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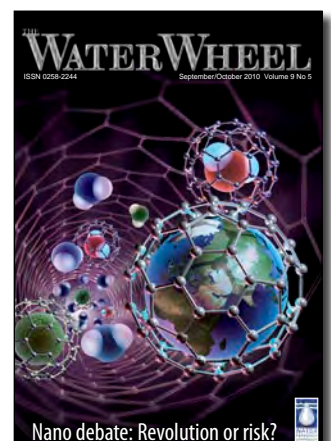
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Cover: The debate is raging over the benefits versus the risks of nanotechnology. See page 14. Cover illustration by Ralf Broemer.





Letters to the Editor

Appreciation for the Water Wheel

The team producing *the Water Wheel* magazine deserves a jolly big pat on the back. The magazine contents are interesting, well written, informative and of a very high quality. The layout and presentation is superb and very professional. I particularly enjoy the articles on the history of dams and readers' comments.

Having been involved in hydrology for some 41 years now, I find the various articles on climate change and global warming intriguing as many theories exist, resulting in our renowned scientists occasionally being at loggerheads with each other, often leaving readers amused and sometimes confused. More of this please.

You can truly be proud of an outstanding publication. Keep up the excellent work.

Felix Wulff, Pretoria

Why ORP was never expanded

In his letter in *the Water Wheel* of July/August 2010 Robert Blythe wrote: *"The scope of the project as outlined in the 1962 White Paper was far greater than has actually been implemented since. This is particularly true of the irrigated areas to the west. There has been virtually no transformation of the desert."*

The idea of "making the desert bloom" in the Karoo by means of supplying water from the Orange River was simply an illusion. To make a desert bloom by means of irrigated agriculture one needs both (a) irrigable soils and (b) water. In the planning of the Orange River scheme attention was given only to the provision of water. This consisted only of engineering planning, such as identification of dam sites, types of dam wall structures, identification of water command lines for the siting of canals for delivering water from the Vanderkloof Dam to envisaged irrigated areas, etc. All emphasis was

on irrigation development south of the Orange River, i.e. in the Karoo. North of the river provision was to be made only for a small canal to supply water to the Rama area.

No soil surveys were done before or during the planning stage of the Orange River scheme to determine how much irrigable land there was in the envisaged irrigated areas and where these irrigable soils were. Soil surveys were conducted only when the Gariep Dam was already being constructed. When soil surveys eventually started in the northern Karoo, close to where the Vanderkloof Dam was to be built, it soon became clear that there were extremely little irrigable soils in the area. There were only a few small areas near Hopetown.

The findings by the young soil scientists doing the survey led to great drama. They started contacting Prof Roelof du Toit (Roelf or "Tuffy") Burger, then Head of the Department of Soil Science at the University of the Orange Free State, informing him of their findings. They knew that he had the strength of character to take this up strongly and clearly with the authorities in Pretoria, which he did repeatedly. He invariably received nasty letters from Pretoria telling him to keep his nose out of the matter. I was a young lecturer in his department at the time and he always discussed the problem with me and showed me the letters. After one particularly nasty letter he said to me: *"Giel, moet ek nie maar liewer ophou nie. Dis nie goed vir my gesondheid nie."* He had serious heart problems. But after a while he said: *"Maar my gewete laat my nie toe nie."*

Eventually tenders were invited for the construction of the Vanderkloof Dam. One day we received instructions to meet a delegation from Pretoria in the board room of the Faculty of Agriculture to once and for all tell them what our objections and reservations were. I remember we had to meet on a Thursday in about the middle of October in I think 1969, a week before the contract for construction of the dam was to be awarded. The persons who received the instructions were Roelf

Burger, Giel Laker, Boet Human (senior lecturer in Agronomy at UOFS), Skroef van Zyl (senior lecturer in Agricultural Engineering at UOFS) and Dries van der Merwe (soil scientist in the OFS region at Glen). The Pretoria delegates included Dr SJ du Plessis, Deputy-Secretary of the Department of Agricultural Technical Services, Mr Kriel, Secretary of the Department of Water Affairs, Mr Du Plessis, Chief Planning Engineer of the Department of Water Affairs, and others. It was pointed out to the delegation that the extent of irrigable soils south of the river was extremely limited, but that there were large blocks of irrigable soils north of the river, especially in the Ploosburg area.

The day of tough discussions was followed by a site visit on the Friday. I could not join the visit because of lecturing duties. As I left the Agriculture building the afternoon Skroef arrived full of smiles. He told me that before 10:00 the morning Dr Du Plessis told his advisors that they had misled him.

The next week it was announced that it was decided to postpone the construction of the Vanderkloof Dam due to 'inflation'. The fact is that the dam, especially the outlets, had to be redesigned and barely a year later construction of the dam started. The Minister of Water

Affairs also announced that the plans regarding the areas to be irrigated from the Vanderkloof Dam had been changed drastically. Although it was very late, the authorities this time at least listened to soil scientists and adapted the planning accordingly. Unfortunately this is seldom the case, not only in South Africa. An unused canal section south from the Vanderkloof Dam which was built prematurely at a cost of about R2-million (a lot of money at the time) is still a silent 'monument' for what could have been a major disaster.

It can safely be said that Roelf Burger, through his unwaivering courage and perseverance saved the country from an economic, agricultural and ecological disaster.

To date there has been no large-scale irrigation development on the irrigable areas identified north of the Orange River. According to the PhD thesis of Dr Koos Eloff (1984) these amount to about 370 000 ha, of which about 160 000 ha are in the Ploosburg area. Only a few small areas have since been developed. In 2009, a senior Water Affairs engineer told me that there is presently no water available for development of these large irrigable areas. One wonders what would have happened if there were large areas



of irrigable soils south of the river and these were developed or if large areas north of the river were developed earlier. Ironically there is thus presently not a lack of irrigable land in the central parts of the country, just a lack of water.

Prof Giel Laker, Pretoria

Climate change – reader provides some answers

Professor Alexander's letter in the May/June edition of the *Water Wheel* (Climate Change – More Questions than Answers) is a defense of his argument that there is no need to take measures to mitigate against climate change. In support of his position, he makes a number of points, none of which carry serious weight:

- 1 *His research has shown no indication of significant changes to rainfall trends in South Africa.*

Professor Alexander's interpretation of his own research has been challenged by South African climatologists. But whatever the interpretation, rainfall in South Africa is but a tiny element of the global climate. It cannot on its own be used to judge whether climate models are accurate.

- 2 *Rainfall trends elsewhere in the world similarly show no evidence of climate change.*

This is simply incorrect. For example, Australian researchers have found a link between surface sea temperature changes in the Indian Ocean and off Indonesia to the significant decline in rainfall in South East Australia since 1950. NASA has found a link between drought in East Africa since 1980 and higher Indian Ocean temperatures.

- 3 *There has been no significant increase in global temperatures over the past few decades.*

Again, the scientific evidence is to the contrary. The UK Met Office recently published a report indicating that global temperatures have risen 0.75° over the last 100 years, with 2000 to 2009 being the warmest decade on

record. The NASA Goddard Institute for Space Studies has found that global surface temperatures have increased significantly since the late 1970s. These findings (and many others) vindicate the "hockey stick" graph mentioned in his letter.

- 4 *The European winter of 2009/2010 was one of the coldest on record.*

This is not a serious argument against global warming. Firstly, there is no evidence that average global temperatures were cooler than normal, and secondly, climate is a long-term phenomenon. Climate has been confused with weather.

- 5 *Scientists at East Anglia University's Climate Research Unit have been manipulating the evidence that supposedly points to anthropogenic (human induced) global warming (AGW).*

Professor Alexander's account of this episode is highly selective, focusing on the media headlines quoting a few fragments of the many thousands of e-mails released by the hackers. He omits crucial information on subsequent inquiries into the matter: In January 2009 the Science and Technology Committee of the British House of Commons announced an inquiry and called for submissions. The concerns expressed by the three scientific institutions mentioned by Dr Alexander formed part of their submissions to the inquiry. The inquiry report was released at the end of March. **It cleared the scientists of all serious allegations.** On the integrity of the scientists, the inquiry found that "the scientific reputation of Professor Jones and CRU remains intact". On the actual climate science, it found that "the controversy did not challenge the scientific consensus that 'global warming is happening and that it is induced by human activity'". A more detailed inquiry into the conduct of the researchers was set up by the University, led by an international team of scientists. The "CRU Scientific Assessment Panel"

was selected in consultation with the Royal Society. It consisted of scientists from Cambridge, Imperial College, MIT, University of Arizona and ETH (Swiss Federal Institute of Technology, Zürich). Its conclusions were even more emphatic. According to the panel's chairman, they found "**absolutely no evidence of any impropriety whatsoever**", and concluded that the allegations had been made by people "who do not like the implications of some of the conclusions" reached by CRU.

- 6 *The International Panel on Climate Change (IPCC) has been publishing false information to support its position on AGW.*

These are errors in how the panel's findings have been communicated, and have no bearing on the underlying science. To label them as "fraudulent activities" is ridiculous. What they indicate is that the IPCC should exclude non-scientific sources for information in its reports and improve its editing procedures.

The IPCC's reports reflect the scientific consensus that anthropogenic global warming is happening now. This view is supported by the large majority of scientific institutions across the world. These include the US National Academy of Sciences, the UK Met Office, the American Association for the Advancement of Science, the American Geophysical Union, the American Institute of Physics and the American Meteorological Society. Virtually all peer reviewed climatological research on climate change also supports this consensus.

The implications of the consensus are that the risk of rapid global warming is very high, and that the consequences of this are likely to be catastrophic for human society. In attempting to refute the scientific consensus, Professor Alexander has focused on media headlines and has regrettably made unfounded attacks on the integrity on fellow scientists at the University of East Anglia.

For any readers who are concerned about the risk that global warming poses to future generations, and who

are interested in the answers to the professor's questions, there is plenty of information available. The *New Scientist* has a series "Climate change: A guide for the perplexed" and *The Scientific American* has published "Seven Answers to Climate Contrarian Nonsense". Both are easily found on the Internet.

Rob Dyer, Durban

Prof Will Alexander responds:

Climate change scientists have three fundamental obligations. First, they have to determine the natural conditions. Second, they have to determine the departure from these conditions if no action is taken to control greenhouse gas emissions. Third, they have to determine the reduction in the undesirable consequences if these emissions are controlled. These three responses have to be a numerical format in order to facilitate mitigation and adaptation procedures. The procedures in turn require the cooperation of those of us in the applied and engineering sciences.

Sadly, climate change scientists refuse to consider inputs from those of us in the other disciplines. I have yet to see this information in a climate change publication. The absence of this information supports my view that there is no need for concern regarding climate change until such time that this information has been produced, verified and distributed.

The following are the responses to Rob Dyer's comments.

- 1 *Rainfall is the dominant concern globally as well as in South Africa. Without it there would be no life on this planet. If the model outputs predict a drier climate when the opposite is the case, then they are obviously inaccurate.*
- 2 *There is no evidence of a decrease in South African rainfall during the past 100 years despite increasing global temperatures and emissions. This demonstrates that there is a fundamental error in the basic theory.*
- 3 *The hockey stick growth has been totally discredited. It is based on studies of tree*

- rings and ice cores. It suppresses the well-documented historical warm and cold periods during the past 1 000 years.
- Climate change scientists are fond of claiming that unusual events are the consequence of climate change, except when they are contrary to model predictions when they become weather, not climate.
 - The climate gate affair and the need to appoint three committees to investigate it precipitated a flood of responses worldwide. These, in turn, resulted in both the Royal Society and the chairman of the IPC see having to acknowledge that there were still uncertainties in climate change theory. Both were previously adamant that the signs were settled. This was also the consensus view. Obviously the consensus view is in error.
 - The claims in the IPC reports that the Himalayan glaciers would melt within 25 years and that the Amazon forests were being damaged by climate change, were both acknowledged to be false and misleading. They were by no means simple editorial errors. They were deliberate erroneous statements.
 - The statement that there is a scientific consensus that anthropogenic global warming is happening now is also false. Dr Jones and others have acknowledged that there has been no sustained increase in global temperatures since 1998. The authorities that are quoted by the writer have been challenged. They are fears that the world could be entering a mini ice age.
 - The conclusion that the consequences of increases in global temperatures could be catastrophic for human society is unbelievably naive. Variations in global climate are driven by variations in the receipt and redistribution of solar energy, not variations in global temperatures. Temperature does not feature in the analysis of floods, droughts and water resource development.

- Finally, why does the writer not quote the Royal Society's decision to rewrite its document on the basics of climate change theory? There are also several published books that are critical of climate change science.

Editor: The debate on this matter is now closed. No further correspondence will be published in this regard.

Who is protecting imported peat?

Great magazine, although I have some comments regarding the saving of local peatlands from exploitation ('For Peat Sakes', *the Water Wheel* July/August 2010). The article was very informative and covered the wide ranging effects of the destruction of our peatlands, but what was jarring at cross purposes was the way that the use of imported peat was condoned.

It makes little sense that South African peat should not be exploited or removed commercially by opening up the land for agriculture and development, but the imported peat from Europe is obtained at the expense of their marshes! Surely what is bad here is bad there too!

I would not be comfortable protecting our peatlands and feeling smug about it when we well know that the imported peat we use is a product of the very actions we want to stop here!

Riyaz Nakhwa, Cape Town



SA's peatlands facing extinction

Water by numbers

20-million hectares – The land area of South Africa infested with invasive alien plants, according to a new report by the Agricultural Research Council. This is twice as large as previously estimated. The largest infestation of invasive alien plants occur in the Eastern Cape (600 000 ha affected), followed by KwaZulu-Natal (300 000 ha).

R800 000 – The money set aside by government for the Luvuvhu Adopt-a-River project in Limpopo, according to Deputy Minister of Water & Environmental Affairs Rejoice Mabudafhasi. Through this initiative around 100 women from villages around Vhembe have been identified to clean the river for the next year at a stipend.

1 600 – The estimated number of people who lost their lives in devastating floods triggered by monsoon rains in Pakistan. According to the UN, more than 300 000 homes were destroyed or damaged, 14 000 cattle perished and 2,6 million acres of crop land was inundated, leaving 17 million people affected.

50% – The percentage of industrial drainage that is returned for reuse in urban and industrial areas such as Johannesburg and Pretoria.

24 hours – The notice given to Coal of Africa to cease all operations at its Vele Colliery in the area of Mapungubwe, in Limpopo. The mine incurred the wrath of environmental groups when it allegedly started illegal mining operations in this historic area.

15 – The number of transboundary rivers in southern Africa, whose combined drainage area cover 78% of the region's continental land area. Major international rivers in the region include the Congo, Zambezi, Okavango, Limpopo, Orange, and the Cunene.

New research chair to look at food security and water quality

Rising concern over the effect of deteriorating water quality on the country's food security has prompted the CSIR to establish a Research Chair in Food Security and Water Quality.

According to Dr Paul Oberholster, limnologist at the CSIR, the need to establish such a chair became apparent after the consideration of the results of recent preliminary studies conducted on behalf of the Loskop Irrigation Board. Among others, the chair will scientifically investigate the extent and severity of water pollution and its effect on the availability and quality of food in South Africa. Funding will be sought from private-sector partners to achieve its goals.

The Transvaal Agriculture Union (TAU) has expressed its whole-hearted support of the chair. "The elements that go into produce the nation's food are like the links in a chain. All of these elements – be it fertilisers, good soil or good water – need to be in place to ensure optimal crop production," explained TAU Deputy President Louis Meintjies. "We have been concerned over the deteriorating quality of South Africa's water for some time, and we need to understand the overall impact this is having on crop production and the nation's food security. We hope the new chair will be able to achieve this."



Chemicals manufacturer cleans up its act

A company's efforts to clean up its act has won it an award.

AECI has received the runner-up award in the innovative strategies category of the *Mail & Guardian's* Greening the Future awards. The award was received for the firm's remediation initiatives at its Umbogintwini Industrial Complex near Amanzimtoti, KwaZulu-Natal.

The remediation project, led by SRK Consulting, was initiated in 1995 to address the contamination of land and groundwater resources as a result of historical activities associated with the manufacture, storage and distribution of chemicals, agrochemicals and fertilisers. The Vumbuka Reserve, a 27-ha area in the north-west portion of the complex proved the greatest challenge to the remediation team. This area was historically used for the disposal of liquid and semi-solid wastes, and had provided the source for widespread off-site and on-site groundwater contamination. The main contaminants of concern were

chlorinated solvent. SRK consequently developed a rehabilitation strategy for the reserve containing six elements: hydraulic control of contaminated groundwater migration; minimisation of rainwater infiltration; management of surface water run-off on to and from the area; natural and enhanced *in-situ* source reduction; monitoring of performance; and community liaison.

