THE
WATER WHEEL
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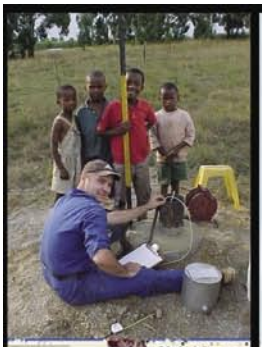
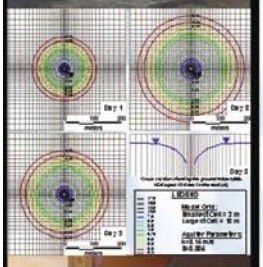
WATER SCIENCE: Finding value in every drop









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Wat(t)ermense?

Mense is fassinerend. Hulle amuseer jou, frustreer jou, of maak jou sommer pleinweg de hoenders in. Seker diè dat ons medemense (wel, dan seker ek ook…) heelwat meer as gereeld die onderwerp van 'n bespreking is. En op 'n stadium – hetsy goed of sleg - vergelyk ons hul selfs met dinge of onderwerpe soos die weer, 'n boek, 'n haas of 'n edelsteen.

Weens die aard van my (natterige) beroep, vergestalt mense vir my in water verwante voorwerpe. Ek kry die (nat) draad sonder veel moeite deurgetrek na my vriende en familie toe. Daar kry ek toe windpomp-bure, kraan-familie en dam-maters. En die verwantskap raak al hoe interessanter.

Eerstens sien ek die windpomp-mense. Hulle is dood-gelukkig (lees ook gelukkig-dood) met hulle wortels stewig op een stukkie grond en geen behoefte om die wêreld te verken óf hul visie te verbreed nie. Die wind is nodig om enigsins reaksie uit hul te kry: die wind van groepsdruk, of 'n klap van aanhitsing tussen die blaaie. Dus meestal afhanklik, in 'n sieldodende groef en vol wind. Máár, dit is ook hulle wat na jaaare se kontak verloor nog steeds op dieselfde plek by 'n reünie vir jou wag. Met AL die nuus en die skandes.

Die water-mense wat ek waarskynlik die meeste van ken, is die kraan-mense: betroubaar, stabiel en gerieflik naby. En gewoonlik baie voorspelbaar. Wees egter bedag – jy kry hier en daar tog 'n vergulde Cobra erfstuk. Dan is daar ongelukkig die groep druppende krane: aanhoudend, irriterend en vra gedurig aandag. Maar laat iemand nou durf waag om aan hulle pype te karring – dan kan jy jou maar regmaak vir 'n *bêkwash!*

Die volgende groep watermense is die rivier-mense. Hulle is seker die mees wispelturigste. Vandag is hulle vol van hulleself en môre is hulle net 'n klein stroompie wat amper onopmerklik tussen sandbanke en wilgers deurvloei. Hulle het egter ook die potensiaal om verwoestende vloedskade aan te rig met selfsugtige dade of kwetsende woorde. Maar kyk mooi, want iewers in 'n rustige stroompie lê vriendskaps-diamante en skitter… En hoe heerlik is dit nie om in daardie blink eienskappe te lawe nie! Die gevaarlikste van dié spul is die wat ewe rustig vloei en net om die volgende draai donderend teen regaf klipmure afstorm. (Ek sou my Afrikaanse onderwyseres op 'n Maandagoggend dalk hieronder kon klassifiseer.)

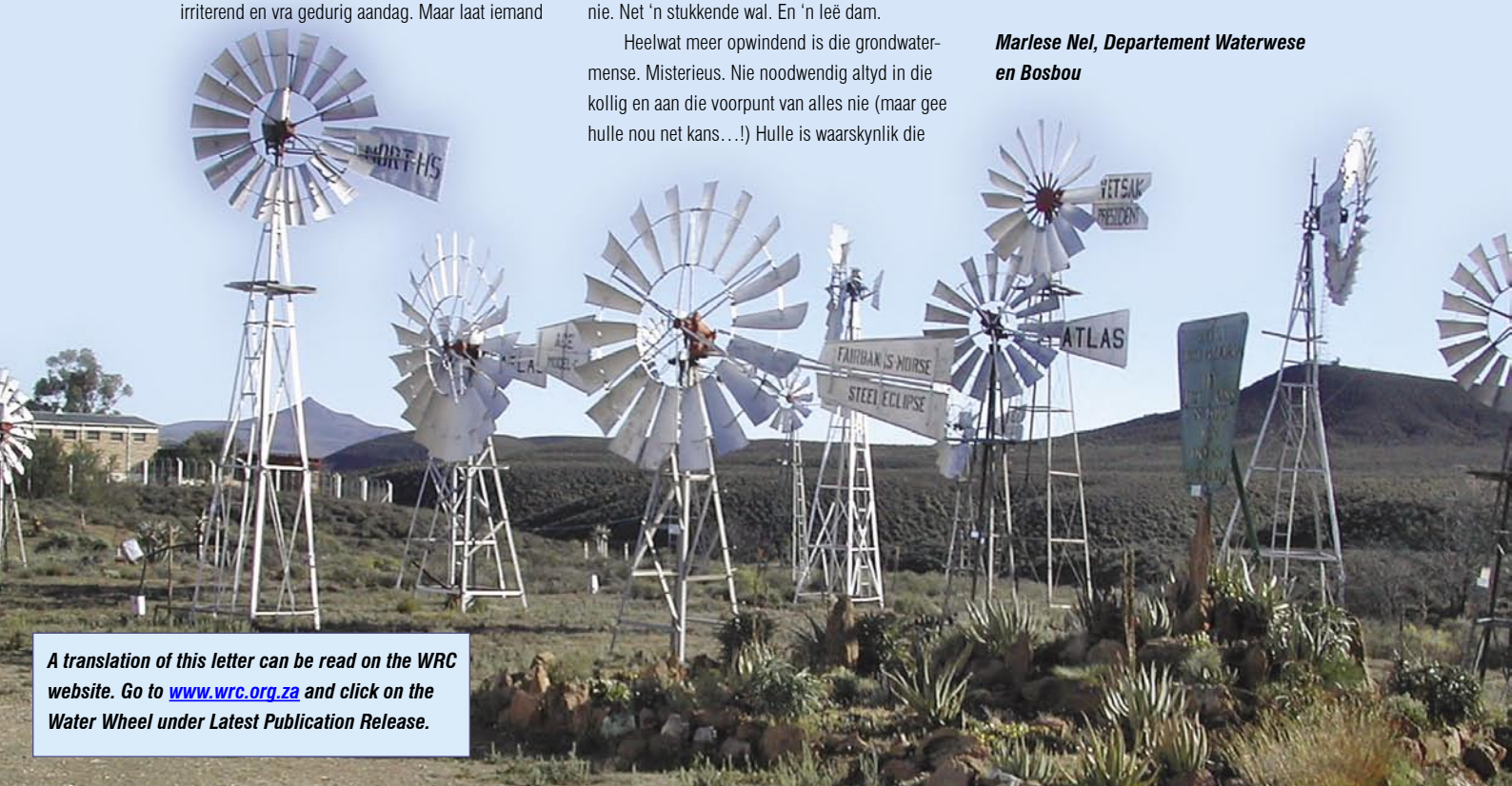
Die dammense (nie noodwendig dom of dêm nie….) is nou 'n interessante spul. Hulle is baie prominent en maak seker almal is bewus van hulle teenwoordigheid. Jy kan hulle selfs van hoog bo uit die lug uit sien, en hulle word selfs almal op kaarte aangestip! As daar een ding is waarvan hulle alles weet, dan is dit opgaar. Van skoenbokse vol kysbriefies tot motorhuise vol potensiële noodvoorraad. Dit is ook die mense wat ek sien as die introverte. Hulle laat net selektief 'n bietjie van hulleself uit – net genoeg om die omstanders gelukkig te hou. Maar die dag as daardie damwal bars is daar chaos: al die opgegaarde emosies oorstroom en verswelg alles daaronder. En dan is daar niks oor nie. Net 'n stukkende wal. En 'n leë dam.

Heelwat meer opwindend is die grondwatermense. Misterieus. Nie noodwendig altyd in die kollig en aan die voorpunt van alles nie (maar gee hulle nou net kans…!) Hulle is waarskynlik die "007's" van die waterras: ondergronds en geheimsinnig. En net sodra jy vergeet van hulle bestaan, borrel 'n fontein iewers uit, waar jy dit die minste verwag. Moeilik is hulle wel om te vind, maar as jou stokkie eers op hulle gedraai het, ontdek jy 'n weggesteekte skat wat menige lewe kan beïnvloed. (En dit ìs die beste water saam met jou whiskey….). Maar so ook kan hulle jou hoofbrekens besorg: net sodra jy dink jy weet waar jy staan met hulle, verdwyn hulle spoorloos en los jou in die stof. En niemand het gesê dit is 'n maklike spulletjie om mee oor die weg te kom nie. Introvert groep nommer twee!

Maar moenie haastige afleidings maak nie – ek het niks teen ander watermense nie. Daar is beslis river- en dammense in my vriendekring. Selfs 'n windpomp woonstelmaat hier en daar. En dit is juis hierdie variasie wat maak dat ons alles van watervalle tot modderpoele kan beleef. Saam met mense woon en werk wat die winde van verandering hanteer, altyd byderhand is met raad, jou oorspoel met ondersteuning en liefde of ook daar is om saam met jou wal te gooi vir 'n goeie saak.

Miskien is ons almal eintlik 'n waterdruppel, wat deur die loop van ons lewe die hele watersiklus deurgaan. Van 'n gegroefde windpompfase, deur 'n *nagging* kraanfase na 'n "los-my-net-uit" damfase. Om dan geskuur en gevorm te word in die rivierfase en uiteindelik die lewe diep binne onsself te voel vloei in die grondwater-fase. (So miskien is ek so klein bietjie bevooroordeeld…)

Marlese Nel, Departement Waterwese en Bosbou



A translation of this letter can be read on the WRC website. Go to www.wrc.org.za and click on the Water Wheel under Latest Publication Release.

Dirty water a headache for farmers

Deciduous fruit and wine farmers along the Berg River may lose out on exports to the European Union (EU) because of the quality of the water used for irrigation.

Farmers told the *Cape Times* that they fear the EU may close its markets to them since the pollution in the Berg River is way over internationally accepted limits. *E. coli* counts in the river over the past 18 months have reportedly ranged from around 5 000 to 2 400 million per 100 mℓ compared to the EU accepted count of no more than 1 000 in 100 mℓ of water to irrigate crops.

The main sources of pollution are said to be discharges from wineries and from food-processing factories, runoff from informal settlements on the river banks and effluent leaks from municipal sewerage systems.

Ready, steady, monitor!

World Water Monitoring Day will be celebrated on 18 October. This annual event aims at drawing direct attention to water quality by measuring for four basic water quality indicators (temperature, pH, dissolved oxygen, and turbidity) at numerous places on the same day. It also seeks to promote personal stewardship and individual involvement in the protection of the world's water resources.

