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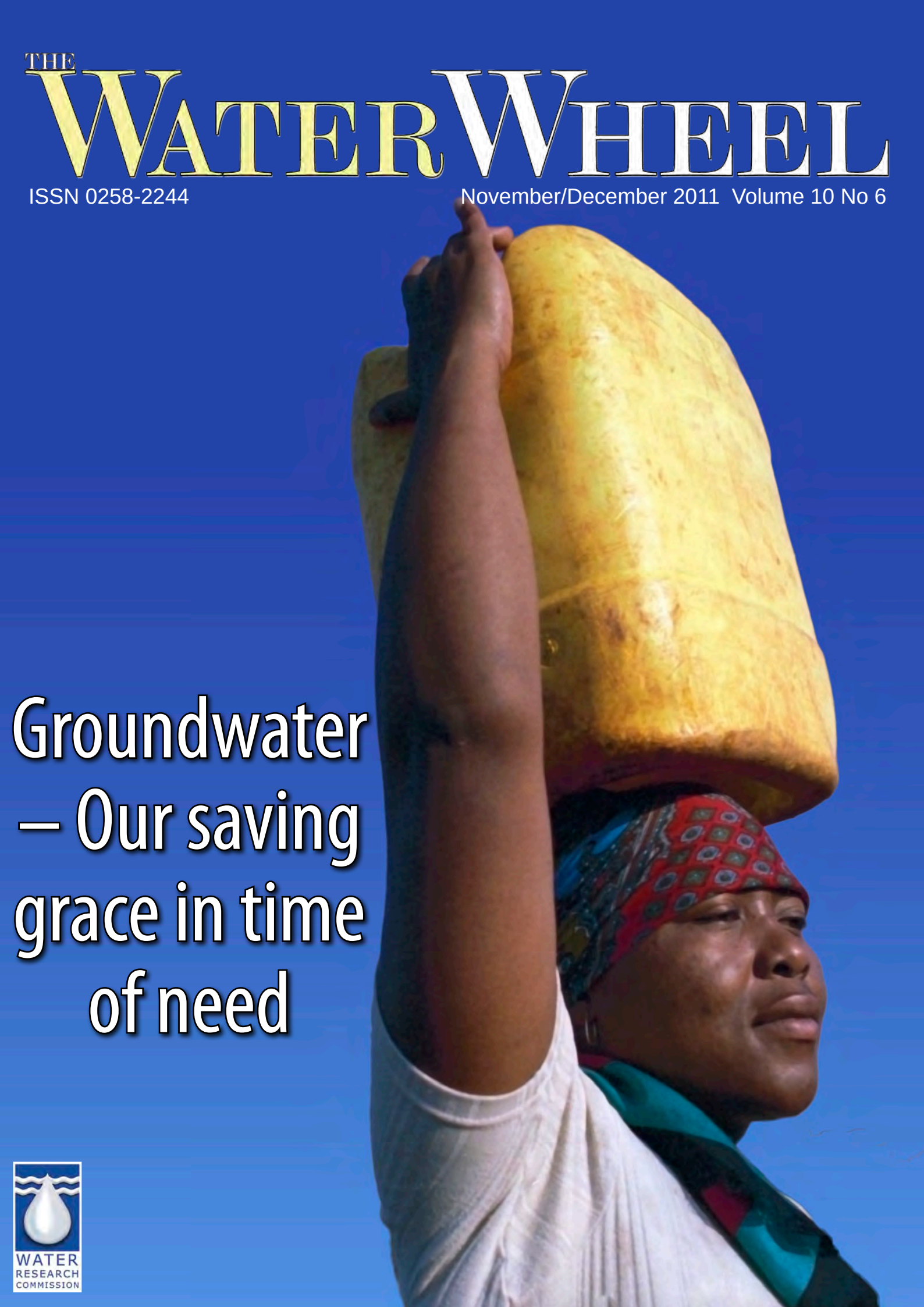

Groundwater – Our saving grace in time of need

WATER RESEARCH COMMISSION

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

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__Cover__: Groundwater is cited as a major source of future water augmentation, yet many challenges still impede its successful implementation and management. See page 12. Cover photograph by Guy Stubbs/Africa Media Online.

Letters to the Editor

Water in war and peace

Following Deon Visser's excellent article on the SA Engineer Corps activities in Kenya (South African Military Water Diviners in Kenya during World War II, *the Water Wheel* September/October 2011) and your request for other photos and information, I share some from my collection.

My late father served with the South African forces in Abyssinia and North Africa from the beginning of World War II through to June 1942 when the South African 2nd Infantry Division was defeated at Tobruk. He was taken prisoner of war.

I was a university student at the time. I joined the South African Engineer Corps two months after he was captured. I was posted to the 11th Field Company of the South African Engineer Corps in Tripoli, and served with them in North Africa and Italy for the rest of the war. Together, the two of us served our country on active service throughout the war.

The North African Campaign commenced with the invasion of Egypt by Italian forces in June 1940 and ended with the surrender of the remnants of the Axis forces (German and Italian troops) in Tunisia three years later, in May 1943.

Prof Will Alexander

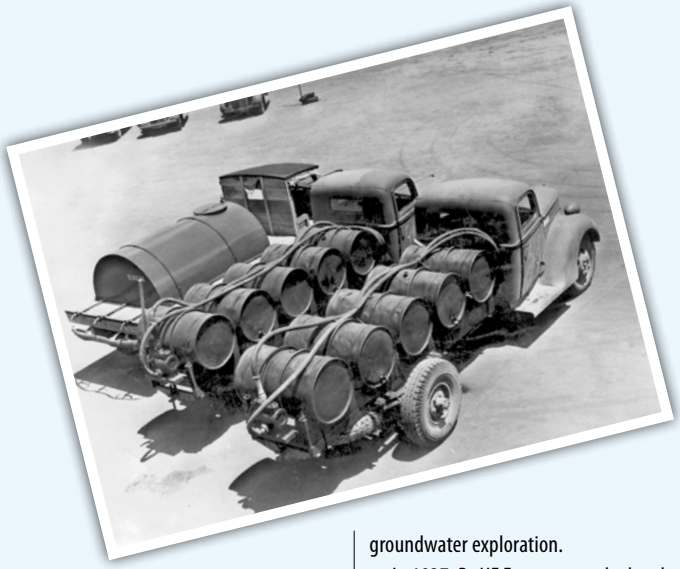
It is not often appreciated that during early civilisations, domestic animals had to be used for drawing and transporting water. This was still practised in Egypt during the war. In this photograph a blindfolded cow is used to pump water from a canal into an irrigation furrow.

Armies had to store supplies of water at strategic places ahead of battles The allies stored the water in four-gallon cans. This supply was almost covered by subsequent sandstorms.

A camel-drawn water cart.

In Roman times farming was practised along the North African coastal areas. Water was stored in underground cisterns carved out of the soft limestone rock. During the war these cisterns were used by both sides as shelters from enemy bombs and shells as the battles raged backwards and forwards across Libya. The only access to the cisterns was through a wide hole in the solid roof of the cistern. This Roman cistern was converted into brigade headquarters. The large entrance was constructed by wartime engineers.

At meal times in the desert small water tankers were always close at hand. One of them can be seen at the left of this photograph. During the war soldiers on both sides always carried steel water bottles strapped to their belts when in action.



Term 'water diviners' demeaning to skill of earth scientists

The contribution by Deon Visser (South African Military Water Diviners in Kenya during World War II, *the Water Wheel* September/October 2011) deals with a very interesting aspect of South African earth science.

However, the title is very far from the mark. I get the impression that the author and/or the editor are not aware of the sensitivities around water divining and scientific groundwater exploration. These South African soldiers were not water diviners; they were serious, well-qualified and experienced earth scientists, as the author also indicates.

The history of this group of scientists is the following. In 1934 the first geophysicists to join the Geological Survey staff were DJ Simpson and GL Paver. Others were to follow soon and this team embarked on a systematic programme to evaluate geophysical methods and applications such as the siting of boreholes. The groundwater applications were performed in collaboration with the Department of Irrigation and the South-African Railways. With the development of appropriate electrical and electromagnetic geophysical methods the siting of water boreholes became more technically sophisticated. During the latter years of the 1930s the Geological Survey built a strong team of geologists trained in geophysical work for the purpose of groundwater exploration.

In 1937, Dr HF Frommurze, the head of the groundwater and geophysics group in the Geological Survey published a memoir on the water-bearing properties of the more important geological formations in South Africa. He discussed the results of more than 22 000 water boreholes.

At the outbreak of World War II, the director of the Geological Survey, Dr SH Haughton, assisted in the formation of the 42nd Geological Section of the South African Engineering Corps, manned initially by Dr Frommurze, Dr Simpson and, then still, Mr Paver. The section had the primary objective of locating water supplies for the troops. Electrical resistivity methods were mostly used. These geologists/geophysicists saw service in the East- and North-African as well as Middle Eastern Campaigns and on their return had gained a considerable amount of experience in the problems of underground water supply in those areas. It is also known that Drs Frommurze and Paver held the rank of Major during the war.

In 1944, the anniversary address of the President of the Geological Society of South Africa (GSSA) was published in which Dr Frommurze (President of the GSSA in 1942) addressed the topic: Scientific methods of water finding. In this address he dealt amongst other topics with diviners and divining as well as geophysics.

After the war Dr Paver published several papers on their experiences in *Water and Water Engineering*. Dr DJ Simpson in his 1960 Presidential Address to the GSSA entitled 'Water and Warfare' also described their exploits.

In 1948, at the General Assembly of IUGG in Oslo, Paver commented: "The proper scientific investigation of underground water supply should embrace the correlation and reconcilement of all available and observable hydrological, geological and geophysical data. The geophysical work should rest on a sound geological and hydrological foundation and be regarded as an extension of the collection of attainable data and not looked upon as a separate investigation. No interpretation of observed results, however feasible mathematically or physically, are (*sic*) acceptable if they contradict the established facts of hydrology and geology. The initial application and final interpretation of geophysical data demands a thorough knowledge of geology and an understanding of the hydrological conditions controlling the occurrence of underground water in the various rock types." This displays a sound scientific approach that is still valid today.

During the late 1930s these men were amongst the best people in the country (if not the world) to carry out the job of scientific groundwater exploration for the military campaigns in Eastern- and Northern Africa and the Middle East. They were definitely not your run-of-the-mill water diviners!

Dr Johan de Beer, geophysicist, Stellenbosch

(Bibliography available)

Lt-Col Visser responds: "I was quite unaware of the sensitivities around the term 'water diviners'. In retrospect, perhaps it should have been used in quotation marks as it was a nickname mentioned in one of my sources. Neil Orpen writes: "One of the most highly specialised of all units in Kenya was what Colonel H Sugden, Brigadier Minnis' Chief Staff Officer, aptly called South Africa's "water divining unit", officially designated 42nd Geological Survey Section, SAEC (Major HF Frommurze)'. (N Orpen, South African Forces World War II, I: East African and Abyssinian Campaigns (Purnell, Cape Town and Johannesburg, 1979), p.35.) The article in the Water Wheel *was a mere summary of a longer paper on the subject. In the longer text it is written: 'The Union of South Africa, as was the case with Southern Rhodesia (Zimbabwe) and most of the other colonial administrations, employed both geological and geophysical methods to select sites for boreholes as recent deposits often obscured surface indicators of underground water. By 1940, the Geological Survey Section of the South African Mines Department and the Boring Branch of the Irrigation Department had been working together very closely for 35 years to increase the success rate of the Union's water boring efforts, which led to considerable advances in the scientific methods of underground water location, particularly electrical resistivity and magnetometric methods of surveying. Much successful experimenting with these methods had been done in low rainfall areas in the Union, including the Kalahari Desert where conditions are comparable with those in arid and semi-arid regions in East Africa and elsewhere in the world.' What I am particularly interested in is to determine whether any of these water sources (boreholes, dams etc.) established by the military during the war are still in use today".*

(Response has been edited)

Gremlins strike again

Your article, 'Domestic water filters under scrutiny in new project' in the September/October 2011 issue of *the Water Wheel* makes very interesting reading. However, the download address given for the electronic brochure, *To Buy a Water Filter or Not to Buy a Water Filter,* is incorrect. The correct address is: www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Documents/water%20filter%20brochure.pdf

Arend Hoogervorst, Kloof

Praise for the Water Wheel

I have been receiving *the Water Wheel* for quite some time and I must congratulate you on the excellent quality of the magazine. I rate it as the best popular science magazine in South Africa.

Irene de Moor, Grahamstown

WRC welcomes new chief

In October the Water Research Commission welcomed its new CEO, Dhesigen Naidoo.

Naidoo joins the Commission from the University of Pretoria, where he was employed as Director: Research and Innovation Support. Here he was involved in managing the overall research portfolio of the university, providing strategic direction and support to the various facilities, schools and centres. He has also worked for the departments of science & technology, environmental affairs and water affairs.

Naidoo holds a B.Sc degree in Chemistry and Biochemistry and a B.Sc Honours from the University of KwaZulu-Natal. He then completed his Masters Degree in Medicine at the University of Cape Town. He also holds a Post Graduate Diploma in Health Management from the latter institution.

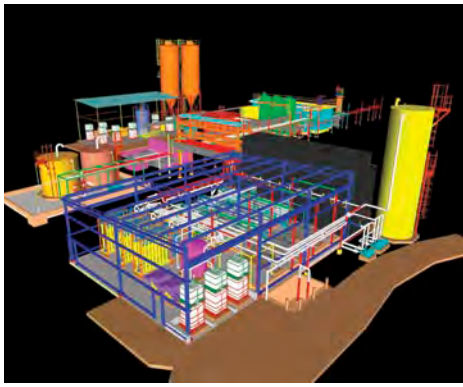
Welcoming the new CEO into the WRC fold, Chairperson Prof Janine Adams said: "Change is never easy, but we know the excellent staff and teamwork at the WRC will provide the new CEO with the required support. The Board looks forward to future great achievements. Through strong leadership we know that the Commission will grow as the water research and knowledge hub of South Africa."

Project reduces brine effluent for power station

VWS South Africa is currently completing a R60-million project aimed at reducing the amount of unexploited brine water produced at Eskom's Tutuka Power Station, in Mpumalanga.

The company's Actiflo ballast clarification solution is being used as the main cog in the brine treatment process for the first time in South African industrial water treatment. At present, 3 Mℓ/day, generated by the power station and New Denmark Colliery, are disposed of using unsustainable methods. The new treatment plant will reduce this quantity into lined evaporation ponds to 0,6 Mℓ/day.

Brine water is high in total dissolved solids, including organics, calcium and sulphates, making it prone to scaling and fouling membrane systems downstream. To prevent this, the following range of wastewater treatment processes is being provided: the flocculated



solids in the brine will be coagulated inside the Actiflow maturation tank with the addition of Actisand for ballasted floc formation. The next step involves the Actiflow where water, flowing under gravity into the clarification system, is allowed to settle; separating and collecting heavier particles.

Collected sludge will be processed in a vertical thickening unit to ensure that solids are reasonably dry, while still fluid enough to be pumped. The clarified water flows under gravity to another unit where it will be coagulated again. The addition of lime, soda ash, magnesium chloride and sludge recycle streams will reduce the scaling potential of the water. Then, the softened water will then be passed through three carbon filters, further reducing the water's organic content.

Following these steps the water will be treated using ultrafiltration with non-oxidising biocide, after which reverse osmosis (RO) units will complete final polishing. The brine produced by the RO plant is the final effluent to be disposed of in lined evaporation ponds. The permeate generated by this plant will be used in the Tutuka power station's cooling towers, ensuring minimal waste generation.

According to VWS project manager Julius Pistorius, the result is that overall recovery of water is greater than 75%. "This will reduce expenses associated with evaporation brine treatment and the power station's raw water intake."

Construction should be completed by the end of the year.

Local government asset registers still lacking – Treasury

There are still local governments in South Africa who have no idea about the age and state of their assets or even what and where these assets are located.

This is according to the *2011 Local Government Budgets and Expenditure Review*, released by Treasury earlier this year. According to the review, this lack of knowledge makes it impossible to determine the investment needs required. As a result most municipalities have not paid sufficient attention to the maintenance of their existing infrastructure.

The persistent underspending on repairs and maintenance is probably the most serious misalignment in municipal budgets, according to the report. "Medium to long-term consequences of underspending on repairs and maintenance include deteriorating reliability and quality of services, more expensive crisis maintenance, increased cost of future maintenance, reducing the useful life of assets, increased distribution losses, reduced revenue and rising tariffs over the medium term," it stated.

Municipalities generally allocate about 5% to 12% of their annual operating budgets for repairs and maintenance. However, these are budgeted figures, with no information currently available on the actual repairs and maintenance spend by local governments.

Municipalities budgeted to spend R32-billion on water and sanitation in 2010/11, compared to R8,4-billion spent in 2006/7. The cost of extending the network infrastructure to outlying communities was described as being neither cost effective nor sustainable, which pointed to the need to explore alternative service delivery options.

Other factors influencing the efficient provision of water services were non-revenue water, uncertainties over the impact of climate change and the skills shortage. "The number of engineers in local government per 100 000 people has decreased from 20 in 1992 to 3 in 2010 – a ratio clearly indicative of a crisis, the report said.

In general, the report cautioned local governments to pay more attention to all aspects of the revenue management value chain. These include the integrity of billing information, accuracy of billing systems and the ability to collect revenues. The majority of municipalities have collection rates below 80%, undermining their ability to deliver optimum services.

Unnecessary spending on non-priority items also undermined local government budgets. "International experience with government cost-saving initiatives indicates that savings of as much as 15% can be realised over time. This suggests that by eliminating non-priority spending, municipalities on aggregate could have saved up to R27-billion on their 2009/10 budgets, which is more than the total equitable share for local government in that year," the report pointed out.

Towns face major challenge to improve water supply

Most of South Africa's current water supply problems and restrictions could be avoided by proper management of existing schemes.

