THE WATER WHEEL

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Mine-water: The time to act is NOW

WATER RESEARCH COMMISSION

THE WATER WHEEL

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***Cover**: Authorities have less than 12 months to act before the mine-water rising beneath the country's City of Gold reaches critical levels. See page 12. Cover illustration by Ralf Broemer.*

Letters to the Editor

Young hydrologist left without professional home

I would like to bring to the attention of the hydrological community of South Africa, the outcome of an application by a young hydrologist for professional registration with SACNASP (South African Council for Natural Scientific Professions).

This person has a first degree in agricultural engineering, an MSc in Water Resources Management from WATERNET and a PhD focused on hydrological modelling uncertainties from Rhodes University. His application was rejected twice (once after an appeal) on the grounds that his undergraduate qualification is not in geography or geology/earth science. He has been informed that he can re-apply under the 'Recognition of Prior Learning and Experience' option after a minimum of 10 years continuous appropriate vocational experience.

This represents a serious problem for many young hydrologists in South Africa who have been trained as scientists rather than as engineers (who obviously have their own professional body). It is also a problem from two other perspectives. The first is that SACNASP seems to be totally unaware of the training requirements for professional hydrologists and the relevance of the course material given in different undergraduate disciplines. The second is their almost complete disregard for the MSc and PhD qualifications of the applicant.

Many of us will be aware that the content of many geography courses offered in South Africa would be of little use to a hydrologist, while hydrology has always featured strongly in the course content of the agricultural engineering degree at UKZN and other universities. The implication is that hydrology is not considered to be part of the field of practice of earth science according to SACNASP and if that is the case, where do young practising hydrology scientists find a professional home?

There are many hydrologists who have trained as engineers and whose professional home is clearly the South African Institution of Civil Engineers. However, there are many hydrologists who are not engineers and yet make contributions to solving some of our water resources problems. My experience suggests that they come from different undergraduate backgrounds and that their professional capabilities are mostly associated with the field and quality of their post-graduate studies. This seems to be something that SACNASP seem unwilling to take into account.

It is my opinion that we should be encouraging young professional scientists and yet this recent experience suggests quite the opposite. I would be very interested to hear the experience and opinions of other people.

Prof Denis Hughes, Institute for Water Research, Rhodes University

Deteriorating water quality to cost country dearly

A decrease in water quality of a mere 1% may result in as many as 200 000 job losses in South Africa.

This is but one of the thought-provoking findings of an economic impact study conducted by Plus Economics on behalf of trade union UASA. The aim of the study was to ascertain and quantify the effects of deteriorating water quality on South Africa's economy. The status of the country's water has been under intense scrutiny, with major water quality risks such as acid mine drainage, eutrophication of surface water, bacterial and viral pathogens and contamination by pesticides and organic pollutants making headlines.

Decreases in water quality – leading to reduced usability of water – will have profound effects on individual people's disposable income as well as government spending, the study found. The study forms part of the trade union's ongoing Water Security Campaign. According to Plus Economics CEO Prof Charlotte du Toit, additional macroeconomic effects of decreased water quality include a rise in the ratio of government debt to gross domestic product (GDP) to 28%, a drop of R16-billion in household spending, a drop of 1 percentage point in the GDP growth rate as well as a drop of R9-billion (2,5%) in total fixed investment. "A decrease in the quality of water will have negative and different effects on the individual economic sectors. Among our findings are that growth in the electricity and water sector will decrease by 2%, and that as many as 14 000 jobs may be lost in the financial services sector."

Du Toit also discussed the effect of a decrease in the quantity of water available on the different economic sectors. She said that if a decline in the final availability of water supply of, e.g. R10-million was assumed (which would need to be supplemented from other sources, including desalination of sea water), the study showed the following effects can be expected to manifest:

- Agricultural output will drop by R570 000
- Mining output will decrease by R1,1-million
- Manufacturing output will drop by R7-million
- Electricity output will drop by R1-million
- Tourism output will decrease by R2,3-million
- Financial services output will decrease by R4,6-million
- Community and social services output will drop by R5,4-million.

This means that the total economic output would decrease by R41,7-million. "For every one job lost in the water sector, a further two jobs are lost elsewhere," Du Toit said. Similarly, she showed how a decline of R10-million in the availability of usable water for manufacturing would result in a decrease in total economic output of R51,5-million while the decrease in employee compensation would decrease by R7,8-million as a result of a decrease in the quantity of water available.

UASA CEO Koos Bezuidenhout said the report would help South Africa to gain a better understanding of the crucial role of water and start to appreciate the real value of water in their daily lives. "The outcomes of this economic impact study are extremely useful...for the first time we can clearly see the role of water in the South African economy. As UASA has urged before, water needs to top all the agendas in the country and we need to develop a new respect for this precious commodity."

Source: UASA

Water expert wins environmental award

Touchstone Resources Director Dr Anthony Turton has won the Nick Steele Memorial Award for South African Breweries Environmentalist of the year.

The annual award, presented in November, is given in honour of the late legendary game ranger Nick Steele, and honours those who have promoted the cause of conservation and whose work will leave a legacy for years to come.

Dr Turton has been gathering information about the risks facing our natural watersheds for over ten years. While he has systematically made his findings available to both government and industry, the relevant authorities have reacted with alleged lethargy and ambivalence. In November 2008 after his presentation of findings was withdrawn from a conference for being too sensational in context, Dr Turton took his story to the media where the alarming facts about the urgency of acid mine drainage finally reached the public domain.

Dr Turton was suspended from his post at the CSIR and later resigned, and now continues his efforts in his personal capacity, raising awareness about the urgent intervention needed to save our water resources from further degradation.

Source: SAB

Eskom and WRC strengthens research partnership

The latest Memorandum of Agreement (MoA) between Eskom and the Water Research Commission is not the beginning of a partnership, but rather the strengthening of a relationship that has been built over many decades.

This is according to WRC CEO, Dr Rivka Kfir. Through this MoA, signed towards the end of last year, the two parties agreed to strengthen their strategic research ties. Eskom and WRC will jointly fund and undertake research on topics of mutual and strategic interest overcoming climate change, water resource availability and accessibility, water quality, operation and maintenance, water conservation and water demand management, as well as technology development among others.

"Eskom is currently a major user of water and water will continue to be a major resource for our future activities," notes Eskom Divisional Executive for Corporate Services, Dr Steve Lennon. "In addition, our water resources are increasingly under threat due to increasing demand and climate change impacts. As such, we need to be innovative in the way we access, treat and use water in future – and I see this partnership as a key enabler to sustainable water use in Eskom into the future."

Dr Kfir adds: "In light of water challenges facing South Africa, it just makes good sense to combine resources to the benefit of the country. The two entities will now be able to undertake research on topics of mutual and strategic interest while developing and growing adequate human resources in the water sector through growing the research capacity pool and encouraging skills transfer, mentoring and coaching."

'We can turn sewage treatment around'

The public's confidence in municipalities' wastewater treatment ability is slowly being restored.

This is according to Leonardo Manus, Department of Water Affairs (DWA) Acting Director: Water Services Regulation.

Speaking in East London at the Second Small Wastewater Treatment Systems Conference, organised by the Water Institute of Southern Africa, Manus said that, while in its infancy, the DWA Green Drop certification process was generally having a positive effect on the municipal wastewater treatment sector, with more local authorities striving to improve the management of their works. The process – an incentive-based regulatory approach to evaluate the performance of municipal wastewater services – was first implemented during 2009. During this first round of assessments less than 550 (53%) of the country's municipal sewage treatment works had enough data to be assessed, and only 7% achieved Green Drop status.

The second round of assessments is currently taking place, and the next report will be made available in the middle of this year. Manus said his team was encouraged by the fact that more municipalities were now participating in the process, and they were seeing an overall improvement in the manner in which these works were now being operated and managed. "The fact that small towns such as Carnarvon [in the Northern Cape] can turn themselves around means that it can be done anywhere," Manus said.

Manus cautioned, however, that incentive-based schemes alone were not enough to bring sustainability back to the sector. The department is still enforcing and regulating compliance, and currently there are four court cases pending against local authorities in this regard.

Other challenges threaten to derail the process, including municipalities making uninformed choices around sewage treatment technology (elaborate systems being introduced in inappropriate places), present lack of skills and capacity as well as procurement bureaucracy.

Still Manus remained positive. "We are seeing improvement, and an attitude change is definitely evident."

International limnology society recognises SA professor

One of South Africa's foremost limnologists has received international recognition for his efforts.

'Father of limnology' in South Africa, Prof Brian Allanson, was awarded the Naumann-Thienemann medal at the International Society for Limnology (SIL) Conference held in Cape Town last year. The medal – the highest honour that can be bestowed internationally – is awarded for outstanding scientific contributions to limnology and is named after the founders of SIL.

Prof Allanson initially worked in marine biology at the University of Cape Town before switching to river limnology work. Among others, he was instrumental in establishing the Lake Sibaya Research Station in northern KwaZulu-Natal. He was conjointly Professor and Head of Zoology and Entomology at Rhodes University and Director of the Institute for Freshwater Studies until he retired in the late 1980s.

His pioneering work on the structure and functioning of Lake Sibaya created a template of understanding of South African and Mozambican coastal lakes and effectively presented the only South African contribution to the International Biological programme section on the productivity of freshwaters in the 1960s. Under his leadership instrumental work was also carried out at the Vanderkloof Dam, Hartbeespoort Dam and the coastal lake Swartvlei. Many of the senior names in South African limnology cut their teeth in the Sibaya, Vanderkloof, Hartbeespoort and Swartvlei projects.

Alongside his many limnological achievements, Prof Allanson also provided many services to the national limnological behaviour. He served several terms as President of the Limnological Society of Southern Africa, and as South Africa's National Representative to SIL. His advisory outputs and services in national scientific steering committees and panels were many.

With his sometimes diverse interests and activities, and sometimes formidable reputation for scientific rigour and commitment, he holds the unique honour in having been awarded the Gold Medal both by the Limnological and by the Zoological Societies of Southern Africa, alongside the Order of Meritorious Service (Silver), of the Chancery of Orders, South Africa, for services to Science and University Education, an award bestowed on a very select few individuals by the President of the country.

Water diary

BENCHMARKING
MARCH 14-16
The IWA International Conference on Benchmarking and Performance Assessment of Water Services will be held in Valencia, Spain. Proposed themes include benchmarking and performance assessment projects; definition and establishment of performance assessment systems; decision support tools based on performance indicators; and benchmarking as a regulatory tool; among others. Enquiries: Conference Secretariat; Tel: +34 96 387 98 98; Email: secretariat@pi2011.com; Visit: pi2011.com.

EFFICIENT USE
MARCH 29-APRIL 2
The 6th IWA Specialist Conference on Efficient Use and Management of Water will be held at the Dead Sea, in Jordan. This conference will present the experiences of different countries in water demand management and their accomplishments in improving water use efficiency and dealing with the challenges of drought. Email: info@efficient2011.com or Visit: www.efficient2011.com.

WATER TREATMENT
APRIL 18-22
The 10th Specialised IWA Conference on Small Water and Wastewater Systems will be held in Venice, Italy. The conference will be held together with the 4th Conference on Decentralised Water and Wastewater International Network and the 3rd Specialised Conference on Resource Oriented Sanitation (EcoSan). Visit: wastewater-venice-2011.com.

INDUSTRIAL WATER
MAY 1-4
The Water & Industry 2011 IWA Specialist Conference Chemical Industries will take place in Valladolid, Spain. The event is the latest related to wastewater, gas and solid waste management in industry with a special focus on energy efficiency and sustainability. Visit: www.iqtma.uva.es/iwa2011.

HYDROLOGY & ECOLOGY
MAY 2-5
The 3d International Multidisciplinary Conference on Hydrology & Ecology (HydroEco 2011) will take place in Vienna, Austria. Visit: http://web.natur.cuni.cz/hydreco2011/

New CEO for engineering institution

The South African Institution of Civil Engineering (SAICE) has a new CEO.

Appointed from 1 October, 2010, Manglin Pillay is a civil engineer with a particular interest in environmental engineering. He gained experience primarily in the municipal solid waste and mining waste management sector.

Pillay spent more than a year at national government, followed by seven years of professional consulting experience. Described as 'a highly motivated and energetic leader who enjoys networking and connecting with people', Pillay joins SAICE directly from consulting engineering. He brings to the organisation qualities such as his strengths in communication, business management, business strategy and marketing.

"While we embrace transformation in South Africa, we need to simultaneously preserve the admiration and respect that the civil engineering profession has gained over many years," maintains Pillay. "Civil engineering and civil engineers are central to the sustainable economic and social development of our nation...SAICE wants to continue creating a home for civil engineers."

New book on 'jewels' of SA coast

South Africa has about 250 functional estuaries comprising five major categories.

Despite considerable diversity, estuaries represent sheltered coastal habitats that are sought-after for activities ranging from resource exploitation (e.g. fishing) to residential and industrial development. This attraction to estuaries has meant that many coastal settlements are built on or around these water bodies, which will inevitably impact on these ecosystems.

Consequently, the conservation and management needs of estuaries must be addressed by municipal, provincial and national decision makers.

A new publication by the South African Institute for Aquatic Biodiversity (SAIAB) focuses on temporarily open/closed estuaries, which are generally small estuarine systems, located mostly on the eastern and southern coasts of the country. Despite their abundance, more than 175 in total, and widespread distribution around the coastline, it was only in the 1980s and 1990s that research effort in South Africa started to focus on issues pertaining to these estuaries. According to SAIAB, we have now reached a stage where our understanding of the functioning of these estuaries has enabled the production of this booklet, *A Guide to the Ecology of Temporarily Open/Closed Estuaries*, for use by the general public as well as coastal managers. The booklet was funded by the Water Research Commission

For more information, visit: www.saiab.ac.za

Source: SAIAB

Many coastal wetlands likely to disappear this century

Many coastal wetlands worldwide may be more sensitive than previously thought to climate change and sea-level rise projections for the 21st century.