Hydraulic controls, such as the abstraction and treatment of groundwater, were implemented early in the project to prevent further groundwater contamination from reaching the neighbouring residential area of Ezimbokodweni. Dewatering the dams in the reserve also served to reduce the hydraulic head that was driving groundwater beyond the boundaries of the complex.

Furthermore, after much investigation, a vegetative, evapo-transpiration (ET) cover was implemented to cap the dewatered dams and thus reduce rain-

water infiltration. The ET cover provides long-term sustainability for remediation since the microbial action associated with vegetation and its growth reduces maintenance and provides contaminant source reduction as roots grow deeper into the waste body.

After evaluating the likely effectiveness of various methods of contaminant source reduction, including physical removal by excavation and/or pumping and treating, *in-situ* bio-remediation was selected as the preferred approach. Monitoring of contaminant levels and other parameters demonstrated that natural degradation is occurring in the dams area of the Vumbuka Reserve, but that in the so-called drums area (where drums originally containing chlorinated hydrocarbon wastes have been buried) enhanced degradation will be required. A programme of *in-situ* trials was carried out by SRK and has resulted in the injection of an organic substrate and

bacterial population injected into selected wells to create a bio-barrier within the drums area.

The Vumbuka dams from the air prior to decommissioning (below) and after rehabilitation (bottom).



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SA government commits to protecting grasslands



Minister of Water & Environmental Affairs, Buyelwa Sonjica, together with eight MECs responsible for environmental affairs have signed the Grasslands Declaration committing government to the conservation of grasslands biodiversity.

The Declaration is an effort to collaborate in good faith to pursue biodiversity targets and objectives in securing and sustaining the ecosystem services of the grasslands biome. Among others, it commits government to take active measures to involve stakeholders in the management and conservation of biodiversity of grasslands.

The South African grasslands biome is the second-largest in South Africa, covering an area of 339 237 km². It occurs

in eight of the country's nine provinces. The grasslands biome is one of the most threatened biomes in South Africa, with 30% of grasslands irreversibly transformed and only 1,9% of the biodiversity target for the biome formally conserved.

According to Sonjica, grasslands sustain the economic heartland of South Africa by providing the bulk of its water. "Several of South Africa's priority river catchments occur in the grasslands biome, including the Thukela River catchment. Good management of South Africa's mountain grasslands will result in more water being released back into the river catchment system in the form of 12,8 m³ of water in winter river flows. In Rand value, this equates to between R18-million and R788,7-million per annum."

Biodiversity climbing the corporate agenda – study

Business leaders in biodiversity-rich developing economies are concerned about losses of natural capital, according to a new report.

Over 50% of CEOs surveyed in Latin America and 45% in Africa see declines in biodiversity as a challenge to business growth. In contrast, less than 20% of their counterparts in western Europe share such concerns.

The findings, compiled by a study of The Economics of Ecosystems and Biodiversity and backed by the United Nations, indicate that those corporate chiefs who fail to make sustainable management of

biodiversity part of their business plans may find themselves increasingly out of step with the market place. "We are entering an era where the multi-trillion dollar losses of natural and nature-based resources are starting to shape markets and consumer concerns," noted UNEP Executive Director Achim Steiner. "How companies respond to these risks, realities and opportunities will increasingly define their profitability; corporate profile in the marketplace and the overall development paradigm of the coming decades on a planet of six billion to over nine billion by 2050."

Nature NGO measures world's fine paper footprint

Global nature non-governmental organisation (NGO) WWF has launched a new voluntary rating tool for paper companies to report on their global ecological footprint.

Fine papers have everyday uses, including copier/printer paper, book paper, envelopes, forms, writing pads, high-quality magazines and brochures, catalogues and annual reports. The Paper Company Environmental Index assesses key environmental criteria, such as the use of recycled or fibre coming from well-managed forests, energy use and carbon dioxide emissions, water consumption and water pollution.

Five globally significant fine paper manufacturers, including Mondi Group from South Africa, have been the first to

voluntarily disclose their environmental profiles on WWF's new Paper Company Index. "WWF applauds these companies for their leadership and transparency," said Harri Karjalainen, WWF's Pulp and Paper Programme Manager. "They are the vanguard of a more sustainable paper industry."

Other fine paper and tissue companies have been invited to follow suit, and show what they have done to reduce their global ecological footprint. "We hope this new online tool can promote some healthy competition within the paper industry as to who can achieve the lightest footprint," noted Karjalainen.

Results and profiles of the participating companies can be found at www.panda.org/PaperCompanyIndex.

Are protected areas harbouring invasive species?

Protected areas, long thought of as safe refuges for animals and plants, are under increasing threat from invasive alien species, which not only affect biodiversity but also people's livelihoods.

Protected areas can have huge social and economic value, particularly in Africa, where national parks are a major tourist attraction and a significant source of income. But according to the Global Invasive Species Programme, many managers of protected areas in Africa are not aware of the severity of the problem which is on their doorsteps nor how to address it.

"Habitat conservation is vital for stemming the decline in biodiversity and the establishment of protected areas is an important mechanism for achieving this aim," said Sarah Simons, Director of the Global Invasive Species Programme. "But, with invasive species rapidly invading our ever-increasing protected areas unchecked, we are in danger of exacerbating one of the greatest threats to our biodiversity."

A negligible amount of the funding spent on biodiversity conservation projects each year is devoted to invasive species, even though they are the second biggest threat to biodiversity globally, and in some

ecosystems, the biggest single threat to biodiversity. In Zambia, for example, the Giant Mimosa (*Mimosa pigra*), originally alien to Africa, has spread over 3 000 ha of prime habitat since being introduced to the Kafue floodplain in the 1980s, pushing out many large and important aquatic antelopes, water birds, reptiles, amphibians, fish, invertebrates and plants from their natural habitat.

Mesquite (*Prosopis juliflora*) is one of the most widespread dryland invasive species in north and east Africa having already invaded 500 000 and 700 000 ha in Kenya and Ethiopia respectively. Under ideal conditions, it has the ability to double its range every five years.

"We need to build invasive species monitoring and management into regular protected area management routines," maintained Geoffrey Howard, IUCN Global Invasive Species Coordinator. "Unfortunately, the vast majority of protected areas in Africa do not have the capacity or resources to recognise or identify invasive species. People are largely unaware of how damaging they can be and, more importantly, do not possess the necessary information and equipment to actually manage them."

Biodiversity protection can save nature and dollars



Liese Coulter/CSIRO

A more flexible approach to the expansion of protected area systems could ultimately protect much more biodiversity for the same budget.

This is according to a paper in scientific journal, *Nature*. Lead author Dr Richard Fuller of the University of Queensland, in Australia, said that without spending extra money “we could dramatically improve the performance of protected area systems by replacing a small number of poor performing areas with more cost-effective ones.”

Protected areas are one of the most important tools in modern nature conservation, with over 100 000 sites covering about 12% of the land and territorial waters of countries worldwide. The paper examines how effectively different sites can conserve a range of vegetation types.

“Replacing the least cost-effective 1% of Australia’s 6 990 strictly protected areas could more than double the number of vegetation types that have 15% or

more of their original extent protected,” Fuller noted. “We can do this if we reverse the protection status of the least cost-effective sites and use the resulting capital to establish and manage new protected areas.”

Fuller and his co-authors, including colleagues from CSIRO and the University of Queensland, acknowledge that community values would need to be incorporated when considering changes to the protected status of selected reserves. However, the benefits of reducing management costs in low performing areas are also worth exploring.

By being informed by this analysis method, future investments in protected areas could better protect biodiversity from threats such as climate change. “As the rate of investment in new protected areas has slowed globally in recent years ensuring the best places are protected is more important than ever.”

Water on the web

<http://dev.unep-wcmc.org/csn/default.html>

The critical site network (CSN) tool is a new online resource for the conservation of 294 species of water birds, and the important sites upon which they depend in Africa and Western Eurasia. Leading global conservation

organisations working for the protection of water birds and their habitats have joined forces to develop this tool, which makes it easy to obtain information on the sites critical for water bird species. It accesses several independent databases and analyses information at the biogeographical population level, so providing a comprehensive basis for management and decision making.

Shape-shifting fish adapts to changing river conditions

When rivers are impounded many aquatic species adapted to fast-flowing waters suddenly find themselves trapped in still reservoirs.

Scientists from Tulane University, in the US, have discovered one species of fresh-water fish that morphs into a new shape in response to a lake-like environment.

Among the characteristics of the reservoir-dwelling *C. venusta*, commonly known as the blacktail shiner, are smaller heads, lower-set eyes, a shorter dorsal fin positioned closer to the head and deeper bodies.

“The public hears that dams do things like prevent salmon from migrating

upstream to spawn, or that some species are wiped out entirely within a stream when a dam goes in,” reports Travis Haas, lead author of the study and a PhD student in the Department of Ecology and Evolutionary Biology. “But this is an example of a species that remains in a stream that becomes a lake and changes in response to it.”

Haas studied the aquatic life in eight pairs of rivers and reservoir sites in the Mobile River Basin in Alabama. He found that the characteristics of shiners from reservoirs diverged consistently from those in rivers. This indicates that water impoundment – constructing dams – may be an evolutionary driver acting on aquatic biodiversity.

New conservation plans for endangered wetland bird

New conservation plans for the Siberian Crane (*Grus leucogeranus*) covering its entire range and migration routes that span continents have now been endorsed to save the species from extinction.

During its annual migration, the Siberian Crane travels 5 000 km from its breeding grounds in Yakutia and western Siberia, intermediate resting and feeding places, to its wintering sites in southern China and Iran respectively. During these extensive journeys along three migration routes, called flyways, they overcome considerable obstacles such as high mountains and vast deserts. Major threats like hunting in West and Central Asia and the drainage of critical wetlands in East Asia put them at even greater risk. Only 3 000 to 3 500 birds remain globally.

Now, under the new Siberian Crane Wetland Project, supported by UNEP’s

Global Environment Facility, government officials, scientists and conservationists are coming together to adopt strategies to reduce hunting, improve water management and mitigate the impact of climate change.

Among others, loss of wetland habitats is a major threat to the Siberian Crane. Water management for wetland areas is therefore crucial. Agriculture use, diversion of water resources and channels have resulted in severe shortages at the birds’ critical habitats. This mismanagement is enhanced by climate change, intensifying pressure on the species.

At present, plans are being prepared to improve water resource management at sites such as the Thanedar Wala Game Reserve and the Taunsa Barrage, both located in Pakistan and recognised for their importance for migratory water birds.

www.iwawaterwiki.org

The IWA (International Water Association) WaterWiki provides a platform for the global water community to interact and share knowledge online. The site aims to be a reference for all areas of water, wastewater and environmental science and management.

www.wmo.int/youth/

This is the youth Webpage of the World Meteorological Association. The site contains interesting information about the climate and weather as well as games, videos, a library and links to other weather-related sites.



Simple sari cloth holds key to better health

Women are literally wearing the answer to cleaner water and better health, according to a study in Bangladesh.

Using the simple sari to filter household water protects not only the household from cholera, but reduces the incidence

of disease in neighbouring households that do not filter. "During an earlier study, this filtering method was field tested in Matlab, Bangladesh, and proved to reduce the incidence of cholera by 48%. This latest follow-up study, conducted five years later to see whether filtering by sari has persisted, showed that nearly a third of the village women continued to filter water for their households, with both an expected and unexpected benefit," explains Rita Colwell of the University of Maryland, a researcher on the study.

Over 7 000 village women collecting water daily for their households in Bangladesh were selected from the same population used in the previous study. Survey data showed that 31% continued to filter their water, of which 60% used a sari. "This is a clear indication of both

compliance with instructions and the sustainability of the method, but it also shows the need for continuing education in the appropriate use and benefits of simple filtration," notes Colwell.

The researchers also looked at the incidence of cholera in households during the follow-up period. While not statistically significant, they found the incidence of hospitalisation for cholera during the five-year period between studies reduced by 25%. "With the lower rate of filtration in this follow-up study, it is not surprising that the observed reduction in disease was not as high as the 48% observed in the original trial, suggesting that active reinforcement would have been effective in ensuring higher protection," says Colwell.

Researchers also found an indirect benefit. Household that did not filter their water, but were located in neighbourhoods where water filtration was regularly practiced by others also had a lower incidence of cholera. "Results of this study showed that the practice of filtration not only was accepted and sustained by the villagers but also benefited those who filtered their water, as well as their neighbours not filtering water for household use, in reducing the incidence of cholera," concludes Colwell.

UN declares access to clean water and sanitation a human right

Safe and clean drinking water and sanitation is a human right essential to the full enjoyment of life and all other human rights, the General Assembly of the United Nations (UN) has declared.

The 192-member Assembly also called on UN member states and international organisations to offer funding, technology and other resources to help poorer countries scale up their efforts to provide clean, accessible and affordable drinking water and sanitation to all. The text of the latest resolution expressed deep concern that an estimated 884-million people lack access to safe drinking water and more than 2,6 billion people do not have access to basic sanitation. Studies also indicate that about 1,5 million children under the age of five die each year and 443 million school days are lost because of water- and sanitation-related diseases.



Malaria-proof mosquito a world first

The creation of genetically-altered mosquitoes that cannot infect humans with malaria is providing new hope to countries where millions of people die from the disease each year.

University of Arizona (UA) entomologists, who created the mosquitoes which are completely immune to the malaria parasite, *Plasmodium*, aim to one day replace wild mosquitoes with lab-bred populations unable to act as vectors. "If you want to effectively stop the spreading of the malaria parasite, you need mosquitoes that are 100% resistant to it. If a single parasite slips through and infects a human, the whole approach will be doomed to fail," says Prof Michael Riehle of the UA's College of Agriculture and Life Sciences, who led the research effort.

Riehle's team used molecular biology techniques to design a piece of genetic information capable of inserting itself into a mosquito's genome. This construct was then injected into the eggs of the mosquitoes. The emerging generation carries the altered genetic information and passes it on to future generations. For their experiments, the scientists used *Anopheles stephensi*, a mosquito species that is an important malaria vector through the Indian subcontinent.

When the researchers studied the genetically modified mosquitoes after feeding them malaria-infested blood, they noticed that the *Plasmodium* parasites did not infect a single study animal. "We were surprised how well this works," reports Riehle. "We were just hoping to see some effect on the mosquitoes' growth rate, lifespan or their susceptibility to the parasite, but it was great to see that our construct blocked the infection process completely."

The research has been published in the July 15 edition of the journal *Public Library of Science Pathogens*. For more information, go to www.plospathogens.org/home.action.

Waterborne diseases could cost US over \$500-m a year

Hospitalisations for three common waterborne diseases cost the American healthcare system as much as US\$539-million a year, according to researchers from the Centre for Disease Control and Prevention.

"These cost data highlight that water-related diseases pose not only a physical burden to the thousands of people sickened by them each year, but are also a substantial burden in healthcare costs, including direct government payments, reports Michael Beach, who led the study.

At present, there are well-documented data on the total healthcare costs associated with all waterborne diseases. However, using data from a large insurance claims database between 2004 and 2007,

Beach and his colleagues estimated the hospitalisation cost of three common waterborne diseases in the US, namely Legionnaires' disease, cryptosporidiosis and giardiasis. For each case of disease, they calculated the cost paid by the insurer, the out-of-pocket cost to the patient and the total amount paid.

Total estimated costs for hospitalisation for the three diseases was between US\$154-million and US\$539-million. In-patient hospitalisation costs per case averaged more than US\$34 000 for Legionnaires' disease, about US\$9 000 for giardiasis and more than US\$21 000 for cryptosporidiosis. "When people think about these diseases, they usually think of a simple case of diar-

rhoea, which is a nuisance but quickly goes away. However, these infections can cause severe illness that often result in hospital stays of more than a week, which can quickly drive up healthcare costs," notes Beach. Other symptoms can include rashes, eye and ear infections and respiratory or neurological systems, and can be fatal in severe cases.

Modest investments in preventing these diseases could lead to reduced disease and significant healthcare cost savings, maintains Beach. Some examples of possible, low-cost interventions include public education campaigns, appropriate maintenance of water systems, and regular inspection of pools and other recreational water facilities.