It is reported that in 2004, 50 countries registered and 6 527 monitoring sites were counted. The top participants were the US, Taiwan, Germany, Australia and Canada. This year, the event is being sponsored by the International Water Association.

To register go to www.worldwatermonitoringday.org All the results will be captured in World Water Monitoring Day summary reports.

Limpopo water crisis calls for action

The municipality of Polokwane has concluded an agreement with the Lepelle Northern Water Board to transfer water supplies directly to the city from the Olifants River, about 100 km away. The emergency supply will be conveyed through the Olifants/Sand transfer scheme.

The agreement comes in the wake of persistent droughts in Limpopo, with many districts having recorded only 50% of their normal summer rainfall figures, according to government's *BuaNews*. At the time of writing, Polokwane's main bulk water supply, Ebenezer Dam, was only 22% full. The northern, central and south-eastern parts of the province have been worst hit by drought.

Cape Town goes green

The Cape Metropolitan Council has planted 640 saplings in various residential areas in efforts to green the city.

Exotic and indigenous, drought-resistant species were selected. These include fan palm *Washingtonia robusta*, water oak *Quercus nigra*, carob *Ceratonia siliqua*, Natal mahogany *Trichelia emetica*, essenhout *Ekebergia capensis*, and white stinkwood *Celtis sinensis*.

"We will be making use of 'dry-water units' which minimise water usage by ensuring a slow release of water to the root zone as required," said Councillor Tozama Nomza Mlanjeni, Mayoral Committee member for Health, Amenities and Sport.

New water agency established

South Africa has a new agency responsible for its bulk water assets after Cabinet approved the establishment of a National Water Resource Infrastructure Agency earlier this year.

The agency will take responsibility for developing and operating the country's major national dams and water transfer schemes which are currently managed directly by the Department of Water Affairs & Forestry. These include the Vaal Dam, the Tugela-Vaal transfer scheme, the Orange River Scheme and the Western Cape system. According to the department, the organisation will be a major business in its own right. Its assets are valued at nearly R40-billion at present and bulk water sales bring in more than R2-billion a year.

The agency will also integrate the TCTA, the parastatal organisation responsible for funding the Lesotho Highlands Water Project.

DWAF appoints new DG

The Department of Water Affairs & Forestry (DWAF) has appointed Jabu Sindane as its new Director-General.

Sindane previously held the position of Deputy Director-General: Regions. He assumed his new position on 1 September. Before joining DWAF he was department head at the Mpumalanga Provincial Department of Local Government, Traffic Control and Traffic Safety.

Water on the Web

www.enn.com
This is an excellent site for those wanting a round-up of the day's environment and science news. View the latest news or browse the various subjects, including water resources, food and agriculture, and ecosystems.

www.science.howstuffworks.com
This site, aimed at children, contains information on anything from beer to Bigfoot, including some interesting water-related information, such as how water towers work. It also explains why we cannot breathe underwater despite water containing oxygen, among others.

www.win-sa.org.za
This is the official site of the Water Information Network of South Africa, a network of organisations in the water service sector. These organisations (governmental and non-governmental) all have a vested interest in information and knowledge generation and dissemination to local government. They are trying to ensure the body of knowledge in the sector is well managed, readily accessible and applicable, and will lead to decision making and performance in the area of water and sanitation.

WATER BY NUMBERS

- **Two billion** – The number of people around the world whose health and livelihood are threatened by environmental degradation.
- **100 ℓ** – The volume of water used up by a five-minute shower with a standard shower head.
- **10%** – The estimated percentage of the world's irrigated lands that have been damaged by waterlogging and salinisation because of poor drainage and irrigation practices.
- **42 Mℓ** – The volume of water saved by water restrictions imposed in Cape Town in 2004.
- **57%** – The percentage of Eastern Cape's OR Tambo District Municipality citizens who have no access to safe water. A further 62% have no access to safe sanitation.
- **5 000 ℓ** – The volume of water required to produce a standard size meal of steak, potatoes and salad with a couple of glasses of wine.
- **US$1-billion** – Funding from the US over the next five years to prevent and treat malaria in Africa. According to UNICEF, a child is killed by malaria in sub-Saharan Africa every 30 seconds.
- **45 000** – The number of dams in the world that are over 15 m high. Together these dams can store more than 6 500 km^3 of water equal to 15% of the annual freshwater runoff in the world).
- **R1,6-m.** – The value of Mpumalanga's new mobile disaster facility.
- **292 kg** – The weight of what is thought to be the world's biggest freshwater fish, a Mekong giant catfish, netted by fishermen in the Mekong River, northern Thailand, in June.
- **13 000 ha** – New irrigation for which water has been reserved from the Orange River by the Department of Water Affairs & Forestry in its National Water Resource Strategy for the settlement of emerging farmers.
- **R1,2-billion** – The budget available in 2005/2006 to eradicate the bucket system in South Africa.

Global review

- Researchers from the University of Michigan, in the US, say changes in climate can increase the spread of cholera by creating patterns of rainfall that favour the disease's transmission. The team analysed 40 years of Bangladeshi medical records detailing the incidence of cholera in the town of Matlab. They then created a computer model that took into account disease transmission in the region, local people's immunity, and climatic factors such as changes in rainfall.

- Italian scientists have found large quantities of cocaine residue in a river the north of the country – suggesting consumption is much higher than previously thought. The BBC reports that the equivalent of 40 000 doses a day was found in the Po valley by scientists from the Mario Negri Institute for Pharmalogical Research in Milan. The study tested sewage and rivers for levels of a byproduct of cocaine metabolism, called benzoylecgonine, usually found in the urine of cocaine users. It is hoped that in the near future, the scientists will be able to develop similar tests to assess the true number of dagga and heroin users.

- Chinese researchers have found a way to regulate the temperature in buildings by using raw sewage. According to researchers at the Environmental Science Department at Harbin Institute of Technology, their device extracts heat from untreated sewage that has been temporarily diverted on its way to the processing plant. It can also reportedly make air-conditioning units run more efficiently, and absorb the heat they remove from buildings.

- According to Australian researchers, a gene shown to determine how well plants conserve water could help scientists develop drought-resistant crops. SciDev.Net reports that researchers at Australian National University isolated a gene that helps the plant *Arabidopsis* reduce water loss as it grows. The 'erecta' gene, determines how many pores the plant has on its leaves. Plants use these pores to take in carbon dioxide, but lose water through them whenever they are open. It is thought that by changing the structure of the gene, plants could be created with a different balance in the trade-off between losing water and gaining carbon dioxide.

- Residents of the small Russian town Bolotnikovo, located about 250 km east of Moscow, have been stunned by the disappearance of their lake. It is thought that the lake was sucked into an underground cave.

Water Diary

WATERSHEDS SEPTEMBER 13-15

The International Water Association is holding its Tenth International Specialist Conference on Watershed and Basin Management in Calgary, Canada. *Enquiries: E-mail* crothdiddams@shaw.ca; Web: http://content.calgary.ca/CCA+Hall/Business+Units/Waterworks/Events/IWA+Watershed+Conference+2005.htm

LAKE BASINS OCTOBER 31-NOVEMBER 4

A conference on the Management of Lake Basins for their Sustainable Use: Global Experiences and African Issues will be held in Nairobi, Kenya. Enquiries: kenya2005@ilec.or.jp; Web: www.ilec.or.jp/eg/wlc.html

METEOROLOGY OCTOBER 24-29

The 32nd Radar Meteorology Conference will be held in Albuquerque, in the US. The conference aims to highlight recent developments in radar technology in understanding mesoscale atmospheric processes. Specifically, the conference intends to demonstrate the use of radars, including spaceborne radars, for the description and numerical simulation of the dynamic and microphysical processes controlling cloud and precipitation systems worldwide. Enquiries: Megal Krol; E-mail: mkrol@ametsoc.org; Web: www.ametsoc.org/meet/fainst/albuquerque.html

WETLANDS NOVEMBER 8-15

The RAMSAR Convention on Wetlands will be hosting a conference entitled Wetlands and Water: Supporting Life, Sustaining Livelihoods at the Speke Resort, Munyonyo, Kampala, Uganda. Enquiries: E-mail: COP9@ramsar.org; Web: www.ugandawetlands.org

MALARIA NOVEMBER 13-18

The Multilateral Initiative on Malaria's Pan-African Malaria Conference, the largest meeting worldwide focusing solely on malaria, will be held at Youndé, Cameroon. Enquiries: E-mail: mimconference@mum.su.se; Web: www2.mim.su.se@conference2005/

ECOHYDROLOGY NOVEMBER 21-24

The International Symposium on Ecohydrology, to take place in Bali, Indonesia, will be themed around Experiences and Best Practices of Ecohydrological Principles for Good Water Governance. Topics include, among others, erosion and sedimentation trials, water quality and environmental sanitation, and water, culture and religion. Enquiries: Mr Hidayat; E-mail: workshop_eco@yahoo.com; Web: www.limnologi.lipi.go.id/Bali2005_files/slide0002.htm

Trees Don't Save Water, Says Report

A new international report hopes to finally squash the notion that planting more trees improves water availability.

The report, *From the Mountain to the Tap*, summarises four years of research led by the Centre for Land Use and Water Resources Research at the University of Newcastle, UK, and the Free University of Amsterdam, the Netherlands, into water management programmes.

In some countries immense sums of money, backed by international aid, are being spent on tree planting, soil and water conservation structures and allied measures, in the belief that they are attracting rainfall and/or facilitating recharge of groundwater. However, the report concludes that while trees can play many vital environmental functions, their negative effects, such as in water-hungry areas of India, are either misunderstood or ignored.

"We are not saying forests never produce water benefits or that they don't have an important role in the ecosystem," comments Ian Calder, director of the Centre for Land Use and Water Resources Research at the University of Newcastle. "But if we are trying to manage our water resources effectively, the overenthusiastic adoption of the simple view that 'more trees are always better' is a prime example of how a failure to root decisions in scientific evidence leads to bad water policy."

Studies in South Africa have found that commercial plantations on non-native tree species reduce surface runoff nationally by 3,2%. The country now requires commercial forest operators to pay an "interception levy" to account for the high water use and reduced stream flows associated with timber plantations. This is one reason why Calder and other researchers view South Africa as a model for how to match water policy to scientific evidence.

A new international report has driven the axe into the belief that more trees necessarily mean more water.

The booklet derives the following policy lessons:

- If water shortages are a problem in dry countries, impose limits on forest plantations, especially of fast-growing evergreen species;
- Implement 'green water' instruments (based on data from plant transpiration) to control levels of evaporation from upland vegetation;
- If upland forests are cleared for cultivation, provide farmers with guidelines of best agricultural practice;
- Any market mechanism or tax system linking land management to quantified streamflow should ensure that scientific validation is possible at the scale of the operation;
- Use decision support systems to assess the impact of alternative land management options on water resources, and alternative land-use and water management and policy options on different social groups;
- Ensure policy instruments are equitable in terms of livelihood benefits, not just water allocation;
- Ensure that any proposed market mechanism is adequately pro-poor;
- Consider improvements in rain-fed farming in preference to further investments in rural small-scale irrigation schemes;
- Use negotiation support system techniques such as choice experiments to ascertain stakeholder preferences for policy agreements; and
- Tailor employment programmes to dovetail with other livelihood activities of the people.

