not only aimed to fill in these knowledge gaps, but to raise the status of traditional food plants in South Africa by pointing out the valuable contribution these plants could make to the food security and hence, nutrition security of South African households."

Ultimately the project hoped to encourage and strengthen people's abilities to generate food for themselves, as opposed to merely depending on government support systems, such as social grants. In this way communities are empowered to help themselves become food secure and maintain a healthy balanced diet.

"Meat is a visitor but *morogo* is a daily food" – Pedi proverb

One of the main products of the project is the publication, *Nutritional Value and Water Use of African Leafy Vegetables for Improved Livelihoods* – arguably the most comprehensive compendium of knowledge on these traditional food crops produced in South Africa to date. "The report gives thorough attention to a range of aspects, such as water requirements, drought and heat tolerance; agronomic characterisation and human nutritional," Dr Backeberg tells the *Water Wheel*. "Together with the production guidelines produced as part of the project it will support the implementation of the National Strategy for Indigenous Food Crops by DAFF, which is currently under discussion."

The project was undertaken by a multi-disciplinary team of scientists in the crop, food and nutrition disciplines from the University of Pretoria, Tshwane University of Technology (TUT), the Medical and Agricultural Research Councils.

Traditional African leafy vegetables do not only stave off hunger, they can also provide valuable income, especially in rural areas.

According to project team member, Prof Wim van Averbeke, of the Department of Crop Sciences at TUT, it was this multidisciplinary approach which makes the project unique and groundbreaking. "The collaboration with researchers active in the field of human nutrition was enriching for agricultural scientists and, I am certain, this also applied the other way around."

THE MAIN QUESTION

The central question the project hoped to answer was whether household production and consumption of African leafy vegetables should be promoted as part of the strategy to combat under-nutrition under conditions of resource

WHAT ARE TRADITIONAL AFRICAN LEAFY VEGETABLES?

Traditional African leafy vegetables refer to the collective of plant species whose leaves and stalks are consumed as leafy vegetables. Collectively referred to as morogo or imifino, these vegetables include indigenous, indigenised and recently introduced leafy vegetable species.

Source: Production Guidelines for African Leafy Vegetables

Above left: *For the first time production guidelines have been produced for African traditional vegetables to allow for sustainable production.*

Above right: *The spider flower, another one of the traditional African leafy vegetables.*

limitation, particularly soil, water and plant nutrient availability – commonly encountered in rural areas of South Africa.

According to Prof Van Averbeke, the project collected sufficient data to answer this question with a fairly high degree of confidence. "The results clearly indicate that regular consumption of African leafy vegetables can assist in balancing diets by adding essential micro-nutrients, particularly Beta carotene and iron."

Some plants provided more than 50% of the recommended daily allowance for vitamin A, and all eight vegetables studied provided at least 30% of the estimated average requirement. What's more, the vegetables provided varying amounts of other important nutrients, such as protein and various mineral elements, and also contained significant amounts of fibre.

USE OF TRADITIONAL VEGETABLES 'AS OLD AS MODERN MAN'

In South Africa, the use of green leafy vegetables as food is as old as the history of modern man. The !Kung people, who have lived in southern Africa for at least 120 000 years, relied heavily on the gathering of plants from the wild for their survival. In turn, Bantu-speaking tribes, who started to settle in South Africa about 2 000 years ago, also collected leafy vegetables from the wild. Hunting and the collection of edible plants were particularly important in their food acquisition systems during times of emergency, when crops had failed or livestock herds had been decimated.

Source: Nutritional Value and Water Use of African Leafy Vegetables for Improved Livelihoods

*To order the reports, Nutritional Value and Water Use of African Leafy Vegetables for Improved Livelihoods (***Report No. TT 535/12***); Production Guidelines for African Leafy Vegetables (***Report No. TT 536/12***); and/or Nutritional Status of South Africans: Links to Agriculture and Water (***Report No. TT 362/P/08***) contact Publications at Email: orders@wrc.org.za; Tel: (012) 330-0340; Fax: (012) 331-2565; or Visit: www.wrc.org.za to download a free copy.*

The study also confirmed that African leafy vegetables could be grown in home gardens using local resources. Importantly, the eight indigenous vegetables selected were shown to be more drought and heat tolerant than Swiss chard, a commonly grown exotic vegetable which was the reference crop in this study. This could prove significant in the context of climate change. Cowpea was found to be the most drought tolerable crop, followed by nightshade, pumpkin and tsamma melon. Amaranth was the most heat tolerant crop. For optimum growth, water requirements for the African leafy vegetables studied for a full growing season range between 240 mm and 463 mm.

Traditional vegetables are no more difficult to grow than exotic ones, and in some cases are easier. Prof Van Averbeke explains that since many African leafy vegetables grow the same way as weeds, they produce large amounts of seed, which can easily be stored. "The first batch of seed can be obtained from existing growers or researchers. Seeds can also be collected from plants growing in the wild. Once you have the seed, the system is easy to reproduce."

Planting at the correct time is important. Preferably the plants should be grown directly from seed. "Producing seedlings followed by transplanting sometimes causes stress, and when stressed some of these crops quickly switch from vegetative to reproductive growth and start flowering to enhance their survival. That obviously does not suit the purpose of harvesting leaves," explains Prof Van Averbeke.

Elsewhere in Africa traditional vegetables are mainstream and there is no reason why this could not be the case in South Africa, notes Prof Van Averbeke. "Every area in South Africa has its own particular suite of African leafy vegetables that form part of the local culinary tradition. It is important that we break the current view of especially younger South Africans who associate traditional food plants with poverty and backwardness. The media can play an important role in turning this image around."

Cowpeas are often grown in home gardens as part of a mixed cropping system.

This study demonstrated that traditional African vegetables offer exciting opportunities for enhanced exploitation. The WRC is continuing its investment in these traditional food plants. Research is continuing on water requirements, fertilisation and nutritional productivity of African leafy vegetables and yellow fleshed sweet potatoes, including the modelling of water use of these crops. Furthermore, new research work will be undertaken on water use of indigenous legume and grain crops. By following this thematic and programmatic approach in water research, a comprehensive and detailed set of research reports on indigenous food crops will be available by 2017. ❑

Knowledge of traditional African vegetables are usually passed on by women from one generation to the next.

New research aims to identify those at extreme risk of climate change impacts

Lani van Vuuren

While climate change research has identified several 'hotspots' in South Africa where biodiversity and natural resources are particularly vulnerable to climatic deviations, it is not to say the communities in these areas are equally vulnerable or that those in potentially less impacted areas are not as vulnerable. This is according to research by the Centre for Water Resources Research (CWRR) at the University of KwaZulu-Natal (UKZN). Article compiled by Lani van Vuuren.