This is according to research presented at the International Groundwater Conference held at the CSIR International Convention Centre in Pretoria earlier this year. According to Dr Kornelius Riemann, principal hydrogeologist at consulting firm Umvoto Africa, at least 34 million m^3/year of water are lost between the water resource and the end-user in the Western Cape alone, excluding Cape Town and surrounds. "More than 10 million m^3 of this (enough to supply the water requirements of towns like George and Stellenbosch) could be saved through effective water conservation and water demand management measures."

These findings are based on research by Umvoto Africa in the Western and Eastern Cape, as part of the All Towns Study of the Department of Water Affairs. This is a nationwide programme started in 2008 to map and develop water reconciliation strategies for all metropolitan areas, as well as towns, villages and clusters of villages.

Research shows that many communities rely on untreated raw water from rivers, springs or boreholes. Many are contaminated due to poor land management and source protection. "The smaller stand-alone water supply and treatment schemes may achieve the required drinking water standard, but often lack the required water quality management to ensure continuously good drinking water quality," said Riemann.

The situation for the wastewater treatment plants is often bleaker, with many works not complying with effluent water quality standards. In most cases, the poor condition of water treatment plants, and wastewater treatment plants, can be attributed to neglect of the works from an operation and maintenance perspective.

Often, the best and most cost-effective solution lies in the refurbishment and proper maintenance of existing infrastructure, noted Riemann. "This is mainly found with groundwater schemes, where boreholes are dismantled or pumps broken, and the municipalities then complain about the 'unreliability' of groundwater."

Importantly, any infrastructure development projects and/or repair measures have to be combined with skills development and training on all levels within the municipal structure to ensure that the local schemes are operated efficiency and reliably.

Water diary

NANOTECHNOLOGY
NOVEMBER 27-DECEMBER 2

The Second South African Nanoscience and Nanotechnology Summer School is being organised by the Department of Science & Technology in association with the Nelson Mandela Metropolitan University. The theme is 'Nanoscience characterisation techniques'. *Enquiries: Thereza Botha; Tel: (012) 807-0869; Fax: 086 549 0184; Email: thereza@technoscene.co.za or Visit: www.sananoschool.co.za*

YOUNG WATER PROFESSIONALS
DECEMBER 11-13

The First East Africa Young Water Professionals Conference will take place in Kampala, Uganda, with the theme 'Water for tomorrow: A collective responsibility'. *Visit: http://mail.nwsc.co.ug/eaywp/*

WATER IN AFRICA
FEBRUARY 20-23

The 16th Africa Water and Sanitation Congress will be held in Marrakech, Morocco, with the theme 'Collaborative mechanisms and innovations for sustainable development of the water and sanitation sector in Africa'. *Email: contact@afwa-hq.org or Visit: http://www.afwa-hq.org/siteweb/index.php?option=com_content&view=article&id=169%3Amarrakech-2012&catid=53%3A-congres&Itemid=111&lang=en*

WATER LOSS
FEBRUARY 26-29

Water Loss 2012 will be held in Manila, Philippines. The conference is intended to present and discuss latest developments, strategies, techniques and applications of international best practices in non-revenue water management. The Conference is the sixth event in a series of IWA water loss reduction speciality conference. *Email: 2012committee@iwa-waterloss.org or Visit: www.iwa-waterloss.org/2012*

WORLD WATER
MARCH 12-17

The 6th World Water Forum will take place in Marseille, France, with the theme 'Time for Solutions'. *Email: secretariat@worldwaterforum.org or Visit: www.worldwaterforum6.org*

DWA finally ready to curb Vaal water theft

Nearly five years after large-scale water theft was unearthed in the Vaal River system the Department of Water Affairs (DWA) is finally ready to lay down the law.

During water quantity and quality investigations in the Vaal River system published in 2007 it was found that as much as 244 million m^3/year of water is being used illegally – particularly by farmers along the Liebenbergsvlei River which serves as the conduit for the transfer of water from Lesotho. This is over 15% of the total volume of water used in the Vaal River system, and has added significantly to current deficits.

In September, DWA issued a stern warning to illegal water users, saying in a statement that it was now clamping down on transgressors. The department aims to address 92% of unlawful water use in the Vaal River system by March next year.

In addition, government's quest for renewable energy sources could prove to be beneficial to the Vaal River system – a water transfer scheme planned to augment the Crocodile (West) River system and the coal-fired power stations near Lephalale in Limpopo from the Vaal system has been postponed. This will reduce the water requirements in the system; however, to have sufficient water up to 2050, key strategies must also be successfully implemented.

In addition to cracking down on illegal water users, DWA has set water conservation (WC) and water demand management (WDM) targets for all metros and municipalities within the Vaal River system which collectively amounts to a target of 15%. Workshops between the Gauteng departments of local government and housing and the various municipalities have been held to facilitate the financial prioritisation by the municipal chief financial officers to prioritise budget allocations for the WC/WDM activities.

Various management interventions are also being implemented to address water quality issues, such as eutrophication, salinisation and microbial pollution.

Leg up for SADC transboundary aquifers

With up to 168 million of southern Africa's people relying on groundwater supplies, a present Southern African Development Community (SADC) project hopes to place the management of transboundary aquifers higher on the regional agenda. Lani van Vuuren reports.

Within southern Africa it is estimated that at least 37% of the population relies on formal or improved groundwater supplies, while another 40% rely on unimproved resources (such as hand-dug wells and springs). This makes groundwater an extremely important resource in the region, especially in drought-prone areas.

Groundwater systems are by their very nature transboundary, and there are about 20 of these cross-border aquifers in southern Africa. According to Gereon Hunger of the Department of Water Affairs & Forestry, Namibia, while the transboundary nature of these systems has been recognised for a long time, it is only recently that steps have been taken to grow the region's knowledge of transboundary aquifers and so improve their management and sustainable development.

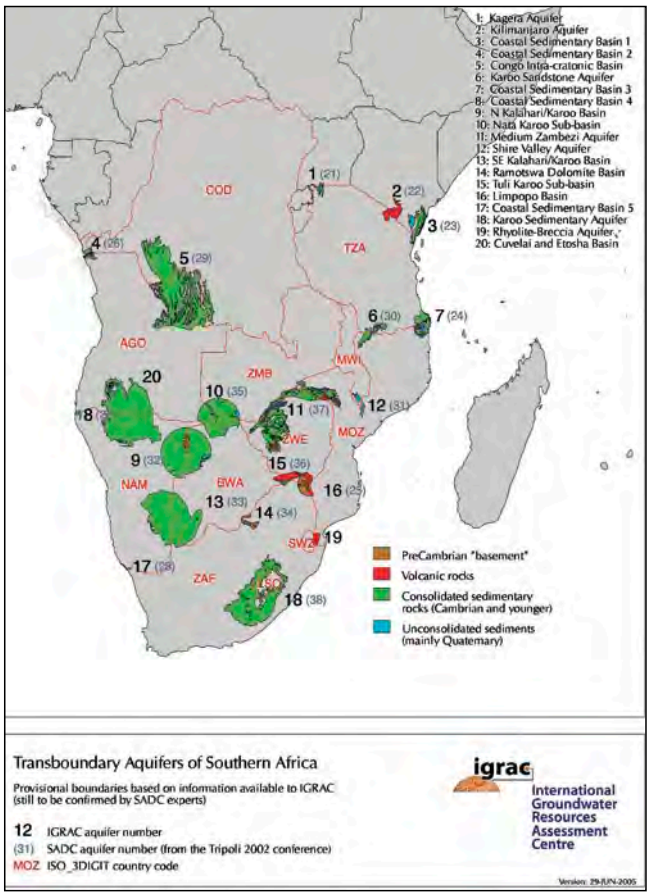
"While the Revised SADC Protocol on Shared Watercourse Systems [which came into force in 2003] has resulted in the successful creation of a number of river basin organisations, it has not yet lead to the creation of effective mechanisms to address the challenge of transboundary aquifer management," he said, speaking at the International Groundwater Conference held in Pretoria earlier this year. "Spatial variation, the groundwater rights of stakeholders within each basin state, water quality degradation, water conservation and the potential of conflict, in particular because of the unseen and little understood nature of groundwater, are some of the issues that need to be resolved."

In order to address some of these issues, a new SADC-wide groundwater management project was launched earlier this year. The project, supported by a number of national and international organisations, is aimed at strengthening the institutional and policy frameworks governing transboundary aquifers in the region; to protect the integrity of groundwater systems and ensure the sustainability and protection of groundwater dependent ecosystems, among others.

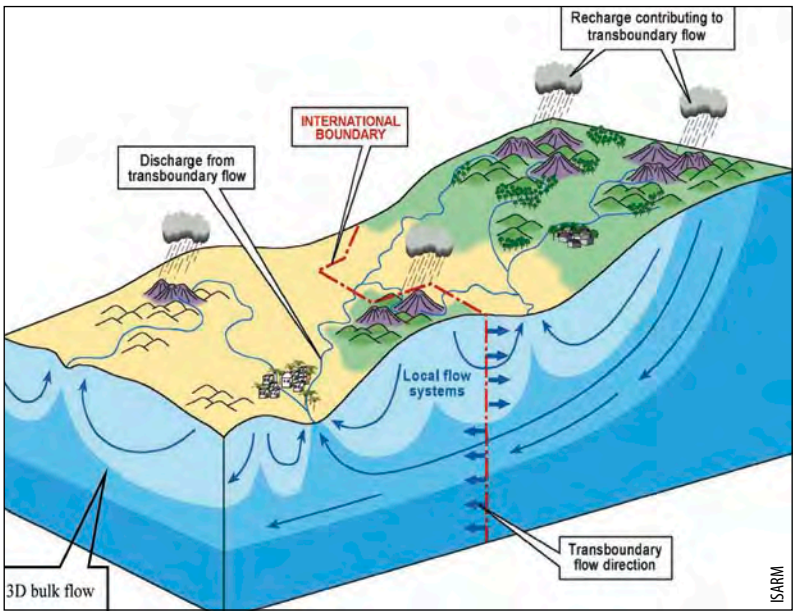
A need was identified to develop and apply transboundary aquifer management principles on a pilot basis, and to date two aquifers have been selected for this purpose. The first is the Stampriet Kalahari-Karoo aquifer shared between Namibia, South Africa and Botswana and the other the Ramotswa Dolomite aquifer shared between South Africa and Botswana. "These aquifers have entirely different characteristics. This was done purposefully to ensure that a full range of different management needs and challenges are addressed," noted Hunger. The Stampriet system is mainly used for commercial irrigation purposes in Namibia, with the main applications being pastoral farming and domestic use in Botswana, and game and stock watering in South Africa. The Ramotswa aquifer, on the other hand, is mainly used for bulk water supply in South Africa and Botswana. This aquifer is highly vulnerable and currently in a state of deterioration, mainly as a result of pollution.

A transboundary diagnostic analysis will be undertaken in each transboundary aquifer, followed by the development of a strategic action programme in order to reach an informed consensus on the factors affecting their integrity at the national and cross-border level, explained Hunger. It is hoped that through this process the commitment of the countries sharing the resources will be attained to implement priority actions. It is envisioned that eventually this process will facilitate the establishment of a cooperative process for the integration of groundwater resources management into organisational frameworks for the respective river basin organisations already in existence in the region.

As populations grow and areas develop groundwater is bound to play an even more important role in regional water supply in future. It is hoped that this new project will go a long way towards the sustainable management of the resources.



Transboundary aquifers of southern Africa



A typical transboundary aquifer

New from the WRC

Report No: 1838/1/11

Incorporating uncertainty in water resources simulation and assessment tools in South Africa (DA Hughes; E Kapangazi-wiri; SJL Mallory; T Wagener & J Smithers)

The main objective of the project was to contribute to the incorporation of uncertainty assessments in water resource decision making in South Africa, thereby quantifying the risks associated with specific decisions about planned future water resource developments. The main output of the project has been the development of a framework for uncertainty assessments in water resources availability analyses within South Africa.

Report No: 1658/1/11

Evaluation of a South African clinoptilolite for the removal of ammonia-nitrogen from secondary sewage effluent for pollution control (JJ Schoeman; EL Sekgwela & D Hallis)

Ammonia-nitrogen discharges into the water environment accelerate eutrophication of rivers and dams and dissolved oxygen depletion in receiving waters. Ammonia-nitrogen can be removed from wastewaters by selective ion-exchange using clinoptilolite, biological nitrification and denitrification, liming the pH to 11 followed by air (or stream) stripping, breakpoint chlorination followed by treatment with activated carbon and treatment in algae ponds. The main aim of this investigation was to develop process design criteria and costs for the implementation of a South African clinoptilolite for ammonia-nitrogen removal from secondary effluents for pollution control.

Report No: 1846/1/11

Optimised monitoring of groundwater-surface water-atmospheric parameters for enhanced decision-making at local scale (N Jovanovic; S Israel; C Petersen; RDH Bugan; G Tredoux; WP de Clerq; T Vermeulen; R Rose; J Conrad & M Demlie)

Advances have been made in recent years in developing networks and databases for monitoring water systems in South Africa, in particular groundwater and atmospheric variables, with the ultimate aim of facilitating integrated water resources management at a catchment scale. However, these monitoring systems need to be consolidated and integrated among various components of catchment systems: groundwater, surface water, soil and vadose zone and atmospheric monitoring. The main aim of this project was the development of an integrated framework for optimised monitoring of water resources that will account for the different components of catchment systems and their interactions.

Report No: 1796/1/10

Deriving conservation targets for rivers (NA Rivers-Moore)

Freshwater ecosystems are the most threatened ecosystems globally, experiencing the fastest loss of biodiversity and the greatest number of species extinctions. The last appraisal of South African freshwater ecosystems estimates that over 80% of the country's river ecosystems are threatened. One tool available to conservationists to staunch the current rate of loss to freshwater biodiversity and ecosystems is systematic conservation planning, which provides a structured approach in identifying biologically significant areas for conservation action. A necessary component of conservation planning is to set targets for how much of each biodiversity feature (i.e. element of biodiversity which can be quantified and spatially represented) needs to be protected, and additionally for rivers, to maintain connection between different biodiversity patches. This study proposes a new direction for setting river targets, based on established measures of species diversity. The aim of this research was to develop a scientific methodology, equivalent to the species-area curve used for terrestrial systems, to set conservation targets for river lengths.

Report No: 1693/1/10

Hydrogeology of basement aquifers in the Limpopo Province (KT Witthüser; M Holland, TG Rossouw; E Rambau; AJ Bumby; KJ Petzer; I Dennis; H Beekman; JL van Rooy; M Dippenaar and M de Wit)

Archaean basement lithologies are distributed extensively in Africa and also underlie large parts of the semi-arid Limpopo Province. Groundwater is the only dependable source of water for many users in this province. A socio-economic study showed that water supply is chronically short in many rural areas and that households often pay exorbitant prices for water in informal local water markets. The importance of the basement aquifers in the province in meeting water demand makes it important to identify high-yiedling hydrogeological zones that can be targeted for water supply. Due to the intrinsic low primary permeability and porosity of basement lithologies, the biggest challenge is to understand the factors that determine the secondary permeability and storativity of these aquifers. The focus of this study was therefore to systematically analyse regional factors that may influence borehole yields and aquifer transmissivities.

Report No: 1781/1/10

Lightweight moveable superstructures for VIP toilets (EP Kearsley)

In South Africa there are still many households without access to basic infrastructure such as water and sanitation and, in many areas, onsite dry sanitation systems in the form of ventilated improved pit (VIP) latrines will continue to be an appropriate technology choice. However, many of these systems will require rehabilitation or replacement when the pit reaches its capacity of design life. However, current standard construction techniques and materials make the superstructure very heavy to move to a new site or even to allow access for desludging. Superstructures are also difficult to dismantle and reuse the material to build a new structure. In many cases it is not possible for the average household to relocate the superstructure, resulting in overflow of raw sewage. The aim of this project was to develop an affordable moveable superstructure for a VIP toilet that can be used in rural communities. A moveable lightweight superstructure system made from high-strength fibre-reinforced concrete was developed. This system consists of a base slab, wallpanels, a roof and a door and the system can be provided to communities in package or it can be manufactured by the communities themselves in controlled environments. The other reports in the series are: *Lightweight Toilet Superstructures: Manufacturing Guide* **(TT 483/10)** *and Lightweight Toilet Superstructures: Installation and Assembly Guide* **(TT 484/10)**.

Report No: KV 274/11

The effect of formaldehyde use in sanitation (PA Crous & J Haarhoff)

Besides its multiple other uses in industry, formaldehyde is used as an additive to inhibit the biodegradation within chemical toilets. This raises an obvious question about its effects on the receiving wastewater treatment facilities which accept the contents. A desktop study was consequently commissioned by the WRC and conducted at the University of Johannesburg. Among others, the study summarised the main chemical and toxicological properties of formaldehyde which may be of environmental concern; reviewed international and South African legislation, regulations and standards on the use of formaldehyde in portable toilets; established the prevalence of formaldehyde-based chemicals used in temporary chemical toilets; assessed the impacts of these chemicals and advised on the need and direction of more detailed investigation of tighter regulation of these chemicals.

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

Extreme 2010 Russian fires and Pakistan floods linked meteorologically

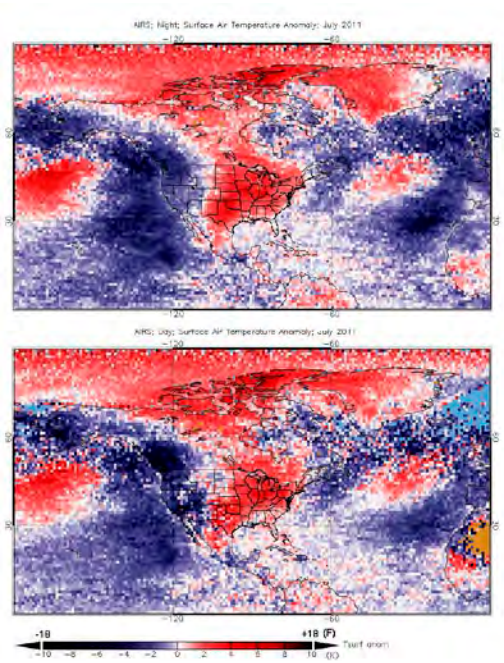
Two of the most destructive natural disasters of 2010 were closely linked by a single meteorological event, even though they occurred 2 400 km apart and were of completely different natures, a new NASA study suggests.