New packaged wastewater treatment units for chemical company



VWS Envig has been awarded a contract to supply a KwaZulu-Natal based chemical manufacturing company with a wastewater treatment plant.

The plant comprises two evaporation technology package units – only the second pair in the country.

The initial contract negotiated covered supply only, however, this was later converted to a turnkey contract. The client required that no liquid discharge should leave the plant. After research and consultation, contract engineer proposed the so-called EVALED evaporators.

“It was established that the effluent produced by the manufacturing plant would hardly be treatable using conventional treatment technology, therefore the decision to use these evaporators, which are particularly suited to treating effluent with high chemical oxygen demand and high concentrations of salts, organics and metals,” explains VWS

Envig GM Wayne Taljaard.

The effluent will be treated in the first evaporator, recovering 12 m³/day of water. Then the treated water or distillate will be returned to the client’s process system to be re-used. The concentrate from the first evaporator will be transferred to the second for further treatment.

At this stage, a further 2 m³/day of water will be recovered, with the resulting concentrate being discharged as a semi-solid. “This plant is unique in that no pre-treatment is required. The effluent will be fed directly into the evaporators with significant cost savings,” notes Taljaard.

With this technology, the production plant has the potential to become a complete zero liquid effluent discharge facility which has far reaching environmental benefits. Commissioning of the plant is anticipated during the third quarter of 2010.

Unusual technology separates hot and cold water at Implats



Specialist contractor BBE has conceptualised and designed an unusual water thermal storage scheme for Implats Platinum in the North West.

The system promises to achieve significant power savings. “The challenge has been to introduce water thermal storage into the cooling systems on seven shafts using existing water storage dams for both hot and cold water storage at different times during the day,” explains BBE MD Richard Gundersen.

Five of the shafts have dams where the hot and cold water is stored, relying on thermal stratification alone. In these dams, the height to diameter ratio is such that the hot water remains above the cold with minimal mixing. The shape of the other two shaft dams (shallow, large diameter) has required another means of keeping the hot and cold water separate.

Consequently each dam has been fitted with five plasticised canvas bladders, with a combined capacity of 3 ME per dam. The largest bladder measures 30 m by 7 m and is 6 m high when full. The bladders have been secured to the base of the dam and a piping system feeds and extracts the cold water in and out of the bladder, while the hot water is fed and extracted from the surrounding area.

The capital costs for the simultaneous storage of hot and cold water in the same reservoir has been achieved at a fraction of the cost of a new dam, says Gundersen. “The electrical operating costs will be reduced by producing more cold water than is required during off-peak tariff periods, then switching the refrigeration machines off during the peak tariff periods of the day and using the stored cold water. The saving is achieved through the tariff differential.”

New pipeline brings more water to iLembe



Robor Pipe Systems has successfully completed a contract for Umgeni Water to convey water from the Tugela River to the iLembe District Municipality in KwaZulu-Natal.

The company handled both the bulk water pumping system and reticulation, providing a 150NB steel pipe for the project. More than 16 000 people have gained access to potable water through this scheme.

The project involved the upgrading of abstraction works on the Tugela River, water treatment works and pumping

systems, concrete reservoirs, 21 km of bulk supply pipelines and take-off points. Robor Pipe Systems supplied pipe coating, lining and jointing, and was involved in cathodic protection particularly for this scheme.

Galvanised piping was selected and externally coated with a patented shrink wrap product that helps to protect the steel pipeline from corrosion and deterioration. The solution also offers cathodic protection.

In order to meet the requirements of Umgeni Water, TOSAwrap was re-specified and is now compliant with the international standard EN12068, which governs corrosion

protection for buried pipelines and covers performance and quality assurance. This status elevates Robor Pipe Systems into an unusual market space and offers customers greater value, as well as peace of mind.

Robor Pipe Systems GM Gavin Fait expressed his delight with the company’s involvement in the iLembe project. “It is great that the South African government is starting to fulfil its promises. The market is buzzing with activity as municipalities begin to award projects to speed up the delivery of water to people, and Robor Pipe Systems is very proud to be a part of this drive.”

New from the WRC

Report No: 1685/1/10

The Use of ^{222}Rn as a Hydrological Tracer in Natural and Polluted Environments (PJ Hobbs; R Lindsay; A Maherry; M Matshaya; RT Newman and SA Talha)

Radon-222 (^{222}Rn or simply radon) is an inert odourless and colourless noble gas that occurs naturally in air, water, rocks and soil. The daughter of ^{226}Ra , it is a radioactive isotope with a half-life of 3.82 days. These properties have promoted its use as a natural tracer in numerous hydrological and hydrogeological applications. The use of ^{222}Rn in groundwater studies has not enjoyed much attention in South Africa, being limited to the tracing of fault zones in groundwater exploration. A study of its local applications as a hydrological tracer in natural and polluted environments is therefore both appropriate and opportune, as is a comparison of the results produced by various measurement methods.

Report No: TT 446/10

Investigation of the Positive and Negative Consequences Associated with the Introduction of Zero-phosphate Detergents into South Africa (LM Quayle; CWS Dickens; M Graham; D Simpson; A Goliger; JK Dickens; S Freese and J Blignaut)



In response to the growing awareness of the role played by phosphate contained in powdered laundry detergents in the

eutrophication of water resources, and the apparent failure of the legislature to control this problem, the WRC identified the need to investigate the positive and negative consequences associated with the introduction of zero-phosphate powdered laundry detergents into the South African market. Among others, the project reviewed current local and international best practice with regards to the use and restriction of phosphates in detergents; estimated the impact detergent phosphates are having on the phosphate loading and efficacy of wastewater treatment plants as well as the frequency and severity of algal blooms in key dams; and investigated the impacts of the introduction of zero-phosphate detergents on the waste discharge charge system.

Report No 1496/1/10

A Stakeholder Driven Process to Develop a Catchment Management Plan for the Kat Valley (K Rowntree; S Birkholz; J Burt and S Farolfi)

The WRC has supported catchment management in the Kat River valley, in the Eastern Cape, since 2004. This report details the process and outcomes of the development of a catchment management plan for the valley by local stakeholders and researchers from Rhodes University. In the Kat River valley, the principle objective of the catchment management plan was to establish a water allocation plan for present and future water use in the valley, and to facilitate the water licensing process in the catchment.

Report No: 1503/1/10

Land Use Impacts on Salinity in Berg River Water – Research on Berg River Water Management (WP de Clerq; N Jovanovic and MV Fey)

Dryland salinity is widespread throughout semi-arid regions of the world, including

some of the major catchments of the Western Cape, with wheat lands in the Swartland and Overberg regions widely known to contain 'brak kolle' (saline scalds) where the wheat will not germinate. Numerous salinisation studies have been conducted, however, they do not seem to address the possibility that changes in land use over the last century, from extensive pastoral use to intensive cropping, may have triggered salt decantation. This three-year project followed a preliminary study published in 2004, which found convincing evidence of dryland salinisation impacts on water quality in the Berg River. The central aim was to develop a thorough understanding of water and salinity dynamics in the regolith of a small dryland catchment representative of semi-arid conditions in the Berg River basin. The perspective would include not only salt sources and storage but also groundwater fluxes and catchment runoff in order to inform future large-scale modelling, and to guide the design of practices that reduce the degradation of land and water resources.

Report No: 1313/2/10

Development of Protocols for Acute Fish Toxicity Bioassays, using Suitable Indigenous Freshwater Fish Species (VE Rall; JS Engelbrecht; H Musgrave; LJ Rall; DBG Williams; R Simelane)

Toxicity testing is playing an increasingly important role in water resource management in South Africa. A need was identified for nationally standardised fish bioassay protocols as well as for the use of indigenous fish representing receptor organisms actually present in aquatic ecosystems to extrapolate meaningful, relevant and ecologically significant results and management objectives from ecotoxicity tests. This project, initiated in 2002, aimed to, among others, develop capacity to ensure the continued production of adequate test organisms to be provided to research

and consulting facilities in South Africa; establish protocols for the laboratory culturing and maintenance of selected indigenous freshwater fish species, for use in ecotoxicity testing; and to establish fish bioassay protocols which will provide representative data for ecosystems in the South African context.

Report No: TT 454/10

Integrated Management of Water Hyacinth in South Africa: Development of an Integrated Management Plan for Water Hyacinth Control, combining Biological Control, Herbicidal Control and Nutrient Control, Tailored to the Climatic Regions of South Africa (M Byrne; M Hill; M Robertson; A King; A Jadhav; N Katembo; J Wilson; R Brudwig and J Fisher)

Water hyacinth is South Africa's most damaging floating aquatic weed. Despite notable success with the biological control of other floating aquatic weeds, and a concerted biological control effort against water hyacinth, its populations continue to reach newsworthy proportions on major rivers and dams. The research presented in this report addressed the effect of temperature and nutrients on the growth of water hyacinth and some of its biological control agents. It also investigated the interaction of herbicide application with biological control. This has been done in light of



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discovering a sublethal dose of herbicide which will retain water hyacinth plants in a system to maintain populations of the agents. In addition, a management plan has been developed to guide water managers as to what action should be taken in terms of combining biological control with herbicidal control under different climatic and nutrient conditions.

Report No: TT 458/10

Towards Standards for Municipal Invoices in South Africa (Sarah Slabbert Associates)



The tax invoices or bills that municipalities send out to customers on a monthly basis are a key interface between local government and citizens. Consumers' level of understanding of their municipal invoices is therefore indicative of the effectiveness of this communication. Local and international research has shown that consumers of many municipal entities, in both the developed and developing countries, struggle to understand their municipal invoices. A lack of understanding of invoices has a negative effect on customer awareness, participation and the regulation of water services. It also leads to distrust in the correctness of the invoice, which, in turn, could affect consumers' willingness to pay. Through this document, the WRC has created a platform for South African municipalities to work towards improving compliance and standardising their domestic municipal invoices. The standards document is an effort to steer municipalities, financial services, businesses and customers towards quality and efficiency in water management.

Report No: 1554/1/10

Kinetic Development of Oxidation Zones in Tailings Dams with Specific Reference to the Witwatersrand Gold Mine Tailings Dams (B Yibas; W Pulles and C Nengovhela)

The understanding of oxidation zones and phreatic water surfaces plays an important role in the prediction of acid rock drainage. Many gold mines in South Africa are currently engaged in active reclamation of gold tailings dams. This large-scale reclamation of dams provides a perfect opportunity to study tailings dam profiles and characterise their oxidation profiles. This study of oxidation zones of tailings dams was initiated based on literature surveys conducted by PHD and personal communications, which showed that the reported values for the depth of the oxidation zones of gold-mine tailings in the Witwatersrand Basin are inconsistent and have a considerable range from 20 cm to more than 7 m. It is believed that the findings of this project have advanced our knowledge and ability to practically implement improved prediction capacity by being able to better understand the active oxidation zone within the tailings dams that need to be described in a predictive model.

Report No: 1565/1/10

Flow Conceptualisation, Recharge and Storativity Determination in Karoo Aquifers, with Special Emphasis on Mzimvubu-, Keiskamma- and Mvoti-Umzimkulu Water Management Areas (C Dondo; L Chevallier; AC Woodford; R Murray; LO Nhleko; A Nomnganga and D Gqiba)

The WRC and Department of Water Affairs have invested substantial financial resources on research into the geohydrology of Karoo aquifer systems over the past three decades. However, it has been shown that little geohydrological research has focused on the Karoo aquifers in the Eastern Cape and southern KwaZulu-Natal, where the basic needs for clean drinking water are the greatest. Thousands of boreholes have been drilled in the area and the data collected, such as borehole depths, water strikes, strike yields and pumping tests, were not previously organised into a useful and easily accessible format. The need was therefore identified to properly restructure it in

order to develop reasonable conceptual models describing the occurrence and flow dynamics of groundwater in the Eastern Karoo Basin.

Report No: 1785/1/09

Review of Technology Used in Strategic Asset Management: Existing and Future Needs (CJ von Holdt; HMS Belmonte and JE Amadi-Echendu)

This study was commissioned by the WRC primarily to determine what technologies are currently available to water utilities that can be used to determine the condition of assets deployed for water extraction, storage and distribution. The study also reviewed national and international trends in management processes with regard to condition assessment, and prediction of asset performance and asset risk determination techniques as applicable to water assets. It is envisaged that this review would serve as a useful point of reference for South African utilities as they embark on the journey towards effective management of water infrastructure assets.

Report No: TT 433/09 to TT 443/09

Wetland Health and Importance Research Programme (H Malan – Series Editor)

This series of reports (No 1 to 11) is an output of the Wetland Health and Importance research programme funded by the WRC. This programme forms Phase 2 of the National Wetlands Research Programme, and is broadly aimed at assessing wetland environmental condition and socio-economic importance. The series includes reports on assessing wetland environmental condition using biota,

broad-scale assessment of impacts and ecosystem services, and socio-economic and sustainability studies.

Report No: KV 242/10

Developing Sediment Quality Guidelines for South Africa (AK Gordon and WJ Muller)

The issue of sediment contamination in South African freshwaters has been largely ignored. Currently no sediment quality guidelines exist for freshwaters in this country. The objective of this project was to critically review sediment quality guidelines derivation methods being utilised internationally, and to identify specific factors that need addressing in order to derive and implement effective sediment quality guidelines in South Africa.

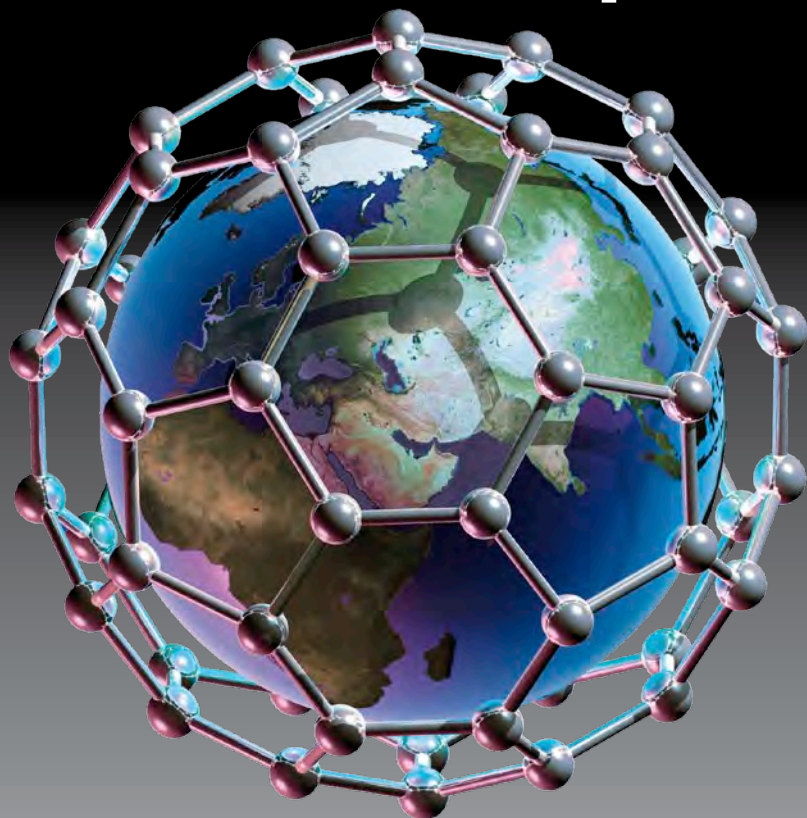
Report No: 1690/1/09

Remote Sensing as a Tool for Resource Assessment towards the Determination of the Legal Compliance of Surface and Groundwater Use (L Gibson; Z Münch; J Engelbrecht; N Petersen & J Conrad)

Since South Africa is such a water scarce country, it is important for water resource managers to have accurate information on all aspects of water resource occurrence and use. This includes knowledge of the level of compliance of water users to water use licence legislation and the quantity of unlicensed water usage and storage. The overall objective of this project was to determine the usefulness and applicability of using remote sensing technologies as a tool for resource assessment towards the determination of the legal compliance of surface and groundwater use.



SA hopes to answer big questions around the impact of small science



From everyday consumer products such as socks, paints and sunscreens to sophisticated applications in healthcare and water treatment, nanotechnology is fast becoming one of the most important drivers of innovation in the twenty-first century. But whereas promoters of engineered nanomaterials are hailing it as the catalyst of the next industrial revolution, South Africa has recognised the need for action against potential health, safety and environmental risks. Article by Lani van Vuuren and Ndeke Musee.