US Geological Survey (USGS) scientists made this conclusion from an international research modelling effort published in the journal Geophysical Research Letters, a publication of the American Geophysical Union. The scientists identified conditions under which coastal wetlands could survive rising sea levels.

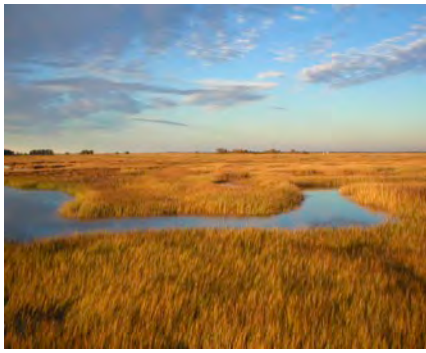
Using a rapid sea-level rise scenario, most coastal wetlands worldwide will disappear near the end of the 21st century. In contrast, under the slow sea-level rise projection, wetlands with low sediment availability and low tidal ranges are vulnerable and may drown. However, in the slow sea-level rise projection, wetlands with higher sediment availability would be more likely to survive.

"Accurate information about the adaptability of coastal wetlands to accelerations in sea-level rise, such as that reported in this study, helps narrow the uncertainties associated with their disappearance," notes USGS scientist Glenn Guntenspergen, an author of the report. "This research is essential for allowing decision makers to best manage local tradeoffs between economic and conservation concerns."

"Previous assessments of coastal wetland responses to sea-level rise have been constrained because they did not consider the ability of wetlands to naturally modify their physical environment for adaptation" says fellow author, USGS scientist Matt Kirwan. "Failure to incorporate the interactions of inundation, vegetation and sedimentation in wetlands limits the usefulness of past assessments."

USGS scientists specifically identified the sediment levels and tidal changes necessary for marshes to survive sea-level rise. As water floods a wetland and flows through its vegetation, sediment is carried from upstream and deposited on the wetland's surface, allowing it to gain elevation. High tidal ranges allow for better sediment delivery, and the higher sediment concentrations in the water allow wetland to build more elevation.

Coastal wetlands provide critical services such as absorbing energy from coastal storms, preserving shorelines, protecting human populations and infrastructure, supporting commercial seafood harvests, absorbing pollutants and serving as critical habitat for migratory bird populations. These resources and services will be threatened as sea-level rise inundates wetlands.



Water on the Web

www.water-network.co.za

This website follows the letter of intent signed by the Water Institute of Southern Africa and the Netherlands Dutch Partnership earlier this year with the goal of creating a platform for South African and Dutch water partners to explore and expand existing initiatives and to facilitate new partnerships. The Web portal provides opportunities for networking, exchanging knowledge and building relationships between companies and organisations from the two countries.

www.wetlands.za.net

The new South African wetland website was launched at the National Wetlands Indaba 2010 in Kimberley last year. The portal not only offers easy access to important wetland information, but also allows users to take part in the great wetland debate. The portal builds on and replaces the Wetlands SA website that was hosted by Working for Wetlands provisionally until a more viable platform could be found.

Water availability in Africa declining – UN survey

The amount of water available per person in Africa is declining, and only 26 of the continent's 53 countries are currently on track to meet the Millennium Development Goals related to access to water.

This is according to the latest survey by the United Nations Environment Programme (UNEP), released in November.

Furthermore, the survey showed that only five countries in Africa are expected to attain the target of reducing by half the proportion of people without access to sustainable sanitation by 2015.

The Africa Water Atlas, compiled by UNEP at the request of the African Ministers' Council on Water, also maps out new solutions and success stories on water resource management from across the continent. It contains the first detailed mapping of how rainwater conservation is improving food security in drought-prone regions. Images also reveal how irrigation projects in Kenya, Senegal and Sudan are helping to improve food security.

Prepared in cooperation with the African Union, the European Union, the United Stated Department of State and the United States Geological Survey, the Atlas gathers information about the role of water in Africa's economies and development, food security, transboundary cooperation, capacity building and environmental change in one comprehensive volume.

Among others, the Atlas drawn attention to Africa's 'water towers', which are sources for many of Africa's transboundary rivers and contribute immensely to the total streamflow of African major rivers. They supply life-giving resources and services in downstream areas, including water for hydropower, wildlife and tourism, agriculture, domestic and ecosystem services.

According to the Atlas, most of these water towers, from the Middle Atlas Range in Morocco to the Lesotho Highlands in southern Africa, are under extreme pressure.

Source: UN News

Nominations sought for international award

The Stockholm International Water Institute (SIWI) is inviting nominations for the Stockholm Industry Water Award.

Companies and business organisations that have made impressive achievements in water and wastewater process technologies, improved performance in production processes, or have made other significant contributions to help improve the world water situation are all eligible to be nominated.

Both external and self nominations are welcome. The deadline for submission is 15 February.

For more information, including details how to enter, Visit: www.siwi.org/siwa/nominate

WASH central to HIV programmes

A new guideline on integrating water, sanitation and hygiene into HIV/AIDS programmes, is now available from the World Health Organisation and USAID.

The publication is aimed at facilitating the integration of WASH (water, sanitation and hygiene practices) into official HIV guidelines and standards, and into HIV programming. Among others, the guide outlines why WASH should be included in HIV programmes; details which WASH practices to include; and identifies how WASH can be included in HIV programmes, illustrated by case studies from various programmes. The document also provides concrete recommendations for country programmes and those implementing them on how to integrate WASH into HIV policies and programmes.

The priority actions to integrate into national HIV programmes are to treat drinking water, store treated drinking water safely, promote hand washing, handle and dispose of faeces safely, manage menstruation, prepare, handle and store food safely and promote personal cleanliness, especially of people living with HIV/AIDS.

To access the guideline document, Visit: http://www.who.int/water_sanitation_health/publications/9789241548014/en/index.html.

Report calls for increased investment in engineers

A shortage of engineers in developing countries, and lack of interest in engineering careers from young people are hampering development, according to a new report, published by UNESCO.

Engineering is vital for raising standards of living and creating opportunities for sustainable prosperity in line with the Millennium Development Goals. However, developing countries on average have only five engineers per 10 000 of the people – and less than one in some African countries. This compares to developed countries which have 20 to 50 engineers per 10 000.

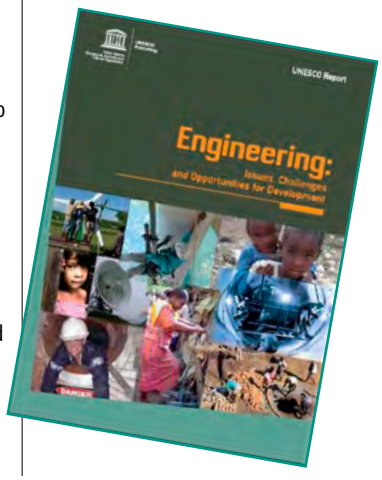
The poorest are hardest hit by this shortage of engineers, for example, 1,1 billion people still have no access to clean water. Around 2,5 million engineers are required only in sub-Saharan Africa just to ensure provision of clean water and sanitation.

The report, *Engineering: Issues, Challenges and Opportunities for Development*, calls for developing public and policy awareness of engineering as a key driver of innovation and social and economic development. It also highlights the need to focus educational efforts on the need for more effective application of engineering to sustainable development, poverty reduction and climate change.

"The report makes it clear that investing in infrastructure and the education of engineers in developing countries will be hugely important to development," notes Andrew Lamb, CE of non-profit organisation Engineers without Borders.

To access the report, Visit: http://unesdoc.unesco.org/images/0018/001897/189753e.pdf

Source: Scidev.net



New project to rid Cape of invasive alien fish

A unique project aimed to remove the century-old invasive alien fish problem in one of the Western Cape's most critical rivers is now underway.

The small Rondegat River, which rises in the Cederberg Wilderness before entering privately-owned farmland and flowing into the Clanwilliam Dam, is one of four rivers in the Cape Floristic Region earmarked for rehabilitation through a present pilot study funded by the Water Research Commission (WRC). The introduction of invasive alien fish to rivers in the region in the late 1800s to mid-1900s, primarily for angling purposes, has had disastrous impacts on almost all the indigenous fish species of this region.

The invasion of the Rondegat River by smallmouth bass has resulted in the local extinction of three out of the six native fish species, leading to significantly altered invertebrate communities in the invaded river. Rehabilitation is focused on the lower reaches of the river, now dominated by the smallmouth bass and another alien species, the bluegill sunfish.

Eradication of invasive alien fish species is regarded by South African fish conservation experts as the best and fastest way of improving the conservation status of our highly threatened indigenous fish species and associated aquatic organisms. Mechanical removal through electric fishing is one way of removing these fish, but this is highly labour intensive and provides only a short-term solution to the problem.

The WRC study is being conducted by the South African Institute for Aquatic Biodiversity, in collaboration with CapeNature and the Cape Action for People and the Environment. The study has attracted attention as rotenone, a toxic natural chemical found in the roots of tropical plants, will be used to rid the river of the invasive alien fish.

Rotenone has already been used successfully to eradicate invasive alien fish from reservoirs and streams in the US, Britain, Australia and New Zealand. In one case, native fish were successfully re-introduced to a treated reservoir after the removal of the invasive species.

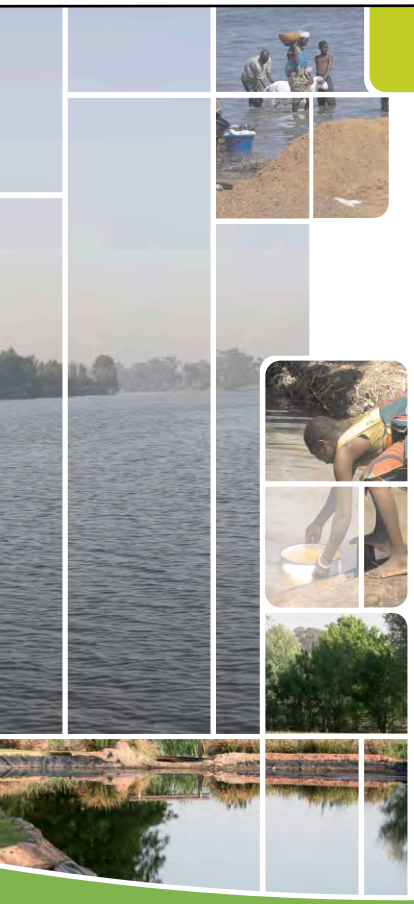
Concerns have been raised in South Africa regarding the impact the chemical might have on other aquatic species. Prior to the start of this project, a comprehensive environmental impact assessment (EIA) was carried out, and the project has been approved by all the relevant authorities.

A preliminary assessment of the threat posed by rotenone to the invertebrates of the Rondegat River was conducted as part of the EIA. The finding was that, at concentrations and doses to be used, rotenone posed a low threat.

It is reported that the Rondegat River rehabilitation pilot study represents an important opportunity to meet the need for quantifying the impacts of rotenone treatment as a river rehabilitation method on a suitably wide range of native aquatic organisms. Accordingly, the WRC is supporting short-term research in the form of a detailed impacts monitoring programme, focusing on aquatic macro-invertebrates, fish and also amphibians. In addition, habitat information is being gathered and biomass measurements made of periphyton (algae attached to surfaces of stones and rock), representing part of the food web.

Successful river rehabilitation will depend, firstly, on the ability of rotenone to completely eradicate invasive alien fish species and, secondly, on the ability of invertebrates and other aquatic life to re-colonise the river following treatment.

Following the Rondegat project, similar rehabilitation is scheduled to take place in the Krom River (Eastern Cape), and Suurvlei River (Cedarberg).



New from the WRC

Report No: KV 238/10

A high level scoping investigation into the potential of energy saving and production/ generation in the supply of water through pressurised conduits (Prof SJ van Vuuren)

Hydropower development has major potential benefits. In this scoping study the emphasis was on the potential power generation by retrofitting hydropower generation facilities at existing dams and utilising the untapped energy on the supply side of storage reservoirs in water distribution systems where the excess heads are normally dissipated across control valves.

Report No: TT 459/10

Developing a method for determining the environmental water requirements for non-perennial systems (MT Seaman, MF Avenant, M Watson, J King, J Armour, CH Barker, E Dollar, PJ du Preez, D Hughes, L Rossouw & G van Tonder)

The National Water Act requires that the environmental reserve be determined for each significant water body before licenses may be issued. Methods currently available to achieve this are based on perennial rivers. This research programme began by identifying which existing methods might initially seem to be suitable for use and where further work needs to be done. It then took this research a step further with the overarching objective to develop a prototype methodology for determining the environmental water requirements for non-perennial rivers. This would be based on field-based knowledge acquired during comprehensive research on a range of non-perennial systems.

Report No: TT 456/10

The effects of stream flow manipulation on the invertebrate hosts of malaria, bilharzia and liver fluke disease (LM Quayle; CC Appleton & CWS Dickens)

The regulation of rivers is known to cause a number of changes to the function and form of rivers. Almost every major river in South Africa has been regulated to a certain degree, largely to meet the growing needs of development. This report aims to assess the current state of knowledge concerning the relationship between river flow regulation and its effects, and the population dynamics of invertebrate hosts of malaria, schistosomiasis (bilharzia) and fascioliasis (liver fluke disease) in South African rivers. The habitat requirements of these invertebrates are central to this discussion. Additionally, the concept of using the manipulation of flows to control these invertebrates and thus also the transmission of their associated diseases is addressed.

Report No: TT 400/09

Energy from wastewater – A feasibility study (S Burton; B Cohen; S Harrison; S Pather-Elias; W Stafford; R van Hille & H von Blottnitz)

This guide is based on a study with the purpose of determining the feasibility of developing technologies for energy recovery from wastewater (Report No: 1732/1/09). Historically, the use of wastewater as a renewable energy resource has been poorly exploited, particularly in developing countries, such as South Africa. The study reviewed the available literature and surveyed international and national practice in energy recovery from wastewater in order to identify the most significant potential for new research and innovation. The project also included a set of case studies that show what factors to consider in developing energy from wastewater projects.