The research finds that the same large-scale meteorological event – an abnormal Rossby wave – sparked extreme heat and persistent wildfires in Russia as well as unusual downstream wind patterns that shifted rainfall in the Indian monsoon region and fuelled heavy flooding in Pakistan. Although the heat wave started before the floods, both events attained maximum strength at about the same time, the researchers found by analysing satellite data generated by NASA instruments capable of measuring the land-surface temperature, precipitation intensity and wildlife activity.

William Lau and Kyu-Myong Kim, atmospheric scientists at NASA's Goddard Space Flight Centre, authored the study, which was published earlier this year in the *Journal of Hydrometeorology*.

The atmosphere, gaseous and transparent, may not seem like a fluid, but that is precisely how the thin layer of air encasing the planet behaves. As Earth spins on its axis, huge rivers of air – scientists call them Rossby waves – meander around the globe in a westerly direction. Currents in the centre of these waves form the jet streams, fast-moving columns of air that push weather systems from west to east.

Rossby waves are not uniform. They tend to undulate and have troughs and ridges. Areas of low pressure typically develop in the troughs of the waves, while high-pressure areas form in their ridges. Parcels of warm air from the tropics and cool air from the poles swirl around the low- and high-pressure parts of the waves creating a complex tapestry of warm and cool fronts that meet and interact constantly. Collisions between warm and cool fronts produce storms and precipitation.



Under normal summertime conditions, the jet stream pushes weather fronts through Eurasia in four of five days, but something unusual happened in July 2010. A large-scale, stagnant weather pattern – known as an Omega blocking event – developed over a high-pressure ridge above western Russia. This blocking event, which divided the jet stream, had the effect of slowing the Rossby wave and prevented the normal progression of the weather system from west to east.

As a result, a large region of high pressure formed over Russia and trapped a hot, dry air mass. As the high pressure lingered, the land surface dried and the normal transfer of moisture from the soil to the atmosphere slowed. Precipitation ceased, vegetation dried out and the region became a taiga tinderbox.

Meanwhile, the blocking patter created unusual downstream wind patterns over Pakistan. Areas of low pressure on the leading edge of the Rossby wave formed in response to the high that pulled cold, dry Siberian air into lower latitudes.

"From NASA satellite data and wind analysis, we can clearly see the connection between the two events," said Lau. "Think of the atmosphere like a loose membrane. If you push one part up, something else has to come down somewhere else. If your produce a high in one region, you produce a corresponding low in another."

This cold air from Siberia clashed with warm, moist air arriving over Pakistan from the Bay of Bengal. There is nothing unusual about moisture moving north over India toward the Himalayas. It is a normal part of a monsoon. However, in this case, the unusual wind patterns associated with the blocking high brought upper level air disturbances farther south than is typical, which helped shift the entire monsoon rainfall system north and west. The shift brought heavy monsoon rains squarely over the northern part of Pakistan.

Source: NASA

Aussies proclaim war against invading willows

A project by Australian research organisation CSIRO is investigating the reproductive ecology and dispersal ability of the most aggressive invasive species of willows in Australia.

It is hoped that the study will provide urgently needed information to help land managers more efficiently control this alien invasive plant, which obstructs water flow, increases water temperature, changes water chemistry and displaces native riverine plant species.

According to the organisation, the results are crucial as willow control is expensive, time consuming, and eradication can be unsuccessful because of the willows' capacity to reinfest areas a short time after they have been removed.

CSIRO researcher Tara Hopley investigated the reproductive ecology and seed dispersal strategies of Salix cinerea or grey sallow, which is a weed of national significance. The study focused on three main problems: how willows are pollinated and how much seed they can make; how far willow pollen and seed can move across catchments; and identifying trees and populations within catchments that are key seed 'donators'.

"We discovered that this species of willow is pollinated by both insects and wind, and that the average willow tree can make 330 000 seeds in a season," noted Hopley. "That is about 25 million seeds generated each year by an average infestation of half a kilometre."

Genetic paternity tests and spatial analysis were used to determine how pollen and seeds are dispersed across a typical catchment. "The results show that over half the pollen and seed is moving more than 15 km between rivers. This high rate of spread suggests that land managers have to act urgently on control efforts across the whole catchment if long-term eradication is going to be effective," said Hopley.

Source: CSIRO

Cellphone innovation helps US teenager win international prize

American teenager Alison Bick, seen in the photograph with HRH Crown Princess Victoria of Sweden, has won the 2011 Stockholm Junior Water Prize.

The winner of the annual competition, which is open to young people between 15 and 20, takes home a prize of US$5 000 and a handmade blue crystal sculpture.

Bick worked for four years on her winning project, a low-cost portable method to test water quality using a cellular phone. The technology combines micro-fluidic devices, cellphones and chemical indicators to evaluate water quality. Her innovative method does not only accurately assess the bacteria content of water; it is also up to 200 times less expensive than standard testing procedures.

"This year's winning project reflects truly out-of-the-box thinking to find a solution to an important real world problem that is relevant in both a developing and developed country context. It is the result of a creative-multi-faceted and long-term effort that was triggered by an actual problem in the local community. It has the potential to revolutionise our ability to monitor water quality in a way that is fast, accurate, more flexible and less expensive than existing technologies, said the International Jury in its citation.

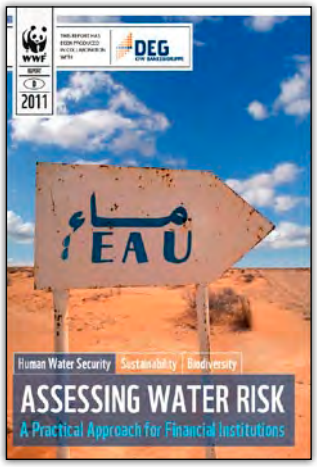
The international Stockholm Junior Water Prize competition brings together thousands of participants in over 28 countries, including South Africa. The representatives at the international final held during World Water Week in Stockholm are the winners of national competitions that fielded over 9 000 submitted projects this past year.

Water shortage becoming growth risk for business – report

According to a new study by WWF and German development bank DEG, the shortage of freshwater is not only becoming more and more of an ecological risk, but is also rapidly becoming a major business growth risk – one that investors need to take into account.

Assessing Water Risk: A Practical Approach to Financial Institutions, states that climate change, population growth and increasing living standards are contributing to the rising pressure on existing and already scarce water resources, particularly in developing countries. In Southeast Asia and Africa, for example, water shortages constitute a threat to entire ecosystems and to the living standards of the population.

"The availability of water is becoming a development bottleneck for companies. With the water risk filter we have now developed a new tool to identify such risks to companies and to offer support in water management," noted Dr Peter Thimme, head of DEG's department for Sustainable Development. Access to a sufficient quantity of water of adequate quality, he added, is therefore a considerable economic significance. "Business risk stemming from a company's relationship to



water can be broken into three broad, inter-related categories: physical – as a result of too little, too much or polluted water; regulatory – with dwindling availability and increased pollution, the regulation of water is bound to become stricter; and reputational – public and media awareness of water and how companies are handling this resource is on the rise."

The report goes on to state that "all of these risks can cause disruption of supply and, in worst cases, termination of business operations."

To access the report, Visit: http://assets.wwf.org.uk/downloads/deg_wwf_water_risk.pdf

Want to protect wild species? Then grow more food on less land

In parts of the world still rich in biodiversity, separating natural habitats from high-yielding farmland could be a more effective way to conserve wild species than trying to grow crops and conserve nature on the same land.

This is according to a study published in the 2 September edition of the journal, *Science*.

Researchers at the University of Cambridge and the Royal Society for the Protection of Birds, collected information on more than 600 species in southwest Ghana and northern India, two parts of the world where demand for agricultural land is putting ever more pressure on wild species. The researchers measured crop production as well as the abundance of birds and trees in forests and in various types of farmland.

"Farmland with some retained natural vegetation had more species of birds and trees than high-yielding monocultures of oil palm, rice or wheat but produced far less food energy and profit per hectare," reported lead author Dr Ben Phalan from the University of Cambridge. "As well as requiring more land to produce the same amount of food, the 'wildlife-friendly' farmlands were not as wildlife-friendly as they first appeared. Compared with forest, they failed to provide good habitat for the majority of bird and tree species in either region.

The researchers discovered that, under current and future scenarios of food demand, most species would have larger total populations if farming was restricted to the smallest area feasible, while protecting as much natural forest as possible. This was true not just for rare species, but for common species as well.

This strategy, called 'land sparing', uses higher yields on existing farmlands to spare land for nature (in contrast with 'land sharing', which aims to conserve wild species and grow crops on the same land). Because high-yielding farming produced more food from less land, it could be used as part of a strategy to protect larger tracts of natural habitats such as forest.

"It would be nice to think that we could conserve species and produce lots of food, all on the same land," said study author, Dr Malvika Onial from the University of Cambridge. "But our data from Ghana and India show that is not the best option for most species. To produce a given amount of food, it would be better for biodiversity to farm as productively as possible, if that allows more natural habitat to be protected or restored."

GROUNDWATER – from 'inferior' to 'superior'

Groundwater has long ago shed its historical image as a 'Cinderella' or hidden resource. Following the promulgation of the National Water Act in 1998, in which groundwater finally gained its rightful place in the national water cycle; much work has been done nationally to both gain knowledge of the resource and its interaction with surface water resources, and elevate its status in the water resource planning and development process. Last year the Department of Water Affairs (DWA) completed the National Groundwater Strategy aimed at capturing the understanding, position and value of groundwater so that it can fulfil its role as equal partner in integrated water resource management and use.

Around 2 000 million m^3 of groundwater is currently used every year by South African users, with a further minimum of 3 500 million m^3/year estimated to be in easy reach for future application. In fact, two thirds of the country's population depend on groundwater for their daily domestic needs. Groundwater is also essential to the water supplies of towns such as Beaufort West, Prince Albert, Graaff Reinet, Atlantis, Vryburg and Musina. Even large cities such as Pretoria and Johannesburg are partly dependent on groundwater.

Groundwater provides an invaluable lifeline to millions of South Africans from small, rural areas to large cities yet many still eye it with suspicion, viewing it as an inferior resource. Lani van Vuuren examines the opportunities and hindrances to raising groundwater's profile in the national water supply mix.

David Larsen/Africa Media Online

Despite this important role, groundwater resources have not received the same level of attention, either from managers or users, as surface water. As a result it remains an underutilised resource. According to Fanus Fourie of the DWA Directorate: Water Resource Planning Systems, there is considerable scope to increase and even double the present groundwater volume used in South Africa. "The recent All Town Reconciliation Strategies, in which the present demand and future supply options of more than 1 000 towns were investigated, placed groundwater development high on the list of future water supply options. In almost all instances groundwater was the second water augmentation choice after water conservation and water demand management and, in some areas, it is the only resource development option to meet future demand."

LAST RESORT

Despite this raised profile on paper, experience on the ground indicates that many municipalities only turn to groundwater as a last resort. During recent droughts in the Southern Cape, for example, around 100 boreholes were drilled to relieve critical water shortages in towns such as Plettenberg Bay, George, Mossel Bay, Sedgefield and Knysna. In all instances, the target expected from groundwater projects were met or exceeded. However, only Sedgefield and Plettenberg Bay made use of this water during their greatest time of need (particularly between 2008 and 2009) and as far has been ascertained none of the boreholes have been brought into permanent production. Instead other alternatives schemes have been undertaken, such as desalination plants.

Specialist groundwater consultant Roger Parsons, who undertook drought relief work for Sedgefield, Knysna, George and Mossel Bay, explains some of the hindrances experienced that prevent the increased use of groundwater by South African municipalities. "Generally, engineering responsible for the development and management of water resources in South Africa have no hydrogeological training, and are unfamiliar with the resource. Consequently, they turn to resources with which they are more familiar and understand. Also, groundwater is a logistically more complex resource as boreholes can be distributed over a wide area. In comparison, water from a dam can be supplied by pushing a button or opening a valve."

According to Christine Colvin, Worldwide Fund for Nature Senior Manager: Fresh Water, municipal managers and town engineers are generally uncomfortable dealing directly with science-based information on the availability of groundwater. "They have greater confidence in dealing with engineering-based 'facts' and figures – however, wrong those figures may be, for example, the costs for the Berg River Dam project were initially estimated at R355-million, but concluded at R2,7-billion. In addition, groundwater supply schemes generally prefer a phased approach of exploration drilling and testing with explicit risk and uncertainty of results. Groundwater development is sometimes a slow and steady option, versus quick wins within election time horizons, hence it is ignored by political decision makers."

According to the National Groundwater Strategy, the quantities of water being produced at present by small-scale desalination plants in towns such as Sedgefield are well within what could be provided by even a small groundwater wellfield. Parsons adds that groundwater resources are a much cheaper water resource development option. "The capital cost of developing groundwater resources during the drought in the southern Cape was R700 000/Mℓ. Generally assuming the cost of linking production boreholes to the reticulation infrastructure was double this, then the cost of using groundwater as a source of water during the drought was in the order of R2,1-million/Mℓ.

Guy Stubbs/Africa Media Online

Assuming all desalination plants achieved their target production, the equivalent cost of desalination was in the order of R13,5-million/Mℓ – almost 6,5 times more expensive." Desalination also has serious energy and carbon implications.

Another potential impediment is the fact that the volumes that can be gained from groundwater resources can also be deceiving. "A 2 ℓ/s borehole will be able to yield 173 m^3/day while 8 boreholes with the same yield will yield 0,5 million m^3/year," notes Fourie. This means that an absolute understanding of the resource is required – a challenge since very few municipalities have in-house hydrogeologists.

A particular problem which arose during the emergency drilling of boreholes in the Southern Cape

***Above**: Around two thirds of South Africa's rural population are mainly or solely dependent on groundwater.*

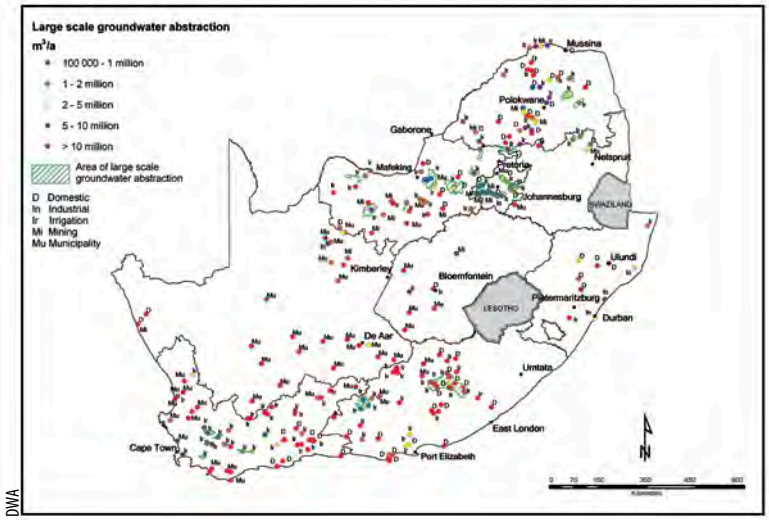
***Below**: Developing one of the emergency boreholes at Sedgefield by air-flushing. This borehole was tested at 8 ℓ/s.*

Roger Parsons

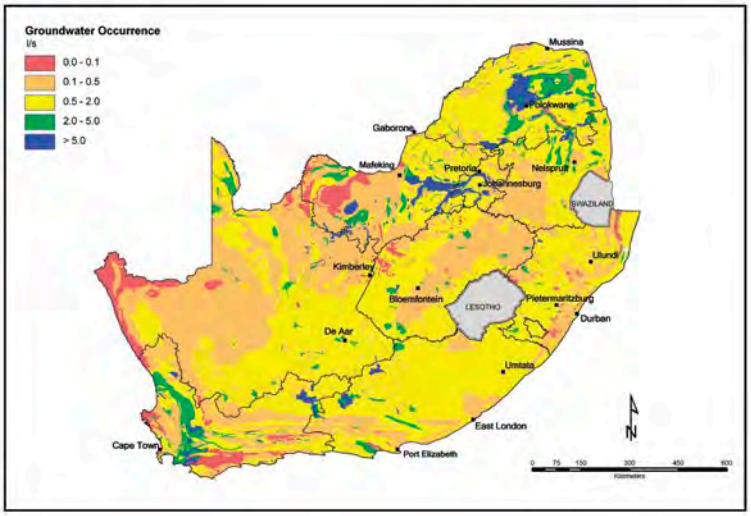
Top right: *Present large-scale groundwater abstraction.*

Middle right: *Groundwater use potential in South Africa.*

Below: *While high yields were obtained from boreholes drilled into the Table Mountain Group in the vicinity of Mossel Bay, surprisingly poor quality limited its immediate use for drought relief purposes.*



DWA



DWA

Roger Parsons

was access to land. "Section 24 of the National Water Act states that a license may be granted to use water found underground on land not owned by the applicant if the owner of the land consents or if there is good reason to do so. Despite the critical situation in the towns gaining access to water on land remained a challenge throughout the drought," notes Parsons. "Most of the drilling targets were outside of the urban area and on property not owned by the municipality. As a result, much time had to be spent with, for example, farmers trying to obtain permission to drill on their farms."

Parsons notes that, groundwater specialists can do much to improve groundwater's image. "The hydrogeological community has still not learnt to speak 'engineering lingo'. If we want our resource to be understood and appreciated, we need to become far better at communicating relevant information pertaining to our resource. For example, we need to give direct and sound answers about how water can be abstracted from boreholes and wellfields so that this information can be taken with confidence by the engineers into the realm of water supply engineering and design."

The groundwater profession also needs to play a leading role in communicating information about the benefits of using groundwater to non-specialists, Parsons notes. "We need to introduce a groundwater component into the education curriculum of engineering and we need to play a bigger role in water resource planning."