To access the report, visit www.frp.uk.com

Stockholm prize comes home

South Africa's National Youth Water Prize Winners have snatched the international Stockholm Junior Water Prize. Seen here with HRH Crown Princess Victoria of Sweden, Pontso Moletsane, Motobele (Elvis) Motshodi and Sechaba Ramabenyane of Setjhaba Se Maketse Combined School in Botshabelo, in the Free State, beat 26 international competitors with their Nocturnal Hydro Minimiser, which reduces the need for water in small-scale irrigation. South Africa also won the prize in 2003. For more information on their invention, see the *Water Wheel,* July/August 2005, p 30.

Watershed Year for Institute

Southern Africa's water professionals are expected to have a louder voice in the industry as its representative body enters a new chapter in its history.

Newly appointed CE Wallace Mayne and 2005 President Dr Marlene van der Merwe-Botha have been tasked with guiding the Water Institute of Southern Africa (WISA) in implementing its new Strategic Plan aimed at sustaining the institute's support for the well-being of the water sector while better serving its members. "With all the changes happening in the South African water sector in the last decade WISA feels the time has come to lay down its quiet diplomacy policy and adopt a more vocal approach," Mayne tells *the Water Wheel*. "While WISA has made a huge contribution to the development of the local water sector over the years, its input has, to date, been made, mainly behind closed doors. In future, our opinion on strategic matters affecting our members will be known more openly."

Among others, WISA represents members at the International Water Association, the Water and Energy Sector Education & Training Authority (SETA), the Water Sector Leadership Group, and the New Partnership for Africa's Development (NEPAD) Business Council for Water. It is also one of the hosts of the Water Sector Colloquium Initiative while the President sits on the National Water Advisory Council.

Commenting on the state of the water industry Van der Merwe-Botha notes that there are several matters of concern. One glaring issue is that, despite the sector's excellent efforts to position itself with regards to policy and legislation, it remains heavily fragmented. "There is serious need for more cohesion, especially regarding issues such as costing and planning across all the spheres of government," Van der Merwe-Botha points out.

This is certainly not an easy task, with the sector having to balance competing demands of sustainability and pleas for higher standards and, at the same time, the maintenance and replacement of infrastructure assets on which societies depend and which are reaching the end of their useful lives. Judging by recent much-televised protests, local authorities are bearing the brunt of this grave responsibility. This is underlined by the fact that a reported 226 out of 284 municipalities are experiencing serious problems.

"Naturally these challenges impact seriously on the national strategic plan to provide all South African citizens with safe water and sanitation by 2008 and 2010 respectively, as well as the provision of free basic services," notes Van der Merwe-Botha. In addition, water losses of between 30% and 40% in the agricultural sector and a national average water loss of 26% raises concerns over the economic value of water used and the expected growth in demand."

At the same time there has been a huge drain of technical capacity in the public sector leaving significant capacity gaps. According to Van der Merwe-Botha while this is a challenge, it also offers opportunities for cross-pollination between the public and private sector.

This also calls for more participation by younger professionals. WISA has more than 340 student members. "One of our aims is to continue engagement and encouragement of young professionals to actively participate and contribute to the sector," says Van der Merwe-Botha.

It is believed WISA can play a major role in bringing different parts of the water sector together. "The institute represents one of the country's major resources, even if only considering the tremendous pool of knowledge and expertise among its membership, making us an ideal platform to knit bodies together," notes Mayne. "The organisation is known for its ability to provide a forum for the exchange of information, for example the WISA Biennial conference."

This exchange of knowledge is not only relevant for the South African water industry, but also for the region. Plans are already underway to introduce a biennial water conference to be held outside South Africa. "There is a need for southern Africa to look at local expertise and indigenous knowledge to find solutions to its unique challenges, and WISA can assist in helping parties to swap ideas, comments Mayne."

WISA has always been a relevant body in the sector. Says Van der Merwe-Botha: "This relevance is now being deepened through a dedicated and collective focus and implementation plan for the future."

Newly-elected WISA President Dr Marlene van der Merwe-Botha

New WISA CE Wallace Mayne

Water Research: Finding Solutions to Benefit All

In South Africa, millions of Rands are spent on research and development (R&D) in the water field every year. In fact, the Water Research Commission (WRC), the country's main water research funder, allocated R53-7-million to research projects (knowledge creation) during 2004/05. But is this enough? And is this research making a difference in the lives of ordinary South Africans? Lani Holtzhausen investigates.

Science and technology is recognised universally as an important tool which can help solve a myriad of problems, including food shortages, water-borne diseases, lack of access to basic services, environmental degradation and biodiversity depletion. Developing scientific research facilities is also said to help sustain economic growth and employment, as well as social equity.

As stated in the National Water Resources Strategy research has been fundamental to understanding South Africa's water resources, and has contributed to the development of many of the techniques and tools used for their management. Research is currently underway on the issue of integrating the voice of the people and the poor, and of equity into integrated water resource management, for example.

According to a survey undertaken by the Human Sciences Research Council (HSRC), South Africa spent about R10,1-billion or 0,51% of its gross domestic product (GDP) on research and development in 2003/04. It is not known exactly what slice of this goes to water research, however, the HSRC estimates that most R&D is performed in the areas of engineering sciences (comprising 24,8% of total R&D), followed by natural sciences (21,9%), and the medical and health sciences.

The South African government has realised that without adequate investment in R&D the country cannot move forward. According to Science & Technology Minister Mosibudi Mangena, innovation is the photosynthesis of economic growth. "Investment in research is the sunlight required for that process to occur; the more you have it; the greater the results."

Because of this, government has committed itself to creating a favourable environment that will see an increase in investment in R&D by the public and private sectors to levels above 1% of GDP by 2008.

INVESTING IN WATER

The water-related research undertaken in South Africa at present is both practical and relevant, says Prof Eugene Cloete, Chair of the School of Biological Sciences at the University of Pretoria and Chair of the Strategic Council of the International Water Association. "One advantage that South African researchers have over the rest of the world is that out of necessity we have had to become much more practical. The fact that we are able to tackle problems in a very scientific way while having our feet firmly on the ground has given us the edge."

The relevance of this water research can also be seen in the strategic areas of the WRC. They are water resource management; water-linked ecosystems; water use (industrial and domestic) and waste management; as well as sustainable water use for agriculture. This is in line with international trends towards increased investment in research in water and health issues, water in arid regions, disaster management, water and the environment, and alternative methods of sanitation.

Talk to anyone involved in water research, and they will tell you that the quality of the work emanating from South Africa is on par with the rest of the world. "Many of our top researchers are considered international leaders in their field," Prof Cloete tells *the Water Wheel.* "They are true national assets, and we should do everything in our power to ensure that the South African water field remains attractive to them."

MORE RESEARCH BUT BY WHOM?

One could always argue that not enough money is being spent on water research. Dr Joy Leaner of CSIR Environmentek mentions a few areas where more key research is needed, including managing water supply in rural areas (for example, developing integrated water resource management plans for rural areas); determining sources and sink pathways in the development of disease (assessing the burden of disease); developing interventions that reduce direct or indirect adverse effects on human health; developing policies and guidelines on preventing, correcting and controlling pollutants that pose a risk to human health; and early detection of infectious disease outbreaks.

However, increased funds require more people to make use of it. The fact is that there are just not enough water researchers in this country. "Our greatest challenge going forward is ensuring that we have a scientifically literate new generation of water scientists with the confidence and ability to influence the way our country responds to an increasingly stressed planet," comments Christine Colvin of CSIR Environmentek. "This requires improving the level of science education at primary, secondary and tertiary levels."

Capacity building is strained not only by the limited number of students choosing the water research field, but also by the dwindling number of lecturers to teach them. The University of Pretoria, for example, where much water-related research is undertaken, only has 25 lecturers dealing with various water-related subjects, including microbiology, soil science, hydropolitics and water engineering.

"We need to develop centres of excellence in water science and technology to build critical mass," maintains Prof Cloete. It has also

MORE SCIENCE IN SCHOOLS

In a bid to meet its target of producing 50 000 Grade 12 students with mathematics and science as subjects by 2008, the Department of Education (DoE) has revealed plans to increase the number of schools under its Dinaledi initiative to 529 next year.

Dinaledi, meaning 'stars' in Sesotho, aims to increase mathematics and science teaching in schools in partnership with the private sector. The programme, launched in 2001, originally targeted 102 schools.

The new expansion strategy seeks to empower under-qualified and unqualified maths and physical science teachers. It also hopes to entice those who have left the sector back to teaching.

The DoE hopes to raise the number of schools under the Dinaledi programme offering maths and science in KwaZulu-Natal to 100; Eastern Cape to 65; Northern Cape to 12; Western Cape to 50; Free State to 31; Mpumalanga to 37; Gauteng to 71; North-West to 50; and Limpopo 113 from 23.

The expansion strategy is being spearheaded by DoE Deputy Minister Enver Surty.

"The scientist does not study nature because it is beautiful; he studies it because he delights in it, and he delights in it because it is beautiful. If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living."
– Jules Henri Pincaré (French mathematician)

been suggested that virtual networks of excellence, linking professionals from different locations working on similar problems through the power of information and communication technology, can multiply the potential effectiveness of individual centres, as can regional cooperation between countries.

The good news is that the need to strengthen the country's scientific human capital has been recognised, and government has launched a number of initiatives in this regard. For example, every WRC funded research project is required to incorporate a strong element of capacity building, especially among previously disadvantaged individuals.

SHARING THE KNOWLEDGE

Another challenge remains the dissemination of the knowledge gained through research. Colvin points out that there is still a great need to communicate effectively to society and make sure that this knowledge influences decisions. "We need to improve the levels of science education for non-scientists so that this generation of decision makers understand how science can be used to support wise governance."

THE BIG FIVE

South Africa's science base – especially basic science – still resides in a small number of institutions. The so-called big five (the universities of Cape Town, KwaZulu-Natal, Pretoria, Stellenbosch, and Witwatersrand) produce 63% of all scientific output (peer reviewed articles); they also produce 53% of all PhDs in the country.

Source: Department of Science & Technology

Prof Cloete agrees. "Whenever I attend an international conference, such as the last World Water Forum, in Kyoto, Japan, I am amazed that despite the number of water and sanitation specialists, there are still people that do not have access to safe water and sanitation. This is not like HIV/Aids where we still need to find a cure. The solutions are there, and they are mostly simple and cost-effective, for example, erecting a rainwater tank next to a low-cost house to supply the household with basic water. The problem is that people are not aware of these solutions."

"We need more capacity for African countries to apply science to their problems, focusing on health, water, agriculture, and the environment, to increase economic competitiveness."
John Mugabe (Science advisor to NEPAD)

It was Minister Mangena who said: "The development of the continent will have to be knowledge driven. This is the dictate of the new global economic order." Let South Africa's water researchers lead the way.