This guide makes recommendations relevant to the research and development (R&D) sector regarding recovery of energy from wastewater. It also seeks to provide information about directions which would be useful to South Africa's research community by identifying areas where R&D are needed. The guide is specifically aimed at technology developers and researchers; industry and wastewater generators as well as policy makers.

Report No: 1547/1/10

A first order inventory of water use and effluent production by SA industrial, mining and electricity generation sectors (TE Cloete; A Gerber & LV Maritz)

The overall objective of this project was to compile a first order inventory of the amount of water used and effluent produced by the South African industrial, mining and power generation sectors, and to assess the impact these might have on water quality. Among others, the study identified a severe challenge in terms of incomplete data around effluent production. This highlights the problem in South Africa around understanding the exact load of waste that is associated with industry. This is of great concern when it comes to managing the impact of effluent production on the environment. Several recommendations are made to remedy this.

Report No: TT 462/10

Framework and manual for the evaluation of aquatic ecosystems services for the resource directed measures (AE Ginsburg; JG Crafford & KR Harris)

This document provides a framework and manual to guide practitioners conducting the evaluation of aquatic ecosystem services required in establishing resource directed measures for the protection of water resources in any water management area or subsidiary catchment. The publication integrates a complex set of disciplines, approaches and methods and is structured into four parts: an introduction to and overview of the framework; the manual; a case studies part; and a supplementary information part.

Report No: TT 451/10

Investigating the applicability of ecological informatics modelling techniques for predicting harmful algal blooms in hypertrophic reservoirs of South Africa (CE van Ginkel; S du Plessis & JJ Bezuidenhout)

Cyanobacterial blooms and their effects are widespread, frequent and typically seasonal. The increasing number events of cyanobacterial blooms in South African impoundments and rivers is a cause of concern. Ecological informatics is an interdisciplinary framework promoting the use of advanced computational technology for the elucidation of principles of information processing at and between levels of complexity of ecosystems – from genes to ecological frameworks – and aiding transparent decision-making in relation to important issues in ecology. This project aims to address the application of these models in the management of cyanobacterial blooms in South African conditions.

Report No: TT 398/10

A review of a selection of local waste bylaws against the framework of the National Environmental Management: Waste Bill, 2007 (N Oosthuizen & A Armstrong)

The National Environmental Management: Waste Bill 2007 (now the National Environmental Management: Waste Act of 2008) seeks to address current shortcomings in waste management legislation. Among others, it introduces preventative strategies aimed at pollution prevention and waste minimisation thereby driving the establishment of integrated pollution and waste management systems. A major problem still facing municipalities is that there are so many bylaws, some outdated, but all needing to be merged and transformed in the context of new legislation. An analysis of the existing and national legislation and policy provides direction and guidelines as to what municipalities should be responsible for, what should be in their bylaws, and how integrated waste management should be implemented in their jurisdictions.

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Indigenous knowledge celebrated in new weather book

Lani van Vuuren

Weather SA CEO, Dr Linda Makuleni, and Deputy Minister of Tourism, Thozile Xasa, with the new book on indigenous weather knowledge, beliefs and folklore in South Africa.

Weather and climate have a significant impact on our daily lives and for centuries South Africa's diverse cultures have built beliefs and myths around natural phenomena such as rain, lightning, drought and floods.

Now, for the first time, this indigenous knowledge has been captured in a single volume. *Rainbows in the Mist: Indigenous Weather Knowledge, Beliefs and Folklore in South Africa*, is the product of more than three years of intensive research by author, Dr Peter Alcock. Published by Weather SA as part of its 150th anniversary celebrations in 2010, the book covers a comprehensive list of weather folklore (also known as ethno-meteorology) from the importance of historical rain ceremonies, the significance of heavenly bodies to farming, to animal behaviour around the seasons. "The whole rhythm of life was once geared to the seasons. Many activities were specific to a particular time of year; planting (spring/early summer); reaping and threshing (autumn/early winter)," the author writes.

At around 600 pages, the book is quite comprehensive, however readers interested in the subject will not be disappointed. Technical terms have largely been avoided, and the book is divided in several sub-themes, making it an easy read. Most enchanting are the tales of mythical creatures found in various cultures, from mermaids in the Karoo, to the *inkanyamba* (water serpent) of Howick Falls and the *abantu bomlambo* (people of the river). The book even includes poems which have weather as a central theme.

According to Dr Deon Terblanche of Weather SA, *Rainbows in the Mist* provides an important link between indigenous knowledge and modern science around weather and climate. "Historically, humans lived much closer to nature and contained within these myths and beliefs lie real wisdom. There is much to learn from the 'recipes' contained in this book."

Speaking at the launch of the book last year, Terblanche said it would aid weather scientists to improve their understanding of human priorities in terms of the weather and climate and would consequently help Weather SA to align its focus more closely with these priorities. "No amount of scientific research will be accepted by a community if it goes against their traditional beliefs and culture. The book will certainly assist us to improve our services to the public."

Deputy Minister of Tourism, Thozile Xasa, said that for quite some time there has been a lack among communities in understanding scientific atmospheric sciences – especially since communities have always relied on their indigenous knowledge about the weather. She expressed her hope that more research would be done to collate this knowledge for future generations. "For hundreds of years people have relied on their knowledge of the weather and climate for their survival. There is a need to pass this on from generation to generation, and to make sure this knowledge does not get lost."

To order *Rainbows in the Mist* contact Elsa de Jager at Weather SA, Tel: (012) 367-6022; Email: elsa.dejager@weathersa.co.za

RED LETTER YEAR for authorities to prevent mine-water catastrophe

Authorities have less than 400 days to act before acid mine-water rising beneath Johannesburg reaches critical levels. Lani van Vuuren looks at what could arguably be the most important environmental decision in South African history.

One of the richest gold-bearing areas in the world, the Witwatersrand has, through more than a century of mining, brought unspeakable wealth to South Africa. It has also brought economic growth, infrastructure and development, all exemplified in Africa's 'City of Gold'. Now this city is under threat by what has been described as one of the worst potential environmental catastrophes in the country's history.

One of the largest gold-bearing areas in the world, the Witwatersrand is around 350 km long and 200 km wide. Since gold was discovered here in 1886, it has been mined to depths of more than 3 000 m and has yielded by far the most gold ever mined in South Africa. Geologically, the Witwatersrand is sub-divided into four main geological areas, the Far Western Basin, the Western Basin, the Central Basin and the Eastern Basin.

Much has been said and written about the acid mine drainage menace lurking underground, steadily rising in the catacombs of old mined-out shafts that underlie Gauteng. On the East Rand, the struggling Grootvlei Mine remains the last man standing, although at the time of writing, pumping and treatment was wholly inadequate from this mine, and millions of litres of polluted mine-water were flowing into the Ramsar-listed Marievale Bird Sanctuary in the Blesbokspruit.

Water is already decanting (flowing from underground) in the area of Krugersdorp/Randfontein on the West Rand while in the Central Basin water has passed the 500 m mark, and is expected to decant by early 2012. The former imperils thousands of years of cultural history lying buried in the Cradle of Humankind, and has rendered much of the water supply in the Krugersdorp Nature Reserve undrinkable and inhabitable. However, it is the latter threat to the people and

economic institutions of South Africa's wealthiest province that has caught the attention of the public, who are now demanding action. "The threat of acid water decanting from old mine workings is a real and present danger. It poses a threat to our economy, environment, health and history," noted Prof Terence McCarthy of the School of Geosciences at the University of Witwatersrand.

Speaking at the launch of the latest in the Gauteng City Region Observatory Provocation Series titled 'The decanting of acid mine drainage in the Gauteng City Region' Prof McCarthy stated that "The solutions are expensive, though not technically daunting, and must be implemented within a matter of months, if we are to prevent acid mine drainage at different points in the Gauteng city region."

AREAS AT RISK

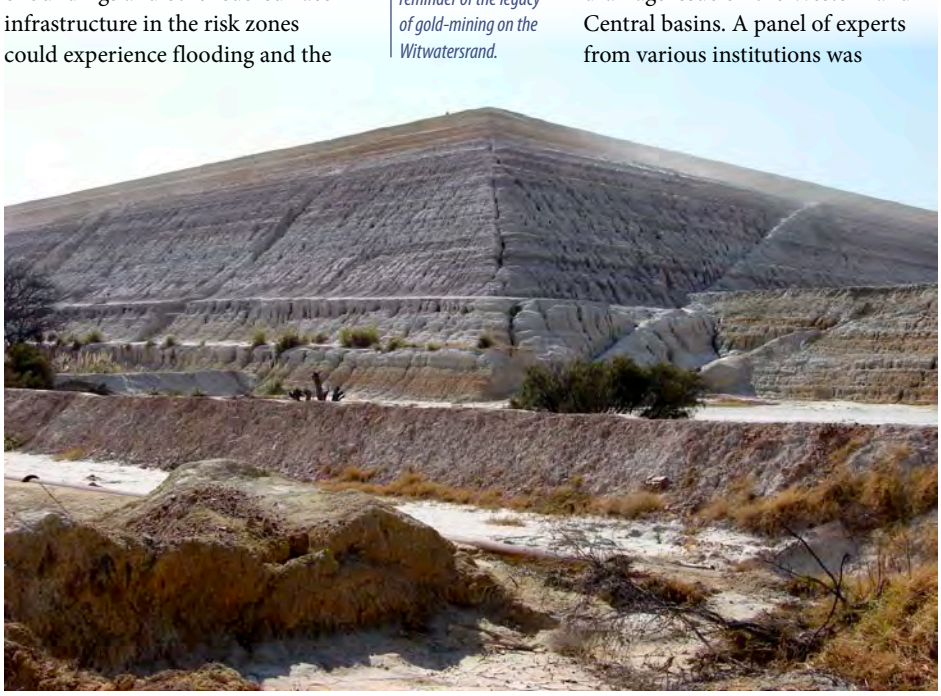
According to Prof McCarthy, the prime risk area where decant points are likely to develop is in a zone about 500 m wide straddling Main Reef Road and the M2 motorway, plus a secondary zone some 2 km to the south. "Deep basements of buildings and other sub-surface infrastructure in the risk zones could experience flooding and the underground facility at Gold Reef City, a national treasure, will be lost."

It is not only where this toxic water is likely to decant that is cause for concern, but when. The water level in the mine void is currently rising at a rate of around 15 m a month (this rate of rise increases exponentially during the rainy season). Estimates suggest that if left to fill the mine void unhindered, acid mine drainage will start decanting in the Central Basin in a year's time.

However, action will need to be taken much earlier. The environmental critical level has been set at between 100 and 150 m below surface. If acid mine-water is allowed to cross this level unspeakable damage to the environment could occur. It should be noted, however, that to ensure the security of the Gold Reef City underground facility, the water level would need to be maintained at a depth of at least 250 m below surface.

CALL TO ACTION

Authorities have been criticised for taking so long to come up with an assertive plan of action. Only in September last year was an Inter-Ministerial Committee (IMC) appointed to address the acid mine drainage issue on the Western and Central basins. A panel of experts from various institutions was subsequently tasked to investigate the issues at hand, as well as to study possible remedies and costs, and come up with a series of recommendations for Cabinet to make an appropriate decision.



Gold-mine tailings such as these are a grim reminder of the legacy of gold-mining on the Witwatersrand.

WHAT CAUSES ACID MINE DRAINAGE?

Gold was discovered on the Witwatersrand in 1886. Through the centuries, vertical shafts were sunk to depths of more than 3 000 m below the surface. In the process, the layers of gold-bearing reef rock were extracted (around 1 300 million tons in total), and an extensive cavity was created. This cavity is known as the mine void. Adjacent mines are generally interconnected through their workings.

In the course of mining, water-bearing fractures are intersected, causing water to flow from these openings into the mine workings. Water also penetrates from the surface. While a mine is operational, this water is pumped out to allow mining to continue unhindered.

The mines on the Witwatersrand began to close in the late 1950s due to declining profits. Closure of a mine means that pumping of water from the mine void ceases and water starts accumulating in the deeper underground workings. The gold-bearing rock contains all sorts of metals and minerals, including pyrite or 'fool's gold'. When pyrite is exposed to oxygenated water, it forms sulphuric acid. In the acidic water, other minerals also break down and their metals dissolve into the water.

By the time acid mine drainage reaches the surface it is highly acidic, and usually contains high concentrations of metals, sulphides and salts. This water is not only corrosive but highly toxic.

The Marievale Bird Sanctuary, part of the RAMSAR-listed Blesbokspruit, which is on the receiving end of the acid mine-water flowing from Grootvlei Mine on the Eastern Basin.

The final report was laid before Parliament in December. Two main options have been considered, the 'do nothing' approach and intervention through pumping and treatment. While not acting immediately might not cost anything in the short term, the resultant socio-economic and environmental damage will take decades if not hundreds of years to remediate.

Pumping and treating the water seems the only option. Within this recommendation there are various options and technologies available and, at the time of writing, no details had been publicly available yet, although the IMC made the following statement on 15 December: "[The IMC] advocates for the three priority basins to have implementation plans that include pumping and neutralisation of AMD." A decision will have to be taken before the end of January to enable any intervention decided upon to be carried out in time.

The Department of Water Affairs' Marius Keet remains positive that action will take place in time. Speaking at the WISA Mine Water Reclamation Symposium in Pretoria late last year he defended government's apparent inaction saying it was arguably the most important decision South Africa would ever make, and all options had to be considered before a final commitment was made.