Materials with nano-scale dimensions are as old as time and often occur naturally in the environment, for example, volcanic dust, pollen grains and mineral composites. However, our ability to manufacture engineered nanomaterials is relatively new. The small size of these materials (one nanometre equals a billionth of a metre) means they have different properties than those of larger particles of the same substance; they may be more conductive, stronger, or more chemically reactive, for example.

Because of these novel properties engineered nanomaterials offer considerable promise, from business opportunities to meeting global challenges in energy, water treatment, healthcare and climate change. To date, billions of dollars have been invested in research and development (R&D) in this field by governments (including South Africa) and private investors.

Since *the Water Wheel* first introduced nanotechnology to its readers in 2008 (January/February edition) the number of consumer products containing engineered nanomaterials has increased considerably. At

present, there are more than 1 000 nanotechnology-enabled consumer products available to the public globally and the number is growing exponentially on a daily basis.

Today, one can find these tiny particles in everything from non-stick cookware and batteries to T-shirts and health supplements. It is estimated that at the present rate, the inventory will reach the 1 600 mark within the next year. By 2014, nanotechnology is expected to contribute up to 15% of the global manufacturing output, with a worldwide economic value exceeding US\$2,6-trillion. The USA, Japan and European countries such as Germany, France and the United Kingdom are the global nanotechnology leaders in business. However, 'newcomers' such as China, India and Korea are fast growing in this field with respect to the number of patents registered and scientific papers published.

NANOTECHNOLOGY IN SOUTH AFRICA

In South Africa, nanotechnology, while still in its infancy,

has grown rapidly since the launch of the National Nanotechnology Strategy in 2006. To date, the government, through the Department of Science & Technology (DST), has invested over R170-million in different aspects of nanotechnology R&D. The core R&D efforts are chiefly focused on the development of engineered nanomaterials.

Academic institutions, for instance, the universities of Johannesburg, Witwatersrand, Zululand and Stellenbosch, have developed strong nanotechnology research centres. Similarly, the potential of nanotechnology has been recognised by organisations such as the CSIR, Mintek and the Water Research Commission (WRC), and it is expected that others, particularly from industry, will soon follow suit.

This year the WRC, for example, is investing more than R1,7-million in nanotechnology R&D projects, mostly towards the treatment of water and wastewater (domestic, industrial and mining) and for environmental remedial applications, such as the treatment of acid mine drainage. The Commission is also

represented on the Steering Committee of Mintek's Nanotechnology Innovation Centre as well as on the International Water Association's Water and Nano Specialist Group to closely track global advances in nanotechnology.

"The potential benefits of nanotechnology are staggering – and almost limitless," reports Dr Jo Burgess, WRC Research Manager. "Just looking at the water sector, nanotechnology has endless potential applications from drinking water treatment (both routine and in emergencies), treatment of sewage, new water pipes that are hydrophobic and do not corrode, to selective ways of removing metals from wastewater, one at a time."

BENEFITS VS RISKS

While the potential benefits of nanotechnology in all aspects of human life is beyond debate, there is growing global concern over the potential health, safety and environmental implications of this technology both to humans and ecosystems. It is recognised that because of the widespread use of engineered nanomaterials in consumer products and industrial applications our exposure to them is practically unavoidable. For example, engineered nanomaterials used in products such as fuel additives, cosmetics, and sprays will interact directly with people and the environment.

Another example is silver nanoparticles used in socks and other products for antibacterial purposes, which have been shown by US scientists to result in unexpectedly high increases in the concentrations in biosolids in wastewater systems and are suspected to kill many of the microorganisms that are essential for the optimal functioning of biological wastewater treatment systems (e.g. nitrogen removing bacteria responsible for the removal of nitrates from wastewater). Other preliminary international scientific research has shown that many types of engineering

nanoparticles are potentially toxic to human tissue and cell cultures.

Unlike macro-scale chemicals whose toxic effects are dependent on inherent chemical composition, in the case of engineered nanomaterials, the toxicity is dependent on numerous factors, particularly the physico-chemical properties (e.g. surface chemistry, size, shape, surface area, etc) and environmental factors (surrounding pH, organic matter, ionic strength, cell membrane, etc.). This large number of factors has made it difficult to adequately elucidate the toxicological effects of engineered nanomaterials to the receptor organisms.

Because the properties of engineered nanomaterials are distinctive from those of their counterpart macro-scale chemicals the present risk assessment tools used for the latter may not be adequate to evaluate the risk of materials with nano-scale dimensions. We simply have not yet developed the tools or the human capacity to assess the risk of engineered nanomaterials and/or monitor their movement in the environment. For this reason, tracking the fate and behaviour of engineered nanomaterials in the environment is currently impossible. (Looking for a nanoparticle in a river, for example, is like kicking a soccer ball somewhere on Earth and then attempting to determine where it fell).

It is for these reasons that, according to Dr Burgess, finding a way of adequately assessing the risk of engineered nanomaterials is extremely important. Among the questions remaining are those surrounding the potential bioaccumulation and bio-persistence of these materials in species; links between the physico-chemical properties of engineered nanomaterials and the observed ecotoxicity in animals and plants; and the effect of weathering of both engineered nanomaterials and covalent surface modifications under diverse environmental conditions, just to name but a few.

It is also important to note that there may be a substantial difference

in the toxicity of nanoparticles when exposure of them occurs in the workplace, or near the point of manufacturing due to the high concentrations of mobile nanoparticles at or near that point, explains Stéphan Roux of CSIR's National Resources and the Environment (NRE). "Once released into the environment, nanoparticles may well become bio-unavailable very quickly due to the aggregation in natural, often aqueous surroundings," he notes. "It is therefore likely that significant fractions of nanoparticles released into the environment may become inert, or at least far less toxic than the characteristics of these nanoparticles may suggest when studied in isolation."

If these questions are not answered adequately it may jeopardise the long-term sustainable use and exploitation of nanotechnology capabilities for the good of society. This would be an unfortunate scenario especially given the numerous benefits associated with this technology.

REGULATING NANOTECHNOLOGY

Regulators all over the world are entering unknown territory with respect to legislating nanotechnology. Last year, Canada became the first country in the world to introduce a mandatory safety reporting scheme for companies producing engineered nanomaterials. In this country, any company producing more than two kilograms of engineered nanomaterials must

FURTHER READING

- Musee N et al (2010) 'A South African research agenda to investigate the potential environmental, health and safety risks of nanotechnology' in *Journal of Science* **106** (3-4), accessible at <http://www.sajs.co.za/index.php/SAJS/article/view/159>
- Visit: http://nanohealth.org.za/nano_discussions for more information about the First National Workshop on Risk Assessment of Nanotechnologies and Nanosciences.
- Visit: <http://www.nanotechproject.org/inventories/consumer/browse/categories/> for a global inventory on consumer products containing nanomaterials.



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- CEM-06.1.1: Handling, Storage and Transportation of Dangerous Goods and Hazardous Substances
- CEM-06.4.3: Water Quality Monitoring: Principles, Approaches and Techniques
- CEM-06.5.1: Basic Principles of Ecological Rehabilitation and Mine Closure
- CEM-06.5.3: Integrated Land Management Towards Sustainable Land Use: Rehabilitation and Monitoring
- CEM-08.1.1: Occupational Health and Safety Law for Managers

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NANO GLOSSARY

Nanotechnology – The ability to measure, see, manipulate, manufacture, and apply materials at between 1 and 100 nanometres.

Nanometre – Equals one billionth of a metre. A human hair, for example, is 80 000 nm wide.

Nanoparticle – A particle with at least one dimension less than 100 nm, and that exhibits novel properties in comparison to counterpart macro-scale chemicals.

Nanomaterials – Materials which have structured components with at least one dimension less than 100 nm. This includes nanowires and nanotubes that have two dimensions at nano scale, and colloids and quantum dots (tiny particles of semiconductor materials) that typically have three dimensions at nano scale.

Nanomanufacturing – Manufacturing at the nano scale. The industrial application of nanotechnology.

report the volumes to the regulatory authorities and provide the necessary safety data.

Present environmental and health regulations, developed long before the advent of nanotechnology, are considered inadequate to deal with these new materials. For example, the surface area and chemical composition of nanoparticles might also have to be taken into account – an aspect unanticipated by the current approaches of dealing with macro-scale chemicals.

When dealing with nanoparticles it may be important to give significance to the number of particles per volume or mass of material. Current regulatory limitation terms were developed mainly to deal with particle-air pollution and with nanoparticles, the number ingested or exposed to have more significance than the mass of the substance, as is the case with conventional chemicals or toxic compounds.

The South African government has recognised the need to establish

regulations to govern nanotechnology. “As with all new technologies, nanotechnology holds potential risks – to health, safety and to ethical practices,” said Science & Technology Minister Naledi Pandor at a nanotechnology workshop in Harare, Zimbabwe, earlier this year. “The department is working to provide a platform for the proactive identification and mitigation of such risks.”

According to JJ Molapisi, DST Director: Emerging Research Areas, the government is actively looking to address the issue, however, any regulations considered must be based on sound scientific principles. “The situation is challenging as we have no precedent to follow. As far as nanotechnology regulation is concerned South Africa is in the same boat as the rest of the world.”

Among other proactive measures DST has formed a Nanotechnology Ethics Committee whose primary focus is ensuring that the development of nanotechnology nationally is undertaken in a manner that does not undermine ethical considerations. The committee has already developed ethical guidelines for South Africa, which will govern conduct in the local development and application of nanotechnology.

NANOTECHNOLOGY RESEARCH PLATFORM

South Africa held its first National Workshop on Risk Assessment of Nanotechnologies and Nanosciences last year. Among others, the workshop was aimed at providing a basis to illustrate the need for risk assessment of engineered nanomaterials in South Africa. It was a notable milestone in the country as it marked the start of a systematic and nationwide coordinated programme to address the potential risks of nanotechnology. Following the workshop, the need for the risk assessment of engineered nanomaterials in South Africa has begun to enjoy wider acceptance as evidenced by the

apparent change in attitude of industry role-players, researchers working in the field of nanotechnology, and government officials from different departments.

It also provided important impetus to the establishment of a national nanotechnology research platform aimed at systematic investigation of aspects related to health, safety and the environment, which is currently in early phases of development. This platform, funded by DST, is aimed at promoting the development of human capacity, necessary infrastructure and a dedicated research programme whose primary goal is to elucidate the potential effects of engineered nanomaterials as well as how they can be adequately mitigated. “Ultimately we would like to have two parallel research streams: one developing engineered nanomaterials and the other for undertaking the necessary risk assessments,” notes Molapisi.

In the end, there remains a real need to find the balance between harnessing the benefits and novel capabilities that nanotechnology bring while preventing and/or mitigating any potential risk stemming from this technology. All role-players, be they government, funding organisations, researchers or the public have a duty to ensure the responsible and sustainable development of nanotechnology for a better future for all. □

Storm in a teacup? Globally, concern is being raised over the potential health, safety and environmental risks of nanotechnology.





The hunt's afoot for Kruger's amphibians in new kiss-and-tell study

Once upon a time, a kiss and a frog were enough for a happy ending. In fact, the humble amphibian has fared well in the realm of fiction. However, show-stopper names like the Golden Leaf-Folding Frog, the Eastern Olive Toad and the Shovel Foot Squeaker have not seen them shine in the area of conservation. Now researchers are looking to save what is left of the Kruger National Park's frog population.

Article by Petro Kotzé.

Indeed, life for a frog is no fairytale. Amphibian population declines and species extinction are occurring around the world. Locally, the picture is just as gloomy. According to James Harrison, project leader of *The Atlas and Red Data Book of Frogs of South Africa, Lesotho and Swaziland* (published in 2004) locally, 25 species are classified as threatened or as near threatened, more than 20% of the total number of species. He adds that as new species are still being discovered and described, the number of threatened species is likely to grow.

During Harrison's study, 14 threats to South African frogs were identified, of which the four most important are habitat destruction

and fragmentation, alien plants and afforestation as well as pesticides and pollution. Threatened species occur predominantly in the Eastern and Western Cape, as well as Kwazulu-Natal. However, the species in the northern parts of the country could also be, metaphorically speaking, sitting in the boiling pot.

Frogs and toads in the Kruger National Park (KNP) may be protected against many of the threats faced by relatives elsewhere, but they are far from unaffected. Dr Andrew Deacon, Programme Manager for Small Vertebrates of the Savanna Unit of the KNP explains that about 10% of the park's frogs live in its rivers, while thousands converge at smaller, seasonal wetlands during breeding seasons. These habitats are especially vulnerable to air and water pollution. Problems with the park's rivers became glaringly obvious after recent, comprehensive media coverage of the death of hundreds of crocodiles in the Olifant's River Gorge (also discussed in the *Water Wheel* edition of January/February 2009). Deacon says that some of the rivers' predicament relates to a decrease in water volume and an increase in the amount of pollution due to continuous irrigation and development outside the park.

Another concern, he says, is the increase in air pollution from nearby industrial areas and Mozambique. It is suspected that the KNP lies in a 'cloud' of pollution as a result of its location. Questions are now being raised about the effect of increased water pollution, and possibly that of acid rain, on the aquatic stages of the amphibian's life.

In 2009, the KNP tasked a group of researchers, under the helm of Dr Wynand Vlok, to find the answers to some of these slippery subjects. Vlok and his team are busy with an assessment of the current biodiversity of amphibians associated with the major river systems and wetlands of the KNP, as well as the physical and chemical factors affecting their distribution. The Water Research Commission (WRC) is one of the sponsors of the project.

ASSESSING THE SITUATION

Vlok, of BioAssets, is no stranger to WRC-sponsored projects. He was previously involved in the assessment of the water quality parameters of the Nylsvley floodplain catchment. He explains that the absence of many of the mentioned common threats to amphibians makes it a good place for a comparison of the current biodiversity

and chemical influences to historical data. An added plus is the sheer diversity of amphibians present.

The study is being conducted across 41 wetlands throughout the park, while 14 sites in the six rivers (winter breeders) are also being studied. The rivers being sampled are the Luvuvhu, Shingwedzi, Letaba, Olifants, Sabie and the Crocodile.

Adult frogs are counted along visual and aural transects. In other words, they are physically counted or through identifying the different species' calls to potential mates and rivals. In addition to the adult frog inventory, tadpoles, often found in larger concentrations at breeding sites over longer periods of time, are sampled. Surface-water and deep-water temperatures are also recorded. This data can now be used to estimate species richness at the sites and to determine which sites are more suitable for amphibians' development. The primary goal of these habitat-based studies is a species inventory but, in addition, other aspects such as the effects of pollution and the presence of predators can be determined.

Chemical factors that might affect amphibian distribution are tested at the University of Johannesburg. Amphibians from some of the most abundant species are dissected for biochemical analysis. Of special importance for this purpose are the livers, adipose tissue and for histological examination, the gonads.

Further tests are done on water and sediment samples from the test areas. Different chemical factors such as metals are identified and quantified, as well as organic constituents and pH levels from the rivers, pans and rainwater. Lastly, the effect of different concentrations of acid water is tested on amphibian eggs and the development of the tadpoles.

Finally, the physical inventory and the biochemical analysis together will create a clearer picture

Top right: The study is concentrated across 41 wetlands and six rivers in the park.

Middle right: Amphibians are most conspicuous at breeding ponds or along rivers during the appropriate breeding period.

Bottom right: A fine example of the tadpoles of the Muller's Platanna (*Xenopus muelleri*) under close inspection.



BioAssets



BioAssets



BioAssets

The primary goal of these habitat based studies is a species inventory, but other aspects such as the effects of pollution and the presence of predators can also be determined.



BioAssets



BioAssets



BioAssets

of the distribution of amphibians in the park, as well as the effects of pollution on this. Frogs and tadpoles can then not only be used as indicators of water quality but, says Deacon, to put pressure on decision makers to curb pollution through legislation.

FURTHER DEVELOPMENTS

The study has already yielded some exciting results outside of the expected areas of performance. From the historical list of 37 amphibians that should be found at

Top left: By studying the biospheres surrounding the pans, decisions can be made in regards to broader Kruger National Park management issues, such as grazing patterns.

Middle left: PhD student Clayton Cook at work gathering tadpole samples from a pan in the Kruger National Park.

Bottom left: Clayton Cook assisted by a park field ranger while gathering samples to be used in laboratory testing.