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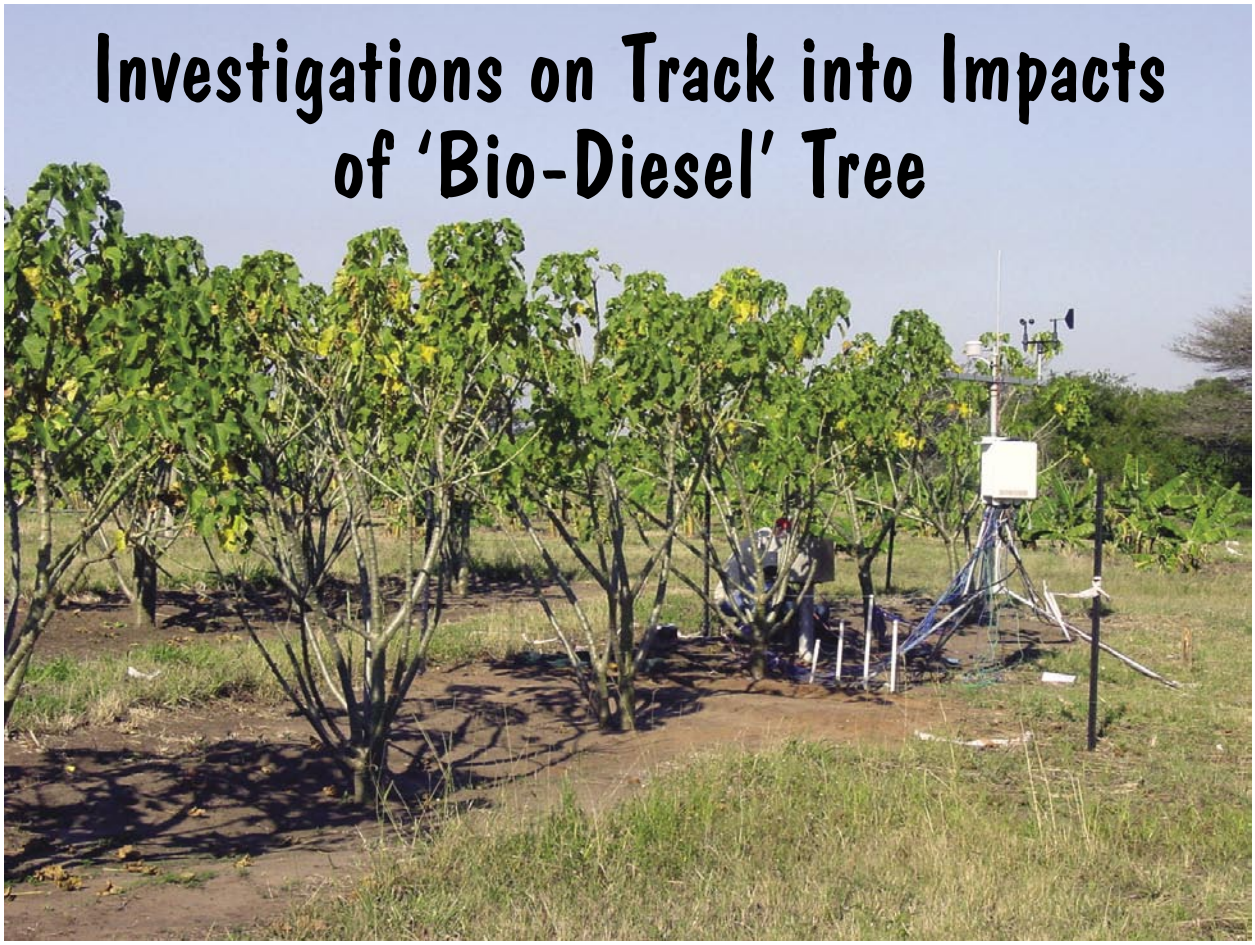
Investigations on Track into Impacts of 'Bio-Diesel' Tree



A three-year hydrological investigation is currently underway to determine the potential impact of the bio-diesel producing Jatropha curcas *tree on local water resources.*

Introducing an alien species into the environment, even if it could potentially contribute to rural employment and poverty alleviation and an alternative source of bio-fuel, is not an easy consideration. The social, economic and environmental implications need to be well understood. Investigations are currently underway to determine the potential for South Africa to 'grow' its own energy in the form of a bio-diesel producing tree.

Lani Holtzhausen reports.

The *Jatropha curcas* tree, which originates from Mexico, has long since been cited as a way for South Africa to increase its use of renewable energy sources. The prime ingredient in the manufacture of bio-diesel is vegetable oil (e.g. sunflower oil, soya or peanut oil); however, these oils are edible and generally fetch high prices, which preclude them from being used in bio-diesel production.

Research indicated that *Jatropha curcas,* whose oil-producing seeds are inedible (toxic) to humans, and most animals and birds, merited serious consideration as a viable alternative. Now initiatives have been proposed to introduce this exotic species for large-scale planting and bio-diesel production in the country.

GROWING BIO-DIESEL

A small tree or shrub with a maximum height of 5 m*, Jatropha curcas* reportedly grows readily in areas of low rainfall (from 250 mm a year) and in poor soils, however, yield is strongly affected by growing conditions. The trees are easy to establish (from seeds or cuttings), grow relatively quickly (producing seed after their second year) and are hardy to drought, although they are relatively sensitive to frost.

The seeds of the Jatropha contain high percentages (30%-35%) of oil, which can be extracted easily for further processing (trans-esterification) and refinement. This processed oil can then be used in diesel engines after minor modifications. To avoid engine modifications the bio-diesel can also be blended with conventional diesel. On average, each mature tree produces about four kilograms of seed per year.

The byproducts of the bio-diesel processing plant are nitrogen-rich press cake and glycerol, which are said to have good commercial value as fertiliser and as a base for soap and cosmetics respectively. The leaves, root and bark could also have potential for numerous other industrial and pharmaceutical uses.

ASSESSING THE POTENTIAL IMPACT

However, while this could provide welcome income to rural communities the potential impact of the crop on the country's environment has to be considered. There are several concerns around the affect of such a species on the country's already scarce water resources as well as the possible invasive nature of the plant.

The Water Research Commission (WRC) has launched a three-year research study into the water resource-related impacts of large-scale planting of *Jatropha curcas.* Two sites have been identified in KwaZulu-Natal where the water use patterns of existing Jatropha trees are currently being studied, namely at the Owen Sithole College of Agriculture near Empangeni, and on the Makhatini Flats between Jozini and the Makhatini Research Station.

Mark Gush of the CSIR Land Use Hydrology Group in Pietermaritzburg, who is leading the technical research team, explains that transpiration (sap-flow), climate and site water balance measurements are being conducted at each site. This includes soil moisture measurements beneath the selected trees in comparison with the soil moisture of unplanted grassland sites nearby.

Mature Jatropha *trees at Owen Sithole College of Agriculture near Empangeni. The trees effectively 'shut down' during dry periods and winter when they lose their leaves.*

Mark Gush of the CSIR Land Use Hydrology Group in Pietermaritzburg shows off the logging system at the Owen Sithole site. All data from the hourly measurements are fed into this logging system. Data is then downloaded remotely to the CSIR Pietermaritzburg office via cell phone link.

An automatic weather station has been set up at each site for climatic measurements. These include rainfall, wind direction/speed, solar radiation, and temperature and humidity measurements.

The heat pulse velocity (HPV) technique is being applied to determine the water use of the trees. This is done by measuring the sap-flow (transpiration) through the trees. A short pulse of heat is injected by means of a probe into the sap-conducting wood (xylem) of the tree. As the pulse of heat is carried up the tree by the sap, temperature-sensitive thermocouples detect the sap-flow velocity from the rate of ascent of this pulse in the stem. Sap-flow velocity by the cross-sectional conducting wood area gives the volume flow of water per unit time.

In addition, soil moisture and soil water potential sensors have been imbedded in the soil at the two sites. The project will look at hydrological impacts of *Jatropha curcas* by means of detailed plant water use, soil moisture, and site water balance measurements.

Once this project has been completed the relevant national government departments are expected to undertake specific environmental impact assessments to determine whether this wonder species is destined to be introduced on a wide scale in South Africa.

The data should reveal whether there is movement of water down through the soil into the groundwater table (i.e. excess water) or whether there is a net loss of water from the groundwater system. The team will also be able to determine where the tree is getting its water from i.e. near the surface or from deep underground sources.

REMOTE DATA COLLECTION

Measurements are taken hourly and all of the data are fed into a logging system. Data are downloaded remotely to the CSIR Pietermaritzburg office via cell phone link. While saving time and transport costs it also allows for rapid analysis of potential problems.

WRC Research Manager Renias Dube tells *the Water Wheel* that measurements will be taken for the next year to determine the *Jatropha*'s water requirements throughout the seasons. Hereafter a modelling exercise will be undertaken wherein site-specific simulations of water use will be verified against the measured data and extrapolated to a larger scale.

While it is still early in the project, the research has already yielded some interesting results. For example, early indications are that the trees at the Owen Sithole site are using more water than the nearby grassland.

There are clear diurnal patterns to the sap-flow with no transpiration occurring at night. The trees, which are deciduous, also seem to effectively 'shut down' during dry periods and in winter when they lose their leaves. Peak transpiration rates occur during the warm, wet summer months.

The heat pulse velocity (HPV) technique is being applied to determine the water use of the trees. This is done by measuring the sap-flow (transpiration) through the trees.

An automatic weather station has been set up at each site for climatic measurements.

BIO-DIESEL AT A GLANCE

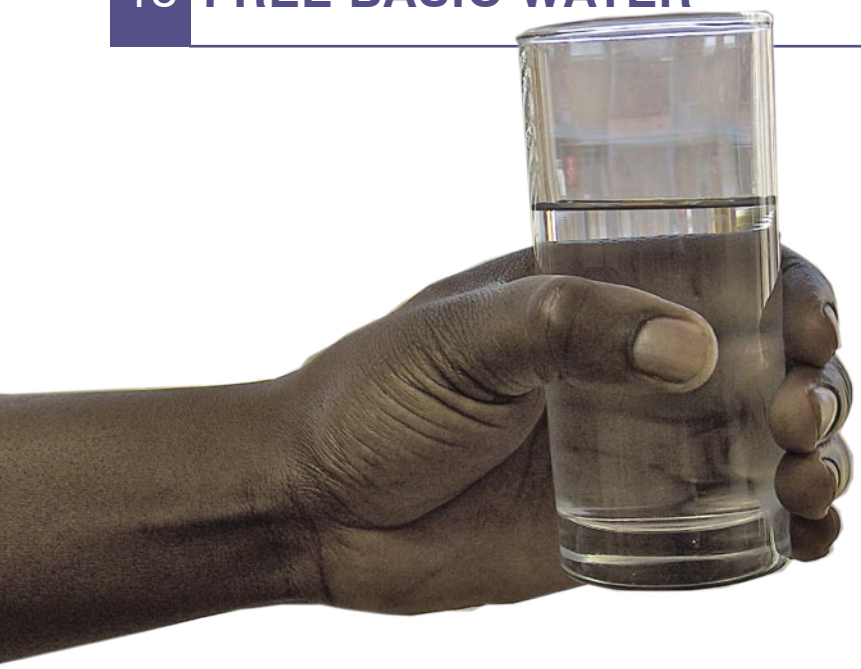
In the wake of rising oil prices, bio-diesel has been identified as a way for the world to meet its increasing energy needs. Bio-diesel has similar physical and chemical properties to petroleum diesel with reference to the operation of a diesel motor. Also its physical and chemical properties as it relates to operation of diesel engines are similar to petroleum-based diesel fuels.