As global research increasingly points to the significant potential consequences climate change could have on South Africa, attention is turning not only to mitigating potential climate change, but also adapting to possible impacts. As part of an effective adaptation plan there is a need to identify those communities who are most vulnerable to possible climate change, says environmental hydrologist, Sabine Stuart-Hill, of the CWRR. She was speaking at the 16th National Hydrology Symposium, held in Pretoria, late last year. "This is irrespective of their adaptive ability and the overall resilience of society, the environment and the economy."

Poor communities are usually assumed to be the most vulnerable members of society as they neither have the relevant knowledge nor the finances to cope and depend on a few resources. Nonetheless, it cannot and should not be assumed that regions experiencing high levels of climate change will also be the most vulnerable, or that high levels of poverty equal high vulnerability, noted Stuart-Hill.

INVESTIGATING VULNERABILITY

As part of a larger Water Research Commission-funded project, Stuart-Hill and her team investigated how research could assist in identifying vulnerable communities, which should be primary targets for adaptation strategies. The project aimed to, firstly, identify which communities are most sensitive to climate change due to their socio-economic status; secondly, investigate how able those communities are to respond to the risks imposed on them; and thirdly, define what the risks are that these communities are most exposed to.

Vulnerability communities were assessed according to three main components, namely adaptability (or response capacity), sensitivity (resource dependency) and exposure

(or risks) to stressors or hazards.

'Adaptability' refers to the response capacity of a community. Stuart-Hill explained it as the communities' ability to make informed decisions about the risk climate change imposes on them and their ability to use this information to protect themselves against the threats, or react and recover from the effects of the threats.

In turn, 'sensitivity' to impacts is characterised by the communities' dependency on the resources around them. "Those people who are directly dependent on resources around them are more likely to be affected by any changes in the availability and distribution of those resources," said Stuart-Hill.

Lastly, 'exposure' can be characterised as the probability of a physical impact being imposed on a community. This may be in relation to the physical location of people, for example, those living next to a river where they are at greater risk to increased runoff and flooding. "By analysing the distribution of these three characteristics, we can identify which communities are most vulnerable to climate change and focus adaptation plans on these communities."

TWO OPPOSING CATCHMENTS

Two divergent catchments were selected to test the project team's methodology: the Mgeni catchment, in KwaZulu-Natal, where a projected increase in annual rainfall is predicted due to climate change; and the Berg catchment, in the Western Cape, where decreases in annual rainfall are predicted. The Mgeni catchment includes two major cities, Pietermaritzburg and Durban, while the Berg catchment includes Cape Town. Both catchments comprise a mixture of land uses, including urban settlement (formal and informal), rural areas, subsistence and commercial farming as well as various open spaces to degraded areas.

In addition, in both catchments high density settlements characterise urban settlement patterns, implying that a large number of people, living in a relatively small area, are vulnerable to climate change impacts. "Urban migration may have a negative effect on people's ability to adapt to climate change as they experience disruptions in social structure and lose traditional practices," explained Stuart-Hill. "This presents a challenge to city managers and decision-makers to help protect a large number of highly vulnerable people."

Furthermore, the research showed that often the communities least able to adapt were also those most sensitive and exposed to climate change, partly also due to patterns of urban migration, legacies of past legislation and the urban structure of society.

It was found that each catchment has areas of more or less vulnerable communities. Those with low-economic status based on their income, education and housing type were found to be most vulnerable to climate change in both catchments. Stuart-Hill explained that the adaptability of communities with lower education and income levels are compromised due to their inability to make informed decisions, or the inability to protect themselves from the effects of climate change.

Families in traditional or informal households are at greater risk due to flooding as the buildings materials and structure lack the structural integrity to withstand the pressures of flood water. This of particular concern in the Mgeni catchment, where large projected changed in three-day flood events are predicted, especially in the interior around Pietermaritzburg, where a large number of informal houses are still to be found.

Communities in the Mgeni catchment were found to be more reliant on open sources of water than communities in the Berg catchment (it must be noted, however, that data from Census 2001 were used in the study, and that the situation might have changed in the meantime). While streamflow is projected to increase in the Mgeni catchment as a result of projected climate change, this streamflow may become more variable. In the Berg catchment, the problem is rather of too little water as annual streamflow is projected to decrease between 10% and 20%, resulting in less water being available in rivers and dams.

Using open water also has various social and health issues, such as risk to waterborne diseases. In Mgeni catchment, many communities have

Guy Stubbs/Africa Media Online

A recently concluded project by the WRC assessed the vulnerability of South African communities to climate change.