FROG FACTS

The four critically endangered frog species of South Africa are:

- Table Mountain Ghost Frog (*Heleophryne rosei*), found only in four streams on Table Mountain.
- Hewitt's Ghost Frog (*Heleophryne hewitti*), found only in the Elandsberg Mountains of the Eastern Cape.
- Mistbelt Moss Frog (*Anhydrophryne ngongoniensis*), found only on a small part of the eastern escarpment in KwaZulu-Natal.
- Micro Frog (*Microbatrachella capensis*), found in a few undisturbed fynbos wetlands in the lowlands of the south-western Cape.

An analysis of conservation hotspots for South African frogs revealed that most threatened and near threatened species are concentrated in five areas:

- Western Cape lowlands (five species)
- Western Cape uplands (six species)
- KZN coastal region (four species)
- KZN midlands (four species)
- Amatola Mountains (two species)

Source: Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland

the breeding sites, an abundance of Ornate Frogs (*Hildebrandtia ornate*) have been found – even though they were thought to be quite scarce. What's more, the Giant Bullfrog (*Pyxicephalus adspersus*), while listed in the historical data, has not been found up to date. At Harpi Pan East, researchers have come across a new species that was not previously listed, namely the East African Puddle Frog (*Phrynobatrachus acridoides*).

According to Harrison, the significance of surveys lies primarily in revealing patterns of distribution and the location of threatened species, in order to identify priority areas for conservation action. In an area like the KNP with unique management problems, research findings can also

be applied to other areas. For example, to cater for specific needs, some of the water supplies are man-made. Vlok and his team are also looking at the biospheres surrounding the pans, and if it is found that a specific water source is under too much pressure, management strategies can be adapted in accordance.

Another important outcome of the study should be information dissemination, stresses Deacon, and creating public awareness of the situation. Vlok adds that an exciting possibility could be the training of KNP field guides to identify the different amphibian calls. In this way, they can continue and update the inventory with GPS coordinates after the researchers have left the field.

They may not be the most glamorous inhabitants of the famed Kruger National Park, but hopefully, with an increase in research into the lives and times of amphibians, they might stand a sporting chance to live happily ever after.

Top right: A school of African Bullfrog (*Pyxicephalus edulis*) tadpoles.

Bottom right: The flamboyant tadpole of the aptly named Red-Legged Kassina (*Kassina maculata*).



Call for Expression of Interest: WDM Projects

The Water Demand Management (WDM) Programme is hosted by the Development Bank of Southern Africa (DBSA), and supported by the Swedish International Development Cooperation Agency (Sida). The Programme is focused on building a WDM culture in the Southern African Development Community (SADC) region to ensure effective and sustainable use of water that contributes to the SADC goals of regional integration and poverty alleviation.

Support from the WDM Programme will be considered for projects which embody the Programme objectives. The Programme Implementation Unit (PIU) invites Expressions of Interest (EOIs) for WDM projects. The EOI should outline the project details, the WDM intervention required, an estimated budget, and proposed time frame. It should be no longer than 10 pages. There are three fundamental criteria an EOI should exhibit, namely (1) pro-poor impact, (2) cost effectiveness, and (3) demonstration value.

The types of projects the WDM Programme will consider supporting include technical as well as community based projects.

Who should apply?

Municipalities * Water Utilities * Water Services Institutions, including water user associations and international water management bodies * State owned enterprises * Government departments.

Once an EOI is received, an assessment is made by the PIU and a decision is taken, in consultation with the Reference Group (RG), regarding support for implementation.

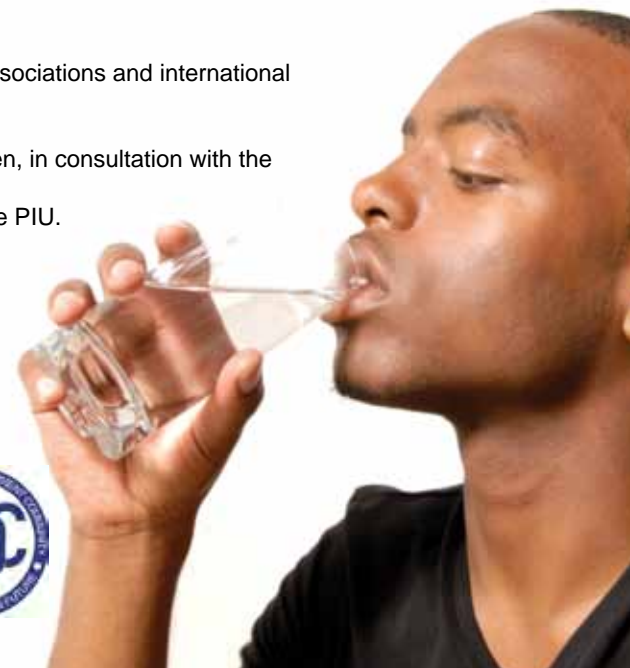
EOI guidelines are available from the WDM Programme website as well as from the PIU. The process is flexible and tailored to each case.

Tel +27 (0)11 313 3362

Fax +27 (0)11 206 3362

Email: info@wdm-in-sadc.net

Website: www.wdm-in-sadc-net



WDM
WATER DEMAND MANAGEMENT





Clanwilliam Dam was raised in 1962 through the installation of 13 crest gates.

eWISA

OLIFANTS RIVER – Home to one of South Africa's oldest irrigation schemes

It took two walls across the Olifants River to provide enough water for irrigation farmers in this part of the Western Cape. Lani van Vuuren takes a look at the history of the Bulshoek and Clanwilliam dams.

Known today for its rooibos and wine, the hamlet of Clanwilliam lies at the foot of the Cederberg Mountains in the Western Cape. Regarded as

one of the ten oldest towns in the country, Clanwilliam's beginnings go as far back as 1660 when a team of Dutch explorers sent out by Jan van Riebeeck first reached the Olifants River. The river was named by Jan Danckaert, the Dutch cadet in charge of the party, who, upon entering the valley, saw 300 elephants frolicking on the riverbank.

The first farm in the Olifants River valley was awarded to Pieter van Zyl in 1732, and by the late eighteenth

century small-scale irrigation was well established. Originally known as Jan Disselsvlei (after Jan Dissel, a local pioneer), the area first formed part of the district of Stellenbosch, but was declared a sub-district of its own in 1808 by the Earl of Caledon, then Governor of the Cape. In 1814, Caledon's successor, Sir John Cradock, renamed the area after his father-in-law, the Earl of Clanwilliam.

Originally, farmers planted crops in the fine alluvial deposits on the

banks of the Olifants River. These crops would be irrigated every time the river overflowed (the first flood ever recorded occurred in the Olifants River in 1822). However, vast destruction of riparian vegetation caused the river's banks to widen and deepen, until after a while it rarely overflowed. Between 1822 and 1870 the river had widened from an average 29 m to about 38 m.

THE FIRST SURVEY

On 16 October, 1858, Patrick Fletcher left Cape Town for Clanwilliam on orders from the Colonial Secretary to undertake one of the first surveys for a potential large irrigation scheme in the Cape. He travelled to the Olifants River mouth and surveyed the latter upstream for about 37 km. His report, which included estimates for two possible dams, was submitted in 1860.

Around 120 people were living around the irrigable portion of the Olifants River at that time. According to Fletcher, however, the farmers were not very successful: "The total income of the whole valley could not have exceeded £1 400 per annum during the last nine years. Except when the river overflows they scarcely grow sufficient bread for their own consumption."

In 1883, Hydraulic Engineer to the Cape Colony, John Gamble, suggested the construction of a series of moderately-sized weirs to restore original conditions in the river i.e. resulting in floodwaters once again spilling over its banks. Despite petitions from farmers in the area to the government, Gamble's plans were rejected due to the prohibitive cost of the scheme. Not long after that the post of Hydraulic Engineer was abolished as a result of economic circumstances prevailing at the Cape, and Gamble returned to England.

Meanwhile, local farmers started their own irrigation initiatives, including the use of steam pumps, windmills and bucket pumps (*bakkiespompe*) to boost their

A historic photograph of the Bulshoek Dam, completed in 1920.



eWISA



DWA/eWISA

The Bulshoek Dam features 15 hand-operated gates of the Ashford type. These gates, which sit on top of the solid weir, slide in cast-iron grooves of special construction with a patented system of anti-friction rollers. Each gate is 4,6 m high and 6 m wide.

production. During the following decades the farmers would appeal to government time and time again for assistance in various forms without success. Finally, in 1907, the Cape government asked the Director of Irrigation, Francis Edgar Kanthack, to determine the possibility of an irrigation scheme on the Olifants River. His brief was to investigate the possibility of introducing irrigation on a perennial basis by means of a canal system fed from a high weir with 'considerable storage capacity' as much land as possible on both banks of the Olifants River and along the lower reaches of the Doorn and Hol Rivers.

Kanthack was at first sceptical of the possibility of such a scheme. In his 1909 report he writes: "Local opinion as to the suitability of the land for irrigation was very conflicting and it was with some feeling of uncertainty that I authorised a traverse line of levels along the Olifants River...some 20 miles below Clanwilliam down to the mouth."

BULSHOEK DAM

This was followed by a contour survey and a soil survey, and, in September 1908, Kanthack himself visited the district. He must have cut quite the scene in his motorcar,

the first to visit the area. He visited the upper portion of the valley from Clanwilliam to the Hol River mouth during September 1908 to 'get a clear idea of the nature of the area.'

When the plans were sufficiently advanced, in June 1909, Kanthack laid down the final alignment for the main canal and branches, fixed the site of the headworks and designed the weir. This proved a difficult task as a result of the irrigable land being only available on the left bank with distributaries crossing over to the right bank. The headworks were thus designed to compensate for this fact.

While it was the Director's original intention to keep the weir as low as possible (to save costs), to keep grades as steep as possible and allow for the irrigation of the greatest amount of irrigable land, it was decided to construct the weir with a maximum height of about 7 m above the riverbed.

In 1911, an irrigation district was proclaimed and Parliament approved the sum of £155 000 for the construction of the weir and the associated (unlined) irrigation canals, which were to extend down the Olifants River valley for about 80 km. The site originally selected for the weir and offtake was at the head of a rocky rapid named Oshoek, on the farm Rondeberg. The original design was for a solid masonry weir (in Roman style) with falling shutters, each 1,8 m wide and 0,9 m high.

However, when the project was initially prepared little or nothing was known of the flow of the Olifants River at the proposed weir site. Observations by the Cape Irrigation Department between 1909 and 1912 indicated that if the original design were to be carried out, the flow would not be sufficient to



fill the irrigation canals at periods of greatest demand. It also showed that storage above the solid weir crest originally proposed (about 1,8 m) would not be sufficient.

As a result it was decided to increase this storage by erecting gates 4,6 m high above the solid weir. These 15 hand-operated gates are of the Ashford type, which consists of gates sliding in cast-iron grooves

A full Bulshoek Dam in 2004. The weir was originally supposed to be constructed at a rocky rapid in the Olifants River known as Oshoek, but was later moved to the farm Bulshoek, a few kilometres downstream of the original site.

of special construction with a patent system of anti-friction rollers. The gates, each 6 m wide, are capable of being raised clear of flood by lifting gear mounted on an overhead superstructure and is supported by 2 m wide sandstone masonry pillars. (Each gate has since been provided with a sand-filled counterweight to ease operation). A 16th gate of 6,9 m clear span, but 5,7 m high, was placed on the extreme left flank near the head gates of the canal to act as a scour, the sill being considerably lower than that of the other 15 gates. The final design was undertaken by the firm Glenfield & Kennedy of

The gates, each 6 m wide, are capable of being raised clear of flood by lifting gear mounted on an overhead superstructure and is supported by 2 m wide sandstone masonry pillars.



eWISA

Scotland in cooperation with engineer WM Watt. The firm also oversaw the construction of the weir. The site selected was now on the farm Bulshoek, a few kilometres downstream of the original site.

Floods as well as an apparent lack of labour prevented construction of the weir and canals from starting until March 1913. The project mainly employed white workers, who earned two shillings and eight pennies a day. Cement was imported from England, while the sandstone was obtained from a nearby quarry. Work was disrupted again by the First World War (1914-1919), during

which time materials (particularly cement) and equipment were extremely scarce and expensive. Many labourers also left to join the war effort. During October 1918, construction halted for a third time as a result of an outbreak of Spanish Influenza as those who remained unaffected were left taking care of the ill.

By 1920, the canal on the left bank was completed up to Bakleiplaas and the masonry of the 143,3-m-long weir and headworks as well as the erection of the steel gates and superstructures were practically finished by 31 March of that year. The entire scheme was eventually completed in 1924 at a total cost of £601 569.

CLANWILLIAM DAM

Despite the construction of Bulshoek Dam water demand soon again outstripped supply, especially during the hot summer months. In 1927, a start was made to line the canals with concrete, and by 1932 nearly £89 000 was spent on this endeavour. Meanwhile, the Union Irrigation Department undertook surveys along the Olifants River and its tributary, the Doorn River, in search of a suitable site for a new storage dam. It was hoped that this new dam would not only store enough water for the existing irrigation scheme, but allow for the expansion of agricultural activities.

A suitable site was found just outside Clanwilliam. Work started with the construction of staff housing and the erection of machinery in September 1932. As with many water infrastructure schemes at the time, only white workers were employed on the construction of the dam. However, as the new dam would inundate part of the Clanwilliam-Piketberg Road, a new bypass had to be created, and here use was made of 'coloured' labour.

At the height of construction (1934) an average of 428 whites and 366 coloured workers were



DWA/eWISA



DWA/eWISA

Top: The Clanwilliam Dam shortly after its completion. The original dam was a mass concrete gravity structure with a centrally situated overspill section.

Bottom: The outlets of the Clanwilliam Dam in 1936.

employed. White workers earned 4 shillings and eight pennies a day, while their coloured counterparts earned two shillings and 6 pennies a day. In his 1934 report, Director of Irrigation Alfred Lewis complains about the productivity of the white workers. Recruited by the Department of Labour, many of these workers probably had no construction skills (in subsequent reports the aversion of many of these workers to hard, physical labour is also noted).

Staff housing comprised wood houses with tin roofs, along with a combined mess hall and entertainment area. Meals were supplied to workers daily at a cost of one shilling, and the mess hall was managed by the farmer on whose farm the dam was being built.

By December 1933, the foundations had been completed and placing of concrete started in January 1934. Clanwilliam Dam was completed in March, 1935. The original dam was a mass concrete gravity structure with a centrally situated overspill section, 117 m long.

By 1962 the Olifants River valley



André Roux

was inhabited by about 13 000 people. The ever increasing need for water resulted in the dam being raised between 1962 and 1964. The overspill crest was increased in length, remodelled and raised by the addition of 3,05 m of mass concrete on top of the crest, and the installation of 13 crest gates, each 7,77 m wide and 3,05 m high.

In addition, the non-overspill flanks were raised by 4,88 m by means of mass concrete. A bridge superstructure was constructed across the dam to provide access for the operation of the gates. For stability, the dam was tied to its foundations by means of post-tensioned cables positioned along the centre line of the dam. Clanwilliam Dam has a present height of 43 m, and a capacity of around 122 million m³.

FUTURE PLANS

At present, plans are being finalised to raise the dam by another 13 m. This dual-purpose

Canals filled with water from the Bulshoek Weir and Clanwilliam Dam supply water to the members of the Lower Olifants River Water Users Association. The area is especially renowned for its viticulture and rooibos tea-growing activities.

project will not only see the increase of storage capacity of the dam, but also aims to upgrade and strengthen the wall to ensure its safety and long-term viability, especially during flood events. This will entail increasing the width and height of the wall and spillway. A new multi-level outlet structure will also be constructed.

A portion of the N7 national road will be affected by the raised water level and will be re-aligned by the South African National Roads Agency. Minor roads, property developments and cultivated land surrounding the dam basin will also be affected by the raised water level.

According to the National Water Infrastructure Branch of the

This dual-purpose project will not only see the increase of storage capacity of the dam, but also aims to upgrade and strengthen the wall to ensure its safety and long-term viability, especially during flood events.

Department of Water Affairs, the raising of the dam will increase the yield of water supplied from the dam by 70 million m³/year. "This will stabilise the current irrigation development and provide an opportunity to establish resource poor farmers to promote food security and decent employment through inclusive economic growth."

At least 75% of the additional water is earmarked for the development of resource poor farmers. The project has the potential to create about 3 800 jobs and provide tax revenue, including about R700-million on wine produced on the scheme.

In addition to the raising of the dam, the existing conveyance infrastructure needs to be improved and new conveyance infrastructure

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- Thanks and appreciation to eWISA and André Roux for photographs, and the Department of Water Affairs for additional information.