However, since it is produced from natural source, it produces 80% less carbon dioxide, 100% less sulphur dioxide and up to 75% less exhaust smoke emissions. In addition, it is reported to degrade about four times faster after spillage and provide significant lubricity improvement over petroleum diesel fuel.

It can be produced from edible oil sources, such as sunflower, soya or peanut oil, or non-edible oil sources, such as from Jatropha curcas.

Source: www.biodieselsa.co.za

Once this project has been completed the relevant national government departments are expected to undertake specific environmental impact assessments to determine whether this wonder species is destined to be introduced on a wide scale in South Africa. The verdict is likely to weigh up the negatives such as potential for invasiveness, likely hydrological impacts, and the feasibility of using alternative seed-oil producing species, against the potential benefits to local communities and the national economy, of this species.



Rural Free Basic Water Under Magnifying Glass

Since the South African government started rolling out its Free Basic Water (FBW) policy in 2001, critics have argued that it is not feasible, especially in poor rural municipal areas. However, a recent study funded by the Water Research Commission (WRC) found that FBW could just work. Lani Holtzhausen reports.

While the FBW policy has been implemented relatively promptly and successfully in most urban areas, implementation in the rural areas has been much more difficult, with many rural villages not yet seeing the rollout of this basic service. In fact, few water services authorities (WSAs), which is the local or district municipality in most cases, have a fully operational policy that is reaching the rural areas.

There are a myriad of reasons for this lack of implementation, mostly to do with varying financial, technical, political and logistical problems at local and district municipality level. In rural areas water provision is generally communal, unmetered and, for the most part, not paid for. Even where rural areas exist alongside more wealthy urban areas, there are only limited opportunities for cross subsidisation – especially as rural consumers are usually connected to stand-alone community-based water systems.

Developing new water systems in the rural areas means more than simply putting taps in the ground. It implies the development of new institutional mechanisms – local government, private sector run or community-based – able to manage projects and ensure long-term operations and maintenance sustainably.

"FBW-by-default could result in greater expenditure than if the time, resources and budget are allocated for the development of a sound FBW policy and implementation strategy."

But exactly how many people are receiving free basic water? In answer to a question in Parliament earlier this year, Minister of Water Affairs & Forestry, Buyelwa Sonjica, said that about 16 million poor people (defined as households with an income of less than R1 000 a month) are receiving FBW via formal infrastructure. A further four million have infrastructure and, although they do not yet have a formalised FBW administrative system in place, are getting their water for free.

"There are also an additional two million poor with infrastructure slightly below the basic level who also get their water for free," said Sonjica. "Thus, about 76% of the country's poor are getting their water free of charge."

DIFFICULT BUT POSSIBLE

The WRC study, concluded earlier this year, investigated the present situation with regards to FBW roll-out in rural areas. Five areas were scrutinised, uThukela Water Partnership and Vulindlela Water Project in KwaZulu-Natal; Alfred Nzo District Municipality and Ngqushwa Local Municipality in the Eastern Cape; and Nhlungwane Water Project, a small community run scheme in the uMzinyathi District, in KwaZulu-Natal.

Interestingly, several municipalities in the North West and Limpopo provinces were approached with a view to doing comparative case studies

there. None of those with a significant rural population were implementing free basic water at the time of the study.

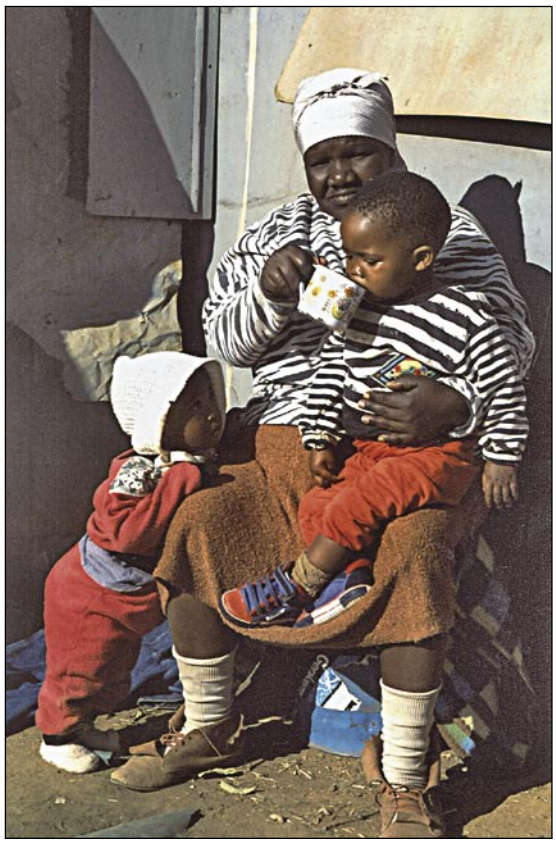
From the case studies it was concluded that, while difficult, implementing FBW in rural areas remains feasible. A common factor in efficient, cost-effective provision of FBW was found to be the contracting by local authorities not having sufficient own capacity of organisations with the necessary expertise to successfully manage water provision within a budget.

Alfred Nzo District Municipality is one such a WSA that contracts specialist consultants to implement its FBW policy. In fact, it has done so since it started implementing FBW services in 2001. Comments deputy director of water and sanitation, Ernst Zellhuber: "Success is reliant on the involvement of the private sector. It is very unlikely that the WSA has the expertise, or the time to provide the intensive and diverse services needed for the successful implementation of FBW in rural areas. From our experience in the last four years, it has also proved highly cost-effective to employ the support services agents (SSAs)."

SUPPORT SERVICES AGENTS

The project team is quick to point out that contracting SSAs to support the WSA does not infer that privatisation is necessary, only that an independent SSA (public or private) with the necessary expertise appears to be an essential element for reliable and economical provision of water.

The WSA is responsible for policy, contracting the SSA and water services providers, budgets and ensuring all parties are fulfilling their obligations. In turn, the SSAs ensure that daily operation and maintenance of schemes happens, and are responsible for community liaison and capacitating, management, and budgets, and regular reporting to the WSA and WSP.



Cost recovery remains an issue in poor municipalities. Affordability of FBW is therefore determined mainly by the Equitable Share allocations from national government.

OPERATION AND MAINTENANCE

Implementing FBW certainly does not come cheaply. It is estimated that implementing this policy could cost local authorities about R5,84 per capita per month. This includes operation and support and asset replacement.

One recurring cause for concern was the lack of asset replacement costs in WSA budgeting. This will cause a major problem in the future when infrastructure needs to be replaced. As noted by Jim Gibson of Maluti Water, a SSA to Alfred Nzo District Municipality: "Operation and maintenance is not a project, it is an enterprise. Planning should be done with this in mind, and the different cycles the system will go through must be allowed for."

It was noted that where a WSA had not developed a FBW policy, an *ad hoc*, unreliable operations and maintenance system tended to be in place, with higher costs than encountered where a reliable, comprehensive service was provided. This highlights the need for WSAs to prioritise FBW, regardless of their budget restraints, as FBW-by-default could result in greater expenditure than if the time, resources and budget are allocated for the development of a sound FBW policy and implementation strategy.

How much should be budgeted? While plastic pipes and concrete reservoirs do have a long life expectancy, other items such as valves, meters, pumps, engines and electrical controls are faster wearing. In today's value, an average scheme costs about R1 400 per capita to construct. If 20% of this has to be replaced or upgraded every ten years, that is R280 per capita to be spent every ten years.

In rural areas water provision is generally communal, unmetered and, for the most part, not paid for.

HOW TO IMPLEMENT A FREE BASIC WATER POLICY

The WRC report, *Development of Models to Facilitate the Provision of Free Basic Water in Rural Areas*, makes the following recommendations with regards to implementing FBW in rural areas:

- Undertake a thorough investigation of the status of existing water schemes. The water services authority (WSA) needs to have a clear understanding of how all the schemes are operating, where refurbishment is needed, and where new capital projects are required.
- Once the current status has been established, the budgets and the implementation of institutional arrangements can be discussed. It needs to be ascertained what expertise is available within the WSA, and where expert assistance will be needed to supply water across the entire WSA. It is at this stage that roles and responsibilities should begin to be allocated.
- A WSA should undertake costing exercises for the different institutional arrangements, drawing of the experience of other WSA.
- The WSA needs to determine what can be afforded, what extra income is needed, and where this money will be found. Included in this must be an allowance for asset replacement.
- From the costing, the required percentage allocation from the Equitable Share will be clear, and can be motivated for.
- It is essential that political support and commitment is obtained at an early stage and nurtured throughout planning and implementation.

EQUITABLE SHARE

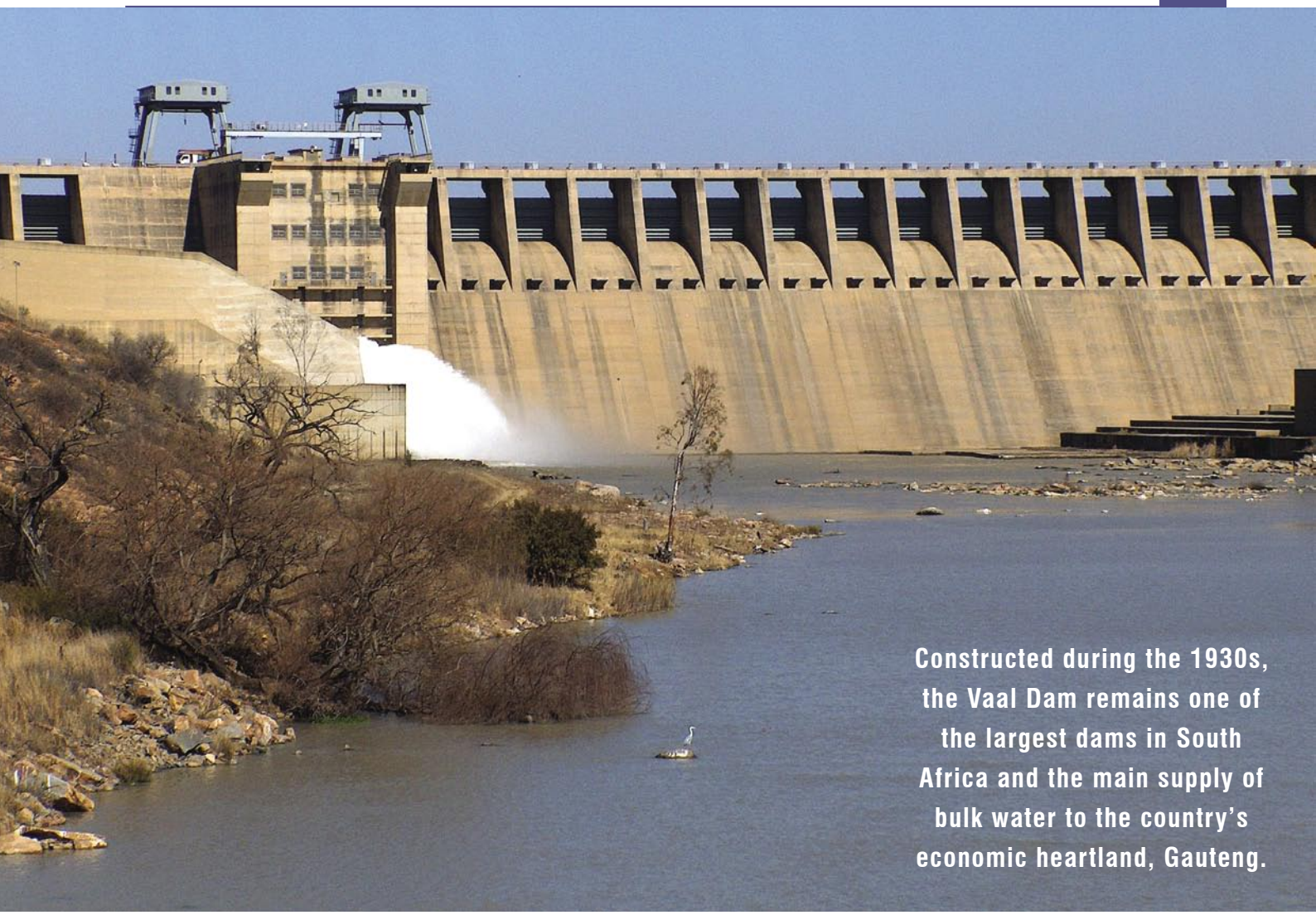
Cost recovery remains an issue in poor municipalities. Affordability of FBW is therefore determined mainly by the Equitable Share allocations from national government. The study found that at present, ES allocations are insufficient to cover operations and maintenance costs in all but one of the rural areas investigated.