LACK OF MONITORING

In addition to being misunderstood, groundwater is viewed by many as being an unreliable resource. Communities often consider it 'backward' – at best an interim solution before a 'proper' surface water supply can be installed. Unfortunately, failure of groundwater schemes is often blamed on the resource when it is almost always

due either to failure of infrastructure (e.g. a blocked borehole screen) or unsuitable pumping regimes (e.g. pumping at very high rates for short periods of times) that are related to a lack of monitoring.

Contrary to belief groundwater supply can be sustainable. "Farmers in the Western Cape, for example, have shown me boreholes that have been handed down with the farm from one generation to another," says Colvin. "One borehole, drilled 80 years ago, is still the prime source of drinking water for the small community resident on the farm. The farm manager has the necessary technical skills to fix a tractor and maintain an irrigation scheme – this means he can maintain a diesel pump or a wind pump. Maintenance is his responsibility and the borehole has never been out of action for longer than four days."

"In almost all instances groundwater was the second water augmentation choice after water conservation and water demand management and, in some areas, it is the only resource development option to meet future demand."

Examples of successful use and protection of open springs also exist in Northern Limpopo where some sources have been fenced off to keep livestock out of the water. "The village elders do not allow anyone to wash in the spring that drinking water is collected from. Cultural beliefs about the protection of the spring by the ancestors also ensure that no-one will break this taboo lightly," notes Colvin.

A vital element of groundwater management is therefore day-to-day operations and maintenance – the mainly routine tasks that should be carried out in the course of operating a groundwater supply scheme. This includes maintaining infrastructure, such as cleaning and de-scaling pipes, replacing worn out components, cleaning of boreholes, checking the operation and switchgear etc. Fourie affirms that in cases where communities have taken responsibility for their boreholes and where operations and maintenance is applied regularly the groundwater supply has proven sustainable.

According to Colvin, local government decision makers must be educated on why groundwater schemes have failed in the past. "They should know that basic, but solid planning for effective maintenance is critical and that groundwater can be relied on in well sited and designed schemes. We should be promoting groundwater as a resource that is buffered from the impacts of climate change. Groundwater-based schemes could provide employment in rural areas and develop low cost, low carbon resources that make best use of our natural capital."

It must be pointed out that, just as it is with all possible sources of water, groundwater is not the silver bullet that is going to solve all the country's water supply problems. "In order for us to make informed decisions we need to assess and evaluable all available options based on environmental, economic, legal and institutional considerations. A combination of schemes is probably the best solution," says Fourie.

At the time of writing the National Groundwater Strategy was being incorporated into the Second Edition of the National Water Resource Strategy (NWRS). Timelines and responsibilities will be established as part of the implementation plan of the NWRS and that will become part of the Business Plan of DWA, which will mean a dedicated budget for groundwater. The department has also progressed with regards to filling its many hydrogeology-related vacancies (at one stage the number of vacant posts in the DWA for hydrogeologists was around 47% and 53% for geotechnicians of existing posts).

"There is great opportunity to increase the present volumes of groundwater used in South Africa," notes Fourie. "At the same time, improved management and protection of present sources of groundwater can play a substantial role as a sustainable, reliable resource for generations to come."

- To access the *DWA Groundwater Strategy 2010* and related documents, Visit: http://www.dwa.gov.za/Groundwater/gs.aspx ❑

CITY OF FOUNTAINS

Few people know that it was the presence of fountains rather than the Apies River, which led to the establishment of Pretoria it its particular location. For the first 50 years of its history, the city was nearly solely dependent on groundwater for its water supply, with its first dam at Rietvlei only being constructed during the Depression years. To this day, a proportion of the water supply to Pretoria is derived from springs and boreholes in the dolomite compartments south of the city, and which includes the now famous Fountains. In total, groundwater supplies about 60 million ℓ/day to the city, mainly to the central business district.

Source: Groundwater Strategy 2010

Windmills are a familiar site on the South African landscape.

Lani van Vuuren

ACID MINE DRAINAGE

solutions rearing to go

It is all hands on deck as authorities race to implement short-term measures in time to intercept the acid mine drainage threatening human and environmental health on the Witwatersrand. Report by Lani van Vuuren.

It has been almost a year since *the Water Wheel* reported on the massive challenge ahead for authorities to stem the flow of acid mine drainage in the Western, Central and Eastern basins of the country's largest historical gold-bearing area ('Red letter year for authorities to prevent mine-water catastrophe', *the Water Wheel* January/February 2011).

Since Cabinet's approval of the report of the panel of experts tasked to investigate the issue in February, lead government organisation, the Department of Water Affairs (DWA), has been hard at work implementing the recommendations stemming from the report. Among the recommendations are to pump the underground mine-water to ensure levels remain below the environmental critical level; to neutralise and remove metals from the pumped water through treatment (in the short term); to reduce further ingress of water into underground workings; to improve monitoring and undertake research to inform better decision-making; and to investigate sustainable medium- to long-term management options.

State-owned entity TCTA has been tasked by the Minister of Water & Environmental Affairs to ensure that these recommendations are implemented. In July, a Due Diligence study was completed to define an optimal short-term solution for each basin. Delegates of the recent Water Institute of Southern Africa Mine Water Division's Symposium on Sustainable Water 2030 were informed of the state of plans to implement these measures. At the time of writing, TCTA was finalising the first tender documents.

EMERGENCY MEASURE

The Western Basin, where decanting of acid mine drainage commenced in 2002, will receive the most urgent attention. An emergency scheme will see the upgrade and tripling of capacity of the current Rand Uranium treatment plant to treat up to 36 Mℓ/day of acid mine drainage. The plant has been unable to cope with the volumes of decant water, resulting in the much publicised pollution of the Tweelopiespruit and the downstream Krugersdorp Nature Reserve and Cradle of Humankind.

Increasing the capacity of the plant will at least enable the capture and treatment of average flows (up to 60 Mℓ/day of acid mine drainage flows from the system during the rainy season). This emergency measure is set for completion before the end of the year and will be operated by Rand Uranium. In the short term, treated water will be transferred via the existing channel to the Tweelopiespruit, while sludge will be co-disposed into the Wes Wits Pit.

According to TCTA Project Manager Craig Hasenjager, the challenge in the Western Basin is not only to treat the currently decanting acid mine drainage, but to lower water levels in the mine void to the environmental critical level, which has been established at 165 m below surface. Thus, in addition to the upgrading of the Rand Uranium water treatment plant, a new high-density sludge (HDS) plant and associated pumps and pipework will be constructed at Randfontein Estate with a capacity of 35 Mℓ/day.

HDS processing starts by mixing incoming effluent with a neutralising agent (limestone pre-neutralisation and quicklime dosing) and recycled sludge from a clarifier/thickener unit. After neutralisation, this mixture is fed to the main lime reactor where a combination of aggressive aeration and high shear agitation ensures optimum process chemistry and clarifier performance. The discharge from the lime reactor is then treated with flocculants in the gypsum crystallisation tank to promote the slow growing metal hydroxide and the forming of gypsum crystals before it is sent to the clarifier/thickener unit. The clarifier separates the treated effluent from the sludge, a portion of which is recycled to the head of the process.

The aim of the short-term treatment plant is the neutralisation and metals removal from the acid mine drainage. Based on the water qualities in the basin, the minimum treatments include iron oxidation, neutralisation and metals removal. It will also be prudent to include sulphate precipitation and/or removal to the gypsum solubility in the water (in the order of 2 400 mg/ℓ). Final clarification and removal of precipitated products will

be undertaken prior to discharge to the environment.

This plant is set for completion by August 2012. "Once both plants are in operation we expect to reach the environmental critical level by June 2013," said Hasenjager. This would effectively stop the outflow.

CENTRAL BASIN

In the Central Basin underlying the Johannesburg central business district water has been steadily rising in the mine void at an average 0,36 m/day since pumping stopped in 2008. The flooding of this basin has also been associated with an increase in seismic activity. Current water levels are estimated at around 408 m below surface. The set environmental critical level of 168 m below surface does not take into account feasible mining reserves lying between 168 m and 400 m underground. At the time of writing TCTA was negotiating with Central Rand Gold to take the level down to 400 m to allow mining of these reserves to continue. However, if no agreement is reached in time, these reserves will be flooded.

A HDS plant is also planned for this basin to be situated at the South West Vertical Shaft. The plant will have a capacity of 84 Mℓ/day, but initially treat 57 Mℓ/day of acid mine drainage. Neutralised water will be transferred through a pipeline into the Elsburgspruit, with sludge co-disposal at Durban DRD Gold via dual lines. TCTA was also in discussion with the latter company regarding the use of treated water produced by the HDS plant. Commissioning of this plant was also planned for August next year.

EASTERN BASIN

A third HDS plant is planned for the Eastern Basin, where minewater currently lies around 628 m below surface level. Since the potential date of water levels reaching the environmental critical level is only December 2014, the project team have given themselves a deadline of June 2014 for the commissioning of this plant, which will be constructed with a capacity of 110 Mℓ/day. Treated water from this plant will be transferred via a new pipeline to the Blesbokspruit.

Hasenjager said that in all three cases, infrastructure was to be designed and constructed in such a way that it would have a life expectancy of at least 30 years, and have low operation and maintenance requirements. In addition, plant capacities have been selected to ensure that the environmental critical level will never be breached regardless of high inflows into the mine void. The selected sites have also been selected to have enough room for extension if required in the long term.

In addition to the short timeframe, the greatest impediment to the success of the short-term intervention is the cost. Capital expenditure has been calculated at R924-million, with a further R385-million required for operations and maintenance. To date, only R225-million has been secured, and discussions were being held with National Treasury to secure the additional funding, said DWA's Marius Keet. There are no other funding options at this stage.

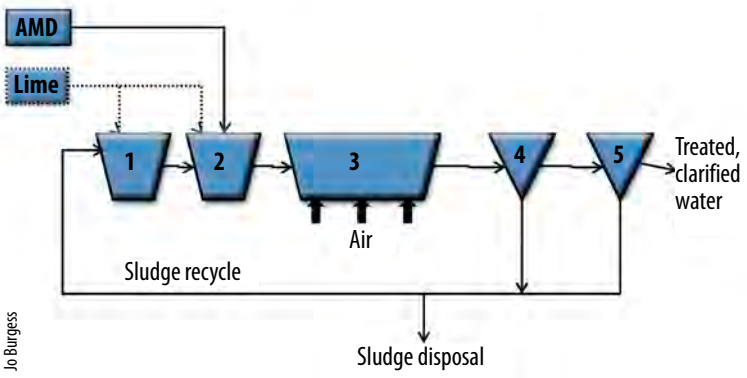
Concerning regulatory and environmental issues, Hasenjager stated that it is hoped to streamline these processes to allow the necessary infrastructure to be constructed in time. Full environmental impact assessments will be undertaken alongside the design and construction phase and engagement with interested and affected parties has begun.

Current status of mine void rewatering on Witwatersrand

Basin	Current status (metres below surface) (October)	Environmental critical level (ECL)	Potential date of reaching ECL
Eastern	626	290	December 2014
Central	408	186	August 2012
Western	Decanting	165	n/a

Concerns have been expressed over the effect of the neutralised acid mine drainage water on the Vaal River system. Dilution is currently required from the Vaal Dam to lower salinity levels in the river to a TDS (total dissolved solids) of 600 mg/ℓ to ensure the usability of the water to users downstream. The impact of the neutralised acid mine drainage on the quality of the Vaal is expected to be similar to discharges made during periods of active mining. However, the volume of water that will need to be released to dilute this water could place the system further in deficit and bring forward costly augmentation schemes. Full treatment and reuse of this water will have to be achieved by 2015 to avoid such a situation, said DWA Director: Water Resource Planning, Johan van Rooyen.

Meanwhile, DWA is in the process of appointing a service provider to assess medium- to long-term options of managing acid mine drainage on the Witwatersrand. The department is also increasing its number of monitoring sites in order to keep a close eye on the situation. ❑



Jo Burgess

A typical HDS plant.

The potential of SMALL HYDROPOWER PLANTS in South Africa

Kendal Power station is one of Eskom's coal-fired power stations in Mpumalanga. In recent times, 'cleaner' energies have stepped into the limelight as alternatives to meet rapidly growing demands for power.

Graeme Williams/www.mediaclubsouthafrica.co.za

Renewable energy in the form of hydropower has been cited as one sustainable way for South Africa to meet its future power needs. Petro Kotzé reports.

Renewable energy is the proverbial Cinderella of the energy sector. Overshadowed by coal and other fossil fuels, the possibilities of 'cleaner' energies have stepped into the limelight as alternatives to meet rapidly growing demands for power. Locally, South Africa's ratification of the Kyoto Protocol and government's approval of the White Paper on Renewable energy in November 2003 pushed renewable energy to the forefront. In the latter, a commitment was made to generate 10 000 GWh of power from renewable sources such as biomass, wind, solar, radiation and small-scale hydropower (SSHP) by 2013. Furthermore, South Africa's Integrated Resource Plan for the period 2010 to 2030 calls for the deployment of 17 800 MW of energy from renewable sources.

For some, SSHP specifically holds certain promise even though its contribution to the mentioned White Paper's target is estimated to amount to only 10%. Roughly defined as systems that generate 10 MW and less power, it is often subdivided into pico (generating up to 20 kW), micro (between 20 kW to 100 kW) and mini (100 kw to 1 MW range). It is tagged as a possible solution to some of the major challenges of the African energy solution, like rural electrification and additional capacity for national and local grids. Furthermore, SSHPs produce minimal quantities of carbon and other emissions during construction and operating life, while it is entirely non-consumptive of water. In reality, even though it never reached massive dissemination, South Africa already has a long history with SSHPs.

SMALL HYDROPOWER IN SOUTH AFRICA

Commissioned in 1895, Cape Town Municipality's first power station, and the country's first hydroelectric station was supplied with water from the Woodhead Reservoir on Table Mountain. With two 150 kW generators commissioned on the banks of the Molteno River, the dynamos of the Graaff Electric Lighting Works at Molteno reservoir in Oranjezicht could be driven either by steam or water power. By June 1896, the plant was run by water-power for 2 590 hours and by steam for 691 hours.

Two 6 kW hydroelectric generators were also in use at the Pilgrim's Rest gold mines in 1892, upgraded to 45 kW in 1894. In 1896, a hydro generating station was built at Brown's Hill using two Escher Wyss Girrard impulse turbines coupled to Siemens 160 kW alternators. Jubilee

Power Station was built downstream and an Escher Wyss Francis turbine and a Siemens 150 kVA alternator were installed. These sets were among the first three-phase alternators installed in the country and were used to power the first electric railway (excluding demonstration prototypes on the Witwatersrand in 1892). The railway transported ore to the reduction works over a 12 mile length of track using two 19 kW locomotives.

Bo Barta, author of the 2002 Baseline Study on Hydropower in South Africa (compiled for the Department of Energy) adds that SSHP power generation also played a significant role in the electrification of urban settlements situated along the eastern side of the Drakensberg Mountain range. He says that most of the SSHPs fell into disrepair after the establishment of the Electricity Supply Commission (now Eskom) in 1923 and the national grid. "Eskom could produce sustainable, bulk energy for relatively cheap," says Barta, "and the small schemes, which were relatively seasonal and unsustainable couldn't compete." As a result people started to switch from hydro to coal-based electricity.

Today there are still a number of SSHPs in operation, like the 2 MW Friedenheim Hydro supplying electricity to Nelspruit since 1988 and the 0,8 MW Bakenkop Hydro at Piet Retief (still in working order after more than 50 years). In total (excluding mines) there is an estimate 42 MW of power supplied by SSHPs in the country. Notable is Bethlehem Hydro, the first hydropower plant to be commissioned in South Africa since 1988. The 7 MW operation entails two plants, a 3 MW operation on the wall of the Sol Plaatje Dam, and a 4 MW run-of-river plant at Merino. It is managed by Independent Power Producer (IPP) NuPlanet and sells its electrical power and capacity under a long-term power purchase agreement (PPA).

According to the mentioned baseline study, there is still significant potential for SSHP development in South Africa, particularly in the Eastern Cape and KwaZulu-Natal. Barta maintains that South Africa's lack of water resources should not necessarily be seen as detrimental for this purpose. This is because hydropower can be derived not only from conventional sources, like rivers but also through more unconventional means; including tapping hydropower from existing infrastructures.

SMALL HYDRO POTENTIAL

Conventional small hydropower installations (run-of-river) often involve the construction of a weir and a simple intake structure with water transferred by a conduit or canal to a suitable point. Here it is dropped through a penstock to the turbine or generator. Also referred to as 'greenfield' hydropower sites, it typically needs to be situated on rivers with relatively constant flow and a suitable water drop, and is mostly suitable for mini and pico hydropower sites.

Barta estimates that there is also potential to blow life back into some of the existing SSHP installations scattered around the country, most notably at Belvedere (2 MW), Ceres (0,8 MW), Clanwilliam (1 MW), Kouga (5,3 MW), Ncora (2,4 MW) and Pongolapoort (2,7 MW) and "a few other smaller privately-owned installations".

More unconventional, mostly untapped potential includes South Africa's inter-basin transfer schemes, where SSHPs can be installed at locations where a gravity water supply scheme component is present. Suitable sites identified in Barta's updated 2010 feasibility report include the Breede/Berg, Lesotho Highlands Water Project, the Orange/Modder, Vaal/Crocodile, Thukela/Vaal and, 'most promising', the Orange/Fish Water Transfer Scheme. However, many systems including irrigation canals, environmental water releases (from large and medium dams) and bulk water supply pipelines can also be utilised, as the potential to generate power in these systems are currently going to waste.