ON THE SHOULDERS OF SOCIETY

Who will carry the cost? Prof McCarthy argues that the cost should be borne by the State as government has for decades been paying pumping subsidies to mines to cover the cost of pumping inflow from defunct, adjacent mines as it is. "Government is invariably the largest single beneficiary of mining ventures through the State share of profits formulae, taxation of company profits and taxation of salaries paid to workers." According to Keet, government will probably be responsible for bearing the costs of intervention on the short term, however, alternative funding options will have to be found over the long term.

Some argue that the remaining mining companies must bear the financial burden. However, it must be borne in mind that acid mine drainage on the Witwatersrand is the result of mining which has taken place over more than a 100 years, and thus cannot be the sole responsibility of the remaining mines. The unsustainability of the situation where this has occurred is clear when one looks at Grootvlei Mine where financial troubles and resultant labour unrest have caused interruptions in the pumping of acid mine-water. Even on the Western Basin where Rand Uranium is operating a treatment plant to partially treat mine-water decanting on its property, it has been left unable to cope with the volumes of water now pouring unhindered into the Tweelopies Spruit.

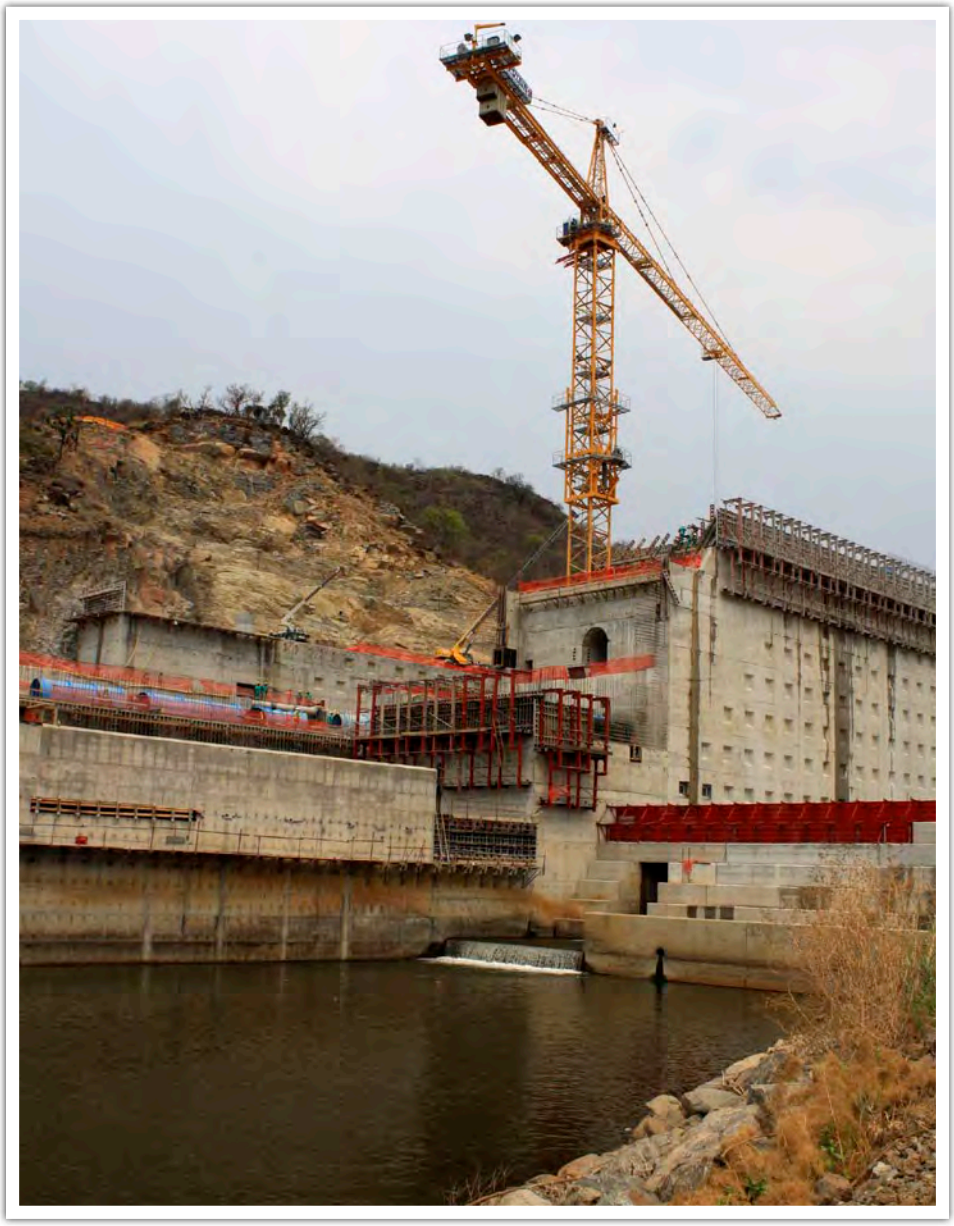
Whatever decision is made, it is hoped that swift action will be taken by all parties concerned to ensure the prevention of this potential crisis situation. ❑

THE FOUR BASINS OF THE WITWATERSRAND AND THEIR ACID MINE-WATER STATUS

- **Far Western Basin**: Most of the mines in this basin are still operational and issues around acid mine drainage are not regarded as urgent at this stage.
- **Western Basin**: Acid mine-water started decanting from the Mogale City/Randfontein area in 2002. Present decant volumes vary from around 25 to 50 Mℓ/day of which only 15 Mℓ/day is partially treated. The remainder of the water flows uncontrolled into the Tweelopies Spruit, which feeds into the Crocodile River system. Decanting mine-water is already impacting the environment and people living in the area and is threatening the Cradle of Humankind World Heritage Site.
- **Central Basin**: Arguably, the basin of biggest concern at present. Pumping in this basin was stopped in 2008 due to health and safety concerns. Due to its proximity to the Johannesburg CBD and particularly the presence of abandoned near-surface workings in the city centre, a solution will urgently need to be found. It is estimated that this basin will start decanting at a rate of between 60 and 70 Mℓ/day in 2012.
- **Eastern Basin**: A single pump station (at Grootvlei Mine) is operating intermittently in this basin at present. The mine pumps out between 50 Mℓ/day and 70 Mℓ/day of mine-water while around 108 Mℓ/day is required to maintain the water balance. Significant financial and administrative issues have resulted in the mine being unable to meet the discharge standards as set out in its water license. Sub-standard effluent is flowing into the Blesbokspruit, a Ramsar-listed wetland.

Giant rising in Olifants tributary

Construction is at full swing at the site of the multibillion Rand De Hoop Dam on the Steelpoort River, in Limpopo. The dam, believed to be one of the biggest to be constructed in South Africa in the last 20 years, is set for completion in 2012. The Water Wheel joined a delegation of the South African National Committee on Large Dams who visited the site in October last year.



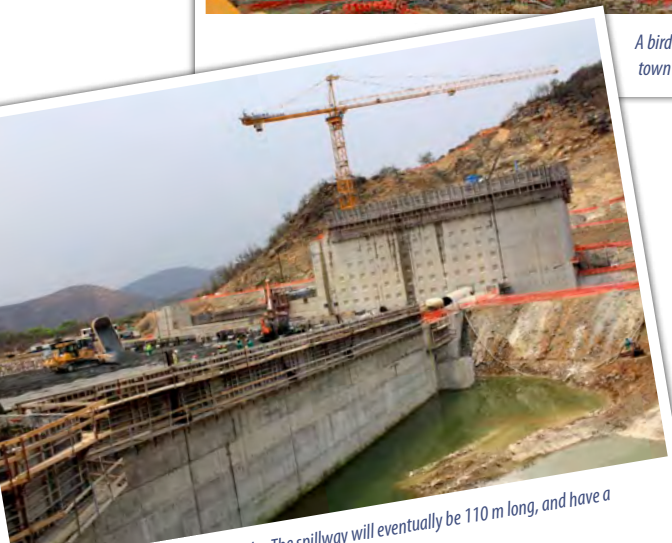
A view of the outlet structure with the river diversion in the foreground. This diversion was completed in July 2009.

De Hoop Dam forms part of the Olifants River Water Resources Development Project, and was first announced in the State of the Nation Address by former President Thabo Mbeki in 2003. Approved by Cabinet in 2004, construction started in 2007 following a revised Record of Decision by the then Minister of Environmental Affairs & Tourism. According to the Department of Water Affairs, the dam was seen as the only viable option to meet the medium- to long-term need for water of populations in the Sekhukhune area as well as expected increased mining activity. Originally the dam was also to supply Eskom proposed Tubatse pump storage scheme, however, this scheme has since been shelved. Construction is currently being financed by government and is being undertaken by the Department of Water Affairs' construction arm.

Construction has not been without its challenges. Among others, geological conditions were found to be more varied than anticipated and the foundations encountered were generally poorer than expected. As a result, excavations were undertaken up to 12 m below design foundations, with close to 500 000 m^3 of material excavated for foundations. Once completed the dam wall will be 88 m high above the lowest foundation. De Hoop is being constructed as a roller compacted concrete (or rollcrete) gravity dam with a vertical upstream face. It is the highest rollcrete dam yet to be constructed in South Africa. The dam wall will be 1 020 m long. An innovative rollcrete mix is being used, negating the need for skin concrete.

At full supply level (FSL) the gross capacity of De Hoop Dam will be 347 million m^3 and the dam will have an annual yield of 80 million m^3. The reservoir will have a surface area of 1 690 ha (at FSL).

A bird's eye view of the De Hoop Dam construction site. The site is situated about 40 km south of the town of Steelpoort.



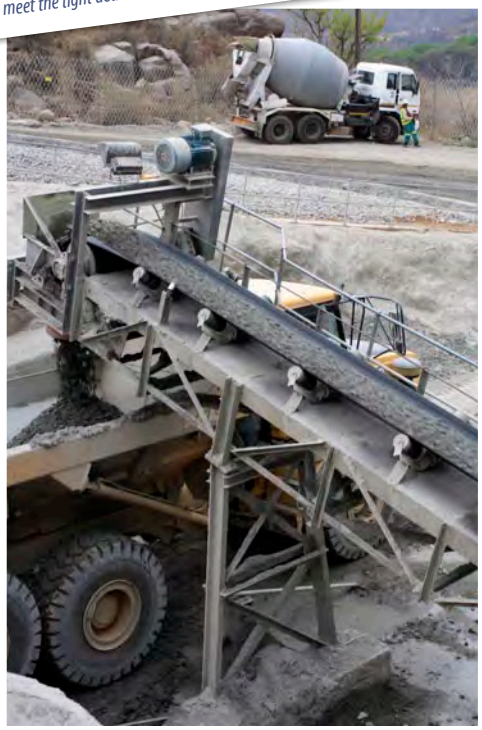
The stepped spillway and outlet works. The spillway will eventually be 110 m long, and have a maximum capacity of 3 616 m3/s.

The enormous 2 m-diameter stainless steel outlet pipes. All the pipes are being manufactured at the DWA Central Construction workshops in Jan Kempdorp.

The multi-level outlet structure. The outlet works will have a maximum capacity of 20 m^3/s – 15 m^3/s of which is to meet Environmental Reserve requirements.

Two of the myriad of articulated dump trucks on site. Concrete is delivered to site in trucks or via conveyer and then spread by bulldozer and compacted by vibratory roller. Production targets of up to 100 000 m^3/month have been set to meet the tight deadlines.

A view of the stepped spillway, apron and end sill. Here the specially designed scaffolding which is being used on site can clearly be seen.



A truck is filled with concrete at the on-site batch plant.

The Steelpoort River downstream from the dam with a section of the new provincial road which had to be relocated to higher ground on the western side of the dam basin.

Five batching plants were established on site to deliver concrete at the required rate. Together the plants have a capacity to deliver up to 500 m^3/hour of concrete. Close to a million cubic metres of concrete will eventually be placed in the dam.

Close to 80% of the workforce has been recruited from the area. It is a 24/7 operation and workers are working three shifts.

Water is life – a South African journey

INTRODUCTION

The video, *Water is Life: A South African Journey*, has been designed to provide an introduction to water-related issues for schools and university students in the sciences. Its purpose is to encourage young people to consider future career options in the water sector.

The video has also been designed for use as an awareness tool for everyone interested in water issues, particularly decision-makers in related disciplines wherein a general understanding of water issues within the South African context will be of benefit.

AIMS AND OBJECTIVES

In order to reach its different target audiences, *Water is Life: A South African Journey*, provides an introduction to the following specific subject areas related to natural water resources within different South African environments:

- Freshwater resources (including surface water and groundwater);
- Natural water cycle and the impact of climate change;
- Water resource management and water ecosystems;
- Cycle of water use;
- Water conservation;
- Protection of water resources.

The facilitated discussion to follow the screening is intended to encourage viewers to consider various aspects of these subjects within their own contexts – from a personal point-of-view through to the perspective of their local municipality – and develop ideas for improving water resource management, conservation, and protection.

SUBJECT INFORMATION

The following gives background information on each of the subject areas covered in the video:

Freshwater resources, including groundwater

Earth is described as the Blue Planet because 70% of its surface is covered by water. But out of all that water, only 2,5% of it is fresh and the rest is salty seawater. Furthermore, just less than 70% of the Earth's freshwater is locked away in the polar ice caps. Only a tiny fraction of the Earth's freshwater is found in streams, rivers, and lakes (0,01%). The remaining unfrozen freshwater is hidden away as groundwater (about 30%).

South Africa is characterised as a dry country that receives less than half the world average rainfall of 850 mm/year. Some areas are very dry (arid) while other areas are wetter (humid). Springs, rivers, dams and wetlands are the visible sources of freshwater in South Africa, but groundwater is a very important source that is generally not visible. Groundwater occupies the space between soil particles in sandy aquifers, and the space within the network of fractures in rocky aquifers.

Freshwater is what is required for the domestic, industrial and agricultural uses of South Africa's 50 million people – as well as the Earth's current population of 6,8 billion people.