The Free Basic Service grant is determined by the number of people actually being provided with the services. Therefore, as the WSA increases its level of provision, the grant allocation will increase. However, the problem is that different indigence statistics are more difficult to rectify.

National Treasury only supplies grant finances for the indigent households as determined by the latest census statistics. These statistics differ significantly from the indigence statistics used by some of the municipalities in this research. For example, in uMzinyathi District Municipality, census 2001 gives an indigency level of 72%, while the water services development plan for the district municipality gives an indigency level of 93%. This means about 100 000 people are not provided for by the ES.

In summary, the key factors in successful implementation are good planning; the honest assessment of WSA capacity and consequential contracting of experts to fulfil the role and responsibilities the WSAs cannot fill; political support for the FBW policy; and accountability.

To order the report, *Development of Models to Facilitate the Provision of Free Basic Water in Rural Areas* (WRC Report No 1379/1/05) contact Rina Winter or Judas Sindana at Tel: (012) 330-0340; Fax: (012) 331-2565 or E-mail: publications@wrc.org.za



Constructed during the 1930s, the Vaal Dam remains one of the largest dams in South Africa and the main supply of bulk water to the country's economic heartland, Gauteng.

SA's Rich Water History Unearthed

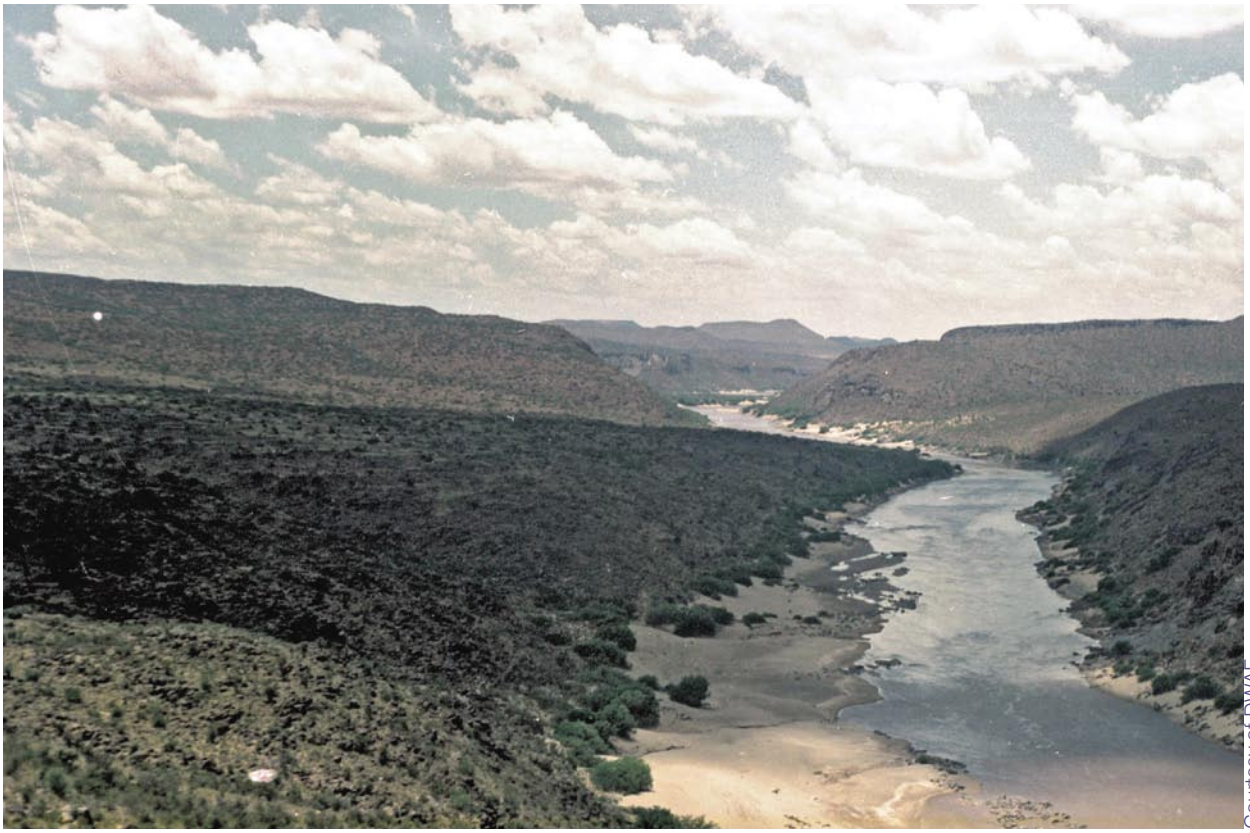
Water remains one of the most influential factors in South Africa's history it has been revealed by a recently published Water Research Commission report. The report,* A Hydropolitical History of International River Basins*, summarises the findings of a study of the country's four international river basins – the Orange, Limpopo, Incomati and Maputo.

This is the first time that the hydropolitical history of these major international river systems in South Africa has been captured in one coherent document. As the authors point out: "From the beginning of South Africa's history water has played an important role in the shaping of the country, not only demographically, but also politically. Water availability helped to determine where and how humans lived, and influenced the way in which they relate to each other. By analysing the history of these river basins we can contextualise the current patterns of conflict and cooperation between riparian countries."

The rivers' development has come a long way since the first humans, the San and the Khoi-Khoi, found their way to the southern tip of Africa about 2 000 years ago. Today they are interconnected through a multi-faceted system of inter-basin transfers. Not only are the four rivers linked to each other, they are also linked to other national river basins, such as the Fish and Sundays rivers in the Eastern Cape.

FINDING ECONOMIC VALUE IN WATER

While rivers such as the Orange had always been valued as a source of



Courtesy of DWAF

water and food for South Africa's indigenous people, it was the Europeans who first attached economic value to it. Being the first large river to be encountered when whites started to move into the interior of South Africa, it was also the first river to be exploited. In fact, plans to develop the Orange River have been found as far back as 1850, indicating that the Orange River Project dates back much further than the 1960s when construction started on what was then one of the biggest projects of its kind in the world.

The Gariep Dam (then known as the Hendrik Verwoerd Dam), near Colesberg, is the main storage structure within the Orange River. From here water is supplied in two directions, namely westward along the Orange River (via hydro-electric power generators) to the Vanderkloof Dam, and southward through the Orange-Fish Tunnel to the Eastern Cape.

While the development of the country's water resources was sparked by the discovery of diamonds in 1867 and gold in 1886, projects were implemented in seriousness after the great depression and drought of the early 1930s. Most of the projects were implemented during the time of the world economic boom (from about 1930 to mid-1970s), an indication that population growth and socio-economic development are some of the most important drivers behind the implementation of such projects. Apart from the Orange River Project other inter-basin transfers include the Tugela-Vaal project, the Vaal-Gamagara Scheme, and the Usutu-Vaal Scheme, among others.

Interestingly, the project team found that international cooperation dates back much further than 1926, when South Africa signed an agreement with Portugal regarding rivers of mutual interest (the Limpopo being one). In 1899, the Aliwal North Water Supply Scheme and the Odendaal Stroom Scheme were discussed between the Cape Colony and the Orange Free State (parts of the Orange River formed the border between the two). Notwithstanding a joint conference between the two governments, the outbreak of the

ALL IN A NAME

The Orange River (above) was named after the House of Orange by Colonel Robert Jacob Gordon during his expeditions to the river in 1777. Before the river had been known as the Gariep ('Great River'), by the Khoi-Khoi or Dragon River by the San.

Anglo-Boer War later that year put a stop to the implementation of the project.

Today, a number of international agreements and treaties have been signed between South Africa and its neighbours regarding the international rivers. According to the authors, these agreements and treaties are positive aspects that bode well for future cooperation within the international river systems.

ASSISTING A MINORITY

Many of the country's water resource development projects implemented during this period, including the construction of the Hartbeespoort and Vaal dams, were done to create employment among so-called poor whites. Politics started playing an even more important role in the development of South Africa's water resources as project after project was implemented in all four river basins for the benefit of a minority white electorate, especially after 1949, when the National Party came to power.

Water also played a central role in the establishment of Bantu homelands, especially when irrigation projects were set up to supply water to these territories' agrarian economies. Thus, water was not only an economic resource, but also one with which the government could advance its ideological and political agendas.

Between the 1960s and 1980s, South Africa found itself isolated and ostracised within the world community as a direct consequence of its apartheid policy. The policy had international and national policy dimensions and reactions: the Bantustans, international mandatory and punitive sanctions, the armed struggle of the African National Congress (ANC) and other black resistance organisations, the South Africa armed forces' fight against communism in Angola, the State's search for security and

Courtesy of TCTA

The Katse Dam, part of the Lesotho Highlands Water Project, arguably the country's greatest water engineering feat yet.

status, the widening disparities of the haves and have-nots (not only in terms of money but water resources as well) and the implementation of the Lesotho Highlands Water Project, a massive, multi-dam scheme built to divert water from Lesotho's Maluti Mountains to South Africa's industrial heartland Gauteng.

When the political transformation in South Africa was started on 2 February 1990 by the then President FW de Klerk, the country was a divided society, both politically and economically. The disparity between rich and poor was stark: nearly 18 million people, most of them rural blacks, had no access to safe drinking water or sanitation facilities.