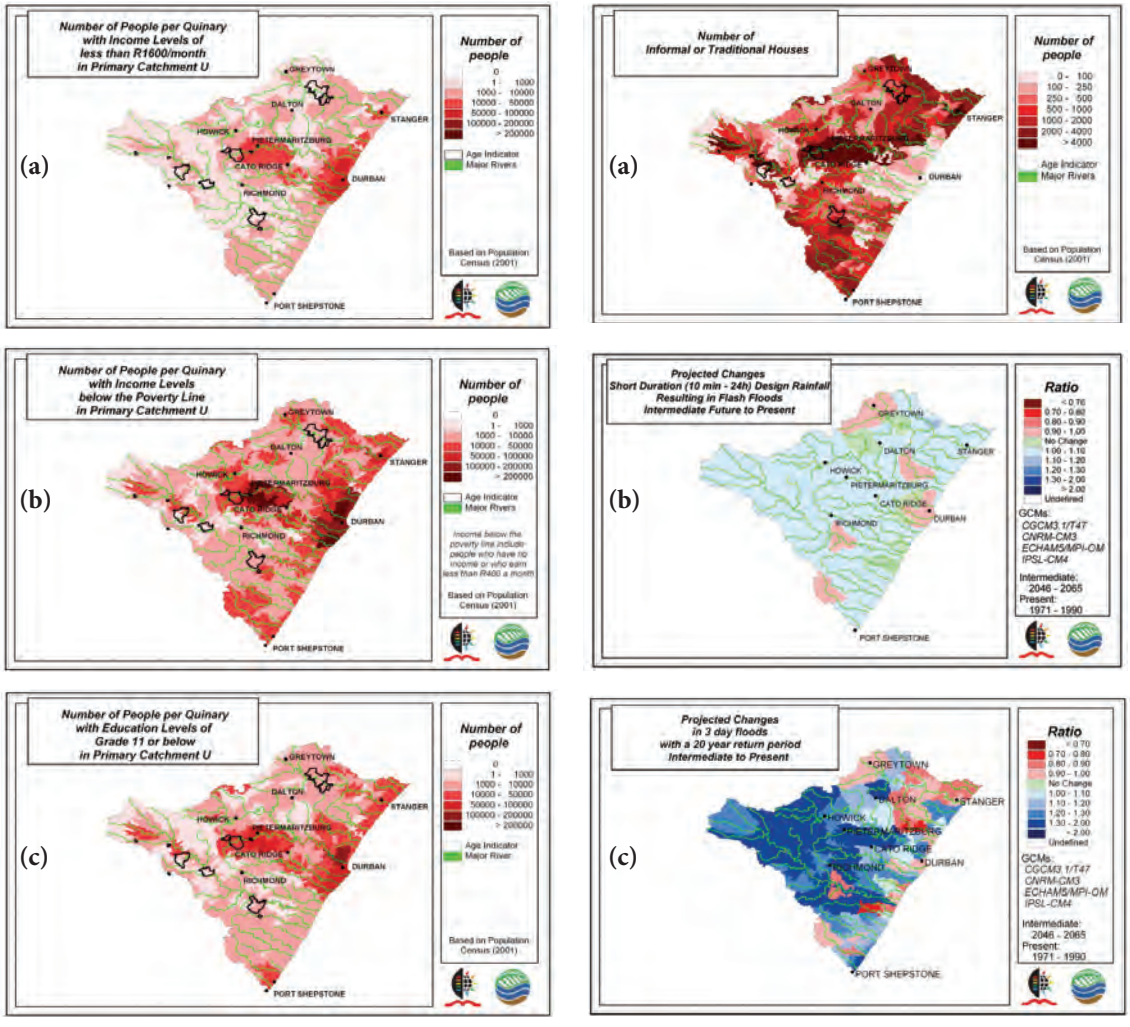
Lori Waselchuk/Africa Media Online

Poor communities living in dense settlements are particularly vulnerable to extreme weather events, such as floods.

a major river running through them, leaving them vulnerable to risks of flooding.

"The need to reduce the number of people relying on open water sources is imperative in both catchments as these people are using an unsafe water source and are at risk to changes in water quality and quantity," said Stuart-Hill. While rainwater tanks and groundwater extraction may be viable alternative water sources in Mgeni catchment, the latter may not be a viable option even to those already making use of boreholes in the Berg catchment, as a decrease in recharge of groundwater is predicted due to climate change.

Overall, the results showed far higher levels of vulnerability in the Mgeni than the Berg catchment. This is based mainly on low income and education levels as well as high population densities in the Mgeni catchment. However, each catchment presents a different set of challenges to municipal managers and different adaptation plans will be required. Especially in the Mgeni catchment challenges will arise from a rather disperse picture of vulnerable communities with divergent characteristics. The research has also underlined the importance of basic levels of service, not only to improve



Right, (a)- (c): *Education in the Mgeni River catchment. Lower education levels indicate greater vulnerability.*

Far right, (a)- (c): *Number of informal or traditional structure households which are at greater risk of damage due to flooding in the Mgeni catchment.*

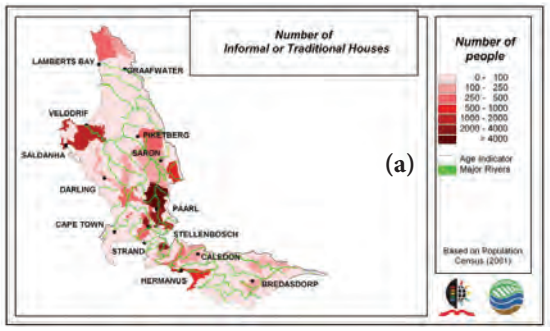
DESCRIPTION OF ADAPTABILITY, SENSITIVITY AND RISK AS INDICATORS OF VULNERABILITY

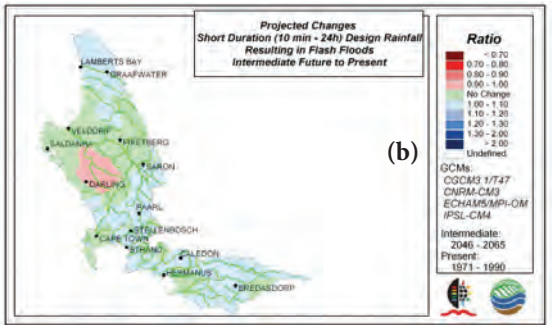
VARIABLE	DESCRIPTION	DATA SOURCE	IMPACT
		Adaptability	
Age	< 15 or > 69 years Or 15 – 69 years	Population Census	
Education	Grade 11 or Lower	Population Census	Lack of knowledge to make informed decision. Reduced employment options, reduces ability to move to safer environment
Income	Below the poverty line (< R400 / month) Low Income (< R1 600 / month)	Population Census	Reduced ability to take precautionary action against threats or to recover from impact. Lack of resources to move to safer environment
		Sensitivity	
Open water	Dams, pools, stagnant water, rivers & streams	Quinary Catchments	Streamflow
Rainfall Tank	Water harvested from rainfall	Quinary Catchments	Rainfall
Borehole	Water pumped from a borehole	Quinary Catchments	Groundwater recharge
Irrigation	Water collected from streamflow for the purpose of irrigating commercial and subsistence agriculture	Quinary Catchments	Changes in irrigation demands, changes in streamflow and changes in evaporation
		Risk	
Proximity to rivers	Risk of flooding	Quinary Catchments	Peak Discharge

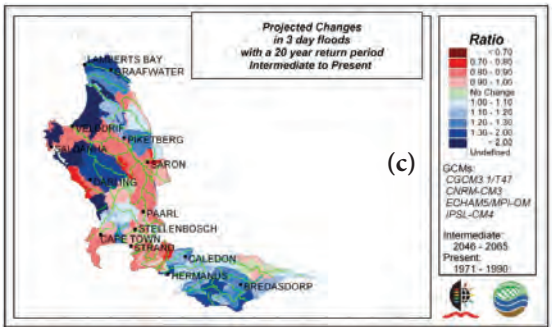
people's daily lives but to make them less vulnerable to the onslaughts of climate change.

By identifying which communities are vulnerable to climate change researchers can provide planners with a starting point on where to focus specific adaptation options and offer insight into which adaptation strategies are most viable for each location.