Natural water cycle and the impact of climate change

The water cycle (hydrological cycle) is the name given to the natural process where water is constantly recycled. Water evaporates from the seas, lakes and rivers, falls as rain, and then flows back down towards the sea in a closed system:

- The sun's heat evaporates water from the surface of the rivers and oceans as water vapour. Plants release water back into the atmosphere through evapo-transpiration. The vapour rises and cools, condensing to form clouds.
- Small droplets join to form larger droplets of water that fall as precipitation (rain; snow; etc).
- Rain falls on the land. Some of this water soaks into the soil to be used by plants; some water drains into the ground to become groundwater; and some flows downhill to form rivers and lakes.
- Water flows from the rivers and through the groundwater into the sea where the cycle continues.

The water cycle is likely to be altered by climate change. Climate change can be defined as 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods' (UNFCC). The climate change problem is related to the growing accumulation of greenhouse gases in the lower atmosphere, mainly due to human activities, which causes changes in the air temperature, precipitation patterns, sea-level rise, and melting of glaciers. As a result, rainfall (and surface sun-off) has become increasingly erratic, unpredictable and extreme – increasing the risks of both flooding and drought in many parts of the world. These changes ultimately impact upon water availability and water quality.

According to predictions of climate change, South Africa on the whole will become even drier. With its current inter-basin transfers of water between catchments as well as buying water from Lesotho, South Africa is left with very expensive alternatives for securing additional surface water resources. In this regard, groundwater sources are promising for new sources of water to a large extent – as well as desalination, fog harvesting, and weather modification to lesser extents.

Water resource management and water ecosystems

The careful management of our freshwater resources is critical if South Africa is to be able to sustain growth and development. The key outcome of wise management of water resources is to balance water needs or demands, economic development, environmental integrity and societal propriety.

The intended future focus of water resource management in South Africa is not on increasing the number of large dams but on identifying ways to manage demand and share existing resources better, as well as on making new water available through water conservation and demand management. Included in this focus is the involvement of water users in management decisions and changing their attitude and behaviour towards water so that water is valued as both a social and economic good.

Cycle of water use

Human intervention in the natural water cycle diverts water away from its natural pathway.

Of all the water used by humans, 8% is used by domestic households; 22% by industry; and almost 70% is used by agriculture.

The basic cycle of water use in formal settlements is as follows:

- ***Capture and storage***: Freshwater is captured for human use through, for example, dams and storage reservoirs.
- ***Purification***: Stored water is sent through a water purification treatment works to make it safe for human consumption.
- ***Distribution***: Purified water is reticulated through a network of pipes to households and industrial users.
- ***Wastewater treatment***: The dirty water leaving houses and industry flows to the sewage treatment works for treatment to an acceptable standard.
- ***Return to the environment***: Treated water is returned to the environment – either flowing into a river or the sea (and sometimes into the ground) to continue its journey through the water cycle. The potential effects on water ecosystems are a critical concern at this stage as inadequately treated effluent is highly polluting.

Additionally, there are many places in South Africa without either a formal water supply or wastewater system. Without these, waste is often washed directly into rivers by rain or may filter into groundwater, contaminating these water resources.

Water conservation

Freshwater resources in South Africa are scarce and under pressure – thus water conservation needs to be a priority for the different users: domestic, industrial and agricultural.

In South Africa, there is free basic water for domestic use, equivalent to 6 000 litres of water per household per month. If a household is connected to a municipal water supply, water use above this amount will come at an additional cost to the consumer. Most people pay for their water in a sliding block tariff, where the cost per litre increases with demand. Approximately 60% of the clean water entering a home gets flushed down the toilet or washed down the plughole and ends up in the sewerage system. The more households that use their water efficiently, the more water can be saved. It is also important for water providers to minimise pipeline leaks to prevent water being lost in reticulation.

Some agricultural users are looking at different ways to minimise their water use, e.g. drip irrigation.

More industrial users are also looking at innovative ways to recycle and re-use their water e.g. some textile industries have on-site water treatment works so that they can recycle their water for repeated use.

Protection of water resources

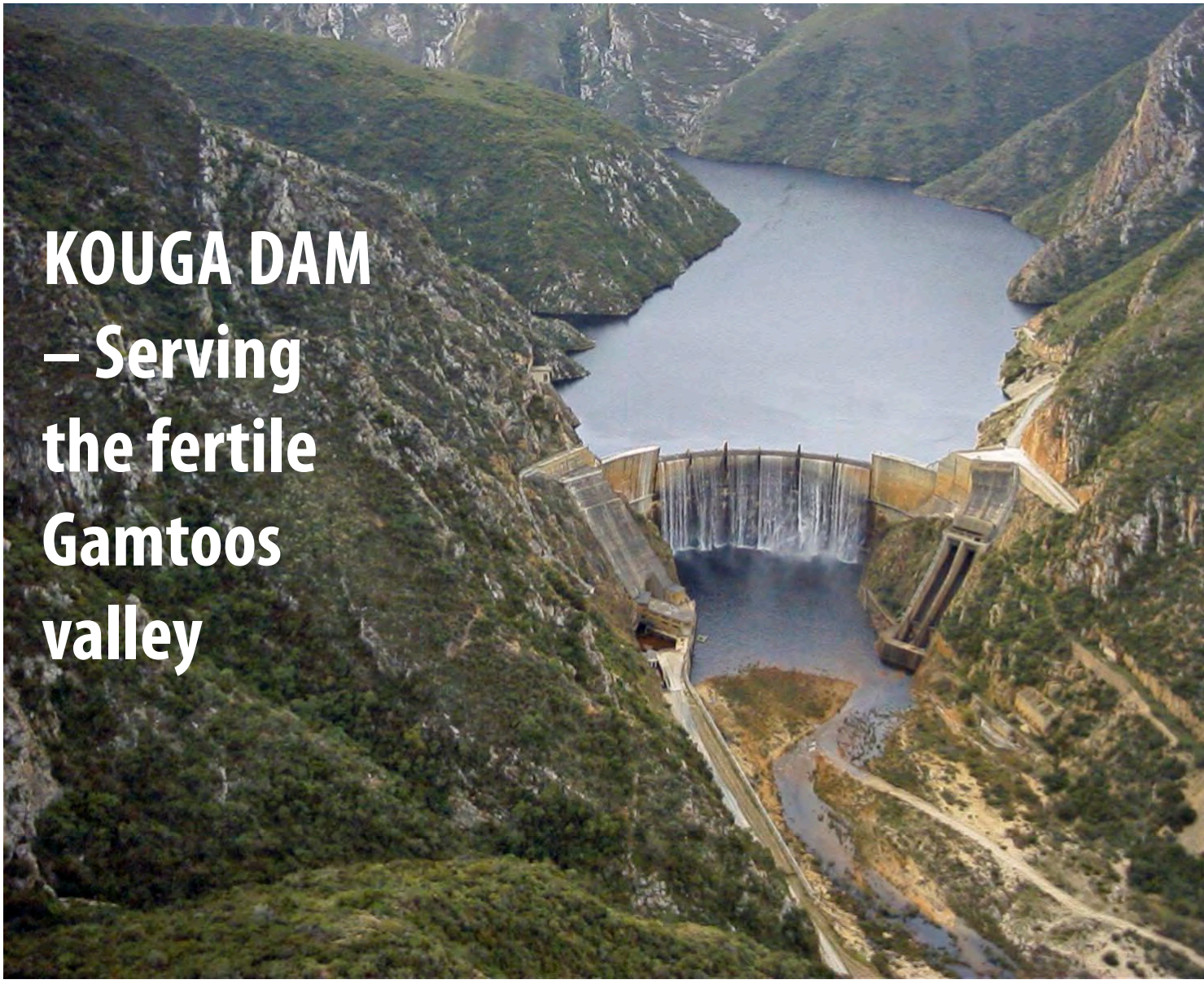
The protection of our water resources must be a priority for all. Water pollution occurs when organic waste and chemicals end up in our streams, rivers, groundwater, or the sea. Threats to freshwater quality come from all users (domestic, agricultural and industrial), as well as from poorly maintained and over-utilised municipal wastewater treatment works and landfills. If the water in our rivers and aquifers becomes polluted, whole ecosystems suffer and impact upon people, plants and animals.

Greater awareness is needed in all sectors of society regarding water pollution hazards and their effects. Potential hazards include point pollution sources such as treatment plants or industrial developments that may affect downstream users, or chemical spills and landfills that may contaminate subsurface water resources (e.g. groundwater). Diffuse or non-point pollution sources from land use activities are more difficult to monitor, trace and control e.g. groundwater.

Water pollution is costly in terms of public health and the environment. Cleaning contaminated freshwater resources so that it is fit for human use is difficult and expensive. Furthermore, the more polluted water is, the more costly it is to treat that water and bring it to an acceptable quality for re-use or for returning it to the environment.

The natural water cycle continually replenishes the water in our rivers and groundwater. By proactively preventing contamination, the water that is available to us today will be available to use in the future. Water shortages and water contamination have huge repercussions to a nation's health and its ability to grow and develop economically. Here in South Africa, where freshwater resources are scarce, and demand continues to grow, protection of our water resources is vital.

Human behaviours and attitudes towards the wise of water resources is very much needed and in part a reason for producing this and other DVDs by the WRC.



KOUGA DAM – Serving the fertile Gamtoos valley

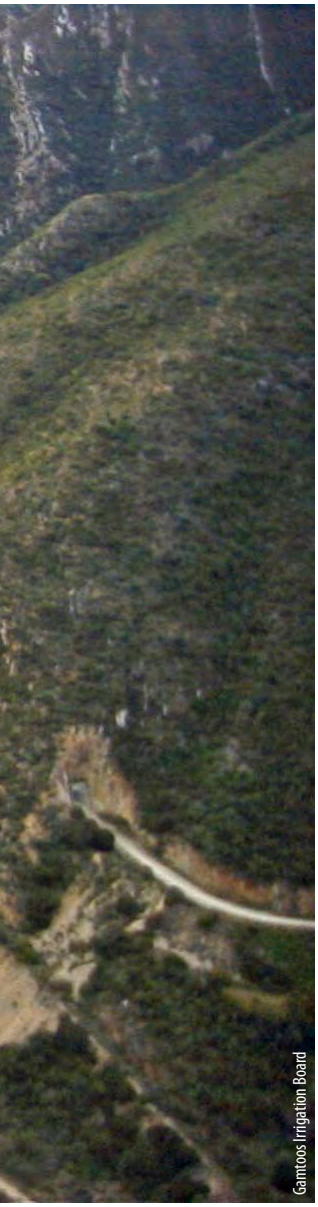
In one of the most fertile valleys of the Eastern Cape lies the Kouga Dam, which for more than 50 years has played a pivotal role in water supply and flood control in the region. Lani van Vuuren traces the history of the dam.

Situated between winter and summer rainfall areas the Gamtoos valley is known for its rich, fertile soils, its fresh water, and its subsequent agricultural bounty. The main river running through the valley is the Kouga River. Rising at Avontuur at a height of 1 500 m above sea level, the Kouga River flows through the Langkloof Valley, lying between the Tsitsikamma, Kouga and Winterhoek mountains. After joining up with its tributary, the Baviaanskloof River, it flows through a narrow gorge, the Kougapoort, to its confluence with the Groot River. After the confluence, the name of the river changes to Gamtoos.

The valley was originally populated by Khoisan communities. Trekboers first settled in the Gamtoos valley with their livestock in the era of Dutch occupation, and by 1770 the Gamtoos River was declared the eastern boundary of the Cape settlement. This remained so until 1804 when the area became part of the newly proclaimed Uitenhage district. Between 1816 and 1818 the first farms of around 1 713 ha each were officially handed over to European farmers.

THE START OF IRRIGATION

Irrigation in the valley started in the 1840s and gained momentum after the introduction of lucerne to bolster the production of ostrich feathers. Storage weirs and



Gamtoos Irrigation Board

distribution canals were constructed by several farmers in the district who wanted a share of one of South Africa's most lucrative export products at the time. Where weirs were impractical steam and oil pumps were used to bring water from the river to the field.

Following a visit to the valley agricultural assistant to the Cape government wrote in 1904: "Some help is needed to simplify the present complicated system of distribution... The present system of using the water is wasteful to extreme. The temporary dams are inefficient and constantly being broken by floods. The water leading canals are small and long, badly laid out and far too numerous, owing to a lack of combination among the proprietors and it only requires organisation and a readier outlet for the produce to bring great prosperity.

"Should the government undertake the work of regulating and conserving the water supply of the Gamtoos valley the scheme that would meet the most general approval on the part of the inhabitants would be one for the construction of a series of dams in the bed of the river itself, from which the water might be brought on the land either by gravitation or by pumping."

These unorganised and primitive methods of extracting water led to numerous requests by community leaders and the farmers themselves for intervention by the State through the development of proper irrigation schemes. In 1910, the Cape Director of Irrigation, FE Kanthack, visited the valley. He called it "the most favourable part of the Union." Following the promulgation of the Irrigation and Conservation of Waters Act of 1912 several Irrigation Boards were established in the Gamtoos valley, including the Kougapoort, Reenen and Rademeyer Irrigation Boards. By the 1950s, there were some 4 798 ha of land under irrigation in the valley. The main crops under irrigation at that time were citrus, tobacco, vegetables, potatoes, wheat, maize and lucerne, with Port Elizabeth proving a convenient market.