Clanwilliam Dam has a present height of 43 m although plans are afoot to raise the dam another 13 m.

needs to be provided for land allocated to resource poor farmers. These actions, in parallel to construction work on the dam, will be required from the relevant agencies, such as the Lower Olifants River Water Users Association, and responsible government departments, such as the Western Cape Department of Agriculture. A coordinating mechanism has been established to clarify roles and responsibilities in this regard.

Environmental authorisation for the project was received in February and, at the time of writing, Ministerial approval for the implementation of the project as a government waterworks was being sought. Construction of the project is scheduled to start during April 2012. □

André Roux



2010 SANCID SYMPOSIUM

South African National Committee on Irrigation and Drainage



The National Committee on Irrigation and Drainage (SANCID) presents its biennial symposium from

16 - 18 November 2010, Upington (Northern Cape)

Theme: Efficient Water use for Food Production

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Much funding of the Water Research Commission has been dedicated to finding solutions to the environmental legacy of the mining sector.

Lani van Vuuren

AMD: Local solutions for local challenges

Current concerns around the present and predicted decanting of acid mine drainage (AMD) from gold mines on the Witwatersrand have again thrust this complex pollution issue into the limelight. But, as Water Research Commission Research (WRC) Manager Dr Jo Burgess points out, the local research fraternity has a range of world-class solutions on offer.

Mine-water related research has become an important research area for the WRC and millions of Rands are spent every year on projects investigating solutions to one of South Africa's most complex water pollution dilemmas. The Commission is the newest member of the Global Alliance of research organisations, which supports the activities of the International Network for Acid Prevention.

Prior to 1990 most South African mine-water related research was conducted by the now disbanded Chamber of Mines Research Organisation. The WRC's involvement in mine-water research was limited to determining the water requirements and pollution potential of gold and uranium mines. Between 1990 and 2000 research focused on the impact mining has on the surface environment, on treatment options for mine

effluents and on the rehabilitation of mining spoils. In the last ten years the emphasis has shifted to the development of predictive tools and modelling techniques, with the focus on treatment options shifting to implementation and passive systems. A brief description of South Africa's contribution towards finding solutions for AMD follows.

IMPROVED PREDICTIVE ABILITY

Two aspects of research related to improved predictive ability have received special attention: firstly, the ability to predict the generation of acid drainage, and secondly, the ability to predict the rise in water levels

and/or time and point of decant when pumping associated with active mining stops.

In view of the plethora of techniques used to predict the likelihood of acid mine drainage, research targeted at opencast coal mining led by the Institute for Groundwater Studies at Free State University started in 1999 to standardise the methods used to quantify the potential and magnitude of AMD. Based on extensive testing of existing static methods, standardised methods of measuring initial pH, neutralisation potential and acid potential of water have been recommended.

“Several approaches have been evaluated in an attempt to reduce the production and impact of AMD associated with mining.”

An easy-to-use spreadsheet tool, ABACUS, has also been developed to standardise the interpretation of static acid-base accounting (ABA) data and, where the suggested sampling methodology has been followed, to provide a method for extrapolation to the field through volume-weighted techniques. Although the project focused on ABA, it strived to define a suite of acid-drainage prediction tools.

The researchers coined a new acronym, ABATE (derived from Acid-Base: Accounting, Techniques and Evaluation), for the approach that integrates a range of tools to predict the potential for acid generation. This also helps to prevent confusion arising in the use of the term ABA, since most people associate ABA with the static test component of drainage chemistry prediction, rather than the entire suite of tools. Research is in progress regarding the use of geochemical modelling techniques to predict the evolution of AMD over time.

There are about 270 gold-mine tailings covering 180 km² in South Africa.

Continued efforts to re-mine and consolidate the tailings into mega-dumps, the contamination and reclamation of the footprint beneath them and the degree to which tailing properties and time affect the depth and rate of weathering of typical tailings dams, have been investigated. An empirical model was developed to predict the likely period over which tailings dams will produce acid mine drainage. Efforts are currently underway to develop a coherent process to facilitate transparent and effective regulatory decision-making regarding the sustainable design, operation and closure of residue disposal facilities. A preliminary decision support system to facilitate decision-making has recently been completed, while a refinement of the system is nearing conclusion.

The ability to predict the rise in water levels, and hence when and where decant to surface would take place after the cessation of mining, has received considerable attention. This ability is particularly important in view of the recovery of water levels in deep gold mines and the seepage of AMD from old shafts.

Pioneering research in this regard was undertaken in the 1990s by the Institute for Groundwater Studies whereby the flooding of Central and East Rand gold mines, which have become largely interconnected through mining activities, were investigated. Among others, the research identified the controls over the inflow rate and water quality and was able to predict the future decant points and timeframes for different scenarios.

Elsewhere in South Africa, a series of collaborative research projects between the WRC and Coaltech (a non-profit organisation funded by coal-mining companies) captured the mine plans and coal seams in a three-dimensional GIS, enabling the mines to determine decant points and the extent of intermine flow within the Mpumalanga coal fields. This ability is currently used to determine the position and capacity of plants to treat the AMD emanating from the coal fields.

REDUCING AMD PRODUCTION AND IMPACT

Several approaches have been evaluated in an attempt to reduce the production and impact of AMD associated with mining.

A regional closure strategy was developed and is being implemented by the regulating authorities to ensure the orderly and responsible closing of mines which exploit the same orebody. This represents a fundamental change from the previous dispensation where the approach to address mine closure from the perspective of individual mines resulted in the last mine standing in an area to be saddled with the responsibility for the combined decant and AMD pollution potential of interconnected neighbouring mines.

Under experimental conditions the use of soil to cover acid generating discard material was found to be effective in reducing the ingress of oxygen and water and thus the volume and strength of AMD percolate. However, under field conditions, where large discard dumps had to be covered, it proved difficult to source sufficient soil for an effective cover reducing cover depth on side slopes.

An evaluating and modelling of the impact that the release to surface streams of stored saline neutralised

The Emalaheni Water Reclamation plant outside Witbank where polluted mine-water is treated to drinking water standard for the local municipality.



Lani van Vuuren

AMD during high flow conditions would have on water quality contributed to the development of a strategy whereby AMD from Mpumalanga coal mines is released periodically during years with above average runoff.

Several research projects have highlighted the benefits in the form of smaller volumes of water that would accumulate in underground mines if the ingress of water through surface cracks and fissures could be reduced. The Department of Minerals & Energy initiated a multimillion Rand project through the Council of Geosciences to identify and close these ingress points as a priority.

Two interesting projects aimed at minimising the impact of production of AMD are currently being conducted. The first is assessing the viability of extracting good quality groundwater in aquifers overlying deep mines in order to reduce the percolation of good quality water into the mines. The potential benefit is to prevent the subsequent contamination of this good quality water with AMD and in the reduction of the volume of AMD requiring mitigation. The second is an investigation into the feasibility of either removing or accelerating the oxidation of pyrites associated with mining. In this way, mining may be able to deal with AMD problems during the lifespan of a mine, so that mines would not have a post-closure AMD legacy.

The patented BioSure process, which uses sewage sludge as energy source for the neutralisation of acid mine drainage has been successfully applied at full scale.



TREATMENT TECHNOLOGIES

In contrast with water-rich mining regions, South Africa does not only face the high acidity and dissolved metal problems associated with AMD. The limited dilution potential associated with low rainfall exacerbates the contribution of salinity associated with this water to the salinisation of water resources. For example, effluents from gold mines contribute about 35% of the salt load but only 6% of the water flow at the Barrage in the Vaal River (the major water source of the industrial heartland of South Africa). For this reason much of the research into treatment technologies undertaken in the country are focusing on developing technology that would remove sulphate in addition to metals and the neutralisation of acidity.

The research into water treatment technology is currently being implemented and evaluated at a range of pilot and operational scales at a number of locations. In a joint venture, Anglo Coal and BHP Billiton constructed a 20 Mℓ/day reverse osmosis plant at 99% water recovery to produce potable water from AMD. Treated water from the Emalahleni Water Reclamation Plant is sold to Emalahleni Municipality to supplement its water supply. Two similar plants are planned for the treatment of AMD from other Mpumalanga coal mines.

Funded by the WRC, the Rhodes BioSure process, whereby sewage sludge is used as energy source for the biological reduction and removal of sulphates from AMD, has been implemented at ERWAT's Ancor wastewater treatment works. At times, as much as 10 Mℓ/day of toxic mine-water from Grootvlei has been treated this way.

The Western Utilities Corporation, established to treat AMD from four basins in the Witwatersrand goldfields, is planning to

treat 75 Mℓ/day of AMD from gold mines using the CSIR's ABC (Alkali-Barium-Calcium) desalination process, which uses barium to precipitate sulphates. A pilot plant using the degrading packed bed reactor, which overcame the failure that is commonly experienced with passive sulphate removal systems once the easily oxidisable organic material has been depleted, and that significantly improved the efficiency of passive systems, is also currently being constructed. The cost saving associated with using limestone (calcium carbonate) rather than lime (calcium hydroxide), and the effectiveness of the technology for the neutralisation of acid waters, have been demonstrated in a number of applications.

TECHNOLOGY TRANSFER

The Department of Water Affairs has completed a series of *Best Practice Guidelines for Resource Protection in the South African Mining Industry*. The series deals with various aspects from the department's water management hierarchy (integrated mine-water management through to water treatment); through to general water management strategies and specialised mining activities, such as small-scale mining.

Workshop and symposia on aspects surrounding AMD, mine closure and other related activities are organised regularly. In 2009, the Mine-Water Division of the Water Institute of Southern Africa, together with the International Minewater Association hosted a successful International Minewater Conference.

South African activities have made significant contributions on several fronts in the quest to deal with the problems associated with AMD emanating from mining activities.

To access the WRC's AMD-related research, visit: www.wrc.org.za. □

The Mapungubwe area in Limpopo is renowned for its golden rhino artefact that has become the icon of a society which settled close to the Limpopo River for some 400 years between about 900 and 1300 AD. The river was not only the lifeblood of this society, which depended on flooding for irrigation of soils to be cropped, but is also offered a multitude of other resources. Riverine forest provided some of these. Stretches of forest along both the Limpopo and Shashe rivers support monarchs of sycamore figs, ana trees, nyala trees, fever trees, marulas, weeping boerbeans, and a smattering of other species.

These verdant pockets of forest are in stark contrast with the surrounding landscape of semi-arid savanna dominated by the ubiquitous mopane tree. Most of our savanna trees in the lowveld support open riverine woodland, but in their classification of the vegetation of South Africa, Mucina and Rutherford recognised the Limpopo riverine forests of this region as a distinct forest type.

TIME BRINGS CHANGE

Toward the end of the thirteenth century, owing to a rapid change in climate as the effects of the 'Little Ice Age' began to manifest, the Mapungubwe society moved on to other pastures. A sequence of three mega-floods over a period of a century or so occurred during the middle of the Little Ice Age, with unknown impacts on these forests, but their presence today indicates that they recovered.

Once most humans had departed, elephants once again became lords of the forest. White agricultural settlement started occurring toward the end of the 1800s. Hunting intensified, and by the 1900s elephants had been displaced further north. By the 1950s almost all land along the Limpopo River had been committed to agriculture.



Drought probably caused the dieback of this fever tree.

The fall and fall of MAPUNGUBWE'S RIVERINE FOREST

The Greefswald riverine forest along the Limpopo River on the northern South African border is increasingly threatened by natural and anthropogenic activities. SAEON Observation Science Specialist Prof Tim O'Conner tracks the impact of these outside influences on this unique habitat.



Tim O'Connor



Tim O'Connor

Although an attempt to create the Dongola National Park failed, a handful of properties, including the farm Greefswald, were maintained as State properties. A substantial portion of riverine forest downstream of Greefswald was lost to the erection of a double electric security fence along the border, thereby increasing the conservation significance of the remaining forest upstream.

The bucolic serenity of the mopaniveld north of the Soutpansberg was set to change even further

Above top: An intact stretch of the riverbank lined with fig trees.

Above bottom: The first recorded elephant mortality in the Mapungubwe National Park – a ring-barked marula tree.

in the 1980s. A diamond pipe was discovered on the farm Venetia, destined to become the largest diamond mine in South Africa. The decision to develop the mine required water. Where else to look in this arid landscape than toward the Limpopo River some 40 km north?

Geography and access dictated that the Greefswald Forest was the most obvious point of supply. As the water was to be pumped from within the forest interior, a comprehensive assessment of potential impacts of water abstraction on vegetation was required. Contrary to popular belief, a diamond mine does not use as much water as some other land uses. The amount is equivalent to two centre-pivot irrigation schemes (duly purchased and discontinued by the mining company).

BASELINE SURVEY

An approach for direct monitoring of the effect of water abstraction on the forest was devised and implemented by the relevant conservation agency. As a prelude to these efforts, baseline information of the composition and structure of the forest was provided in a scoping report, which forms the basis of the subsequent account.

Composition and structure of riverine forest or woodland is influenced primarily by access of plants to the water table, which in turn is a function of distance from and elevation above the river. Accordingly, for the baseline survey undertaken in 1990, the 60 ha of forest were divided into different physiographic units reflecting these variables and each was sampled for shrubs, sub-canopy and canopy trees. Forest both upstream and downstream of the area of abstraction was sampled in order that comparisons could later be made if so desired.

At the time I thought it might be interesting if changes in the forest could be followed up at some later time, and so mapped the location

of, and tagged, 428 canopy trees that were each measured for their size, degree of creeper infestation, and canopy volume lost to drought-dieback or windshear.

DROUGHT, FLOODING AND ELEPHANTS

Fifteen years later I was in a position to follow up on what had happened to this forest. But what are the chances of three infrequent events occurring within such a short time interval – short measured by the presumed lifespan of centuries for these trees?

Water abstraction for the mine had commenced in 1991. Shortly thereafter the country experienced one of the worst droughts on record – the 1991/2 season being the most affected – during which flow of the Limpopo River ceased completely during the summer. This had never been recorded before.

Second, the February 2000 flood was one of the largest on historical record. The Shashe River resembled the mighty Zambezi it used to be before river capture took place. Third, the creation of the Mapungubwe National Park signalled the return of elephants to the southern banks of the Limpopo.

It is obviously easier to establish what has caused the death or disappearance of a tree if a survey is conducted shortly following an event, but various lines of evidence can be used to ascribe the mortality of an individual tree to an agent of mortality for long-lived trees even over such a long interval. This is only as good as the potential agents of mortality that are considered, and whether each would be distinct either in its spatial pattern or effect on the plant.

The set of mortality agents considered was drought, water abstraction, flood, wind-throw, salinisation, elephant use, lightning, creepers, and ring-barking by porcupine. In 2005, no trees had been killed through ring-barking by elephants, although

about half the trees had been debarked to a degree.

The individual and cumulative impact of different agents on canopy trees was quite dramatic. Overall a quarter of the trees were lost, an effect which was greater than it may sound because many of these were the larger rather than the smaller canopy individuals. As a consequence, the forest was transformed to open woodland.

Drought accounted for 76% of trees lost, and the 2000 flood for an additional 21%. Creepers were implicated in the drought-related death of nearly half of the trees which succumbed to drought, but interestingly their effect was felt mostly by species with microphyllous (small) leaves, such as *Acacia xanthophloea*, rather than broad-leaved species.

It could not be determined directly whether a tree had succumbed to natural drought or deprivation of water supply by abstraction, but tree mortality within the area of abstraction was approximately one and a half times that of what it was without – a hard lesson learned, but pumping patterns now better accommodate drought.

Sycamore figs had lined the banks of much of the 4,4 km riverfront that was sampled, but a large proportion of these were lost downstream when the 2000 flood eroded up to 60 m of bank for a distance of at least 1,6 km. There was no evidence in support of mortality by ingress of saline water, porcupine, or windthrow, although the latter had reduced the size of a number of trees.

By 2007 the first deaths resulting from elephant ring-barking had started to occur, and more were likely to follow as the overall extent of debarking, had increased. The species most targeted were marulas, fever trees, and sycamore figs. Elephants, however, had also severed most of the creeper connections with the supporting tree, thereby reducing this stress on remaining canopy plants.

Each of the main canopy species experienced a different degree of impact from the different agents of mortality. Species such as rain trees, boerbeans, and nyala berries had been less affected by most agents, such that woodland composition was now becoming dominated by these seemingly more drought-tolerant species.