Concluded Stuart-Hill: "By improving our understanding of the different dimensions of vulnerability earlier action can be taken. This will greatly enhance the safety of our society, environment and economy to the potential onslaught of climate change." ❑







Below, (a)- (c): *Number of informal or traditional structure households which are at greater risk of damage due to flooding in the Berg catchment.*

WRC PROJECT HELPS WATER SECTOR COPE WITH CLIMATE CHANGE

With projected impacts on drought, flooding, evaporation, storm surges, melting ice caps and sea-level rise, the hydrological cycle is one component of the Earth's system that will possibly be most affected by climate change. Many of the impacts of climate change, including its effects on climate variability, will manifest themselves on the availability of, and demand on, water resources.

In South Africa, where water resources are already scarce and unequally available across the country, climate change has been identified as one of South Africa's most significant threats on its path towards sustainable development and a more equitable society. Juxtaposed with this are land use changes which often amplify flow variability as a result of management practices. Furthermore, there remain disparities in water availability and access to water for many of the country's people. These could well be amplified by climate change.

Therefore, taking current knowledge to a new level, updating it and making it more relevant as well as usable for water managers in their decision-making processes, was the major goal of a recently concluded, multi-year WRC project. The project was led by the School of Bioresources Engineering and Environmental Hydrology at the University of KwaZulu-Natal.

One of the outcomes of the project has been a Handbook on *Adaptive Management Strategies and Options for the Water Sector in South Africa under Climate Change* (**WRC Report No. 1843/2/12**). The practical aid is aimed at mainstreaming climate change issues into decision making. The handbook aims to introduce a potential pathway and process which empowers the water sector and individuals within it to act in the face of climate change by adapting timeously and adequately.

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

KNP CROC DEATHS – Groundbreaking study narrows suspect list

It has been four years since this magazine first reported on efforts to discover the exact cause of alarming, large-scale deaths of Nile crocodiles in the Kruger National Park (KNP). Results of a groundbreaking project, partly funded by the Water Research Commission, provide astonishing insight into the probable trigger leading to these mortalities. Article by Lani van Vuuren.

Drinie van Rensburg

In 2008, the world watched in horror as a third of the estimated crocodile population of the densely populated Olifants River gorge in the KNP perished. While deaths of crocodiles, fish and terrapins had been recorded in the Olifants River system (particularly around Loskop Dam) since at least 2003, the large-scale demise of a keystone species spelled disaster for an aquatic ecosystem long since affected by upstream pollution and land use activities.

Post mortem studies revealed the cause of death to be pansteatitis – a nutritional disease usually found in captive animals as a result of being fed on a diet comprising large amounts of unsaturated or rancid fat. The Olifants River crocodiles were among the first recorded cases in the world of wild crocodilians succumbing to the disease.

While fingers pointed to various anthropogenic impacts on the Olifants River catchment, including mining and agricultural activities as well as the cumulative effect of numerous large dams in the system, what triggered the large-scale crocodile mortalities remained a mystery. The research community responded by establishing the Consortium for the Restoration of the Olifants Catchment (CROC), and a series of multidisciplinary research projects followed. (For more on CROC, read 'Experts Unite to Save Abused River from Extinction', *the Water Wheel* January/February 2009).

Independent fish pathologist, Dr David Huchzermeyer, initiated one of these studies following speculations regarding the possible impact of pollution and toxic bioaccumulation on the health of the KNP crocodiles. "I made the suggestion that if the crocodile deaths were caused by pollution we should look for related pathology in the fish on which the crocodiles were likely to be feeding," he tells *the Water Wheel*.

PANSTEATITIS EXPLAINED

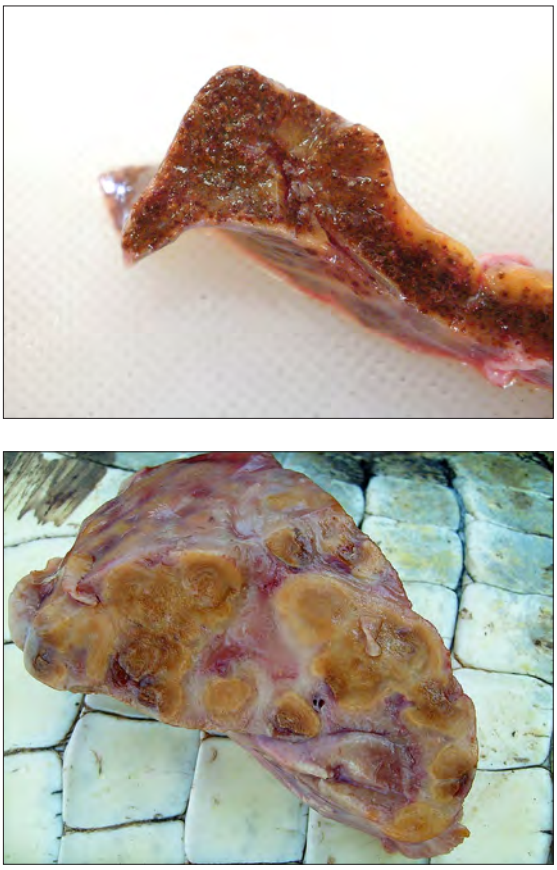
Considered a nutritional disease, pansteatitis develops when susceptible animals consume an overwhelming amount of polyunsaturated fats, typically fatty or oily fish or fats that have become rancid. In the case of the Olifants Gorge, both crocodiles and sharptooth catfish are known to hunt and eat fish. However, diets containing excessive amounts of certain highly polyunsaturated fats are problematic for these animals. Polyunsaturated fats are unstable and easily oxidise. Physiologically they exert a level of oxidative stress that is capable of overwhelming the natural anti-oxidant defence mechanisms of the animal, in particular tissue vitamin E. The oxidative breakdown of fats initiates a chain reaction that eventually consumes the vitamin E in the adipose tissues and leads to the death of fat cells. Dead fat cells release the breakdown products of fat oxidation and these cause the acute and chronic inflammation that lead to clinical pansteatitis. Pansteatitis causes fat to harden reducing mobility and affecting the ability to swim. This is particularly noticeable in crocodiles, and in severe cases leads to drowning or starvation of affected animals.

PREDATORY FISH ALSO AFFECTED

Dr Huchzermeyer's theory that the health of crocodiles and fish species in the Olifants River system was linked was confirmed following a rare, large-scale fish mortality event in the Olifants Gorge in the winter of 2009. Most of the dead fish turned out to be African sharptooth catfish (*Clarias gariepinus*), an opportunistic omnivorous species known to predate on other fish. The fish were mostly found in water overlying the clay-rich deposits at the point where the gorge widens into the recently raised Massingir Dam, of Mozambique. Fish carcasses were observed to be extremely fat, but a definitive diagnosis could not be made due to advanced putrefaction.