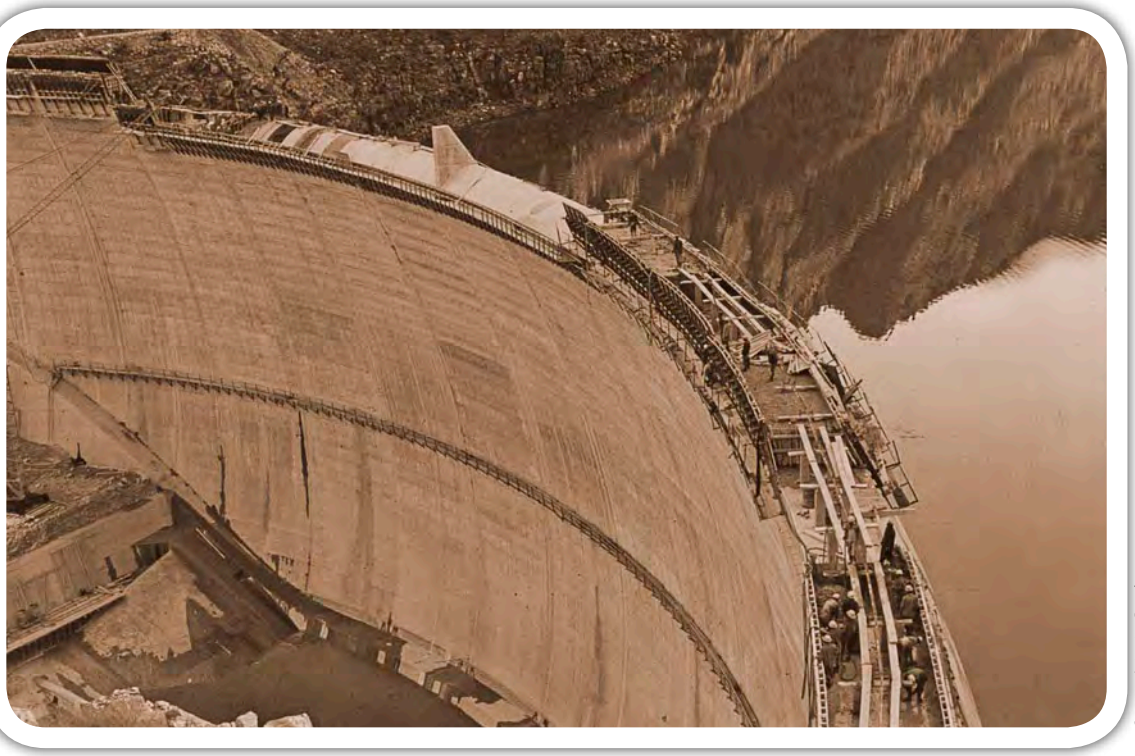
The boards immediately set to work improving irrigation infrastructure with significant loans from the government. One of these schemes, Reenen, was completed in 1916 and included a weir, 29 km-long canal and a tunnel of 163 m to irrigate 1 285 ha of land.

"Prisoners had a tendency to deliberately injure themselves on site so as to avoid the hard, physical work."

Periodical floods were the enemy of irrigation farmers in the Gamtoos valley. In May 1916, such an extreme event led to the death of 24 people. The Gamtoos River destroyed everything in its path, including the newly constructed irrigation infrastructure as well as 514 ha of scheduled irrigation land. Many of the farmers also lost their crops.

More loans had to be made to rebuild the works. Extreme measures were taken to protect the structures from further flood damage, including surrounding them with thorny branches and gabions of rock and steel. These were often simply washed away when the river came down. In long stretches of the river, no large rocks could later be found.

Another notable flood hit the region in 1932, this time destroying



Gamtoos Irrigation Board

***Above**: Kouga Dam is located near the downstream end of the Gamtoos valley in a narrow gorge.*

***Right**: The Kouga Dam wall during construction. Cocopans were used to bring concrete to the top of the wall. Here the rail can clearly be seen.*

The Beervlei Dam during construction. The distinctive multiple arch structure comprises 15 cylindrical arches with gravity sections on its flanks.

932 ha of land and washing away weirs and canals. Thankfully the arrival of a telephone service years earlier meant that people could be forewarned and no loss of life occurred. At Hankey, known at that time for the quality of its apples and other fruit, most of the trees were lost. Following the flood the Irrigation Commission surveyed the damage in the valley and recommended the construction of dams to control these periodical floods.

When the farmers were not tormented by floods they had to contend with droughts. Available flow in the Kouga and Gamtoos rivers was insufficient for around a third of the time. Farmers upstream were better positioned than their downstream neighbours, especially in times of deficit.

A number of sites for storage dams in the Kouga River catchment had been investigated from time to time. As early as 1931 a site on the farm Kruisrivier, immediately below the confluence of the Kouga and Baviaanskloof rivers was surveyed, while in 1947 and 1953 further topographical surveys were made of alternative sites near Guerna, a short distance below the infall of the Witteklip River in the Kouga, and on the farm Tweerivieren in Kougapoort.

The latter site, located about 5 km above upstream of the Kouga/Gamtoos confluence, was eventually selected, and the dam was initially known as Tweerivieren Dam. Topographical surveys were carried out of the Gamtoos valley in 1952/1953. In 1956, the Department of Agriculture commissioned an investigation into the suitability of the soil in the valley for the expansion of irrigation.

BEERVLEI DAM

In 1946, the Union government rather unexpectedly decided to first construct a flood control dam at Beervlei on the Groot River near Willowmore, before making a final decision on a dam in the Gamtoos valley. The site, situated about 5 km below the confluence of the Groot River with the South and Kariega rivers, was first identified in the early 1920s.

Considered one of the best storage basins in the country, irrigators along the Groot River agitated for this dam for many years. However, because of the extremely irregular flow, high mineral content and silt load of the rivers, the government was at first reluctant until it was decided to use Beervlei mainly for flood control instead. Only around 2 190 ha of irrigated area would be regulated from this dam.

Construction of the multiple arch dam started in 1953. At that time it was government policy to make use of black convict labour on large public works projects and so a large prison labour camp was constructed at the site. Around 400 prisoners eventually worked on the dam.

Excavations for foundations started in July 1954, and the first concrete was placed in May, 1955. Due to the high mineral content of the water, a super sulphated cement was imported from Belgium and used in the preparation of concrete for the dam. The spillway was originally at two levels, the upper level was 1,8 m above the full supply level

KOUGA DAM ENGINEERING FEATURES

- **Dam type**: Double curvature arch dam
- **Maximum height above lowest foundation**: 94,5 m
- **Crest length**: 204 m
- **Maximum water depth:** 53 m
- **Gross storage capacity**: 133 million m^3
- **Surface area (at full supply level)**: 555 ha
- **Total quantity of concrete in wall**: 268 000 m^3
- **Maximum thickness of wall**: 10,2 m
- **Design flood (1:200 year)**: 4 249 m^3/s

and reached over three of the dam's 15 cylindrical arches.

The project was finally completed in September, 1957. In 1967, the full supply level of the dam was raised to the level of the upper spillway to increase the capacity of the dam from 52 208 million m^3 to 92 850 million m^3.

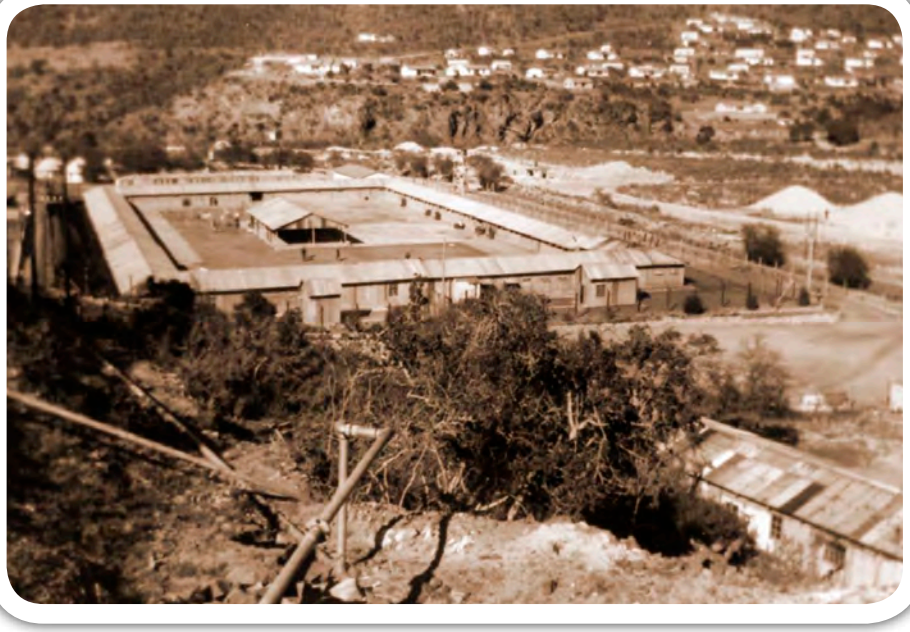
The dam wall has a height above lowest foundation of 31 m, and a crest length of 348 m. The volume content of the dam is 0,042 million m^3 and it has a gross capacity of 100 731 million m^3.

KOUGA DAM

In 1955, Paul Sauer, then Minister of Lands, stated that once Beervlei Dam was completed, a start would be made with a dam on the Kouga River. A White Paper proposing the building of the Kouga Dam was submitted to Parliament in 1957, and not long thereafter a construction team moved onto site. The Department of Water Affairs (DWA) team selected was the same one that had constructed the Beervlei Dam.

The original objectives of the project as stated in the document was to ensure a more assured supply of water to the existing lands under irrigation, permit the development under irrigation of an additional 3 770 ha of land for the purposes of government settlement, and to alleviate serious flood hazards in the Gamtoos valley.

Later it was realised that the dam also had the potential to supply water to Port Elizabeth and renowned water engineer Ninham Shand was appointed by the town council to report on this possibility. The town council resolved to proceed with the Kouga scheme on the basis of a supply drawn from the end of a canal system at Loerie. In 1963, Council negotiated an agreement with government for a water supply from the scheme which was redefined as dual purpose, namely irrigation and urban usage. The agreement provided for the supply by government to council at Loerie of a quantity of water not exceeding an annual average of 140 Mℓ/day.



Gamtoos Irrigation Board

Gamtoos Irrigation Board

***Top**: An elaborately guarded prison camp was constructed on site at Kouga to house the approximately 400 black convicts that worked on site. A similar camp was constructed at Beervlei.*

***Above**: A close-up of the overspill section of Kouga Dam during construction.*

Similar to Beervlei, convict labour was used even though the prisoners tended to be far less productive than their free counterparts. It is reported that prisoners also had a tendency to deliberately injure themselves on site so as to avoid the hard, physical work. The department tried several methods of motivating the prisoners to improve their work output, including providing a ration of tobacco to those who reached a certain quota each day.

Original design and estimates were based on a concrete gravity dam, however, it was later decided to construct the dam as a double curvature thin ('cupola') arch instead as this would be less expensive.

Gamtoos Irrigation Board

Pipes being offloaded during 1965 for distribution of water from the dam.

This was the first dam of its kind to be constructed in South Africa. The DWA project team developed a mathematical mesh model to obtain the optimal shape of the dam and ensure minimum bending within the shell. Solid model laboratory tests were also undertaken – another 'first' for the department.

The geological conditions at the site provided many challenges, and a number of measures had to be provided to safeguard the dam and its foundations. Among others, three tunnels, each 145 m long, were constructed in the right flank for drainage and pressure alleviation. In addition, a thick reinforced concrete slab was built against the downstream right abutment. This was post-stressed with cables extending to a depth of 40 m into the mountain. Lastly, a comprehensive set of observation points and instruments were incorporated on and inside the dam wall. The latter led to even more sophisticated instrumentation in other cupola dams such as the Pongolapoort Dam.

Huge volumes of water had to be diverted from the construction area, resulting in the construction of a substantial coffer dam. This dam was 302 m long and varied from 5 m to 9 m in height.

Excavation for the main wall started in August, 1958. Little over a year later the placing of concrete started. The wall was constructed to a maximum height of 94,5 m above the lowest foundation level. The maximum thickness of the shell is 10,2 m tapering down to 4,8 m at the non-overspill spill. A small hydroelectric power station was constructed on the right bank (it was later found to be non-economical).

In order for the dam to fulfil its flood control function, a radial gate-controlled chute spillway was installed on the left flank, making it possible to draw down to the level in the reservoir before a flood arrived and so alleviate the flood peak. The dam also features an uncontrolled spillway 64 m above apron level. The hydraulics of the dissipation of energy of the water passing over the spillway down to the apron gave rise to a number of problems. The impact forces on the apron were measured through a series of hydraulic model tests and reduced as far as possible using a deep water cushion. The apron was built to be a minimum of 3 m thick, and is heavily reinforced and anchored to the rock.

The dam was eventually completed in 1969. Today, several decades later, it still provides a valuable water supply function in this region.