A NEW BEGINNING

In 1994, the ANC was elected the ruling party and Nelson Mandela became the country's first democratically elected president. Through the Reconstruction and Development Programme the government started to address the disparity between racial groups, with the urban and rural poor targeted as the main beneficiaries to receive safe water and sanitation facilities.

The start of the twenty-first century has also been heralded by another change: whereas farmers were lobbying for the implementation of irrigation projects in the arid parts of the country in the nineteenth century, schemes today are directed by environmental considerations as well as considerations for those affected by these large projects.

One of the most significant events of recent times has been the hearings for southern African Communities affected by large dams held by the World Commission on Dams in 1999 which included testimonies from Xhosa labourers displaced by the construction of Gariep Dam.

Water is not only a life-giver, but also a powerful political tool. It is the elixir of life that will sustain future South African generations.

To order the report, Hydropolitical History of South Africa's International River Basins, ***WRC Report No 1220/1/04****, contact Judas Sindana or Rina Winter at Tel: (012) 330-0340; Fax: (012) 331-2565 of E-mail:* publications@wrc.org.za

Irrigation Water Measurement Evaluated

With effective measurement of irrigation water, farmers will not only contribute to efficient use of South Africa's water resources, but increase their competitiveness in the market. Lani Holtzhausen reports.

The increased pressure on South Africa's water resources has made water demand management everybody's business. With more than half of South Africa's water used by irrigated agriculture, there is huge pressure on farmers to increase the efficiency of their systems.

According to the Department of Water Affairs & Forestry (DWAF), while the social and economic value of agriculture, especially in rural areas, is recognised, the volume of the country's water resources dedicated to this activity cannot be ignored. Agriculture has a demand of more than 60% of total water use and, says DWAF, efficient use of water by the sector has the potential to play a significant role towards making more water available for use not only within the agricultural sector itself but also for other sectors.

Not all of the water abstracted for use through conventional irrigation methods reaches the root systems of plants. It is estimated that water losses through current irrigation practices range between 30% and 40%. This is currently being investigated.

An unaccounted proportion of irrigation water returns to the river systems by overland flow and return seepage. This return water can be nutrient enriched and polluted with herbicides, pesticides and other pollutants that can detrimentally affect the water quality of the receiving river systems, including possible salinisation downstream.

RESPONSIBLE USE

The country's water laws stipulate that water user associations (WUAs) are responsible for supervising and regulating the distribution and use of water from a water resource according to the relevant water use entitlements by erecting and maintaining devices for measuring and dividing, or controlling the diversion of the flow of water. The WUA must also show that it is making progress towards measuring the quality and quantity of inflows and outflows, losses and water supplied to its customers, and towards the use of acceptable measuring devices or techniques. Since farmers are members of WUAs, water measurement on farms and irrigation schemes will benefit farmers individually and collectively.

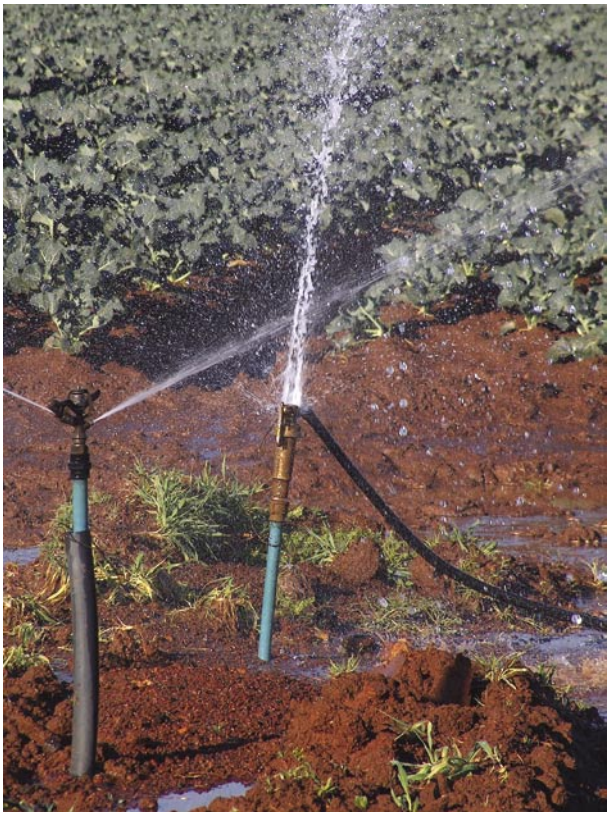
But the law is not the only reason to install measuring devices. A recent project funded by the Water Research Commission (WRC) shows that there are also benefits related to practical water management, including accurate accounting and good records which help allocate equitable shares of water between competitive uses. Moreover, it provides the farmers with the information needed to achieve the best of irrigation water while reducing negative environmental impacts. By reducing their cost of water as an input, farmers can also compete more readily with other producers in today's global market.

"If a measuring system is implemented, accounting for individual water used combined with pricing policies that penalise excessive use is possible."

In addition there are financial incentives for the WUA concerned, comments Isobel van der Stoep, one of the researchers on the three-year project, which was undertaken jointly by the University of Pretoria's Department of Civil and Biosystems Engineering, the Agricultural Research Council's Institute for Agricultural Engineering and Pretoria firm NB Systems. "If a measuring system is implemented, accounting for individual water used combined with pricing policies that penalise excessive use is possible. The combined result at WUA level can improve the operation and cost-recovery of the organisation, and also put it into a strong bargaining position with higher organisations, such as catchment management agencies."

Dr Gerhard Backeberg, Director: Water Utilisation in Agriculture, at the WRC, reports that the last comprehensive report on water meters in South Africa was published by DWAF in 1986. Since then many changes have taken place, e.g. policy, marketing, and technological environment in which farmers take decisions.

There is huge pressure on farmers to increase the efficiency of their systems



Water losses through current irrigation practices range between 30% and 40%.

He points out that the perception that irrigation farmers in general are wasting water is incorrect. "In any case, due to increases in water tariffs and other costs related to over-irrigation, such as electricity and fertilizer, farmers who waste water will not survive financially

SAVING WATER A CHALLENGE FOR SMALL FARMERS

Irrigation water loss remains a dilemma not only in South Africa, but abroad. Research shows that internationally, the average on-farm distribution losses are 15% and on-field application losses 25%.

While South African farmers compare favourably with these figures, it is believed that improvements to reduce wastage can still be achieved in practice. One way in which to do this is through irrigation scheduling.

A Water Research Commission (WRC) funded project on implementation of irrigation scheduling, completed by the University of Pretoria, found that the majority of smallholder farmers do not perceive irrigation scheduling as an important production constraint. "These farmers are preoccupied with persisting barriers to progress, including lack of credit, infrastructure and access to markets, insecure land tenure, vandalism and theft, as well as inadequate extension support," Dr Gerhard Backeberg WRC Director: Water Use in Agriculture, points out.

"These findings show that the situation facing emerging and subsistence farmer is diverse and complex. Given the necessity of including these farmers in the main stream of the economy, must more must be done to assist the farmers by all organisations which can provide support."

In this regard, the WRC has made a significant shift in funding of appropriate research projects to the benefit of smallholder irrigation farmers. These include participatory development of training material, determining best management practices for small-scale farmers, investigating different farm ownership models and support structures, approaches for establishment of profitable small-scale farming and guidelines for revitalisation of irrigation schemes.

because of the narrowing profit margins. Furthermore, from the release of water at the dam wall to the application of water at the root zone, the farmer can only directly control wastage after water has been received at the sluice on the farmer border."

WATER MEASUREMENT IN PRACTICE

Van der Stoep reports that the WRC project was launched in 2000 to review the current situation and needs in the field of irrigation water measurement in South Africa. Extensive field trips were undertaken to identify which measurement technologies were currently being used and which were most effective.

Through its investigations the project team found that there are still many unanswered questions around irrigation water measurement, especially on the policy and legislative side. "WUAs and farmers are concerned over the lack of clear guidelines and directives from DWAF. While water measuring is considered a best management practice, there seem to be no clear guidelines from government on how it should be implemented," notes Van der Stoep.

There are also concerns surrounding the issuing of water use licences (by when will they be issued), improved bulk measurements in rivers (typically at gauging stations) as well as required measuring accuracy should metering at farm level become mandatory. Another issue is how the cost of measuring devices can be covered.

This is especially so among emerging farming communities. "Emerging farmers face so many challenges, not the least of which is a lack of financial and human capacity and access to markets, among others. These issues have to be addressed first before water measurement can be considered a priority, although a start should be made to create awareness of water availability, use and cost recovery," says Van der Stoep.

Accurate measuring devices are expensive and all measuring devices are dependent on correct installation, regular maintenance and calibration, while capturing and recording readings are either labour or instrumentation intensive.

"Emerging farmers face so many challenges, not the least of which is a lack of financial and human capacity and access to markets, among others"

But rather than be a hindrance, water measurement can be a helpful tool. The fair distribution of water on small-scale irrigation schemes in the former homelands areas, for example, is probably one of the biggest causes of conflict among the participants. Often conventional water management procedures are inappropriate, or water management infrastructure is vandalised. This makes it almost impossible for anyone on the scheme to irrigate successfully. Implementing appropriate water measurement tools supported by training and capacity building can assist matters greatly.

CHOOSING THE RIGHT TECHNOLOGY

There is no one magic solution or technology out there to measure irrigation water. Each WUA's situation is unique, and no two WUAs can blindly use or apply the same devices or methods

The selection of a measuring device will depend on how the characteristics of the available devices satisfy the requirements set by the WUA. To

Several water measurement methods are reviewed in the new WRC report.

help WUAs choose the technology that is right for them, the project team compiled a water measuring guideline and developed a computer-based database of commercially available measuring devices for irrigation water.

There is no one magic solution or technology out there to measure irrigation water. Each WUA's situation is unique, and no two WUAs can blindly use or apply the same devices or methods.

The guideline comprises a series of components. They include:

- A reason for measuring;
- Acceptance and support by the water users;
- Assessment of the current situation and planning the system;
- Choosing appropriate technologies;
- Correct installation by skilled technicians;
- Sound operation and maintenance policies;
- A system for data retrieval and management;
- Comprehensive financial planning; and
- Procedures for handling disputes and tampering.

"Water measurement in some form is now a management imperative and, therefore, these guidelines are absolutely essential to meet the requirements of modern farming," Dr Backeberg points out.

THE WAY FORWARD

The legal requirements of the National Water Act are clear. In order to successfully manage and license water use it is necessary to quantitatively verify water use. While there is definite interest from farmers to implement water measurement, across the board overnight introduction of measuring water volumes is neither economically or physically possible, comments Van der Stoep.

"We have had lots of interaction with farmers during the course of this project, however, there is still much knowledge dissemination that needs to take place. There are plans to launch a series of regional workshops before the end of the year. Based on the completed project and guidelines an easy-to-use training manual will also be compiled."

It has also been recommended that a knowledge centre be created to continue research, prepare and distribute information, train students and provide a field service to WUAs in assisting them with measuring, implementation, evaluating devices and trouble-shooting.