Catfish were subsequently sampled regularly over a two-year period from the Olifants Gorge as well as from other sites in and around the KNP. The project brought together researchers from South African National Parks, the universities of Pretoria, North West and the Free State, the CSIR, South African Police Service Forensics Laboratory, and IDEXX Laboratory. Much of the financing was borne by the research institutions and the researchers themselves.

The investigation led to the discovery that the catfish in the Olifants Gorge were also affected by pansteatitis – the first reported case of its kind in the world. Since sharptooth catfish are easier to



*Cross sections of pansteatitis-affected fat from a sharptooth catfish (**top**) and a crocodile (**bottom**).*

Courtesy David Huchzermeyer

Courtesy David Huchzermeyer

Above: *Deep water damming back into the Olifants Gorge from the raised Lake Massingir, in Mozambique.*

Below: *University of Cape Town student, Richard Huchzermeyer, with a large sharptooth catfish from the Olifants Gorge.*

sample than crocodiles, it then provided the project team the opportunity to study the disease in greater detail.

ONCE OFF OR CONTINUOUS?

A key question that needed to be answered was whether the disease was a once-off occurrence or episodic in nature. "My experimental work with captive catfish demonstrated that, in the case of catfish, pansteatitis was not rapidly fatal. Affected fish could survive protracted periods and lesions were likely to accumulate over time," reports Dr Huchzermeyer. "This pointed to periodic or seasonal episodes of dietary oxidative stress in these animals." This explains why crocodile fatalities have occurred in the years following 2008, albeit in much lesser numbers.

Furthermore, pansteatitis has also been identified in catfish at two other sites in the KNP. The catchment areas feeding these sites differ from that of the Olifants River, providing argument against a primary polluted-related oxidative stress.

FISHY CULPRIT

Analyses of the fatty acid composition of crocodiles and catfish with and without pansteatitis by Garry Osthoff and Arno Hugo at the University of the Free State found that the ratio of omega 3 to omega 6 fatty acids was similar in catfish and crocodiles with pansteatitis but differed from that of healthy catfish and crocodiles. Pansteatitis-affected animals had particularly high levels of docosahexaenoic acid (DHA) in their fat.

"This polyunsaturated fatty acid is an essential nutrient that cannot be synthesised by catfish and crocodiles," notes Dr Huchzermeyer. "It is poorly mobilised from adipose tissues and thus reflects what the catfish and crocodiles have been feeding on." Phytoplankton is rich in omega 3 fatty acids, including DHA. Crocodiles and catfish would need to feed on phytoplankton feeding fish species in the Olifants Gorge to assimilate these fatty acids. In a related study, farmed catfish that developed pansteatitis from consuming rotting fish waste did not assimilate the characteristic fatty acids observed in the catfish from Crocodile Gorge.

As part of the project, Stephan Woodborne from the CSIR examined stable isotopes in tissue samples from crocodiles and catfish while investigating the food web in the Olifants Gorge (for more on his research see, 'Searching for clues inside the claws', *the Water Wheel* July/August, 2011)

Abnormally high nitrogen isotope values in the crocodiles and catfish from the Olifants Gorge pointed to a trophic level increase in these animals when compared to animals sampled from sites where pansteatitis did not occur. This, together with Dr Huchzermeyer's work which indicated that catfish from the Olifants Gorge had changed to a predominantly fish diet, raised the question as to whether the catfish and crocodiles were feeding on a species of fish not normally consumed by these animals.

"We still needed to explain an intense dietary intake of polyunsaturated fats," notes Dr Huchzermeyer. "This led me to look for a migratory species that was an obligate phytoplankton feeder and would migrate

Courtesy David Huchzermeyer

Courtesy David Huchzermeyer

"Part of the explanation is still speculative and further research is needed to confirm these speculations."

into the Olifants Gorge seasonally in large enough numbers to provide the catfish and crocodiles with an overwhelming intake of omega 3 fatty acids."

Silver carp (*Hypophthalmichthys molitrix*), an invasive alien species originating from East Asia, are known to occur in Lake Massingir. Though speculative, this provides an explanation for high polyunsaturated fat intakes by crocodiles and catfish. Silver carp are pelagic phytoplankton feeding fish that migrate into fast flowing waters of the Olifants River to spawn. In order to do so, they have to swim through the Olifants Gorge where it is suspected that they become an easy prey for crocodiles and catfish.

Silver carp are known to congregate in large numbers in deep water. The previously shallow, fast-flowing rapids of the gorge have now become a deep water system during the summer as a result of the enlarged Massingir Dam, providing an ideal environment for these invasive alien fish.

High phosphate levels measured in the Olifants River within the KNP prior to 2004 have contributed to the

Top left: *Dr David Huchzermeyer dissecting a fish on site in the Olifants Gorge.*

Top Right: *Dr David Huchzermeyer and his team at the field laboratory on the banks of the Letaba River.*

Above left: *Johann Müller of IDEXXSA Laboratory and independent fish pathologist, Dr David Huchzermeyer with a pansteatitis mortality in the Kruger National Park.*

Above right: *Johann Müller working at the field laboratory in the Olifants Gorge.*

Top right: *The Olifants/Letaba river confluence during normal summer flow showing the few remaining shallow rapids.*

Bottom right: *The same confluence in full flood.*

Courtesy David Huchzermeyer

eutrophication of Lake Massingir. This, in turn, has provided a rich dietary source of phytoplankton on which the silver carp and possibly other fish species have thrived. "To date this provides the only link between water pollution and the pansteatitis deaths of crocodiles in the Olifants Gorge, however, work on toxin bio-accumulation has not yet been completed," Dr Huchzermeyer notes.

He believes that the story leading to the large-scale crocodile mortality in 2008 unfolded as follows: Large man-made lakes (in this case Massingir) act as traps for nutrient pollutants, particularly phosphates. Once trapped in the lake they drive phytoplankton growth leading to eutrophication. The raising of Massingir Dam extended the dam waters into the Olifants gorge altering the habitat of the gorge. This has possibly improved the ease with which crocodiles and catfish hunt and feed on silver carp.

Silver carp thrive on phytoplankton blooms and the fat in their adipose tissues reflects a high omega 3 to omega 6 fatty acid ratio assimilated from phytoplankton. The high intake of omega 3 fatty acids by crocodiles and catfish, associated with consumption of large numbers of such fish, results in an oxidative stress that overwhelms the anti-oxidant protective mechanisms, particularly tissue vitamin E, of the crocodiles and catfish. As the fats in the adipose tissues of the animals begin to oxidise, fat cells die, leading to inflammation of the adipose tissues and pansteatitis.