❑

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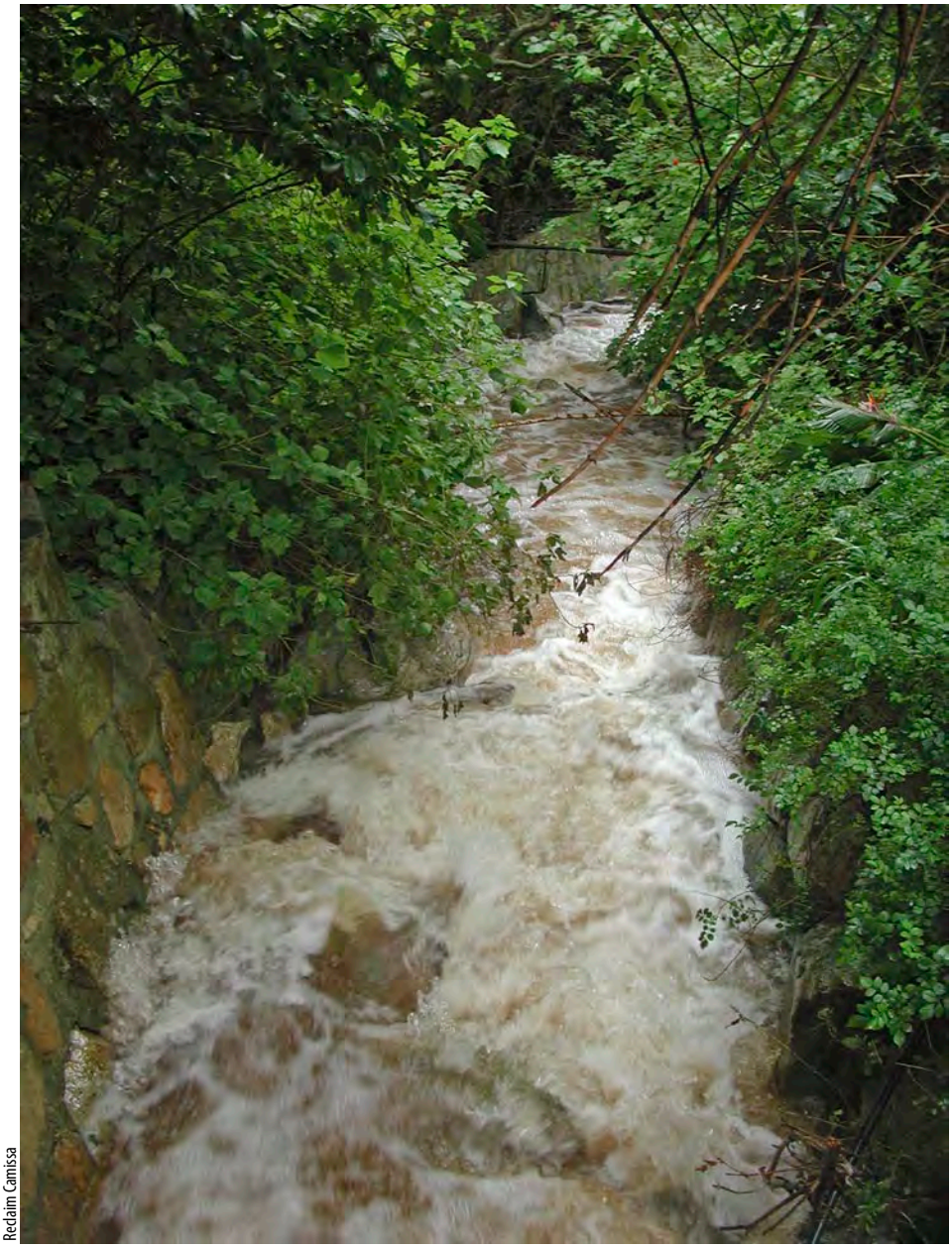
- Thanks to the Gamtoos Irrigation Board and eWISA for photographs



Redaim Camissa

The Platteklip Stream is now canalised.

CAPE TOWN – Water for a thirsty city (Part 2)

In this second instalment of a two-part series, Petro Kotzé investigates the water supply of Cape Town under British rule and the work of non-governmental organisation Reclaim Camissa and others to transform water resource management in the Mother City.

By the time the British took permanent occupation of the Cape in 1806, the settlement was experiencing a serious water shortage, and because Dutch company VOC had not wanted to spend too much of its profits on this half-way station, the water supply system had not changed significantly since Van Riebeeck's time.

The solution offered by leading engineer of the day, John Rennie, in 1918, was to build a 250 000 gallon reservoir in what is now Hof Street. This waterhouse was filled with water from the Oranjezicht, Platteklip and Waterhof springs. The structure was demolished in the 1900s.

Under the guidance of the appointed water superintendent, John Chrisholm, the first cast-iron pipeline of 12-inch diameter was laid down in Long Street, and branches of small bore were extended to cross the street. Around this time, the Burgher Senate was also empowered to impose and raise a tax necessary to fund the pipes. Chrisholm built several pumps to lift water from underground tanks, filled by mountain springs. One of these, the Hurling Swaai Pump in Princess Street, Oranjezicht, still stands, and has been declared a national monument.

The chiming of the death bell of the town's once appealing canals commenced around 1827. By this time, they had become little more than polluted dumping grounds. Systematically, the structures were arched over and enclosed. By the end of the 1850s the last stretch of the Heerengracht had been covered and the street was renamed Adderley

Redaim Camissa

The Hurling Swaai Pump in Princess Street, Oranjezicht, still stands, though somewhat dilapidated. It has been declared a national monument.

Street. When the bubonic plague broke out in Cape Town in 1901, the last of the open water courses was closed.

A series of reservoirs were built in the coming years to try and quench the thirst of the growing city. Of significance are No 1 and No 2 reservoirs. In 1849, at a cost of £2 700, Chrisholm built a 2,5 million gallon reservoir, known as No 1 reservoir. It still lies between Orange and Hof streets, and was fed by the winter flow of the Oranjezicht spring. Due to its apparent success, No 2 Reservoir, with a capacity of 12 million gallons, followed in 1856. No 1 has been empty for a number of years, while No 2 is filled with runoff from the Main and Waterhof springs, and is used for fire-fighting and the watering of the old Company gardens.

The flat rocks of the Platteklip Stream, and what it would have looked like where the washer women of the old Cape settlement did their laundry.

Redaim Camissa

A THIRSTY CITY

By 1856, the municipality had acquired a portion of the Waterhof Estate, the Kotze spring (on the Leeuwenhof Estate) and the mills along the Platteklip stream so that pipes could be spread over the whole of town. The municipality also started investigations into water purification. The first attempt was a slow sand filtration bed built along Platteklip Gorge.

In 1877, the Town Council purchased a section of the estate known as Kampement to allow for the construction of another reservoir, named after Sir John Molteno, the first Prime Minister of the Cape. Completed in 1880, it was, at first, fraught with problems. Designed to hold 40 million gallons, the Molteno reservoir stood empty until 1882 due to exceptionally low winter rainfall.

When the drought broke, the eastern embankment collapsed and, as the reservoir filled up, leaks continued to appear, at one time so severe that it flooded a number of streets. It was not fully repaired until 1886. Today, it serves as a service reservoir and supplies water to the lower areas of Green Point and Sea Point.

Disaster struck the ill-fated Molteno reservoir once again on 4 June, 1900, when celebrated aeronaut and balloonist, Prof Isodore Michaels, ascended from Good Hope Gardens in his hot air balloon. The wind took him towards the mountain. Michaels escaped via a parachute and landed in the middle of Molteno reservoir. Entangled in his parachute ropes, he subsequently drowned. The reservoir had to be drained and cleaned, leading to another period of water shortage for Cape Town.

In the late 1880s, a bold plan to augment diminishing water supplies to the Molteno reservoir from the plateau behind Table Mountain, through the Twelve Apostles, was hatched. This tunnel was completed in 1881 and water from the Disa River was diverted into it.

In the early 1890s, it was also decided that sewage seepage from urban development above the city's historic springs compromised the water's potability. It was decided to divert the water away from domestic consumption and into the sea.

However, the city kept on growing. In 1984, construction of the Woodhead Dam commenced on top of Table Mountain. By the time the dam was completed, the city's new sewerage system had been implemented, and the demand for water grew once more. At the end of the South African War, the large number of British troops that had flooded into Cape Town added to the water shortage. As a result the Hely-Hutchinson Dam was constructed, while three dams were built nearby, also on the mountain, to supply the municipality of Wynberg.

In the 20th century a succession of much larger dams were built further away from the city, the latest being on the Berg River near Franschhoek. However, projections show that pressure on water resources will increase in the Western Cape as temperatures rise due to climate change and population growth. The rulers of the Mother City will no doubt have to look for alternative sources to meet the growing demand for water.

RETURN OF THE LOST SPRING

In 2008, the City of Cape Town commissioned a feasibility study into alternative water sources for irrigation of Green Point Common, as opposed to the use of potable water, which had been used up to that date. Among others things, desalinated seawater, groundwater, greywater treatment, rainwater

harvesting and the harvesting of spring water from the slopes of Table Mountain were considered.

The study concluded that the harvesting of spring water from the once life-sustaining Oranjezicht springs, from which water still runs through a series of stormwater drains into the Atlantic, was indeed the most cost-effective source for the City's purpose. The consequent report notes that the spring water is not potable, and will require treatment to meet drinking water standards.

The flow from the springs has been monitored, with a flow from the new main spring measured as being some 28 ℓ/s. Combined with the flow of other formalised springs in the area, the measurement increases to 40 ℓ/s. This is more than sufficient to meet the annual irrigation needs of the Common,

Reclaim Camissa

In 1869 a filterbed was built alongside Platteklip Gorge. This, the earliest attempt at purification, was by means of slow sand filtration.

Green Point Stadium, the Metropolitan Golf Course and Mouille Point Beachfront. And so, the city could, once again, to some extent at least, be connected to the sweet waters of Camissa.

RECLAIM CAMISSA

Reclaim Camissa is a non-profit organisation aimed at providing stewardship for the waters that flow from Table Mountain to the Atlantic Ocean, through the concept of 'civic hydrology'. Founder, Caron von Zeil, explains that this entails transforming the city's stormwater infrastructure through a sustainable water management system, so that citizens are engaged with their water in ways that a conventional stormwater infrastructure cannot provide.

In the case of Cape Town, this entails a 'resurfacing' of some of the original watercourses within the urban fabric of Cape Town, in ways that are functional, renewable, sustainable and symbolic.

Concepts include dockside markets at the ocean's edge, water taxis to navigable canal connections; a series of linked walkways moving through the old city via a 'green pedestrian spine', re-instating the *leiwater* system to create walking routes that link the heart of lost heritage and cultural spaces; reservoirs and water sustainability parks which are functional, recreational and educational; a public water museum at the original spring in Oranjezicht; reinstatement of the old Platteklip mountain filtration plant and a washer-women museum at the old *wasplatz* or wash-houses found at the start of the Hoerikwaggo Trail leading up to Table Mountain.

Von Zeil, also a member of the Oranjezicht Heritage Society (OHS), stresses that better use must be made of Cape Town's scarce water resources. An OHS presentation to the City helped to establish the Platteklip fountain as a source for irrigating the Green Side Common.

Reclaim Camissa's mission is to, by 2020, let the people of Cape Town gather around 'the common heritage of Camissa, the very waters that defined the location of the city, reflecting the public past and embracing a new civic infrastructure – this time inspired by a deliberate recognition and respect for the social; cultural and ecological significance of this water.'

Interested parties can visit the organisation's Facebook page. ❑

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Thanks to Reclaim Camissa for information and photographs.

PHOSPHATES IN DETERGENTS – Cleaning up our act

www.sxc.hu

Can removing phosphate from laundry detergents make a meaningful difference to nutrient enrichment problems? Article by Leo Quayle.

The shockingly green pictures of Hartbeespoort Dam algal blooms have, for a long time, set the visual scene for studies and articles addressing the subject of the excessive amounts of nutrients we are pouring into our rivers and dams. Although almost synonymous with it, algal blooms and nutrient enrichment problems are not unique to Hartbeespoort, and managers of impoundments around the country are noticing rising levels of chlorophyll *a* in their water quality samples.

A related subject that has also often been discussed is the contribution that powdered laundry detergents make to this problem. In fact, in South Africa, about 23% of a laundry detergent's mass is made up of sodium tripolyphosphate (STPP). This ingredient's jobs is to act as a water softener and to bind up ions which reduce the effectiveness of the detergent.

However, when it is mixed with water, STPP quickly hydrolyses to ortho-phospate (or soluble reactive phosphate – SRP), a nutrient which is important to the growth and survival of all living organisms. In simple terms, adding additional SRP to water bodies allows aquatic plants and algae, in particular, to grow significantly quicker and in greater abundance than they would be able to without it, hence the green hues of Hartbeespoort Dam.

FINDING A SUBSTITUTE

This fact has not been overlooked by several countries around the world, where the banning or limitation of this ingredient from detergent production has reportedly resulted in some reductions in nutrient-related water problems. A variety of substitute ingredients has been identified, and has been in use for quite some time now.

The most commonly used is a combination of anhydrous zeolite-A (a crystalline alumnosillicate) and soda ash. In a study funded by the Water Research Commission (WRC), a team of water quality scientists from Pietermaritzburg, in association with Unilever, have investigated the effect that removing phosphates from detergents and substituting them with alternative builders would have on the problem of eutrophication in a number of important South African dams.

THE PHOSPHATE IN OUR WATERS

Although people washing their clothes in or alongside rivers make a highly visible contribution to the phosphate loading of these water resources, the largest source of

Table 1: Proportional contribution made by detergent phosphates to total SRP loading at sewage treatment facilities

Sewerage works	SRP proportion (%)
Darvill (KwaZulu-Natal)	40,30
Bushkoppies (Gauteng)	17,75
Goudkoppies (Gauteng)	15,40
Driefontein (Gauteng)	15,10
Ennerdale (Gauteng)	58,82
Olifantsvlei (Gauteng)	28,12
Northern (Gauteng)	28,53

detergent phosphate entering South African rivers are urban sewage treatment works. These facilities, and their efficiency in removing phosphate from their effluent, are central to the issue of water resource nutrient enrichment.

Several studies have shown that the majority of these facilities are currently unable to achieve the legislated effluent SRP concentration of less than 1 mg/ℓ. Significantly, it has been shown that even if all treatment works were to adhere to this limit, loading would still be sufficiently high through sheer volume of wastewater to render several important dams permanently eutrophic suggesting that this limit is not sufficiently strict. It is proposed that removing phosphate from powdered laundry detergents can provide an avenue to reduce the phosphate loading arriving at treatment facilities and hence reduce the knock-on effect of nutrient overloading on our water resources.

CRUNCHING THE NUMBERS

Using Unilever detergent consumption data, the team showed that approximately 22% of the total phosphorus (TP) arriving at the Darvill sewage treatment facility in Pietermaritzburg originated from detergents' phosphate builders. This is equivalent to about 40% of the SRP loading. The study also showed that detergents' proportional contribution varied considerably according to the nature of the wastewater intake as facilities such as Goudkoppies and Driefontein in Gauteng, which service industrial areas, showed a much lower proportional contribution.