Rand Water, for example, intends to install four SSHPs within their hydraulic network. According to Rand Water Senior Mechanical Engineer Iveen Mbhele, the water supply to turbines will be tapped from the existing water supply pipelines and fed back to the pipelines. These are currently at tender stage for the supply and installation of four hydropower plants, of which commissioning is expected to take place in 2014/2015. The combined capacity of the four plants will not be more than 16 MW and will be fed into the national power grid, although the main aim is to offset Rand Water's high energy bill, Mbhele says. He adds that the four sites are at Zoekfontein (about 8 km from Vaal

NuPlanet

Bethlehem Hydro's 3 MW operation on the wall of the Sol Plaatje Dam.

Dam), Klipfontein (Kempton Park area), Brakfontein (Midrand area) and Hartebeeshoek (Roslyn area), but there are more sites that will be explored in future.

For power giant Eskom, which has a total net capacity of almost 41 000 MW, but still needs to provide for South Africa's demand for power – expected to double by 2030 from present levels of around 37 000 MW, SSHPs might not be the answer. The potential can, however, be untapped by IPPs. According to Doug Kuni, Independent Power Producers' MD, IPPs are designed to be quick and nimble, and can be viable solution for power supply in a power-short country. Government has initiated a number of programmes aimed to support IPPS.

REGULATORY ENVIRONMENT

Following Cabinet's approval of the White Paper on Renewable Energy, the Department of Energy (DoE) proceeded with the development of its renewable energy strategy. The implementation plan of the various technologies was identified in a macroeconomic study undertaken in 2003. This study highlighted the technologies to be implemented first, based on the level of commercialisation of the technology and natural resource availability. Mini-hydroelectric schemes were included with these, along with sugarcane bagasse (the fibre that comes from crushing the sugar cane) for cogeneration, landfill gas extraction and commercial and domestic solar water heaters. The DoE also established the Renewable Energy Finance and Subsidy Office (REFSO), whose mandate includes the management of renewable energy subsidies, offering advice to developers and other stakeholders.

Regardless of government initiatives, few small hydropower developments are taking place. Kuni says that the challenges that IPPs face are "extreme" and largely structural and regulatory as they are highly dependent on government programmes. Obtaining the right permission and licensing agreements is a long and intricate process, often involving the Departments of Public Enterprise, Energy, Water Affairs, Eskom and the National Energy Regulator of South Africa (NERSA) and more. Furthermore, IPPs are largely dependent on Eskom, which controls who can access the grid. Anton-Louis Olivier, NuPlanet MD agrees that rules and regulations that IPPs have to adhere to are big factors. He adds that start-up funds are also often substantial, and there is thus huge risk involved.

Nevertheless, he is positive that the country's Integrated Resource Plan for 2010 to 2030 could be a massive injection for the renewable sector. The plan envisages renewables contributing 42%, or 17 800 MW of the country's new generation capacity by 2030. The DoE also allocated capacity across various renewable technologies, with 1 850 MW set aside for onshore wind, 200 MW for concentrating solar thermal, 1 450 MW for solar photovoltaic solutions, 12,5 MW for both biomass and biogas, 25 MW for landfill gas capacity, 75 MW for small hydro, and a further 100 MW for other small-scale IPP projects of less than 5 MW. Speaking on small hydro specifically, Olivier says that the generation of 75 MW would create hundreds of job opportunities, and be a huge financial injection into the sector.

The DoE has put out a tender for the procurement of the first 3 725 MW of renewable capacity by 2016, which is likely to attract local and international investment of between US$10 billion and US$12 billion. Potential bidders for the supply of the first 3 725 MW of renewable power, including onshore, concentrated solar, biomass and small hydro, had until 4 November to submit their bids for consideration. The preferred bidders were to be announced at the UN Climate Summit in Durban in November. Another positive development is a collaborative effort between the Department of Water Affairs (DWA), National Treasury, Eskom and the NWRI under coordination with the DoE. It entails the implementation of a pilot project for small hydropower generation at the Vaal Dam as well as the compilation of a list of 20 other possible sites earmarked for feasibility studies for small-scale hydropower plants. These sites are located within government infrastructure, but IPPs could be allowed access for hydropower development should the process be completed successfully.

Henriëtte Anderson, DWA Chief Director of Engineering Services, says that an initial screening process has commenced and will be completed in the near future. During the process, a hydropower engineer investigates all the sites for possible fatal flaws that IPPs may encounter should the sites be developed. These could include issues such as sustainability, affordability and technical, operational and financial risks. It is foreseen that the initiative will help create an enabling environment for IPPs to generate hydropower after a competitive tendering process has been followed. Anderson adds that it seems "very likely" that they will proceed with some of the sites. The way forward after the screening of these sites has been concluded will be determined by the National Treasury. ❑

People started to switch from hydro- to coal-based electricity after the establishment of Eskom. Today, remnants of the Graaff Electric Lighting Works are reminders of South Africa's history with small hydro power plants.

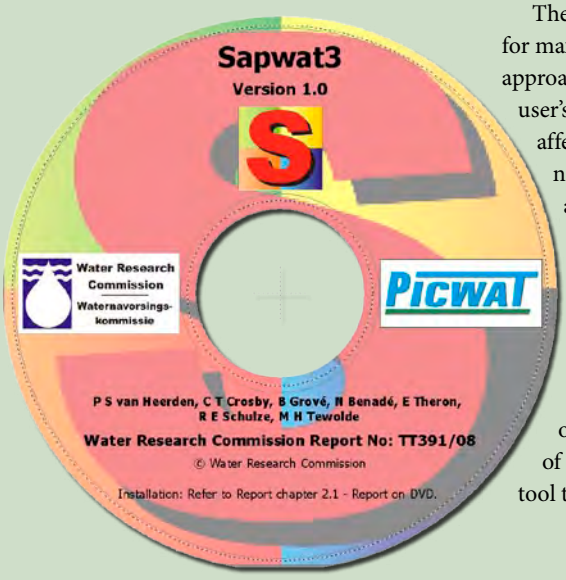
Bruce Sutherland, City of Cape Town

World Agri Award – SA does it again

South Africa has confirmed its status as a world leader in the drive towards irrigation water use efficiency following another international award.

This is after the International Committee on Irrigation and Drainage (ICID) awarded the country its fourth WatSave Award in the last five years during the 21st International Congress on Irrigation and Drainage held in Iran earlier this year. The accolade in the 'Innovative Management' category was awarded to the SAPWAT3 irrigation planning and management tool project managers Pieter van Heerden and Charles Crosby.

The original SAPWAT program was released in 1999. Since then the irrigation requirement and scheduling tool has gained general acceptance in South Africa. SAPWAT is not a crop growth model, but rather a planning and management tool relying heavily on an extensive South African climate and crop database. It is general in applicability in that the same procedure is used for vegetables and field crops, annual and perennial crops, as well as pasture and tree crops. With this program it is possible to simulate wide-bed planting, inter-cropping and different irrigation methods. In addition, the effect of soil water management options, such as deficit irrigation, can be evaluated.



Irrigation strategies can be varied to demonstrate the effect of different strategies on irrigation requirement. This allows the user to devise irrigation strategies aimed at maximising rainfall use efficiency and thus reducing irrigation water requirement. In addition, salinity stress and water stress situations can be imitated. All irrigation requirement estimates can be stored and revisited to determine what effect changes in irrigation water management, irrigation system and changes in planting dates could possibly have.

Since its introduction, SAPWAT has been applied by more than 300 users in 13 countries, including Angola, Mali, Mozambique, Swaziland, Niger, Namibia and Uzbekistan. Through the years the program has been continuously upgraded and improved, mainly with funding from the Water Research Commission. The latest version, SAPWAT3, was released in 2008. Today, SAPWAT3 is used by all irrigation designers in South Africa to optimise water use to its fullest extent.

The latest version is designed for maximum user interaction, an approach which contributes to the user's understanding of issues affecting good irrigation planning and management. This approach has the added benefit that SAPWAT3 serves as a good training and demonstration aid. Water savings have been achieved in a number of water management areas and, as a result, officials of the Department of Water Affairs are using the tool to quantify the optimum amount of water for a specific command area. The department has also endorsed SAPWAT3 as a tool to issue water use licenses for irrigation purposes.

Apart from the WatSave Award, the South African delegation walked away with several additional accolades from the ICID congress. WRC Director: Water Utilisation in Agriculture Dr Gerhard Backeberg was appointed Vice President while WRC Research Manager in the same department, Dr Andrew Sanewe, was appointed chair of the African Working Group. In addition, South Africa won the award for 'Best National Committee' for a third year in a row. This is a considerable achievement considering that ICID is represented by 110 member countries. ❑

Below: *Newly-elected Chair of the African Working Group, Dr Andrew Sanewe, new ICID Vice President Dr Gerhard Backeberg and Chair of the South African National Committee on Irrigation and Drainage (SANCID), Felix Reinders, at the ICID Congress in Iran.*

Bottom: *: SANCID Chair, Felix Reinders, receiving the WatSave Award from ICID President, Prof Chandra Madramootoo, on behalf of SAPWAT project leaders Pieter van Heerden and Charles Crosby.*

New technology helps scientists shed light on fish movement in estuaries

Scientists from the South African Institute for Aquatic Biodiversity (SAIAB) are employing the latest available technology to study the behaviour of fish in the Bushmans River Estuary, in the Eastern Cape. Lani van Vuuren reports.

Often dubbed the 'nurseries' of the aquatic environment, estuaries hold a special place in the ecosystem. While they are among the most productive habitats found in nature, they are also among the most threatened, and it is often the ignorance of the complex dynamics of these systems that lead to their mismanagement.

One way of improving our knowledge about estuaries is to study the movement of the fish within them, and this is exactly what SAIAB post-doctoral researcher Dr Alistair Becker is doing along with his colleagues at the Bushmans River Estuary. He notes the two main questions he hopes to gain insight on through this project: "Firstly, I want to know how artificial light (that which is emitted from brightly lit marinas, bridges, wharfts etc) impact on fish at night. Secondly, I am interested in how tides can influence the movements of large fish within estuaries. There is some evidence that fish will often migrate upstream with the incoming tide, then move back downstream on the outgoing tide, yet it is very difficult to actually quantify this behaviour."

The study of fish movements and behaviour within estuaries and coastal areas is still relatively new. The Bushmans River Estuary is an interesting system in that it is permanently open. "This estuary is the ideal system to test both questions as it is a tidal system with relatively high velocity currents, driven by tides," explains Dr Becker. "There is also a restaurant on the estuary with a floodlight which illuminates the water around the structure in a similar way to wharfs and marinas. We arranged to have this light switched on some nights, and off on others. This allowed us to address both questions simultaneously with simple experiments."

What makes SAIAB's research here so unusual is the technology being used – a Dual Frequency Identification Sonar (DIDSON) – basically an acoustic camera which acts as a very sophisticated fish finder and produces near-quality images from underwater using sound. As far as is known, SAIAB is the only institution in the country currently making use of this technology to study fish behaviour. The device used was brought over from Norway in collaboration with the Norwegian Institute for Nature Research. It was placed next to the channel in the lower reaches of the estuary.

"The DIDSON emits 96 beams of sound (up to 70 m long) through the water and form a high-resolution image from the sound that is bounced back. The sonar is capable of producing 12 images or 'frames' per second, which allows for the creation of free-flowing videos," explains Dr Becker. The images are so clear that the fins of fish can be seen. Because the technology can be used in both clear and turbid water, it offers significant advantages over conventional technologies to study

fish behaviour, such as underwater cameras or direct observations, which become impractical when it is dark or when the water is turbid – which is often the case with estuaries. The fish images are recorded continuously on a computer linked by a cable to the submerged device. The footage is the analysed manually at SAIAB headquarters using various measuring and counting techniques.

In a previous Bushmans River Estuary study which focused on the behaviour of fish in seagrass beds and how changing water levels influence their abundance, SAIAB scientists made use of regular underwater cameras. "Due to the turbidity this study was restricted to areas near the mouth where the water is clear," notes Dr Becker. The DIDSON was first tested last year on a project in the East Kleinemonde Estuary where scientists studied the movement of fish into very shallow littoral habitats at night time. They also looked at the distribution of small and large fish along the estuary.

The biggest surprise to date has been the observation of massive numbers of baitfish, which appear to move out from the shallow edges of the estuary into the deeper main channel during the slack tide period.

The project has not been without its challenges though. Since the Norwegian scientists were only in South Africa for 12 days, this meant very little time for fieldwork, and careful planning was necessary to avoid wasting valuable time spent in the estuary. As a result of the pre-planning, the team managed to collect a massive 260 hours of footage – more than enough to test their hypotheses. "The biggest problem turned out to be supplying the DIDSON with continuous power," says Dr Becker. "Without power the sonar will obviously not work. During our fieldwork period we had two electrical storms, which knocked out the mains power for hours, forcing us to use backup batteries and, once they ran out, to run a generator."

Despite the challenges experienced, the use of the technology in the Bushmans River Estuary is paying off, according to Dr Becker. "Browsing through the footage we collected shows huge numbers of fish swimming around at night time. These range in size from less than 10 cm to large individuals well over a metre long. This footage will certainly allow us to address the questions we have regarding estuarine fish, which simply could not have been answered using any other methods. We are only just beginning to see how useful this technology can be. It is simply a matter of combining an understanding of the capabilities of the DIDSON with novel questions and experiments."

While the footage is still being analysed some interesting patterns are already emerging. It appears that there are many more fish present at night when the floodlight was on, compared to nights when it was turned off. "This is what we anticipated, although we have been surprised at the numbers of fish milling around when the light was on," notes Dr Becker.

The biggest surprise to date, however, has been the observation of massive numbers of baitfish, which appear to move out from the shallow edges of the estuary into the deeper main channel during the slack tide period. "At first we thought we may have been looking at seagrass obscuring the view of the sonar, until we realised it was a mass of fish. It appears to be a common pattern and certainly something neither myself nor the other scientists ever thought to occur."

Dr Becker believes that this research will make an important contribution to our understanding of estuarine fish. "The light experiment will show how artificial lighting can impact on fish behaviour using a simple experimental approach, and I expect it will act as a stepping stone to more comprehensive studies. In turn, the tidal study will provide us with information regarding the movements of fish with tides, which will complement other detailed tagging and monitoring studies which focus on particular species. The end result will be a greater understanding of the ecology of estuarine fish that can be fed directly into the management of fish as well as developments which may impact on estuarine habitats." ❑

All photographs courtesy Alistair Becker

Below: *The Dual Frequency Identification Sonar or DIDSON was used for the first time in South Africa to track fish movement in the Kleinemonde Estuary.*
Below middle: *The DIDSON can provide a 'clear' picture of fish movement even in turbid water. It acts as a very sophisticated fish finder and produces near-quality images from underwater using sound.*
Bottom: *The Bushmans River Estuary.*

New tool to help fight war against ALIEN INVADERS

Three organisations have teamed up to curb the spread of alien invasive plants in the Kruger National Park. Article by Rob Taylor and Dr Dave Thompson.

Invasion biology has become a hugely important scientific field worldwide as invasive species increasingly threaten to decrease biodiversity and modify ecosystems. The same is true in South Africa, where plants establishing outside of their natural distribution ranges represent one of the major threats to ecosystems and their functions.

For these reasons, the South African Environmental Observation Network (SAEON) considers alien organisms – both plant and animal – to be among the most important agents of anthropogenic change.

Areas dedicated to the protection and conservation of natural ecosystems and biodiversity, such as the Kruger National Park, are particularly threatened by alien plants which establish along watercourses, 'escape' into the protected area from adjacent gardens and are inadvertently introduced through road hardening. It is therefore imperative that more be done to recognise and prevent the spread of alien plants in this, and other national parks.

SAEON's Ndlovu Node is collaborating with members of South African National Parks Scientific Services and the French Centre for International Cooperation in Agronomic Research for Development (CIRAD) in compiling a database of the 400 plus alien plant species – from notorious Category 1 invaders to ornamentals currently restricted to gardens – which are known to occur in the Kruger National Park. The outcomes of this collaboration will be detailed

"This 'one-stop' product will assist managers, conservationists, and technical crews in Kruger and beyond, to identify alien plants and will suggest appropriate methods for eradication *in situ*."

All photographs by Rob Taylor

Just five of the estimated 400 alien invasive plant species that have been identified in the Kruger National Park.

descriptions of as many of these alien plants (including their invasiveness, habitat, origin, vernacular names and documented control methods) as is possible, supported by clear photographs and illustrations of various diagnostic plant features.

INTERACTIVE IDENTIFICATION TOOL

Unique to this project will be the Phase 2 development of an interactive identification tool from the 400-odd species accounts. The tool technology (a multimedia approach to computer-aided identification) was developed by members of the CIRAD team and uses an identikit to reconstitute species identity. This process has already been used to produces similar resources for the weeds of the Indian Ocean islands and for other places such as Central Africa, Laos, Cambodia and New Caledonia.

The so-called Pl@nt-Inv Kruger collaboration is a further refinement and validation of this technology. Ultimately, the simple platform produced will guide users towards identifying an unknown alien plant through a series of step-wise choices and simple schematics concerning morphological, habit and habitat characteristics. Final identification is based on the similarity (expressed as a ranked percentage probability) of the unknown specimen to so-called 'type' specimen information database during Phase 1 of the project. Pictures and text can then be accessed to confirm the identity of the plant.

OPEN SOURCE AND USER FRIENDLY

In keeping with the mandates of SAEON, the Kruger National Park and CIRAD, the interactive identification tool-associated software and 'raw' database will be open source and freely available online

Above: *SAEON Technician Thembi Marshall examines an* Argemone mexicana *(Yellow-flowered Mexican poppy) flowering on the banks of the Letaba River. Several plant characteristics as well as the abundance and location are recorded for each species.*

Below: *A cleanly pressed* Senna pendula *(Easter cassia) specimen and herbarium information sheet. The project's specimen collection will be housed at Skukuza herbarium in the Kruger National Park.*

All photographs credit: Rob Taylor

to all interested parties and potential users. It is also planned for the application to be compatible with a range of mobile electronic storage devices, such as smart phones, PDAs and tablets, thus allowing for easy and convenient use under field conditions.