Part of the explanation is still speculative and further research is needed to confirm these speculations. While crocodile mortalities have declined since 2008 it is not known how many crocodiles are still suffering from subclinical pansteatitis. The prevalence of pansteatitis in catfish probably reflects the similar dietary exposure to a polyunsaturated fat-rich diet.

Dr Huchzermeyer notes that this could vary from year to year depending on the intensity of phytoplankton blooms in Lake Massingir and on the degree of fat deposition in silver carp and other plankton-feeding fish. "Silver carp in Lake Flag Boshielo located upstream of the Olifants Gorge, for example, have been observed to be thin and crocodiles in this lake remain healthy. We also do not know to what extent consumption of rotting fish from fish die-offs is contributing to pansteatitis, particularly at sites where the presence of silver carp has not been confirmed."

LESSONS FOR THE FUTURE

Dr Huchzermeyer believes that this case study has many lessons for the way we manage and conserve our natural environment. "As this case has shown, human interference in aquatic systems can have far-reaching consequences, particularly for top predators. Several anthropogenic factors have come together which individually may not have caused the deaths of the crocodiles. Ultimately it was the combination of these factors that led to the tragedy." ❑

YES, I CAN!

A role model for young water professionals

Dr Inga Jacobs has achieved much in the water sector during her short career. Debbie Besseling speaks to this Research Manager for Knowledge Management at the Water Research Commission (WRC) about some of the highlights to date.

You have an extensive educational background, please highlight some of your accomplishments.

I was very fortunate to have received scholarships to study in different corners of the globe, so I was able to travel and see new places from a very young age. This gave me the opportunity to experience different types of education systems in various countries, whilst meeting people from different backgrounds, and it really expanded my world view in so many ways.

Another highlight was my decision to focus on international relations, more specifically political science. With both my Masters and my PhD I specialised in water governance. It was only when I started work, that I realised how useful and applicable a political science degree can be for the water sector. The complexity of water challenges today necessitates a holistic and integrated approach and necessitates inputs from a diverse range of disciplines and expertise. I have found a home as a social scientist in the water sector.

Tell us about your current position as Research Manager: Knowledge Management at the WRC.

The Knowledge Management unit within the WRC is a relatively large unit, covering a wide range of aspects relating to knowledge sharing, knowledge dissemination and impact. The research portfolio that I manage looks at research, which involves metadata research. This covers the impact of the WRC's research in terms of policy uptake, broader public dissemination or public understanding and the overall monitoring of trends in water research and development. I also focus on the role that the WRC occupies in the water knowledge value chain in relation to other partners, and how we support each other through various collaborative projects and other agreements.

You specialise in transboundary water governance in Africa. What are some of the challenges in this regard?

It was a natural progression for me to focus on transboundary water governance because of my focus in international relations. Transboundary water governance looks at the way in which countries cooperate or develop cooperative management strategies around a shared resource, such as an international river. It covers the role that water plays in a regional context, in terms of regional integration and how water can be used as a tool and driver for peace as opposed to what we hear time and time again, water as a potential cause for one of the next world wars.

With my main focus area, Africa, and particularly, the Southern African Development Community, I have tried to understand how countries and non-state actors negotiate and renegotiate rights and access to water. This is a core aspect of transboundary governance.

My recently published book titled, '*The Politics of Water in Africa*,' focuses very specifically on the multi-faceted notions of water security. By researching these areas, I have tried to incentivise social science perspectives in the water sector, and in fact, to promote the movement away from a sector-based silo approach, to a multi-sectoral and

"The complexity of water challenges today necessitates a holistic and integrated approach and necessitates inputs from a diverse range of disciplines and expertise."

Dr Jacobs and head of the Water and Health Research Centre at the University of Johannesburg, Dr Tobias Barnard, with Deputy Minister of Water & Environmental Affairs, Rejoice Mabudafhasi, at the World Water Forum in Marseilles, France.

multi-level lens. One which emphasizes the multiplicity of actors, scale, power, knowledge and agency and the multi-faceted way in which people interact with the environment. This lens encourages the adoption of trans-disciplinary methodologies as an appropriate channel through which to address emerging environmental challenges and complexities.

Transboundary water governance however, often falls victim to the pendulum shift of priorities. For it to be an issue of national attention it requires an outward looking approach to a country's water foreign policy. Sometimes there are particular government administrations that focus on an inward looking national security and national interest, that prioritises service delivery, water access and sanitation issues within the country. Other administrations have a more outward approach dealing with issues such as the role South Africa plays in the region, how we can leverage different partnerships with other countries and institutions to enhance our access to water, how we can use regional dynamics also for socio-economic development.

"Young people in the water sector are really beginning to articulate their voice and a vision for how they want to engage in the sector and around water-related issues."

What have been some of the milestones in your career?

Completing my PhD in International Relations at a relatively young age helped me to get a kick-start quite early in my career. But one of my biggest achievements to date has been through my involvement in the Young Water Professionals (YWP) network, a programme under the International Water Association (IWA) and the Water Institute of Southern Africa (WISA). I have served as the YWP Global President 2010-2012, and currently serve as the YWP Southern Africa President 2012-2014. The SA YWP programme is in its fourth year of existence with more than 800 student members and over 1 800 professionals, and provincial chapters set up in the Western Cape, KwaZulu-Natal, Gauteng and further afield in Zimbabwe, Mozambique and Namibia.

Young people have found the YWP programme immensely supportive in career development, networking, technical skills training, and having a supportive network of individuals who are going through the same challenges when developing their career. This includes the non-technical challenges such as networking at conferences, or finding a mentor, or sharing the challenges of being a young woman professional in a still largely male-dominated sector. Through the YWP, these formal but also informal lessons are shared and help equip young people with the skills needed to develop their careers. Some activities include: organising and hosting the biggest conference for young water professionals biennially, collaborating with the Dutch Embassy on a business development competition for young entrepreneurs, and a host of career development events.

You have recently been recognised at the Excellence in Water Research Awards 2012. Tell us about your presentation.

The presentation, titled 'Bringing the United Nations Watercourses Convention (UNWC) home? A multi-level water governance framework in the Orange-Senqu River Basin in Southern Africa', was based on my research on multi-level water governance and specifically the idea that with international rivers, because of the multiple demands on that particular river, there is always a wide range of codes of conduct, laws and policies that govern the way counties and non-state actors co-operate around this shared resource.