Initial concern about the impact of water abstraction on riparian forest was ultimately dwarfed by the impacts of severe drought in combination with climber infestation, mega-flood, and elephants. The dominant species of this forest can live for centuries, such that a 17-year study is of short duration.

USEFUL POINTERS FOR SAEON

It may have been fortuitous to capture the effect of three major events that transformed the Greefswald Forest, but it may also presage future patterns of riparian forest change globally in response to increasing climatic variability and ever-increasing demands on water. At this time, a large water impoundment on the Shashe River is close to completion, and increasing amounts of water will be abstracted from the Limpopo catchment for power generation. The South African Environmental Observation Network (SAEON) has this data as one small means of assessing anticipated impacts of decreased flow on riparian habitats.

This account offers some useful pointers for SAEON in achieving its goals. First, it was born of an environmental impact assessment process. These are being undertaken all the time yet the data generated by this process is not easily accessed.

Second, it resulted from the interest of an individual rather than being the outcome of a formal procedure, yet most thinking is centred on organisational links. Third, even though it was not required, it was easy to set up sampling so that a follow-up could be conducted.

Perhaps other surveys could be influenced in a similar manner. Following the fate of individual trees rather than simply measurement of stands of vegetation improved considerably the quality of the study – all the more easily accomplished now in an era of GPS.

Below top: A fever tree is slowly smothered by a climber (*Combretum microphyllum*).

Below bottom: An eroded section of the riverbank where many fig trees have been lost.

- This article first appeared in the South African Environmental Observation Network (SAEON) newsletter, June 2010. Visit www.saeon.ac.za for more information. □



Tim O'Connor



Tim O'Connor

WRC tools help farmers improve efficiency, cut costs

A close-up photograph of two golden wheat stalks against a clear blue sky. The stalks are in sharp focus, showing the intricate details of the grain heads and the long, thin awns. The background is a soft, out-of-focus field of similar wheat, creating a sense of depth and a bright, sunny atmosphere.

South African farmers face many challenges in meeting the country's food security needs, from a variable climate to rising production costs and the pressures of a globalised market. The Water Research Commission (WRC) has invested in the development of several tools to help farmers prosper in a volatile environment.

Compared to other countries, the level of subsidisation of agriculture in South Africa is one of the lowest in the world.

This means that local farmers have to continually raise the efficiency of their operations to remain profitable. Over the past few years, local agriculture has also been hard hit by exceptionally high input price increases, for example, fuel, fertilisers and electricity.

Water management, mainly in respect to irrigation practice, is one of the most critical determinants of economically efficient crop production, particularly in a seasonally dry country such as South Africa. In the case of pivot irrigation, for example, the cost of the pump, maintenance and water levies can make up to 25% of the production costs per hectare, thus it is a considerable expense requiring the necessary attention. At the same time, there is pressure from government on the agricultural segment to reduce its overall water use.

Through the years the WRC has funded the development of several computer-based tools to assist farmers in managing their costs and risks. Hundreds of commercial and emerging farmers have already been trained on, and are already benefiting from, these tools.

RISKMAN

Risk management should form an integral part of the daily decision process while managing a farm business. RiskMan is a simulation model of net cashflow for water use and crop combinations at specific risk levels, generally applied at farm scale. The main aim with the development of this program was to provide risk-management information to bridge the gap between theory and practice at whole farm level.

Any agribusiness advisor or farmer can make use of the program. RiskMan weighs up alternative actions to reduce exposure to unfavourable financial outcomes and provides reliable and relevant

information on which decisions can be based. It supports, but does not replace, the decision-maker in risk management.

RiskMan is especially suitable for, among others, the quantification of interest rate, irrigation cost, product price, yield or production variation and hail damage; evaluating different production management strategies; and determining the effect at whole farm level of including or excluding a crop or livestock enterprise from a farm plan. It can also assist in the verification of risk data; simulate the total margin above specified costs or net cash flow at whole farm level; and rank production management strategies, taking risk attitudes into account.

IRRICOST

IrriCost is an aid for the management of irrigation costs. Both the capital and operating costs must be considered when purchasing a new irrigation system. Thus the IrriCost cost-accounting program has been developed to estimate both the annual fixed and variable costs of irrigation systems.

This Windows-based program can be used by all farmers, extension officers and advisers involved in centre pivot and hand-line irrigation who have access to a personal computer. The scope of IrriCost's field of application is wide, and the program can be used to compare the costs of alternative system designs, to evaluate annual costs and to budget irrigation costs.

FARMS

RiskMan and IrriCost have now also been combined in a single system, FARMS (Farm level Agricultural Management Simulator). This computer program combines the benefit of the two programs with other tools to form a comprehensive farm management decision-support system. FARMS can also be used in conjunction with other systems

developed with funding from the WRC, namely SWB (Soil-Water-Balance) and the international award-winning WAS (Water Administration System).

The FARMS program generates short-term whole farm plans and enterprise budgets with fixed quantities and prices. Tested for several farmers in the irrigation areas of Riet River, Rama and Loskop, training has also been extended to agribusinesses, bureau services and advisors in the main irrigation areas of South Africa.

Technology is one of the greatest drivers for progress in agriculture, however, new technology is only valuable when it is appropriately applied. The tools developed by the WRC have already proven to make a difference in the lives of farmers, and others are encouraged to make full use of these programs, which are available free of charge.

For more information on the agricultural tools available from the WRC, contact Publications at Tel: (012) 330-0340, E-mail: orders@wrc.org.za or visit: www.wrc.org.za. For advice on implementation of these decision support tools, please contact Dr Bennie Grové or Prof Klopper Oosthuizen at the Department of Agricultural Economics, University of the Free State in Bloemfontein. □

Water management is one of the most critical determinants of economically efficient crop production.



www.sxc.hu



Liani and Maria are cycling for change

Many people realise the challenges South Africa is facing with regards to its water, but not many people will stand up and do something about it. Maria Botha and Liani Broodryk are two of those rare people. These modern-day water disciples have hit the rivers and roads, preaching for change in our water ways, one town at a time. Petro Kotzé got them to stand still long enough to report on their activities.

“**W**hat is needed along with fresh water is fresh thinking.” When Nobel Peace Prize winner and 7th Secretary General of the United Nations, Kofi Annan uttered these words, he could have been speaking of two women right at the southern tip of Africa.

Indeed, Maria Botha and Liani Broodryk, along with their two dogs, Dante and Katryn, have devoted themselves to motivating others to value water and share the knowledge that something can be done about water

pollution. The tight team of four is just as inspirational as their campaign, *Ripples for Good*. Travelling by any means possible, they are spreading their words of wisdom through southern Africa. They’ve almost drowned, been without water for days and survived a serious road accident, but their spirits have not been dampened. “People’s inherent goodness” make up for it, they say. As Maria puts it, “it puts a smile on your dial.”

After touring South Africa, their mission will take them to Mozambique, Zambia, Zimbabwe, Namibia and Angola, where they will have a closer look at transboundary water resources. But this is just a continuation of a journey that started a while back.

WITH OR WITHOUT A PADDLE

The Ripples team reached the tipping point six years ago, quit

their jobs and packed their bags to “do something that matters”. Maria was 24 years old and Liani 32 when they first cycled from St Lucia to Cape Town. “Our country is amazing”, they say. “We haven’t met one person along our way that has made us feel like we are in danger,” Maria adds. Dante and Katryn are also great travel buddies. “We know that if they are uncomfortable, we should move camp.”

After Cape Town they continued to Upington, got a lift with farmers to Springbok and decided to canoe down the Orange River. “We had never done anything like that before,” explains Liani. “We didn’t even know that we needed a guide”. Admittedly, they might have gotten into hotter water than expected. One near drowning and a lost canoe later, it was time to move on again.

Next, they cycled from Springbok to Potchefstroom. A year passed and the girls took a break to gather their

strengths. They always supported causes close to their hearts during their trips and before long, people asked them when their next adventure would be.

“At the end of the day we all have an idealistic picture in our heads of what we want out of life. The majority of people are really good at heart, have a dream and are on their way somewhere.”

Soon, Dante and Katryn were loaded up for an expedition from Rustenburg to the Drakensberg Mountains, where they wanted to walk from Witsieshoek to the Sani Pass. Somewhat unprepared for what lay ahead, they eventually reached their destination a month later.

“We’ve also tackled the Transkei”, says Maria, “and we got stuck in floods at Kei River Mouth”, adds Liani. Between botched donkey-car trips through the Karoo and planned Swaziland adventures, they eventually travelled to Parys in the Free State, where the friendly locals helped them by sponsoring their next escapade. They decided to canoe down the mighty Vaal River to Douglas. “It was a huge awakening.” The women relate how they had to battle through raw sewage and near solid stretches of hyacinth in the river. Sometimes, they had no choice but to get out and carry the canoe for kilometres. “The Vaal is used for so many things, like growing our food and as a source for drinking,” they exclaim. “If this continues, what will happen to our children?”

“We realised something was happening to the country’s water, and we decided it would be our mission to fight it.” Maria, Liani, Dante and Katryn took an eight-month break to regroup and research water issues and role players in the industry. *Ripples for Good* was born.

THE RIPPLE EFFECT

“People have a basic right to clean water. They shouldn’t have to go out and buy the bottled version”,

explains Liani. “Basic water is free.” Their campaign’s slogan aptly states that “it starts with you”. “If you have to wait for the government to solve your problems, you’re waiting for better

days,” she says. It’s no use pointing the finger at somebody else for the solution if you are not also making an effort to change your own habits.

Maria and Liani believe that the more they tell their story, the more they empower people with the knowledge that they can change their own environments. “As soon as our message touches one person, and they start changing their ways, the ripple effect starts.” They can now be an example to others, like a family member, a community and eventually, on a global scale.

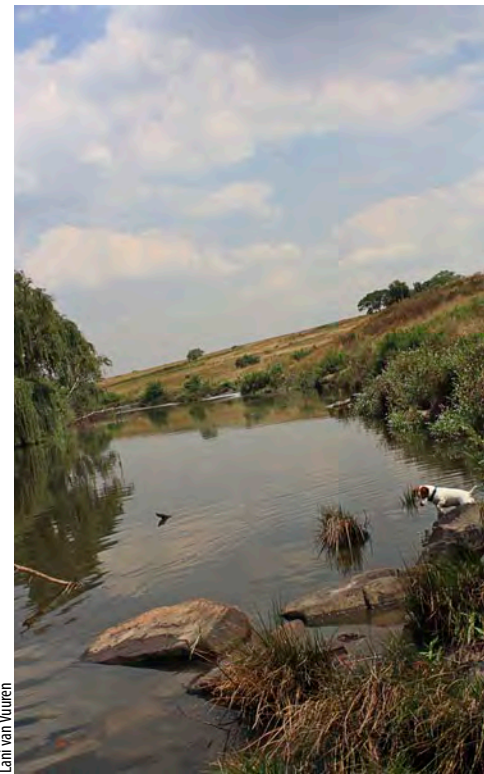
They believe that creating fear around pollution is not the answer, but rather the provision of solutions and knowledge. “You want people to wake up and get involved in a combined, positive effort.” At least, they say, they’ve noticed a “huge” difference in people’s perspectives over the past six years. “You can find a *boer omie* that has just finished his *dop* somewhere in a small town, and then he’d suddenly start telling you all these amazing things about pollution and water conservation.”

The ripples have also circled out to bigger organisations. Currently travelling on motorcycles sponsored by Yamaha, Ripples for Good are able to visit more communities quicker. Dante and Katryn get Royal Canin food couriered to them wherever they are and Garmin ensures that the girls know in what direction they’re aiming most of the time. Companies like Avroy Shlain also organise audiences where possible along their way. Even the CSIR has expressed its support for the quartet.

Top right: Dante takes a closer look at the Olifants River outside Witbank in Mpumalanga.

Middle right: Liani and Katryn share a moment on the road.

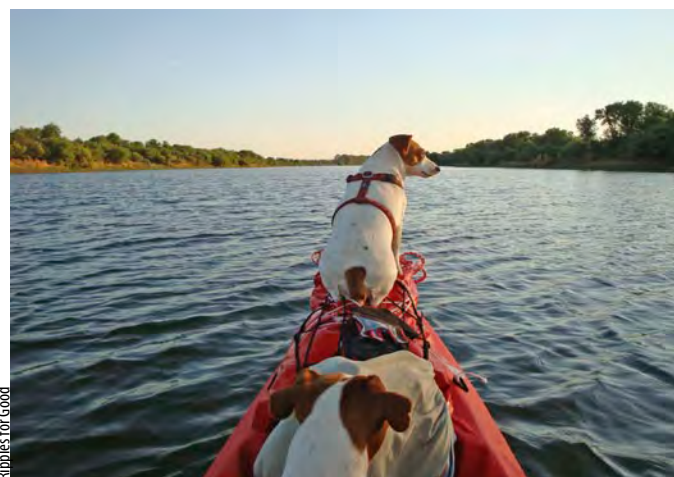
Bottom right: The mighty Vaal River – an impressive sight in spite of the problems that the team encountered on their way.



Liani van Vuuren



Ripples for Good



Ripples for Good



Ripples for Good

Another day at the 'office' for Maria, Dante and Katryn.

GETTING IN DEEPER

Except for the Queen's Corgi's, Dante and Katryn are probably the only two dogs that have been invited to their country's Parliament, muses Maria. They were invited for a visit by DA parliamentary member in Cape Town, Gareth Morgan.

Indeed, the ripples of the past six years have generated more and more attention. They've been featured in Beeld and on Kwêla. Environmental interest television programme 50/50 has interviewed them and plan to follow them as their trip continues. They were also shortlisted for the Mail & Guardian's annual supplement in celebration of 200 of the country's brightest under 35's for their contribution to civil society. According to the paper's criteria, "this is the generation that will define and lead the country in the future."

Having just completed a promotional run on their bikes for the

Maria explains that their main purpose is not only to educate, but to facilitate. They identify positive role-players in communities and link them with people and organisations that can offer continued support. One of the organisations they have

linked up with is the Water Research Commission (WRC). "The WRC is making a huge impact, especially through providing educational material to communities." "Eventually, the way we all look at our water has to change."

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World Cup, the Ripples team is on the road again and heading for Mozambique via Swaziland. Just like the issues at stake, the trip is also a global effort. After the southern African leg of the trip, they will head to South America, then North and Central America, India and the islands as part of their two year plan. But Liani is quick to point out that their lifestyle is not as glamorous as one might think. "It's no joke pushing an 80 kg bike up a hill, being constantly on the lookout for good camping spots and not being sure where your next drinking water will come from."

Looking back at the past six years, they feel content with what they have achieved. "It's great to open yourself up a bit and to realise that you're unique. There's so much to life that we don't know about yet." Just as their mindsets have changed over the past years, this trip is also about changing others' perceptions.

Ripples for Good visit the Tirisano Day Care Centre, this time to talk about solar water disinfection.



Ripples for Good

"Your mindset has everything to do with your reality".

"At the end of the day we all have an idealistic picture in our heads of what we want out of life. The majority of people are really good at heart, have a dream and are on their way somewhere," they say. "Everybody

wants to leave a good ripple effect".

- To support Maria and Liani's efforts search for 'Ripples for Good' on Facebook: and join their group; follow their blog at www.ripplesforgood.com; or E-mail: maria.botha@gmail.com 

Call for Registration: WDM Specialists

The Water Demand Management (WDM) Programme is hosted by the Development Bank of Southern Africa (DBSA) and supported by the Swedish International Development Cooperation Agency (Sida).

The Programme is focused on building a WDM culture in the Southern African Development Community (SADC) region to ensure effective and sustainable use of water that contributes to the SADC goals of regional integration and poverty alleviation.

The WDM Programme invites all WDM specialists in the region to register with the Programme's WDM Specialist Database.

Download the Specialist CV template from the Programme website :

www.wdm-in-sadc.net or send an email to the Programme Implementation Unit (PIU) : **info@wdm-in-sadc.net** requesting the template.

The WDM Specialist Database will be accessible to all registered members on the website, as well as potential Clients.

Tel +27 (0)11 313 3362
 Fax +27 (0)11 206 3362
 Email: info@wdm-in-sadc.net
 Website: www.wdm-in-sadc.net



Photos courtesy WRP



The adventure of working together: Promoting transdisciplinarity between young water scientists



A national forum for young water scientists aims to bring multiple disciplines together around one goal. Shanna Nienaber and Inga Jacobs report.

The water resources of the Southern African Development Community (SADC) are highly sensitive and complex to understand, govern, use effectively and distribute fairly. This reality is created by many overlapping factors, among others the fact that water is fundamentally a shared resource in the region.