Furthermore, it will be linked to a Web-based collaborative platform where people can share information, knowledge and questions on invasive plants. This 'one-stop' product will assist managers, conservationists, and technical crews in Kruger and beyond, to identify alien plants and will suggest appropriate methods for eradication *in situ*.

ALIEN CONTROL IN OTHER VULNERABLE SYSTEMS

The Pl@nt-Inv Kruger project has the capacity to educate people on the ground regarding the full range of alien plants found in the savannas of north-eastern South Africa as well as stressing the very severe threat posed by these invaders. As a validation of a valuable technology, this collaboration will pave the way for similar alien awareness and control initiatives in other vulnerable systems (many of which are of interest to SAEON, such as grasslands and fynbos) and also in a range of sectors outside of conservation. The reference speciments of all the alien plant species included in the project database will be located in the Skukuza Biological Collection in the Kruger National Park.

Currently Phase 1 of the Pl@nt-Inv Kruger project, which is scheduled to last for 18 months, is underway at the SAEON Ndlovu Node. Two dedicated project technicians, Rob Taylor and Thembi Marshall, are being kept busy collecting reference specimens and photographs during field trips into the Kruger, and populating a database with the relevant supporting information sourced from printed and electronic sources.

In addition, these collecting trips – which include time spent in heavily impacted tourist camps and staff villages, along major rivers, and also in some wilderness areas – have extended the known distribution of specific alien plant species within the Kruger National Park and, in several cases, have turned up alien species previously not recorded in the park.

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Below: *An infestation of* Datura innoxia *(Downy thornapple) hand-pulled on the southern bank of the Limpopo River in northern Kruger National Park. An identification tool for this species and advice on its recommended method of eradication will be supported by the Pl@nt-Inv Kruger project.*

Authorities show commitment but Green Drops still elusive

Heidi Snyman

For the first time since the introduction of the Green Drop certification programme by the Department of Water Affairs (DWA) three years ago, all 821 municipal wastewater treatment works across the country have been assessed. Lani van Vuuren reports on the results of the latest Green Drop report.

South Africa has more than 800 wastewater treatment facilities dotting the national landscape managed by 156 municipalities and treating on average around 5 258 Mℓ/day of sewage. Of these plants, more than 70% are micro, small and medium-sized works.

The latest report of the Department of Water Affairs' (DWA's) Green Drop certification programme, published earlier this year, once again highlighted the challenges most municipalities face in terms of achieving excellence in sewage treatment and management. Only 40 sewage treatment works achieved Green Drop awards, with 20 of the previous 33 recipients 'falling off the wagon' and losing their Green Drop status. It must be noted, though, that Green Drop requirements become more stringent (and detailed) with every assessment cycle.

Still, the most encouraging result of this year's round of assessments is the fact that 100% of the country's municipal works participated, indicating at least a willingness by local and district authorities to start addressing the state of affairs of municipal wastewater treatment in South Africa. This is an increase of 83% of systems assessed (only 449 systems were assessed in 2009). This means that DWA now has a complete database of the exact strengths and gaps per municipality and per wastewater system from where gradual and sustainable improvement can be facilitated and measured on a continuous basis.

"We take cognisance of the fact that the improvement of wastewater services cannot be facilitated by means of regulation alone," said Minister of Water & Environmental Affairs Edna Molewa. "It is for this reason that DWA will go forward in its attempt to intensify its involvement in the multi-department sector support, and capacity building initiatives."

One of the biggest interventions to ensure that dilapidated infrastructure is improved would be the regional bulk infrastructure grant by government. Another would be

Tlokwe Municipality

Above: *Tlokwe Municipality was the only Green Drop achiever in the North West performance and the highest scoring municipality in the country. According to assessors the municipality's excellent performance was the result of premeditated and meticulous planning, implementation and preparation.*

the rollout of the accelerated community infrastructure programme that ensures the rectification of wastewater mechanical and civil infrastructure. "I have also called an infrastructure indaba with provincial stakeholders as well as water boards, and following this I have now instructed my department to draft a comprehensive investment network to address the critical challenges we are facing as a country due to the lack of sufficient water infrastructure," Molewa noted. She added that DWA would not shy away from intensifying conventional regulation in terms of issuing directives and following all possible legal avenues where it is found that commitment towards improvement is lacking.

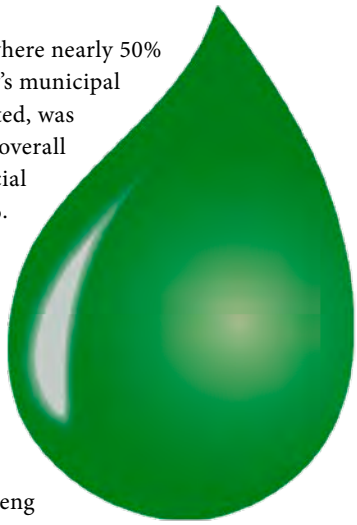
PROVINCIAL SUPERSTARS

Western Cape municipalities proved themselves to be the national superstars when it came to sewage treatment. The province achieved an overall score of 83,1% placing it firmly in the number one spot nationally. The Western Cape has 155 wastewater treatment plants of various sizes, of which a staggering 117 systems achieved scores of more than 50% (compared to 61 systems in 2009). The province earned almost half (19) of the total number of Green Drops in the country. A further 26 systems achieved 'good' scores of between 80% and 90%.

Even more surprising is the fact that the top performing municipality in the Western Cape is not a metro as one would expect, but rather the small Bitou Local Municipality, in Plettenberg Bay. The municipality scored 96,4% overall, achieving Green Drop status for both its sewage plants. The assessors were particularly impressed with the enthusiasm, dedication and eagerness to learn of the small wastewater operations and management team, and attributed the success of the local authority to its team 'praiseworthy commitment'. "Bitou serves as a benchmark to all the country's smaller municipalities that are endeavouring towards the same feat." The other Green Drop scorers were the City of Cape Town (11 Green Drop awards), Mossel Bay (two), with one Green Drop each for Overstrand, Witzenberg, Beaufort West and George.

"The province has been very successful in containing and turning around their risk position, without sliding into a declined risk space as evident with most other provinces," the assessors noted. Only five plants remain critical and are under regulatory surveillance. "The municipalities are commended for their individual contributions to ensure a remarkable turnaround in Green Drop performance."

Following shortly on the heels of the Western Cape are the municipalities of KwaZulu-Natal, who together managed a provincial Green Drop score of 82%. eThekwini Metro achieved the best provincial performance with a score of 90,6%. The municipality received nine of the eleven Green Drops awarded in the province, with Ilembe municipality snatching the other two. A total of 95 systems out of the 143 wastewater treatment plants assessed in the province achieved scores higher than 50%.



Gauteng, where nearly 50% of the country's municipal sewage is treated, was in third place overall with a provincial score of 78,8%. This province features some of the largest sewage treatment works in the country – 25 out of the 56 plants in Gauteng treat more than 25 Mℓ/day of sewage. Johannesburg Metro achieved the best provincial performance with a score of 90,5% and four Green Drop awards. The fifth award in the province went to the Dekama Wastewater Treatment Works in Ekurhuleni.

A worrying trend in Gauteng is the fact that 99% of the provincial sewage works' design capacity is already taken up by current operational flows, which average 2 579 Mℓ/day. However, the report points out that infrastructure is usually oversized by design, which allows for additional treatment capacity that can handle flows beyond design capacity without compromising the effluent quality. "Gauteng municipalities have some of the best wastewater practitioners in South Africa, and these plants

are managed to consistently produce high-quality effluent, where organic and hydraulic loads exceed the theoretical design capacities.

Only one system in Gauteng achieved less than 30%, with six systems scoring between 30% and 50%.

HOPEFUL IMPROVEMENT

There is a marked difference in scores between the top three performing provinces and the other provincial scores. Interestingly, however, a previous under-performer, the Eastern Cape, now managed a fourth place nationally with a score of 67,2%. The province produced three Green Drops (the first ever), with the assessment of all 123 sewage treatment systems proving a significant improvement over the mere five assessed in 2009. According to DWA, this at least showed the province's commitment to raising its service standard and performance.

The best performing municipality in the Eastern Cape was Buffalo City which managed a score of 86,7% along with two Green Drop awards. The other Green Drop in the province was awarded to Nelson Mandela Bay municipality. In total, 32 systems in the province scored more than 50%, and the assessors were left with the overall impression that municipalities in the province are moving towards improving the quality of their wastewater treatment.

In turn, the overall Green Drop score for Mpumalanga was 56%, with Mbombela municipality's Kingstonvale Wastewater Treatment Works managing the only Green Drop for the province. Of the 77 sewage treatment plants in the province, 31 obtained scores of more than 50%, 17 systems scored between 30% and 50% and 29 systems scored below 30%. The last figure was particularly disquieting to assessors. Apart from the high percentage of plants in this high-risk space, another worrying trend was the movement to employ treatment technologies that require higher skill and operational funds, which may not be sustainable in the long term.

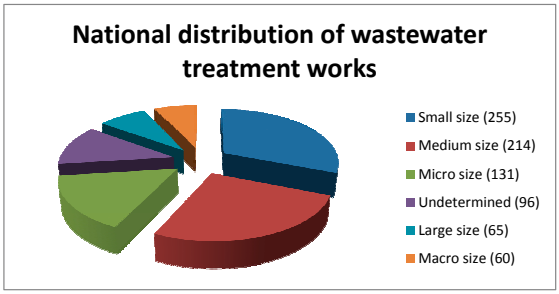
"A 100% of the country's municipal works participated, indicating at least a willingness by local and district authorities to start addressing the state of affairs of municipal wastewater treatment in South Africa."

The only other province who managed to achieve a pass score was North West, which scored 50%. Tlokwe Local Municipality, in Potchefstroom, obtained a score of 97% and a Green Drop for its wastewater treatment plant. Unfortunately the other municipal scores left a lot to be desired, with 83% of the province's 35 sewage treatment plants lying in the scoring bracket of less than 50%. Eight plants are currently considered in a critical state and have been placed under regulatory surveillance, with statistics indicating an overall digress in average performance.

WORRYING TRENDS

The assessors expressed serious concern over the bottom-three provinces, Free State, Limpopo and Northern Cape. 'Atrocious', 'disquieting', 'critical' and 'alarming' were but some of the words used to describe the state of wastewater treatment in these areas. Many of the municipalities in these provinces were assessed for the first time, however, the average scores did not paint a pretty picture of wastewater management in those regions and serious attention and resources are required to rectify the situation. There were no Green Drops awarded in any of these provinces. Close to a 100 municipal treatment plants are in a high-risk to critical state, posing serious risk to the environment and the populations they serve.

According to Molewa, DWA would now further investigate means of facilitating ways to improve wastewater treatment, especially in these critical areas. "We will seek to partner local government in this endeavour to ensure the sustainable enhancement of their business." The next Green Drop assessment will take place in June next year.



Source: Green Drop Report 2011

- *To view the Green Drop results for your area, Visit: http://www.dwa.gov.za/dir_ws/GDS/Default.aspx*

Provincial Green Drop performances

Province	Provincial Green Drop Score
Western Cape	83,1%
KwaZulu-Natal	82%
Gauteng	78,8%
Eastern Cape	67,2%
Mpumalanga	56%
North West	50%
Free State	31,5%
Limpopo	24%
Northern Cape	23%

Source: Green Drop Report 2011

THE GREEN DROP TOP TEN MUNICIPALITIES

- Tlokwe Local Municipality (97%)
- Bitou Local Municipality (96,4%)
- George Local Municipality (91%)
- eThekwini Metro (90,6%)
- City of Johannesburg (90,5%)
- Witzenburg Local Municipality (89,7%)
- Beaufort West Local Municipality (89,5%)
- Overstrand Local Municipality (88,8%)
- Mossel Bay Local Municipality (88,6%)
- City of Cape Town (86,8%)

Source: DWA

BLYDERIVIERSPOORT – dam of extraordinary beauty

Chris Snyman

The Blyderivierspoort Dam in Mpumalanga is situated in one of the most spectacular surroundings in South Africa. Lani van Vuuren takes a peek into the history of this dam.

A significant tributary of the Olifants River, the Blyde River rises on the western slopes of the Drakensberg, near Sabie in Mpumalanga. It flows northwards past the town of Pilgrim's Rest for more than 100 km through a region of extraordinary beauty along the eastern escarpment and through the Blyderivierspoort. Here the Blyde River cascades down a steep series of rapids to its lower reaches, where it again flows northwards to join the Olifants River north of Hoedspruit.

Modern irrigation started in the Lower Blyde River Valley in the late 1800s following the settlement of Voortrekkers in the area. However, Tsetse fly and malaria as well as skirmishes with local populations kept irrigation development to a minimum. Only after the introduction of DDT in the 1930s and 1940s did permanent crop farming take off. The first investigations towards the establishment of a large irrigation scheme were undertaken prior to the Second World War. In the subsequent Irrigation Department report published in 1936, Circle Engineer MA Kean proposed the construction of a dam on the farm *Rietvley 25* in the Lower Breede River Valley with a capacity of 333 million m^3.

The outbreak of the Second World War stemmed any further development, and it was only in 1948 that the Irrigation Department again investigated the possibility of establishing a dam and bulk irrigation infrastructure here. The only irrigation of consequence could be found on the farm *Moriah*, where an irrigation furrow taking water directly from the

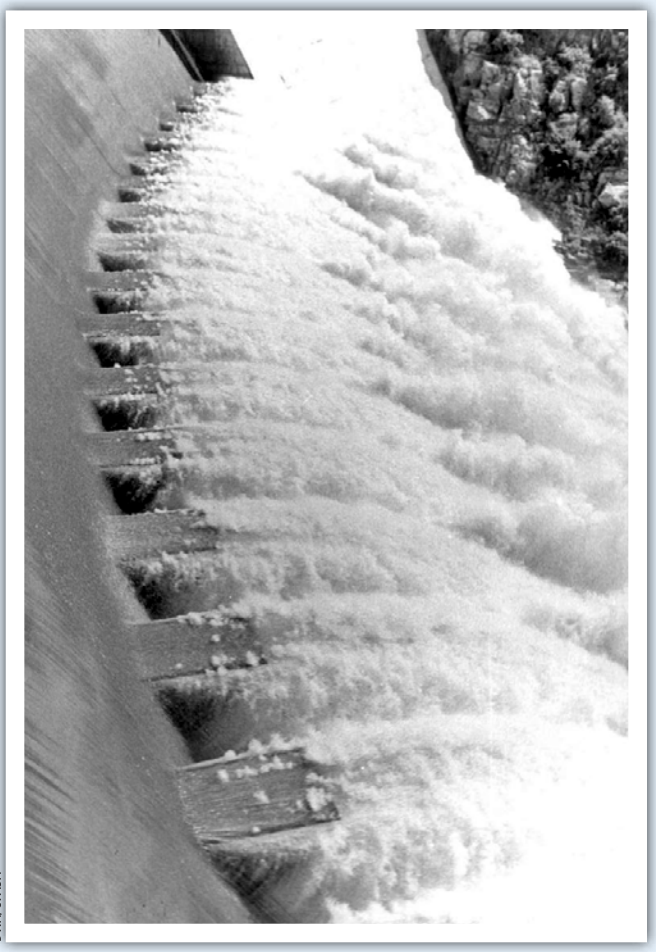
HISTORY IN THE MAKING

In 1972, history was made when the Department of Water Affairs' first female engineer to work on a construction site, A Mouton, joined the team at Blyderivierspoort Dam.

DWA

Left: *An artist's illustration of the Blyderivierpoort Dam made prior to its construction.*

Below: *A close-up of the energy dissipaters situated in the dam wall.*



DWA/eWISA

Blyde River had been established. At this stage there were still only around 200 whites living in the valley (the population of 5 000 black people were not considered), of whom only 31 were farm owners.

This proved not motivation enough to warrant such significant expenditure. The Irrigation Department was also demotivated by the results of soil studies, which indicated that soil conditions were mostly not conducive for irrigation. It was consequently decided that, until such time that the (white) farming community had increased considerably and had become experienced in local farming and irrigation methods, no large irrigation scheme would be contemplated by the government.

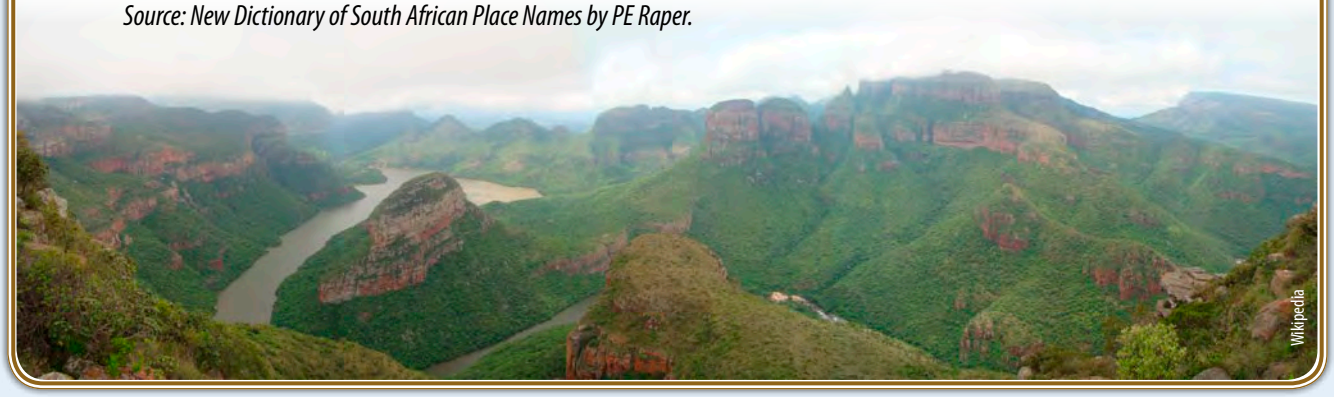
The Phalaborwa mining complex was established in the 1950s, and subsequently the Phalaborwa Barrage was constructed in 1966 to supplement water to the complex. The supply from this 235 m-long concrete structure was controlled by the Phalaborwa Water Board, which had the right to abstract 28 127 290 m^3/day from the Olifants River.