The presentation specifically looked at, apart from the hardware that guides and influences how states and non-state actors cooperate, the huge area of normative software, that is slightly more intangible but yet very influential in shaping how these different actors behave in the trans-boundary context. Basically, this means that cooperation dynamics in shared river basins are not driven solely by prescribed and often imported modes of conduct, or by formal policies and institutions such as River Basin Organisations or similar bodies, but that there are other spheres of practiced collaboration, or integrationist tendencies that have developed and grown over time that tend to foster cooperation.

This includes the role of strategically placed individuals, or networks of people who share the vision of political and economic integration, as well as the role and relevance of technical collaboration, institutional trust-building; and the broader local socio-political context. Among others things it is important therefore, to recognise this reality in all spheres and to strive to retain technical skills and institutional memory through effective succession planning.

You have recently been appointed as the President of the YWP. Tell us about the role of the YWP organisation.

The YWP is a volunteer-based programme. The idea behind the organisation is to have a place where young people can go to build their own capacity and that will help them grow. The idea to link up with the IWA is that it provides international exposure for our members. This enables young professionals to find mentors through the IWA specialist groups and programmes. Our affiliation with WISA is in alignment with our aim to always remain locally relevant. Through WISA, we ensure that our members get access to local events, training and other opportunities.

The types of events and workshops that we organise have the aim of providing and fulfilling the present and the future needs of the water and wastewater industries. So it's about the continuous development of a workforce that is adequate in size and which is capable in terms of its skills and that is strong in leadership.

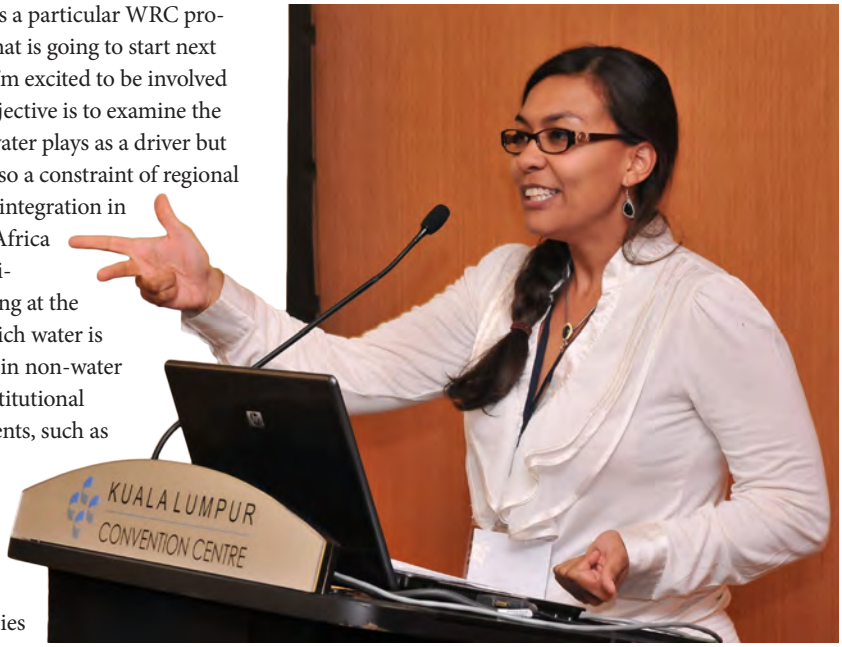
Through the events that we organise we try to have a key message that there are loads of opportunities in this sector and it's about applying the different skills and thinking innovatively about the contribution that you can make.

Are there any other projects you would like to talk about?

There is a particular WRC project that is going to start next year that I'm excited to be involved in. The objective is to examine the role that water plays as a driver but perhaps also a constraint of regional economic integration in southern Africa and specifically looking at the way in which water is addressed in non-water related institutional arrangements, such as for example, the regional economic communities (EECs) like SADC, SACU, COMESA and EAC.

The project's basic premise is that international rivers are increasingly important as development drivers and we know their resource potential in agriculture, and energy production. However, despite these inherent inter-linkages, transboundary water management hasn't really featured as an integral part of economic integration discourse until very recently. Added to this is the fact that overlapping membership to several RECs and the multiplicity and changing nature of such memberships by nation states ensures that river basins are part of an increasingly complex landscape of institutions, policies, trading relations and sectoral demands. The relevance of the existing institutional complexity presents challenges but also opportunities for sectors that are directly or indirectly involved with water issues to increasingly integrate in terms of decision-making in agriculture, energy, industry and urban development in particular.

What the project is going to try to unpack is what I call water centric institutions, such as river based organisations, catchment management agencies, or water user associations, and look at whether they are the most appropriate vehicles through which to channel these kinds of development strategies.



Dr Jacobs regularly addresses large international audiences.

You have achieved success at a young age, what is your message to other young professionals?

I have two very simple life mottos, 'Yes, I can' and 'Commit to the road'. From my own personal experience, there are many opportunities for young people in this sector. It is about taking these opportunities and knowing how to use them to your advantage. The idea around the motto 'Commit to the road' is about perseverance. In my opinion, it is preferable to stay in job for a while to allow yourself to grow and develop your career.

My message to young professionals is that if you persevere, the water sector is actually a very vibrant place to work. Also, young people in the water sector are really beginning to articulate their voice and a vision for how they want to engage in the sector and around water-related issues. It's really just about thinking innovatively about the role that you want to play and not sitting around for someone to help you – you've also got to help yourself.

- To view Inga's interview Visit: http://youtu.be/KwMlfpcaDNw ❑

Unfortunately there are still thousands of households in South Africa making use of unsafe toilets.

Lani van Vuuren

Whether you call it a water closet, a lavatory or a loo, while we don't always like talking about them we cannot deny the importance of toilets in our lives.

Access to safe sanitation is one of the cornerstones to a healthy life. Toilets are so important to us, in fact, that they even have their own dedicated day. World Toilet Day is celebrated every year on 19 November to raise awareness of the importance of safe sanitation and of the plight of the 2,6 billion people around the world who still lack access to this important human right.

Lani van Vuuren

A urine diversion toilet in a nature reserve in Pretoria.

Lack of sanitation facilities forces people to defecate in the open, in rivers or near areas where children play or food is prepared. This increases the risk of transmitting disease. Children are hardest hit by a lack of access to safe toilet facilities. Every year, an estimated 1,5 million children die in Africa under the age of five as a result of diarrhoea – a disease caused by inadequate sanitation and water. This disease kills more young children every year than HIV/AIDS, malaria and measles combined. Studies show that improved sanitation can improve diarrhoea deaths by a third.

Millions of people are also missing school or work because of illness as a result of having no toilet access. For women and young girls it can be dangerous if they have to relieve themselves in community toilets or in the bushes, especially at night.