Some of the most economically developed southern African

states have limited water resources, which may constrain future economic development. This makes it imperative to work carefully with this resource to ensure its continued availability, at an affordable price, to existing and future generations. In addition, there are pronounced developmental differences in SADC, rendering some countries more effective than others at mobilising necessary human, financial and technologies resources to address water scarcity and related human welfare needs. Finally, SADC is confronted by numerous social challenges, such as population growth, urbanisation, climate change, refugee movements,

and outbreaks of disease which impact on water needs and use.

TOWARDS A TRANS-DISCIPLINARY RESPONSE

Traditionally, the technical and scientific communities have been called on to respond to the concerns of the water sector. This had led to much technical and scientific innovation to respond to water challenges. However, emerging water concerns and complexities are demanding more integrated levels of ingenuity and expertise from a diverse set of backgrounds. No amount of technical and scientific

ingenuity is adequate if the solutions generated are not relevant, digestible and acceptable to the specific socio-political and socio-economic contexts of our time.

Given this realisation, there is growing recognition of the need for more transdisciplinary responses to the challenges facing the water sector. Transdisciplinarity is about rising to the challenge of working together; understanding the concepts, contributions and language of different disciplines; and integrating the perspectives of different actors into comprehensive solutions for the water sector.

One of the hindering factors to transdisciplinarity is the reality that there is an ongoing lack of social scientists dealing with water issues. This can be, at least in part, attributed to university curricula that do not adequately equip social science students with the skills needed to grapple with environmental issues; funding agendas that tend to favour natural science methodology and thus support less social science research; and an organisational bias favouring natural scientists and technical experts in research organisations. This is tied to the (mis)perception that 'hard science' is more accurate and valuable than the 'soft' and often qualitative science of social scientists.

Despite these challenges, there is growing recognition of the need for social scientists equipped with skills, understanding and passion for governance issues in the water sector. A social science presence is important as social scientists have unique expertise in cultural, behavioural and societal realities. This equips them with the skills to interpret subjective, objective, inter-subjective and structural aspects of society. This aids understanding of the social developments, needs and drawbacks of a context. Also, social science has a familiarity with institutional capacity building mechanisms and thus can offer critical support to the bodies and individuals that are mandated to manage water in

the region. Furthermore, a primary goal of social science is to influence public policy by general practical knowledge that can help policy-makers make informed decisions and in so doing help to foster more effective policy and governance options.

YOUNG SCHOLARS FORUM

Given the complexity of the challenges facing the water sector in SADC and the obvious value of transdisciplinarity in responding to these issues; it is essential to rise to this challenge.

The Young Scholars Forum (YSF) in Transboundary Water Governance is funded by the Water Research Commission, and aims to incentivise transdisciplinarity in the water sector. The WRC's commitment to funding this initiative is a clear indication of the growing recognition, by institutions in the water sector, of the need to build capacity in transdisciplinarity in order to foster a sector that is equipped to respond to the challenges of water management and governance.

YSF's mission is to facilitate collaborative exchange between young water professionals and students around issues facing the water sector. Conscious effort is made to accommodate multiple voices, facilitate understanding of the language and perspectives of different disciplines, and to nurture the presence of minority voices in the water sector such as social scientists.

The specific aims of the YSF are to build a community and network of professionals who have an interest in dealing with the social dimensions of water challenges in our region, to create opportunities for younger and more experienced professionals to interact and share knowledge, and to increase social science literature output relating to water issues.

This forum is unique in that it is focused on the specific issue of water governance. It is theme-based, allowing young professionals to develop their expertise in a focused, proactive

manner. It is transdisciplinary, and has strong links with the South African Young Water Professionals (YWP), which provides linkages and access to a wider national and global water network with the Water Institute of Southern Africa and the International Water Association.

ACTIVITIES

To date YSF has been involved in a number of initiatives to promote its mission and aims, including three events held in collaboration with the YWP Gauteng Chapter as well as other events held in Pretoria and Durban.

In November the YSF will host a workshop in transdisciplinarity at the CSIR, in Pretoria. The theme of this event is 'Exploring transdisciplinarity to address change in the SADC water sector: establishing the role of social scientists in the vision.'

To overcome the challenges of the SADC water sector, it is essential to come to grips with working across disciplines, across boundaries, and with a diverse spectrum of actors. Young water professionals are strategically placed to respond to this unique challenge. YSF is a constructive way to help promote transdisciplinarity, and to groom, recruit and mentor young professionals who are moving into the sector. This ultimately assists in paving the way for more effective, impactful and relevant solutions for the SADC water sector. □

Dr Inga Jacobs of the CSIR speaks to a group of young water professionals at an event organised by the Young Scholars Forum in collaboration with the Young Water Professionals Gauteng Chapter.



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27850 The Water Wheel

Growing Africa's future water leaders

The African water sector faces many challenges and inspirational leaders are required to pick up the torch of effective water management into the future.

One institution aiming to grow this leadership is the International WaterCentre (IWC) Water Research Node at Monash South Africa.

While there are experienced people working at the coalface of the African water sector already, they are in short supply and overworked. More skilled young people are required to pick up the slack, reports Dr Dirk Roux, Director of the IWC Water Research Node. According to Dr Roux, these leaders require a depth and breadth of knowledge to direct sustainable use, effective management and wise governance of water resources. "They need to be humble enough to serve, yet have the vision and energy to inspire people to treat water resources like the finite and most precious resources that they are."

The IWC Water Research Node was set up at Monash South Africa to help create these water leaders.

INTEGRATED WATER MANAGEMENT

Integrated water management is a holistic approach to water management. It considers the whole water cycle and takes into account the socio-economic, political and environmental factors affecting water challenges, in order to achieve sound, sustainable solutions for water and water-related problems. Understanding the interconnectedness of water in human and natural systems, and the need to take a much bigger perspective than just the single-issue approach, are vital if effective solutions are to be found.

Social, cultural and environmental factors must be taken into consideration. Water practitioners



Current students at Monash SA's International WaterCentre Water Research Node, Liezl Craig and Karin Breytenbach.

need to develop creative and critical thinking skills to solve the complexity of problems Africa is now faced with and to manage water projects in a holistic way.

IWC WATER RESEARCH NODE

The IWC Water Research Node uses integrated water management as a critical theme to make both a practical and theoretical contribution to an inter- and transdisciplinary understanding of water management in Africa. The Node is a collaborative partnership between Monash University and the International WaterCentre – a joint venture of four Australian universities.

The Node was set up to address some of the key water resource management challenges of contemporary Africa through research, education and community engagement. Its flagship educational offering is the two-year research intensive degree, Master of Philosophy in Integrated Water Management.

Because the Water Research Node is a small unit a lot of emphasis

is placed on working with other research organisations, universities and implementation agencies in South and Southern Africa.

FINDING SOLUTIONS FOR THE FUTURE

"If you want to make a difference in the African context," says Liezl Craig, one of the current students, "water management is the field to enter. There are numerous challenges and a severe lack of champions to address them."

The water leaders envisioned by the Water Research Node will have the skills to initiate dialogues between professions, peoples, cultures and countries. They will understand the specialty areas involved in water – engineering, law, politics, agriculture, etc. – and be able to communicate and work between them. They will create diverse teams and develop partnerships with and between professionals, communities and governments and play leadership roles in the critical interface between science and management of water resources. □

How much WATER did you have today?

We all know how important it is to turn off the tap while we are brushing our teeth and that the average shower uses much less water than the bath. But did you know that what you eat can also affect your water consumption?

People obviously use large amounts of water through drinking, cooking and washing, but even more water is used to produce our food, clothes, paper, appliances and everything else we use every day. From the sandwiches in your lunch-box, to the apple for the teacher and your home computer everything requires water whether it is grown, produced, processed or manufactured.

The total volume of water that is required to grow or make a product is called its water footprint. While the world's population keeps on growing the volume of water we have on Earth stays the same. If we don't want to run out of water we need to become more aware not only of the physical water we use, but also of the water footprint of the things we buy, eat, use and dispose of every day.

WATER FOOTPRINT

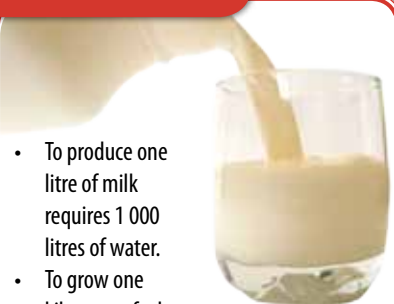
So just how much water are you consuming every day? It really depends on your diet. Animal protein has an especially

large water footprint because vast volumes of water are used to grow the feed consumed by the animals that we derive our meat from. This is increasingly important considering that globally meat production increases every year. Even a small reduction in the animal protein we consume can reduce our water footprint without depriving our bodies of nutrition.

Generally, meat, dairy, and processed foods require far more water to produce than fresh fruit, vegetables and whole grains. That beef hamburger you like eating takes 2 400 litres of water to produce. One bag of 200 grams potato chips (crisps) alone has a water footprint of 185 litres. However, even a seemingly harmless bread and cheese sandwich requires lots of water to make, with 690 litres of water needed to produce a half of kilogram of wheat and 2 500 litres of water needed to make a half a kilogram of cheese. Adding a glass of milk requires another 250 litres of water!

According to the Water Footprint Network the average South African has a yearly water footprint of about 930 cubic metres. That is all the water used to make the food, clothing and other water-driven products we consume. If you times that number by the number of people in the country then the water in the yearly water footprint for the entire South African

HOW MUCH WATER IN THAT MEAL?

- 
- To produce one litre of milk requires 1 000 litres of water.
 - To grow one kilogram of wheat needs 1 300 litres of water.
 - To grow one kilogram of rice needs 3 400 litres of water.
 - More than 140 litres of water goes into every cup of coffee.
 - It takes 2 500 litres of water to produce 1 big (500 g) chunk of cheese.
 - It takes 4 650 litres of water for one steak (300 g).
 - The average water footprint for one apple is 70 litres. One glass of apple juice takes about 190 litres of water to make.
 - Every slice of bread uses about 40 litres of water.
 - One kilogram of chicken meat has a water footprint of 3 900 litres.
 - One egg requires 200 litres of water.
 - One kilogram of sheep meat has a water footprint of 6 100 litres
 - About 50 litres of water is used to produce one orange.
 - One kilogram of maize requires 900 litres of water.



Our love of animal protein is driving up water consumption, with every steak requiring 4 650 litres of water.



Left: The water footprint of an average-sized margherita pizza is 1 200 litres.

Right: Fresh vegetables use much less water than processed foods.



population is enough to fill 1 488 000 Olympic-sized swimming pools! This is a large number, however, our water footprint is still less than the global average, which is 1 243 cubic metres per person per year. In the United States of America, where people consume a lot of animal protein, the average yearly water footprint per person is 2 483 cubic metres (the largest on the planet). In Asian countries such as Japan, where people are more dependent on seafood, the water footprint is only 1 153 cubic metres per person per year.

WHAT YOU CAN DO

There are a few things you can do to reduce your water footprint. Firstly, only buy enough food for your own and

The water footprint of a product does not only take into account the water it needs to grow, but also its processing, packaging and transport to market.



FURTHER READING

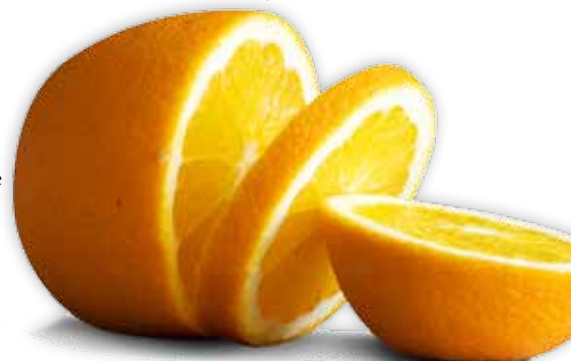
- Visit www.waterfootprint.org to find out more about the water footprint of different products and to calculate your own water footprint.
- Visit www.h2oconserve.org for quizzes and tips on how to reduce your water footprint.
- Visit: <http://tlc.howstuffworks.com/home/going-green1.htm> for general tips on greener living.

your family's consumption and plan meals accordingly. Tossing out leftover or spoiled food means wasting every drop of water that went into growing that food (think of that every time you don't ask for a doggie bag when eating in a restaurant).

Secondly, eat healthier. Your mother was right when she told you to eat your vegetables. Not only is it better for your body (and your waistline), it is good for the environment too. Meat requires five to ten times more water to produce than vegetables. Even better, grow your own fruit and vegetables. Supermarket produce is machine agitated, power-washed, fan-dried, refrigerated and kept from freezing, all which requires electricity. Water is used to make

electricity, and this adds to the water footprint of the products we consume. Water is also used to make the plastic packaging that we buy our produce in.

We all need to become more conscious about how much water it takes to maintain our lifestyles. So drop that packet of crisps and reach for that orange!



CSIR showcases its science

The CSIR held its Third Biennial Conference during August/September 2010. The theme of this year's conference was 'Science: Real and Relevant'. The conference has become a major event on the Council's calendar. This year, close to 900 delegates attended, more than 50% from outside organisations. According to Dr Thulani Dlamini, CSIR Group Executive: Research and Development, the event offers the Council the perfect

opportunity to showcase its work and engage with its shareholders. Presentations represented various subjects in the fields of health and safety, built environment, defence and security, industry, energy and natural environment. Minister of Science & Technology, Naledi Pandor, who delivered the keynote address, made a passionate plea to the CSIR and other science councils to not only focus on 'creative and imaginary' research, but to tackle

projects that would directly impact on the country's poor. "There is no point in having technology, research and development if we still have people without access to energy, health-care and other basic services. Science and technology is a key enabler in boosting the economy. We must look at how technology, research and development respond to local and global problems, and increase science's supportive role in developing and modernising South Africa."

All photographs by Lani van Vuuren



Minister of Science & Technology Naledi Pandor delivered the keynote address.



Dr Patience Mthunzi, Saturnin Ombinda-Lemboumba and Ivy Ndhundhuma, all from the National Laser Centre at the CSIR.



Pieter de Beer, Marius Coetzee, Rob Wallis and Ryan Cowley, all of the South African Air Force.



Dr Nqaba Ngcobo, Chair of the Parliamentary Portfolio Committee on Science & Technology.



There were 67 posters on display at the conference.



Andri Barnard, Lara Kotzé-Jacobs and Ilse Wepener, all from CSIR Polymers and Composites.

Master of Philosophy Integrated Water Management

The course is designed to prepare a next generation of research leaders to address complex and interlinked water management issues. Endorsed by four world-class universities, the course is delivered at Monash South Africa by international leaders and local experts in a broad spectrum of disciplines.

The course

- Commences in Semester 1 of each year at the Monash South Africa campus in Ruimsig, Johannesburg
- Full-time over two years
- Focus on interfaces between science, policy and management
- Lectures and supervision by various experts from South Africa and Australia
- Small intake of students to allow personal coaching and mentoring
- Attractive scholarships available
- Internationally-recognised degree endorsed by four leading Australian universities



Learning objectives

At the end of the course students will be able to:

- appraise freshwater ecosystems as complex social-ecological systems
- evaluate the imperative of sustainable development in relation to the planning and management of water resources
- design an integrated water resource management plan
- develop a research project proposal
- execute an integrated water management research project
- present their research findings
- prepare an academic paper ready for submission to a scientific journal.

Water leadership for the future

The course comprises an interdisciplinary foundation semester consisting of four compulsory units and a three-semester research project.

The masters research thesis will form the bulk of the course weighting, while the coursework component introduces students to some of the complex underlying concepts, such as biological, social and economic factors, which affect sustainable water management.

Admissions criteria

- A four-year qualification or equivalent honours degree
- 70% achievement or higher in this qualification
- Proficiency in written and spoken English

It is recommended that applicants have a science background, research aptitude, an interest in multi-disciplinary water issues and some work experience.

Student profile

This course is ideal for professionals with an interest in research from a variety of water-related backgrounds such as engineering, social sciences, service provision, environment, conservation, health and many others. The course can be used as a gateway to a PhD program or to work in the interface between science and management of water resources.

More information

Tel: 011 950 4143

Email: hester.stols@monash.edu

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

Deadline: 31 October 2010

Monash South Africa is registered with the Department of Education as a private education institution under the Higher Education Act 1997. Registration number: 00HF02.



Water Research Commission



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

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

Impact areas address the following key issues:

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

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