However, upstream developments, such as the raising of the Middelburg and Loskop dams later caused the water supply to the mines to fall short. This pushed the idea of a dam on the Blyde River back onto the table. The

ORIGIN OF THE NAME 'BLYDE'

The naming of the Blyde River is of Dutch origin meaning 'happy river'. It was so called because in 1844 Voortrekker leader Hendrik Potgieter and others returned safely from Delagoa Bay where they had gone in search of a harbour for trading to the rest of their party of trekkers who had considered them dead. While still under this misapprehension they had named the river, where they had been encamped, Treurrivier, or 'river of weeping'.

Source: New Dictionary of South African Place Names by PE Raper.



Wikipedia

Chris Snyman

Chris Kirchhoff/Media Club South Africa

1969 White Paper suggested the construction of a dam on the farm *Blyde River Poort* in the district of Pilgrim's Rest with the purpose of stabilising the supply of water to irrigators in the Blyde River irrigation district while, at the same time, increasing the quantity of water available to the Phalaborwa Water Board.

The proposal was approved by Parliament and preliminary work on the dam site just below the confluence of the Blyde and Ohrigstad rivers started in April 1970 with the establishment of roads and houses by the Department of Water Affairs. Excavation blasting started a year later in April 1971. By June, construction of the cofferdam started. This was completed in April 1972, despite setbacks caused by unprecedented floods (1 200 m^3/s). In August 1972, the first concrete was placed via cableway, and two years later the river diversion gap through the wall was closed and the crusher removed out of the reservoir basin.

Originally it was thought that a double curvature dam could be constructed, but later this was changed to a concrete gravity arch. This was decided as the most suitable type of structure because the massive but weathered and jointed condition of the foundation necessitated a good distribution of load over a wide area. The maximum height of the dam is 71 m, with a crest length of 240 m and a maximum wall thickness of 30 m. Blyderivierspoort Dam has a maximum capacity of 54 million m^3.

The availability of alluvial deposits allowed the crusher to be located inside the dam basin, thus avoiding unnecessary scarring of the natural area. An aerial ropeway transported the aggregate from the crusher to the batching plant. Aggregate was stockpiled in the works area to facilitate early withdrawal of the crusher from the basin. The batching plant comprised aggregate bins into which the ropeway buckets discharged their loads, recovery tunnel and conveyor belts leading up to the top of the 30 m-high batching and mixing tower. The dam was completed in 1975, and spilled for the first time a year later. ❑

Top: *The Blyde River rises on the western slopes of the Drakensberg, near Sabie in Mpumalanga.*

Above: *A spilling Blyderivierspoort Dam. The dam is 71 m high, with a crest length of 240 m.*

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Olifants-Doorn – A class act

Lani van Vuuren

The decision process on possible future usage of significant water resources in the Olifants/Doorn Water Management Area is drawing to a close. Article by Petro Kotzé.

The Olifants/Doorn Water Management Area (WMA), comprising the Olifants, Doring, Sandveld, Kouebokkeveld and Knersvlake sub-areas, is special both because of its unique ecology and the range of industry and communities dependent on it. The area also serves as the first WMA that will be able to pick the proverbial fruit of the current Water Resource Classification process, a long-outstanding imperative of the National Water Act of 1998.

When the process is completed, a management framework describing the extent to which every wetland, river, lake and aquifer in the area can be used, as well as the level of protection it will be afforded, will be in place. Referred to as the resource's 'management class' it has considerable economic, social and ecological implications, as it clearly prescribes what the resource's ideal condition is, and the amount of water that industry, agriculture or any other user will be legally allowed to withdraw from it.

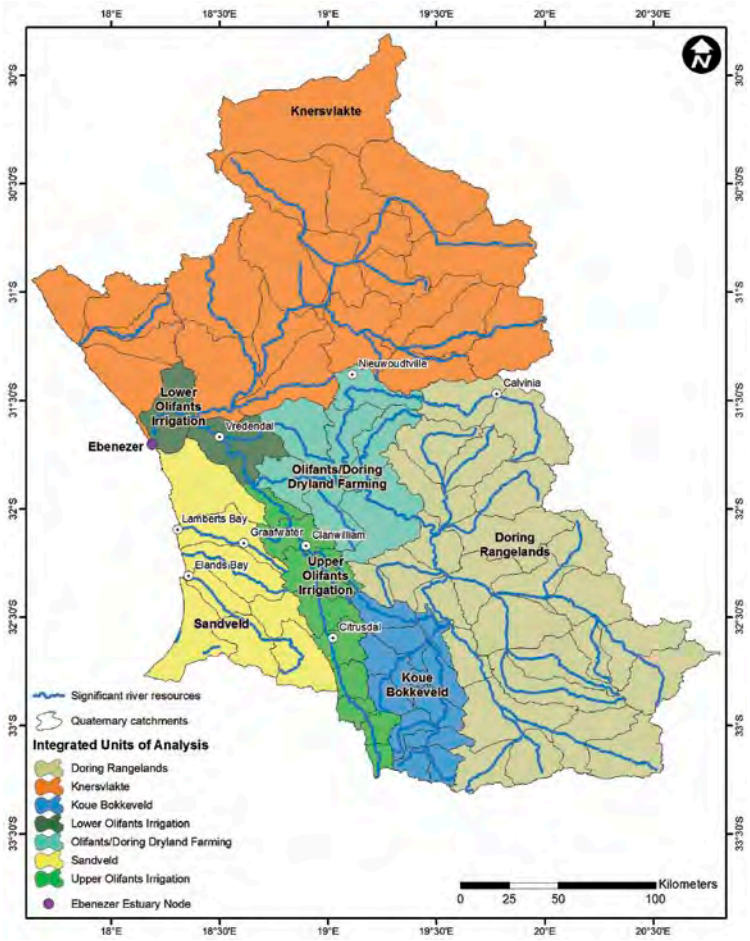
The purpose of classification is to ensure long-term sustainable use of water resources by balancing the need for protection against the need for use, says Department of Water Affairs (DWA) Director of Water Resource Classification, Shane Naidoo. "The determination

of a class brings regulatory certainty and facilitates decision-making by providing a framework in which goals (commonly referred to as Resource Quality Objectives) can be set to measure regulatory performance and compliance of water quality, quantity, habitat and biota requirements of a water resource," she adds. Management classes will be determined for each sub-catchment or, integrated unit of analysis (IUA), within the specific WMA. IUAs are defined in terms of use, and contain a number of aquatic ecosystems. According to Naidoo, "in addition to achieving ecological sustainability of the water resources, the classification process allows for due consideration of social and economic needs of competing interests by all who rely on the water resources."

Due to the accelerated rate of development and demand in South Africa, coupled with changing weather patterns, the management class for every significant water resource in the country will eventually be set. The Olifants/Doorn process will, however, be the first to be completed, as soon as April 2012, and will serve as an example of how the procedure can be applied to other catchments. Indeed, the classification process in this part of the country is seen as a priority. "Even though it is not highly industrialised in comparison to catchments like the Vaal or Olifants," says Naidoo, "the DWA wants to proactively prevent any further degradation of the system."

Right: *Integrated Units of Analysis of the Olifants/Doorn water management area.*

Below: *The Olifants River estuary is one of only three permanently open estuaries on the west coast and is a critical habitat to many estuarine-associated fish species.*



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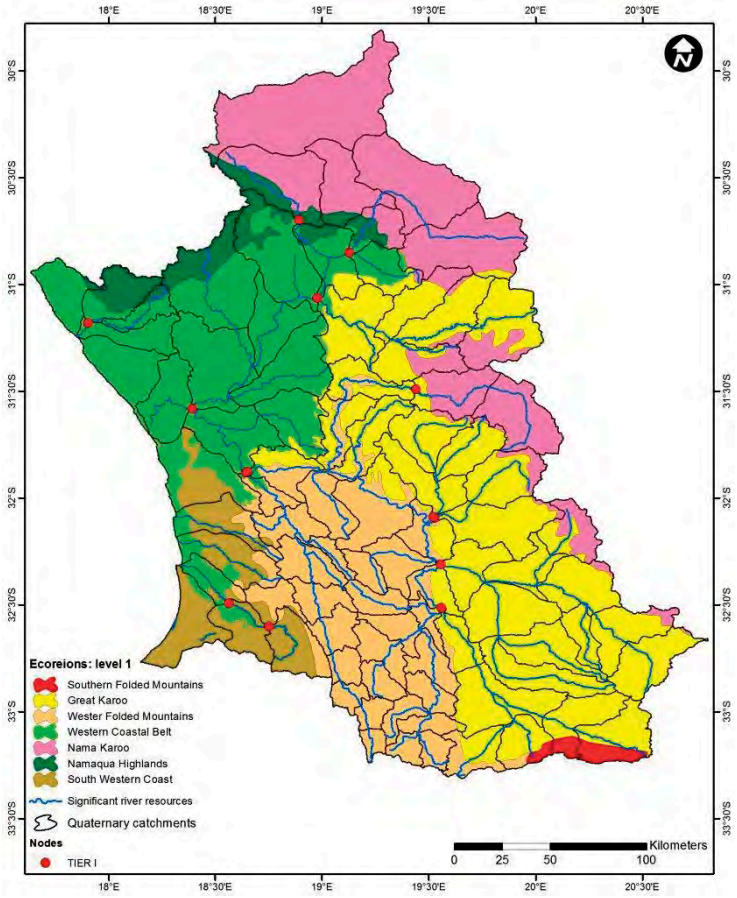


Left: *Ecoregions and quaternary catchments in the Olifants/Doorn WMA.*

Below: *Vanrhynsdorp is one of the small towns dotted across the Olifants/Doorn water management area.*

THE SEVEN STEP CLASSIFICATION

In order to determine a suitable management class for the relevant water resources the following seven steps are followed:

- Delineate the units of analysis and describe status quo of the water resource
- Link the value and condition of the resource
- Quantify ecological water requirements and changes in non-water quality ecosystem goods, services and attributes
- Determine an ecologically sustainable base configuration scenario and establish starter configuration scenarios.
- Evaluate scenarios within the integrated water resource management process.
- Evaluate the scenarios with stakeholders
- Gazette the class configuration

A CLOSER LOOK AT THE OLIFANTS/DOORN WMA

Stretched along the west-coast of South Africa, the main river in this WMA is the Olifants River that, together with one of the major tributaries, the Doring, flow strongly during the winter months. The Doring is especially unique, as it is one of the country's remaining 62 free-flowing rivers, meaning, undammed rivers that flow undisturbed from their source to their confluence with another river or the sea. Of these, it is one of the 19 flagship-rivers prioritised for conservation. The other major tributary in the catchment, the Sout River, only flows very occasionally.

There are a number of unique biological features scattered throughout the catchment. Numerous indigenous fish species occur only in the Olifants River catchment, particularly the Doring River, and nowhere else.

The Olifants estuary is also one of only three permanently open estuaries on the west coast and is a critical habitat to many estuarine-associated fish species. Furthermore, the RAMSAR site, Verlorenvlei, is situated here, together with the vulnerable coastal wetlands of the Sandveld. Here, the Langvlei and Jakkals Rivers flow westwards towards the Atlantic.

Land use in the eastern and northern parts of the catchment consists mainly of livestock farming, but small areas are also being used for dryland farming. Citrus, grapes, deciduous fruit and potato farming is intensive in the south-west. In general, urban and rural development in this part of the country is small, and includes towns like Citrusdal, Clanwilliam, Vredendal, Vanrhynsdorp, Nieuwoudtville, Calvinia and Lamberts Bay.

Project Manager Tovhowani Nyamande explains that while the Olifants River still boasts good quality water and flow upstream from Citrusdal, the lower Olifants is stressed in terms of both water flow and quality. This is mostly due to agricultural run-off, she says, as there are many irrigated farmlands along its banks. Indeed, water abstraction from the surface and groundwater throughout the WMA has modified flow and is predominantly problematic during the dry, summer months. The Doring River tributaries and Sandveld Rivers

Petro Kotzé

Petro Kotzé

The Nieuwoudtville Waterfall in the Doring River is about 5 km outside the town on the way to Loeriesfontein.

are particularly affected. Notably, modified flows have reduced habitat integrity and as a result, the ecological goods and services provided by these rivers.

In 2010, the Water Resource Classification Process (WRCP) for the WMA got underway, and Blue Science Consulting was appointed to assist DWA to complete the process. By this stage, many of the environmental water requirements of water resources in the specific catchment were already determined.

The classification process is both a consultative and a scenario-based approach. Water use within the WMA is incorporated at a number of stages during the assessment. For example, the socio-economic benefits of a water resource are taken into consideration when determining the IUA class. Operational constraints and catchment requirements, again, are incorporated into yield scenario modelling while the impact of the water use on the ecology is considered when determining management class.

Furthermore, the final classification incorporates results from other biodiversity studies and initiatives, most notably, National Freshwater Ecosystem Priority Areas (NFEPAS). In a nutshell, this programme identifies freshwater ecosystems that should be priority conservation areas.

An IUA will eventually be classified as one of three management classes. Class I, 'minimally used', implies that the water resources must be altered only minimally from its pre-development condition. Class II, 'moderately used,' results in an overall water resource condition that is moderately altered from its pre-developed condition. Class III, 'heavily used,' allows for the resource to be significantly altered from its pre-development condition. If a resource is, for example, Class I, the extent of water use will be minimal compared to a class III resource, says Naidoo.

Nyamande explains that decisions regarding trade-offs between users is guided by the principles of sustainability, which rests on a balance between social, economic and ecological needs. When deciding on a class, the socio-economic impact on the catchment needs to be established. The trade-offs are largely influenced by a robust stakeholder engagement process in the area where classification is taking place.

The classification process initially generates different scenarios for each quaternary catchment within an IUA and the anticipated social, ecological and economic consequences should a proposed MC be afforded. This approach enables the DWA to make management decisions based on the different development alternatives and the anticipated consequences.

PRACTICAL IMPLICATIONS

In the Olifants/Doorn WMA, five different scenarios were tested to ascertain if it will allow the various Environmental Water Requirements (EWRs) to be met. The scenarios would, for example, take the effect of a Class III classification upstream in the WMA on the downstream quaternary catchments into consideration. The Project Team found that if they would allow for maximum overall water use, there would be a water deficit in future (shortages to comply with the ecological Reserve). Another recommended scenario took the present Ecological status (PES, as recently updated in 2011) as an indication of maximum protection. The assessment of this scenario indicated a deficit created by the insufficient supply from the upstream catchments. However, the answer seems to lie in balancing the protection requirements against that of use by combing conservation targets (as defined by the NFEPAs) with use requirements.

For example, in order to evaluate the ecological implications of the

In order to capacitate community members and other stakeholders, they are brought in from step one. A number of consultative meetings have taken place in the Olifants/Doorn WMA.

recommended scenarios, the flow in all of the IUAs tributaries could be afforded a Class I status, while the flow in the main stems are afforded Class III status. In this way, if the tributaries are kept healthy they can replenish the main stems. In theory, classes afforded to quaternary catchments should thus contribute to the overall management class of the IUA.

The process is not without its difficulties. In order to capacitate community members and other stakeholders, they are brought in from step one, says Naidoo. She explains that the idea is that they need to be in a position to understand the implications of the management class, and comment when the proposed classes are published in the Government Gazette. This can be challenging. "We have to ensure that we convey the technical information in a clear and logical manner at every public meeting." Nyamande adds that people have raised many concerns, for example, if they will have assurance of supply after the classification. A large group of people were also concerned about the possible implications the process would have on the raising of the Clanwilliam Dam, which they see as addressing many of the flow-related issues in the area. In this instance, the raising of the Clanwilliam Dam will proceed as intended by the DWA with the ecological water requirements and management imperatives as determined by the preliminary Comprehensive Reserve of 2008. The classification process incorporated these requirements during the socio-economic and ecological assessment undertaken for the WMA.

Another concern is data variability. "Some IUAs are data rich, while others aren't," says Naidoo. "You have to ensure that the process is based on data that is readily acceptable and can be defended should there be a query." Lastly, the relevant parties need to ensure that the class is implemented once it has been published in the Gazette. Naidoo adds that the management class needs to fit into regulatory mechanisms in order for the DWA to give effect to it through the issuing of water licences. "We also have to ensure that discharge standards and limits speak to Resource Quality Objectives", she adds. Furthermore, they need to ensure that monitoring systems are in place to ensure that these objectives are being achieved.

Regardless of the hurdles that the team have to overcome, the project is more than well on its way to completion. The recommended scenario report was already presented at a "lively" stakeholder meeting at the beginning of October, setting the trend for more efficient water resources management throughout the whole country. ❑

The dry bed of the Oorlogskloof River showcases the area. The river originates from the Roggeveld Mountains near Calvinia.

Petro Kotzé

REGULATORY ENVIRONMENT OF MANAGEMENT CLASSES

Chapter 3 of the National Water Act provides for the protection of water resources through the implementation of resource directed measures which includes the classification of water resources, setting the Reserve and Resource Quality Objectives. These elements together are intended to ensure comprehensive protection of all water resources.

The classification of water resources in terms of the Water Resource Classification system (WRCS), published in September 2010 is the responsibility of the DWA's Chief Directorate: Resource Directed Measures. The purpose is to ensure that a balance is sought between the need to protect and sustain water resources on one hand and the need to develop and use them on the other.

The WRCS is a set of guidelines and procedures for determining the desired characteristics of a water resource, and is represented by a management class. The management class outlines those attributes that the DWA and society require of different water resources.

The classification process that forms part of the WRCS is consultative development process to classify water resources in such a way that it will facilitate a balance between protection and use of the nation's water resources. In particular, the classification process and the catchment management strategy (CMS) are interactive, as the proposed management class will have significant implications for the allocation schedule. The WRCS is thus an integral component of the integrated water resource management environment. The outcome of the classification process will be the minister's approval of the management class for every significant water resource, and it will be binding on all authorities or institutions when exercising any power, or performing any duty under the National Water Act.