Sanitation is not only necessary to improve people's health and dignity it is also a good investment. The Word Toilet Association reports a strong link between the absence of good sanitation and poverty. The economic growth in Europe and North America went hand in hand with the large-scale introduction of sanitary conditions, resulting in individual health gains and increased labour productivity (because if people are healthy they tend to be more productive). Toilets are a symbol of better health, higher income, more education, higher social status and a cleaner living environment.

WHOSE IDEA WAS IT ANYWAY?

Humans have been looking for ways to manage their excretions for thousands of years. It is estimated that 4 000 to 5 000 years ago, there were already toilet systems using water in places such as Syria and China. The Greeks possessed toilets and sewerage systems as early as 2 500 BC.

Around a thousand years later, the Romans built the Cloaca Maxima, Ancient Rome's huge drainage system. In addition, the Romans had latrines, the use of which was reserved solely for the rich, who met in these informal settings to discuss and do both their big and small business. At the same time, communities in what is now Pakistan and north-western India had water-cleaning toilets that used flowing water in each house that were linked with drains covered with clay bricks.

Early toilets that used flowing water to remove the waste are also found at Skara Brae in Scotland. Some of the houses there had a drain running directly beneath them, and some of these had a cubicle over the drain.

MULTIMEDIA RESOURCES

- http://www.wateraid.org/documents/splish_splash_flush.pdf (video on the importance of toilets)
- http://www.time.com/time/health/article/0,8599,1940525,00.html (article on the history of toilets)
- http://www.worldtoiletday.org/
- http://home.howstuffworks.com/toilet.htm
- http://www.youtube.com/watch?v=C_PAUUX36IA (video on the history of the toilet)
- http://www.bbc.co.uk/news/world-asia-20258175#TWEET346927 (BBC report on the world's first toilet theme park)
- http://www.csir.co.za/Built_environment/santechcentre/

Lani van Vuuren

Not all toilets are connected to wastewater treatment plants. Here a worker is cleaning an on-site, VIP toilet.

Sanitation technology got a little lost in the West after the fall of Rome. In Europe during the Middle Ages, they did make use of a garderobe in castles – a protruding room with a tiny opening usually reserved for nobility, from which waste fells into the castle moat. Later this was replaced by a box and a lid.

The modern toilet is said to have been invented by Englishman, Sir John Harrington, in 1596. This new kind of 'water closet' comprised a raised cistern with a small pipe down which water ran when released by a valve. Queen Elizabeth I had one installed in one of her palaces. About 200 years later Alexander Cummings developed the S-shaped pipe underneath the basin to keep out smells. The basic design of the toilet has not changed much since then.

Interestingly, toilet paper had been used in early medieval China. Elsewhere people have made use of all sort of materials, from wool and lace to leaves, grass, seashells to plant husks. In Ancient Rome, a sponge on a stick was commonly used, which was placed in a bucket of water after use. Modern toilet paper was invented by Joseph Gayetty in 1857, who sold his medicated paper in packages of flat sheets.

DIFFERENT KINDS OF TOILETS

When we think of a toilet many of us automatically think of a flush toilet. However, there are actually many types of safe sanitation options out there. A visit to the CSIR Sanitation Technology Demonstration Centre in Pretoria is well worth it to see all the options available in South Africa.

The basic-level sanitation technology that is rolled out most often in South Africa is the ventilated improved pit (VIP) toilet, a type of pit latrine that has to adhere to a certain standard.

A sanitation technology that is used quite widely in the Durban area is the urine diversion toilet. Waste is deposited in a chamber and dry material (usually sand or ash) is added after each use. Urine is diverted through a specially adapted pedestal. In South Africa, most of the urine is led to a soak-away pit, but it can be used as fertilizer for home gardens.

Other sanitation options include pour-flush toilets, aquaprivvies, conservancy tanks, septic tanks or shallow sewers.

Perhaps it is time we see the porcelain throne for what it is – a truly marvellous thing! ❑

DID YOU KNOW? SOME TOILET FACTS

- In 2007, the readers of the *British Medical Journal* voted sanitation the greatest medical milestone of the last 150 years.
- In November last year the Korean city of Suwon opened the world's first toilet theme park. The Restroom Cultural Park has a museum displaying toilet engineering from Rome, Europe, and ancient Korea.
- The average person visits the toilet 2 500 times a year (About 6-8 times a day).
- The oldest working toilet that we know of can be seen in Knossos in Greece in a small castle. The flushing toilet is still functioning about 4 000 years after it has been built.
- South Africa has its own sanitation technology demonstration centre, located at the CSIR, in Pretoria, where visitors can see life-sized examples of safe sanitation technologies.
- One in three people in the world do not have access to basic sanitation. The regions with the lowest coverage are sub-Saharan Africa (31%), southern Asia (36%) and Oceania (53%).
- The first house to have a flush toilet in South Africa belonged to Scottish railwayman James Douglas Logan, who installed them in his Matjiesfontein home around 1890.

www.wikipedia.org

Public toilets were used by the wealthy to discuss business in Ancient Roman times.

International water governance experts gather in Drakensberg

Cooperation on shared water resources is critical, especially in water-scarce regions where the upstream and downstream impacts of consumption and pollution are magnified. Shared river basin and aquifer systems continue to present opportunities for cooperation and joint water resource development within as well as between countries. To address this and many others, the Water Research Commission (WRC), in collaboration with the Department of Water Affairs and various international and local water institutions, hosted the International Conference on Freshwater Governance for Sustainable Development, in the Drakensberg, in November. The conference, which was attended by more than 400 delegates from 29 countries, covered various topics within the themes of water-related legislation, regulatory environments, human and environmental rights, markers and measures of good governance, and transboundary governance and adaptive management, among others.

Christine Colvin of WWF-SA was part of a panel discussion on how to enable business to become good water managers and stewards.

Mike Muller of the University of the Witwatersrand provided insight into various sessions at the conference.

More than 400 delegates from 29 countries attended the conference.

Prof Claudia Pahl-Wostl of the University of Osnabrück, Germany, provided insight into enhancing water security for humans and nature.

Special conference guest speaker, Prof Ali Mazrui of the State University of New York at Birmingham, and WRC CEO, Dhesigen Naidoo, share a lighter moment during the conference.

WRC HR Executive Manager, Reshmili Lutchman, WRC Research Manager Bonani Madikizela and Mluleki Matiwane of the University of the Western Cape.

Chair of the Parliamentary Portfolio Committee on Water & Environmental Affairs, Adv. Johnny de Lange, delivered the opening address on behalf of Water & Environmental Affairs Minister Edna Molewa.

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