At the same time, the WRC, together with the ARC has initiated a major project and is collaborating with farmers on irrigation schemes in selected WUAs on standards and guidelines for improved efficiency of irrigation water use. In another WRC initiated project, a consortium of researchers are cooperating in a technology transfer project to promote the integrated implementation of irrigation management models.

To obtain a copy of the report, Guidelines for Irrigation Water Measurement in Practice *(**Report No TT 248/05**) contact the publications department at the WRC at Tel: (012) 330-0340, Fax: (012) 331-2565 or E-mail: publications@wrc.org.za*

WATER Kidz

Groundwater – More Valuable Than Gold

Water can be found all around us. In streams, rivers and dams and even in the air. Water can also be found under the ground. Groundwater is an important part of the water cycle.

Groundwater comes from rain, snow, sleet and hail that soak into the ground. The water moves down into the ground because of gravity, passing between particles of soil, sand, gravel, or rock, until it reaches a depth where the ground is filled, or saturated, with water.

The area that is filled with water is called the saturated zone and the top of this zone is called the water table. The water table may be very near the ground's surface or it may be hundreds of metres below.

Although groundwater exists everywhere under the ground, some parts of the saturated zone contain more water than others. An aquifer is an underground formation of permeable rock or loose material which can produce useful quantities of water when tapped by a well. These aquifers may be small, only a few hectares in area, or very large, underlying thousands of square kilometres of the earth's surface.

Even if groundwater isn't used by people it may still play an important role in the local environment and sustain rural livelihoods in that way.

GROUNDWATER IN SOUTH AFRICA

Groundwater, despite its relatively small contribution to bulk water supply (13%), represents an important and strategic water resource in South Africa. Owing to the lack of perennial streams in the semi-desert to desert parts, two-thirds of South Africa's surface area is largely dependent on groundwater. In these water-scarce areas, groundwater is more valuable than gold.

Although irrigation is the largest user, the supply to more than 300 towns and smaller settlements is also extremely important. Groundwater has also become a strategic resource for village water supply in the wetter parts of the country, because of its cost-effectiveness in a widely scattered small-scale-user situation.

DID YOU KNOW?

About 22% of the world's available freshwater is stored underground.

Over about 90% of the surface of South Africa, groundwater occurs in hard rock. Groundwater in these rocks is contained in fractures and in dolomite and limestone, in dissolved openings called fissures.

Hard rock aquifers are known as secondary aquifers because the groundwater occurs in openings which were formed after the rock was formed. Over the remainder of the country groundwater occurs in primary aquifers. These comprise porous sediments and groundwater is contained in the spaces between sand grains.

Primary aquifers are found in river (alluvial) sediments, in coastal sand deposits, and in the Kalahari deposits.

GROUNDWATER POLLUTION

Just because water is underground doesn't mean it can't be polluted. Groundwater can be contaminated in all sorts of ways. Pollutants dumped on the ground or in landfills may leach into the soil, and work their way

GROUNDWATER WORDS

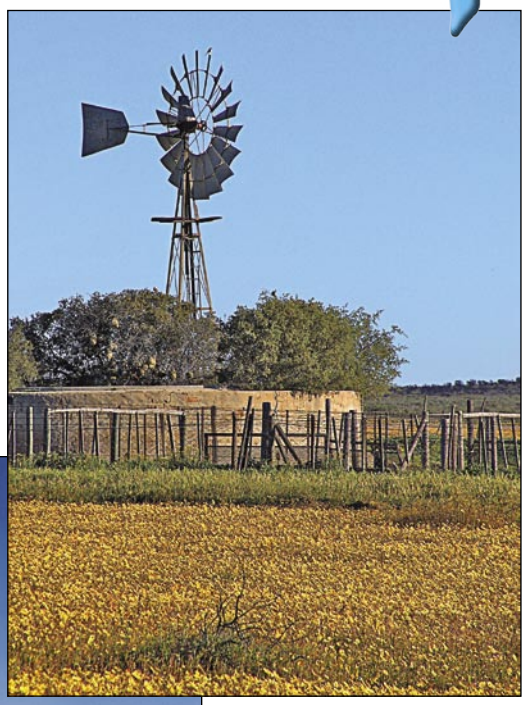
Aquifer: A geologic formation(s) that bears water. A geological formation or structure that stores and/or transmits water, such as wells and springs.
Baseflow: Streamflow coming from groundwater seepage into a stream.
Groundwater: Water stored underground in rock crevices and in the pores of geologic materials that make up the Earth's crust.
Recharge: Water added to an aquifer. For instance, rainfall that seeps into the ground.
Water table: The top of the water surface in the saturated part of an aquifer.

down into aquifers. Pollutants include substances that occur as a liquid (such as oil); or can be dissolved in water (such as nitrate) or are small enough to pass through the pores in soil (such as bacteria).

Movement of water within the aquifer is then likely to spread the pollutant over a wide area, making the groundwater unusable. Typical contamination sources include on-site sanitation (such as unlined latrines); waste disposal sites; burial sites; and animal husbandry.

OVER-ABSTRACTION

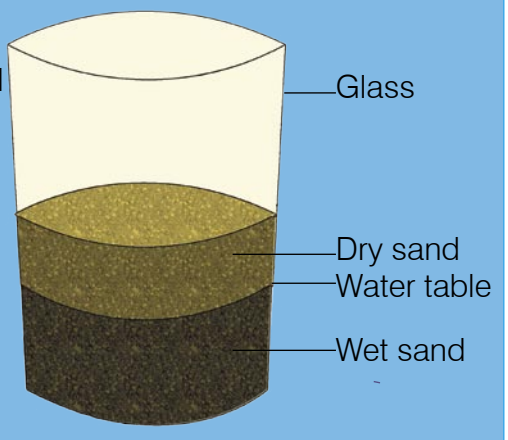
While groundwater is an abundant resource it does not mean we should waste it. The maximum quantity of groundwater that can be developed economically is estimated at about 6 000 million m^3 a year.



Some groundwater resources take a long time to replenish. If too much groundwater is extracted too fast, it may become depleted. Therefore, it is important to decide how much water can be extracted from an aquifer before it is developed.

MAKE A GROUNDWATER MODEL

Take a glass or clear plastic container and fill it with sand. Pour some water into the sand. This shows how water collects under the ground. Pour some water into the sand. What happens to the level of the water? We call this top level of the water the water table. Take a drinking straw and put it down into the wet sand. The straw is like a borehole. Suck up some water. What happens to the water table now?



Combining Science & Art in Search of Groundwater

History tells us that humans have long known that much water is stored underground, but it is only within recent decades that scientists and engineers have learned to estimate how much water is stored in the earth and have begun to document its vast potential for use. The study of where and how water moves underground is called hydrogeology.* The Water Wheel *chatted to one of South Africa's premier hydrogeologists, Gary Small, to find out what this water career entails.

HOW AND WHY DID YOU BECOME INTERESTED IN HYDROGEOLOGY?

I initially studied towards a BSc degree in geology at the University of Witwatersrand. While doing my master's degree in earth sciences at the University of Stockholm, Sweden, I became interested in groundwater issues, particularly in relation to international aid and development. My first interest was to use my earth science training in order to assist communities in developing countries with the provision of clean water. I have also completed MSc course work in environmental engineering at the Royal Institute of Technology, in Stockholm.

WHAT DOES YOUR CURRENT JOB ENTAIL?

I work in a consulting company as a principle hydrogeologist. I am also a director of the company. My work centres on responding to requests from clients for hydrogeological investigations, which may be either related to groundwater quantity (water supply, mine dewatering and so on) or water quality (such as contamination studies) or both.

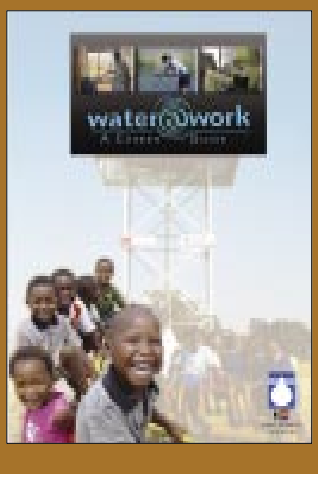
A project typically following the following phases: proposal, desktop study, field work, data interpretation, report writing and client liaison. I am involved with all of these phases, predominantly as a project manager where I supervise and guide or mentor staff with less experience. I do occasionally still undertake small projects completely on my own. I also lecture courses at university in hydrogeology.

There are enormous opportunities for geohydrologists both in South Africa and internationally, for example, I have worked in Sweden, Israel, Burundi, South Africa and Mozambique.

WHAT ARE THE GREATEST ASPECTS OF BEING A HYDROGEOLOGIST?

Hydrogeology is an extremely diverse and stimulating science involving aspects of geology, mathematics, physics, chemistry and geography. There is always something new to learn.

It can also be very challenging. The ability to conceptualise the underground environment with mostly very little available information is the most challenging aspect. It requires a solid understanding of several sciences as well as an imagination that involves artistic ability. It is the combination of science and art.



For more on this and other careers in water, see *Water @Work* available from the Water Research Commission. To obtain a copy phone Publications at
Tel: (012) 330-0340;
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E-mail:
publications@wrc.org.za

WaterNet
Regional Masters Degree Programme
in Integrated Water Resources Management 2006

Applications are herewith invited for admission to the regional Masters Programme in Integrated Water Resources Management to be offered in 2006 by WaterNet member institutions.

Structure of the Programme

The programme comprises a compulsory core (consisting of six modules), followed by a specialisation (consisting of three modules and two electives).

The compulsory modules are:

- Principles of IWRM
- Principles of Hydrology
- Socio-Economic Aspects of Water and Environmental Resources
- Principles of Aquatic Ecology and Environmental Management
- Policies, Laws and Institutions
- Project

The specialisations are:

Specialisation 1: Water Resources Management

- Water Analysis and Planning
- GIS and Database Management
- Catchment Management

Specialisation 2: Hydrology

- Hydrogeology
- Remote Sensing and GIS
- River Engineering

Specialisation 3: Water and Environment

- Environmental Impact Assessment
- Water Quality Management
- Environmental Water Requirements

Specialisation 4: Water for People

- Water Supply and Sanitation
- Utility Management
- Waste Water Management

Specialisation 5: Water and Society

- Water and Security
- Environmental Education
- Water and Development

Financial Assistance

WaterNet will offer scholarships to selected successful applicants. The scholarship covers tuition, fees, travel, accommodation, and reasonable living expenses.

How to Apply

The initial application is made to the WaterNet Secretariat, who will then pass the application to the relevant member institution.

The application should include:

- An application letter in which first and second choices of specialisation are clearly indicated.
- A short curriculum vitae with academic background and professional experience.
- A one-page essay motivating why you should be selected for the Masters programme and the reason for your choice of specialisation.
- Copies of degree transcripts and certificates.

Submit the application in electronic form to waternet@eng.uz.ac.zw or in hardcopy to WaterNet, PO Box MP 600, Mount Pleasant, Harare, Zimbabwe. **Applications should reach WaterNet on or before 7 October 2005.**

(PS: Please clearly distinguish your first name, other name(s), and surname in your application.)

For any further information, please contact the WaterNet Secretariat.

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