Irrigation water use efficiency – It is all about balance

Following nearly a decade of extensive research the Water Research Commission (WRC) has published comprehensive guidelines towards improved efficiencies in the irrigation sector. Compiled by Lani van Vuuren.

The water requirements of irrigated agriculture in South Africa are estimated at 56% of the total annual surface- and groundwater requirements in South Africa. Although the contribution of irrigation to total agricultural production varies according to crop type, most of this water is used for commercial food production in response to consumer demand. With increasing water demand from the domestic, mining and industrial sectors due to urbanisation and higher standards of living, more pressure is being placed on agricultural water users to reduce consumption and so increase the amount of water available for other uses. The implication is that more productive water use in future is essential.

According to Dr Gerhard Backeberg, Director: Water Utilisation in Agriculture at the WRC, water users must understand the economic value and opportunity cost of water as a scarce resource and respond to incentives to use less water, which could then reduce the demand for sources in a river catchment. "For sustainable economic growth and development, the competitiveness of irrigated agriculture will continuously have to improve. This can be achieved through multifactor productivity growth. It requires that more food is produced through higher efficiency and without the use of additional inputs, including that of water. The challenge for profitable farming is finding innovative ways of improving management, technological progress and more efficient resource allocation."

In addition to water scarcity, energy and operating costs affects water management and will do so increasingly in future. Energy prices are rising, pushing up the costs of pumping water, applying fertilisers and transporting products. This will have implications for the lawful access to existing water allocations and use for irrigation. "In order to make best use of available water and energy, it is imperative that we develop and manage irrigation water supply and application systems with demand in mind, so that we minimise our water footprint – to determine how little we can demand

from the water source rather than how much we can supply," explains Dr Backeberg.

BALANCED APPROACH

The WRC already recognised in 2003 that the efficient use of water by the irrigation sector will become increasingly important in the future. For this reason the Commission launched a major project to investigate and formulate guidelines to improve the management and use of water by irrigated agriculture in South Africa.

The resultant publication, *Standards and Guidelines for Improved Efficiency of Irrigation Water Use from Dam Wall Release to Root Zone Application*, introduces a relatively new concept, namely the water balance approach, for achieving the necessary efficiencies in irrigation. Project leader Felix Reinders, Programme Manager: Agricultural Water Resources & Conservation at the Agricultural Research Council Institute for Agricultural Engineering, explains: "The purpose of an irrigation system is to apply the desired amount of water, at the correct application rate and uniformly to the whole field, at the right time, with the least amount of losses and as economically as possible. Optimised irrigation water supply is aimed at maximising the component of water that is used beneficially (i.e. used for its intended purpose such as crop transpiration) and that is recoverable (i.e. drainage water), while reducing non-beneficial uses (e.g. evaporation) and non-recoverable fractions (e.g. water lost to saline groundwater aquifers)."

The guidelines will assist both water users and authorities to obtain a better understanding of how irrigation water management can be improved, thereby building human capacity so that targeted investments can be made with fewer social and environmental costs. Various lessons learnt, best practices and technologies are introduced and illustrated as developed and tested through extensive fieldwork undertaken at irrigation schemes across the country.

OPTIMISING DESIGN AND MANAGEMENT

In order to apply the water balance framework to irrigation areas, typical water infrastructure system components are defined wherein different scenarios may occur. In South Africa, most irrigation areas consist of a dam or weir in a river from which water is released for the users to abstract, either directly from the river or, in some cases, via a canal.

"For sustainable economic growth and development, the competitiveness of irrigated agriculture will continuously have to improve."

Water users can also abstract water directly from a shared source, such as a river or dam, or even a groundwater aquifer. Once the water enters the farm, it can either contribute to storage change (in farm dams), enter an on-farm water distribution system or be directly applied to the crop with a specific type of irrigation system.

When assessing the performance of the whole supply and application

CHARACTERISTICS OF AN EFFICIENT IN-FIELD IRRIGATION SYSTEM

- The system is planned to take the natural resources available in the field, and the management requirements of the irrigator into account.
- The system is designed according to sound design principles, based on limiting discharge variation and energy requirements in the field.
- The system consists of quality components manufactured to a high standard with low coefficients of variation and low energy requirements.
- The system is operated according to the design specifications and site-specfic irrigation water requirements of the crop.
- The system is maintained according to the equipment manufacturers' and/or irrigation designer's recommendations.
- The system is regularly evaluated to assess the level of performance and to detect problems as early as possible.

Irrigation water is sourced in a variety of ways, including direct river abstraction.

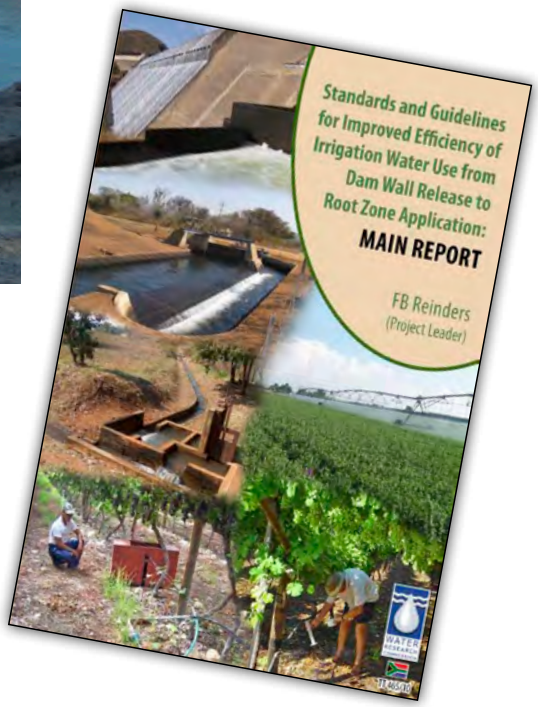
system (from the river to the field) it is important to recognise the purpose of the different components, so that optimisation can be done effectively, notes Reinders. "Optimisation of the performance of any component of these systems furthermore requires careful consideration of the implications of decisions made during both development (planning and design) and management (operations and maintenance) of the component. Every decision we make when developing and managing water supply and application systems has an effect on the water and energy demand of the system."

The guidelines consist of four modules. Each module is a stand-alone unit with its own table of contents, introduction and conclusion:

- **Module 1** (Fundamental concepts) introduces the concept of optimised water use, irrigation system performance and the water balance. It also touches on lawfulness of water use, demand management and appropriate technologies.
- **Module 2** (In-field irrigation systems) addresses the water balance approach at field level, and describes how each decision made during the planning, design and management of irrigation systems influences the amount of water required to irrigate the crop successfully.
- **Module 3** (On-farm conveyance systems) addresses the water balance approach at farm level, and describes how the on-farm distribution system should be planned, designed and managed to optimise water and energy requirements.
- **Module 4** (Irrigation schemes) introduces the water balance approach at irrigation scheme level, and describes how available technologies (e.g. SAPWAT, WAS, iScheme) and water measuring devices can be used to ensure greater reliability of supply to all water users on a scheme.

Higher yields, greater water productivity and reduced input costs are only some of the benefits of good irrigation management practice using the water balance approach. It is hoped that the WRC guidelines will go a long way to addressing water use efficiency in the irrigation sector in South Africa.

To order the reports, *Standards and Guidelines for Improved Efficiency of Irrigation Water Use from Dam Wall Release to Root Zone Applications* [Main Report No: **TT 465/10**; Guidelines Report No: **TT 466/10**; Supplementary Report No: **TT 467/10**] contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za, or Visit: www.wrc.org.za



WATER BALANCE GLOSSARY

Beneficial consumption: The water evaporated or transpired for the intended purpose, e.g. crop transpiration.

Non-beneficial consumption: Water evaporated or transpired for purposes other than the intended, e.g. evaporation from dams and canal structures.

Recoverable fraction: Water that can be captured and re-used, e.g. drainage water from irrigation fields.

Non-recoverable fraction: Water that is lost to further use, e.g. flows to saline groundwater aquifers.

INLAND FISHERIES – A vital rural food source

A recent study by the Water Research Commission (WRC) has confirmed the importance of inland fisheries as a food source of rural communities. Article by Bruce Ellender.

South Africa is a water scarce country and consequently, approximately 3 000 impoundments have been constructed to supplement irrigation, hydro-electricity and urban water supplies. Historically these impoundments also fulfilled a number of secondary roles, predominantly recreational, such as boating, water skiing, sailing and angling.

From a fisheries perspective, the potential of these impoundments was noted early in the twentieth century, and many were viewed as ideal for the stocking of alien and indigenous fish species for both recreational angling and for commercial harvest. To date, commercial fishing has had limited success on a long-term basis, and the fish resources in impoundments are commonly thought to be predominantly used by recreational anglers and their contribution to near-shore communities is poorly understood.

Inland water bodies are increasingly being viewed as a source of food and income opportunities in a time when food security and poverty alleviation are a major priority in South Africa. This coupled with the current economic climate worldwide, makes the development of inland fisheries an attractive option. Recently, the Department of Agriculture became the Department of Agriculture Forestry and Fisheries, resulting in an increased interest to develop inland fisheries.

This interest has also been taken up by the WRC who has solicited a research project to study the development and sustainable use of storage dams for inland fisheries, with a specific focus on rural livelihoods. In essence, the purpose of this baseline survey is to generate the knowledge that would inform government (and relevant stakeholders) on the potential of inland fisheries; the challenges and bottlenecks in developing them and to develop a road map on how to realise this potential.

Pertinent questions to consider before development are: who uses the impoundment, and how do these users benefit from it and how can negative impacts of the development be minimised to create a win-win

A Lake Gariep Subsistence angler with a nice sized common carp, the predominant species in anglers catches.

Dr O Weyl

M. Meadows

Above: *The Oviston settlement on the Lake Gariep shoreline.*

Below: *Subsistence anglers fishing on an island in the Oviston/ Venterstad region of Lake Gariep.*

situation. Although this may be the case, until a recent National Research Foundation-funded research on Lake Gariep, no recent information existed on the fisheries utilisation patterns of a South African impoundment.

Lake Gariep, South Africa's largest impoundment was chosen as a case study to investigate user group dynamics and the utilisation trends of an inland water body. The principal aim of the study was firstly to identify the different user groups (recreational, subsistence, commercial) participating in the fishery, secondly to quantify the catches from the fishery for each sector, and lastly to try and quantify what role this catch plays in the lives of those who are using the resource. This article is essentially a synthesis of three peer-reviewed scientific publications on the Lake Gariep fishery (see references elsewhere).

Two user groups were identified from the Lake Gariep fishery, namely subsistence and recreational anglers. Subsistence fishers are individuals who live on or near the lake, use basic transport methods to access the lake (walk, bicycle, and lift), predominantly use artisanal type gear (handlines) and the primary motivation to fish is as a source of food. For the subsistence fisher, the fish may also be a primary or supplementary source of income.

Recreational anglers, on the other hand, utilise the resource primarily for leisure purposes but may sell some of their catch. They access the resource by vehicle and sometimes lift; they have permanent employment, use high-tech gear, and may consume or sell a portion of their catch. The demographic make-up of the lake Gariep fishery is heterogeneous, although the subsistence fishery is dominated by coloured users with a small proportion made up of black Africans while the recreation fishery is dominated by white individuals and a small amount of black Africans.

This is in contrast to the demographics of the surrounding communities where black Africans are the dominant race. This disparity between user group and local demographics is not surprising, as there are few large natural inland waters where fisheries could have developed in the past. It is only more recently through dam construction that many inland water bodies have been established.

Total annual yield from Lake Gariep is approximately 78,5 t per year. Greater than 75% of the catch consists of common carp, which is an alien invasive fish and at current harvest levels, the fishery can be considered sustainable. Subsistence fishers are the dominant user group on the lake constituting 61% of anglers and the recreational anglers the remaining 39%. This translates in a subsistence yield for the lake of approximately 43,5 t and the recreational yield 27,5 t with catches from angling competitions contributing the remaining 7,5 t.

M. Meadows

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The Lake Gariep subsistence fishery is estimated to have 448 participants. This equates to 96 kg/angler/year, which is a fairly large injection of protein into the local communities. A household survey of the lakeshore communities also indicated that reliance on the fish as an easily accessible food and income resource is high. Unemployment rates are high and 85% of people rely on some sort of social grant for income. Lake Gariep provides a vital alternate source of food and income for the lakeshore communities. This is clearly evident as 95% of households consume fish weekly and 57% of households define themselves as 'fishing households'.

Considering these findings, the development of impoundments is therefore not just a matter of implementing a fishery on an untapped resource. South African inland fisheries are more complex than originally thought. Taking into account the reliance of the local communities on Lake Gariep as a resource, the implementation of fisheries development in any form on the lake will impact the local communities.

Right: *Lake Gariep was completed in 1970 to supplement urban and agricultural water demands, and provide hydroelectricity.*

Bottom right: *A typical Lake Gariep recreational angler on the Lake Gariep shoreline.*

Dr O Weyl

In the Lake Gariep situation, an implemented commercial fishery would most likely not provide 448 people with a livelihood, as subsistence angling currently does. Even if a fishery were to develop, the injection of protein would also not be into the local communities as fish would rather be supplied to larger markets further afield. This, coupled with a probable clash with the existent recreational sector, make developing fisheries on Lake Gariep complicated, and most likely unfavourable. The growth and expansion of inland fisheries will therefore require the development of management plans. These should be based on sound knowledge of the social dynamics of the resource users.

In conclusion, this inland fishery contributes significantly to the livelihoods of the rural poor who use the lake on a subsistence basis and that recreational-angler based tourism may contribute to increased income and employment opportunities through related service industries. The Lake Gariep fishery contributes a major source of protein and income to the lakeshore communities, as well as supporting a fairly large recreational angling sector. Perhaps the continued expansion of inland fisheries relies on better understanding the multiple needs that fisheries are able to satisfy rather than concentrating on a specific role that they may fulfil, such as economic gain. ❑

WRC – 40 years of serving South Africa

The Water Research Commission recently celebrated 40 years of service to South Africa's water sector by hosting a technical conference at Emperor's Palace. The conference, which was held over two days, brought together more than 400 delegates from the entire water spectrum, from researchers to scientists to representatives from government, industry and non-governmental organisations. A total of 125 eminent scientists and subject experts presented on progress and knowledge gaps under various themes . A special publication, *WRC – 40 Years of Excellence* – was also launched.

Without the leadership of the WRC and the contribution of the country's research community South Africa would not be the vibrant country it is today, noted Department of Water Affairs (DWA) Acting Deputy Director General Mbangiseni Nepfumbada. "Today, our country is much better prepared to deal with its water-related problems owing to the Commission's meaningful contribution to the development of the capacity in the water sector; the broadening of the country's water-related research and development base; and the continued commitment to direct and fund research on critical issues." In the past five years, the WRC has employed about 3 000 students on its research projects. The Commission supports around 300 research projects a year with a budget of about R150-million.

The event proved a high note to Prof Rivka Kfir, who is leaving the WRC after ten years as CEO. In her closing speech she said: "I hope I leave behind an effective and vibrant WRC that with your support and under the leadership of the Board and highly capable management will grow and lead the country from strength to strength." ❑

(Photographs by Lani van Vuuren and Hlengiwe Cele)

Keynote speaker Prof Brian O'Connell of the University of the Western Cape.

Golder Associates' Dr Ralph Heath with Water SA Editor Tamsyn Sherwill.

Prof Giel Viljoen of Free State University catching up with Pieter van Heerden.

Dr Jackie King of consultancy Water Matters related her experiences in developing environmental flow assessment methodologies.

Harry Biggs of SanParks and Prof Jay O'Keeffe of Rhodes University.

Retired Prof Giel Laker and former WRC Deputy CEO Dr George Green.

Pieter Viljoen of the Department of Water Affairs in discussion with WRC Research Manager Chris Moseki.

DWA Acting Deputy Director-General Mbangiseni Nepfumbada with WRC outgoing CEO Prof Rivka Kfir and Chair Dr Janine Adams.

Prof Maggie Momba of the Tshwane University of Technology with Adesola Ilemobade of WITS University.

Water Wheel *Editor Lani van Vuuren with* WRC 40 Years *author Petro Kotzé.*

WRC's Eileen Hugo with keynote presenter MmaTshepo Khumbane.

WRC Chair Dr Janine Adams with outgoing CEO Prof Rivka Kfir.

Groundwater recharge expert Dr Ricky Murray.

Groundwater – a source of security

Judging by the close to 400 delegates who attended the International Conference on Groundwater at the CSIR International Convention Centre, in Pretoria, earlier this year, interest in this special water source is certainly gaining momentum. This year's conference incorporated the Biennial Conference of the Groundwater Division of the Geological Society of South Africa and was held in association with the International Association of Hydrogeologists. Under the theme 'Groundwater: Our Source of Security in an Uncertain Future', delegates deliberated on challenges and possibilities around the increased use of groundwater as well as methodologies for improved groundwater development and management, among others. Awards included best student presentation (won by Darian Pearce), best student poster (Evan Swartbooi), best oral presentation (shared by Prof Kai Witthueser and Dr Nicholas Howden) and best poster (shared by Paul Aucamp and Dr Martin Holland).

(All photographs by Lani van Vuuren)

Amelia Freysen of Geo Pollution Technologies; Marisa Ogle of Parsons Birckenhoff Africa; and Yolanda Ehlers of Soil & Groundwater Remediation Services.

Dr Martin Holland and Paul Aucamp delight at their prize for best poster.

Prof Kai Witthueser and Dr Nicholas Howden won the prize for best oral presentation.

Teboho Shakhane of the University of the Free State's Institute for Groundwater Studies (IGS); Ntsako Mabasa of the Department of Water Affairs and Modreck Gomo of the IGS.

Conference Chair Dr Shafick Adams; Prof Roland Schulze of the University of KwaZulu-Natal; Department of Water Affairs Acting Deputy Director General Mbangiseni Nepfumbada; IAH President Dr Willi Struckmeier; and Salvatore D'Angelo of UNESCO-IHP.

Delegates of the international groundwater conference.

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