The total phosphorus export in a catchment was estimated using phosphorus export co-efficients for different land cover types gleaned from several different studies. The area of each land cover type in each catchment was used to determine a total export co-efficient per catchment. Urban phosphorus export was determined using a value calculated from Darvill effluent and a generic surface runoff co-efficient. Around 22% of this figure was deemed to have originated from detergents.

It should be pointed out that in comparison to some treatment facilities around the country, Darvill is an efficient facility, which means that this value is probably an underestimate, which would be carried through all the results of the study.

Based on the figures calculated, it is suggested that the total phosphorus loading at important dams could be reduced significantly by eliminating detergent phosphorus. This is assuming that sewage treatment works continue to operate in the same manner as before and that effluent loading is reduced by an amount equivalent to the reduction in influent loading.

Guy Stubbs

In South Africa, about 23% of laundry detergent mass is made up of sodium tripolyphosphate (STPP)

NO MAGIC BULLET

Dams with a high degree of urban settlement in their catchment are expected to experience the greatest reduction in TP loading, with dams such as Hartbeespoort, Klipvoor, Roodeplaat, Inanda and Laing all expected to experience a reduction in TP loading at inflow of more than 25%. Of course these reductions all become irrelevant if sewage treatment plants reduce their phosphate removal efficiency in response to a decrease in loading in order to enjoy the benefits of reducing their costs while achieving the

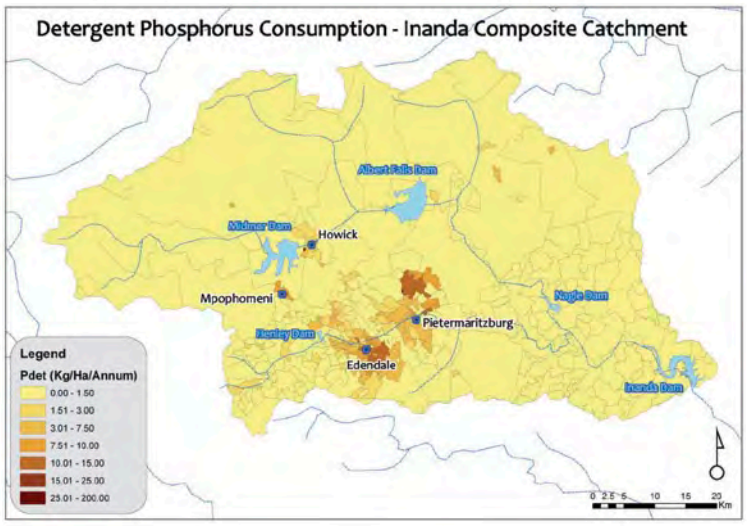


Figure 1: *Detergent consumption intensity in the Inanda composite catchment, including Midmar, Albert Falls, Nagle, Henley and Inanda dams*

same results. If benefits are to be passed on to the aquatic environment, treatment plants will, in the least, need to continue to operate as if nothing has changed.

A reduction in inflow phosphorus does not translate into a reduction in TP and chlorophyll concentration in the dam in a 1:1 ratio. A complex range of processes sees some of the phosphorus being bound up in sediments and also being biologically removed from the water. Modelling enables one to estimate the concentration of both phosphorus and chlorophyll in the dam based on estimated concentrations of phosphorus in its inflow, and dam specific parameters.

The team modelled the in-dam conditions (both TP and chlorophyll) using the OECD and Walker reservoir models. Based on the estimated reductions in inflow concentrations, results were encouraging, with several of the 24 dams showing significant (greater than 20%) decreases in TP and chlorophyll concentrations. A summer TP reduction for all 24 dams was approximately 12%.

Although this level of reduction would not be sufficient to significantly reduce the time some of the worst affected dams spend in an eutrophic state, it reduces the SRP overload margin and makes any reduction targets that are set so much more attainable.

The environmental benefits of a lower nutrient load have been shown to be significant enough to support the proposal to remove phosphates from detergents. However, when looking at the economics of the problem, previous studies of this nature have come to the conclusion that although the elimination of detergent phosphate was desirable, it would not be cost-effective to implement a ban.

Table 2: The estimated reductions in inflow TP loading to be achieved by eliminating detergent phosphates

Catchment	TP production (%)
Albert Falls	17,5
Allemanskraal	3,5
Bloemhof	15,2
Bronkhorstspruit	5,3
Erfenis	4,5
Grootdraai	7,5
Hartbeespoort	28,0
Hazelmere	22,0
Henley	9,0
Inanda	28,0
Klipfontein	18,7
Klipvoor	26,8
Koppies	3,2
Laing	28,3
Lindleyspoort	9,9
Midmar	3,3
Misverstand	6,7
Nagle	7,8
Roodekoppies	8,5
Roodeplaat	29,3
Shongweni	21,0
Vaal	8,6
Welbedacht	13,7
Witbank	8,5

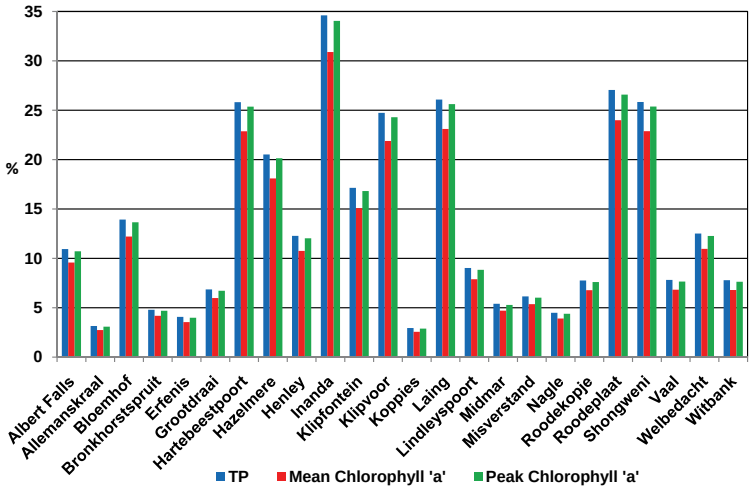


***Figure 2:** Graphical representation of potential reductions in TP and Chlorophyll a*

WEIGHING THE OPTIONS

In these studies, it was calculated that overall, it would be cheaper to retain the phosphate builders in detergents and to continue to extract the phosphate at sewage treatment works than to inflict the costs of introducing a substitute builder on consumers and producers. The suggested costs associated with substitution includes damage to washing machines and fabrics, and the fact that potential substitute materials are generally more expensive than phosphates, increasing the cost of manufacture and pushing the price of detergents up.

As part of this study, a qualitative cost benefit analysis revealed that the costs previously attributed to phosphate substitutes which rendered their implementation as not cost-effective, are today in fact negligible. This conclusion is based largely on the experiences of several countries around the world where phosphate substitutes have now been introduced.

The investigation also concluded that the benefits to be gained by switching to these substitutes will not only accrue to the environment, but to producers and consumers as well. Producers of detergents have seen the cost of phosphate rising rapidly recently due to a global shortage of the resource. This cost escalation makes the suggestion of replacing them with a cheaper substitute product a sensible economic choice. Consumers will therefore also see a benefit in that the cost of detergents in the supermarket will not be escalated by the rising resource price.

A further situation which was unforeseen by previous studies

Although people washing their clothes in or alongside rivers make a highly visible contribution to the phosphate loading of these water resources, the largest source of detergent phosphate entering South African rivers are urban sewage treatment works.

which advocates the elimination of detergent phosphates is the inefficiency of many sewage treatment facilities in removing phosphate from wastewater, and the fact that many of these facilities are overloaded and simply cannot cope with the volume of wastewater currently being produced.

This situation means that the previously adopted approach of leaving the job of removing the detergent phosphate to the wastewater treatment facilities has become untenable. Elimination of detergent phosphates will undoubtedly assist many facilities in achieving better effluent SRP concentrations. This will theoretically constitute a financial saving for these facilities when the Wastewater Discharge Charge System is implemented, reducing the amount each facility will be required to pay for releasing phosphate rich effluent.

Some of the minor market share producers have already begun producing products using zeolite and soda ash builders, and the larger producers have indicated a willingness to adapt their production processes. In essence, the time is right for a shift to phosphate-free detergents in South Africa.

Environmentally, this has long been the case, but economically, the situation has only recently reached a tipping point where consumers, producers and other involved parties will see a direct benefit in switching to alternative builders. Although on its own it does not constitute a 'silver bullet', a move to phosphate-free detergents is undoubtedly an important step in cleaning up our water resources.

This final report, *Investigation of the positive and negative consequences associated with the introduction of zero-phosphate detergents into South Africa* (**Report No: TT 446/10**) is now available from the WRC. ❑

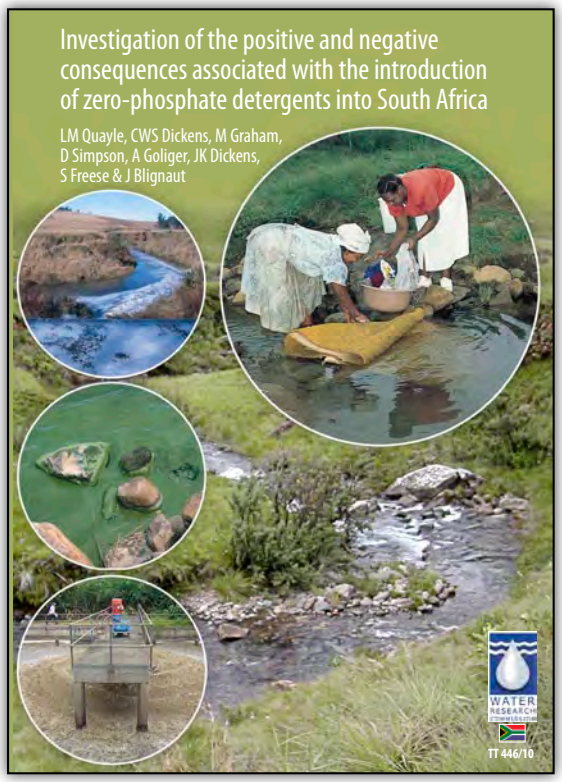


Table 3: Summary of modelled reductions of in-dam TP and Chlorophyll a in the top six dams

Dam	Reductions in TP concentrations	Reductions in Chlorophyll *a*
Inanda	35%	30%
Roodeplaat	27%	23%
Laing	26%	23%
Hartbeespoort	26%	22%
Shongweni	26%	22%
Klipvoor	25%	21%
Total all dams	12%	12%

Eva Masha from Strydkraal, in Limpopo, proudly shows off pumpkins growing in her backyard.

Towards productive water use and household food security in South Africa

A recently completed project funded by the Water Research Commission (WRC) is proving that with the correct knowledge and training families can successfully turn around the hunger cycle by growing their own food.

Despite national efforts, millions of South Africans still go to bed hungry every night. Research shows that around 53% of all the country's households experience hunger, with 59% of households being food insecure.

Increasingly development practitioners are recognising the importance of household food security and especially the impact of under-nourishment among household members (both children and adults) on wider society. The focus is shifting to the potential role of the homestead yard in food production for improvement of family nutrition.

Improving national and household food security has been priority for the WRC for nearly 20 years. According to Drs Gerhard Backeberg and Andrew Sanewe of the WRC's key strategic area focusing on water utilisation in agriculture, while around 9,5% of all households have access to agricultural land (predominantly small plots of less than a hectare), nearly 18% of households can potentially grow food in homestead backyard gardens in rural villages. Most of these households are headed by women. Currently these households rely on multiple sources of income, with rainfed and irrigated farming, on average, contributing respectively 10% and 30% to rural livelihoods.

However, households require more than just material input to successfully grow their own food. The challenge is to empower people who are hungry and under-nourished to produce or acquire sufficient food which meets their dietary needs. Experience indicates that the focus should be on improving people's

knowledge through informal, practical, on the ground training and skills improvement.

PARTICIPATORY RESEARCH

Early in 2004, the WRC solicited a research project to develop training material for agricultural water use in homestead farming systems. The emphasis was placed on participatory research and, as such, households from various communities around South Africa were included throughout the project cycle. This approach emphasised the participation of farmers in the generation, testing and evaluation of technology to increase or promote sustainable agricultural production.

The overall objective of the project was to improve food security through homestead gardening, by developing and evaluating the appropriateness and acceptability of training material for water use management, training the trainers and training of household members in selected areas.

The resultant resource material for facilitators and food gardeners deal with (among others) production potential, water supply and management, dietary requirements for balance nutrition, poverty alleviation, participatory rural appraisal and applicable adult educational approaches within rural social structures. In addition, the specific techniques and infrastructure required to harvest and conserve rain, cultivate soils and produce crops that will impact on the essential dietary needs of people living with limited means and opportunities are explained and illustrated.

Some of the homestead soil and water use techniques introduced include deep trenching for concentrating water and nutrients in the plant zone; run-on ditches for in-garden rainwater harvesting; tower gardens for saving labour and using greywater; drip-kits for saving time and water; and underground rainwater storage tanks, among others.

A homestead garden such as this one could do much to improve hunger statistics in South Africa.

The resource material has succeeded in drawing widely from local and international materials and experience. Its usefulness in practice has already been acknowledged by facilitators who were not part of its development.

It is anticipated that a variety of stakeholders, including practitioners, will rely on this resource material to develop course material for their own purposes. Already a significant demand for the material exists from universities and agricultural colleges that are aware of the material.

With the cooperation and assistance of agricultural colleges, non-governmental organisations, and community-based organisations across the country, a national initiative is now required for training the trainers, facilitators, farmers and individual household members, particularly women. The support of senior managers at provincial and local government level is essential for successful implementation of this training programme.

- This article is based on an original paper by Drs Gerhard Backeberg and Andrew Sanewe of the WRC: Water Utilisation in Agriculture presented at the 6th Asian Regional Conference of the International Commission on Irrigation & Drainage held in Yogyakarta, Indonesia, 10-16 October, 2010.
- To access Volume 1 (Main Report, Report No: **TT 430/09**) and Volume 2 (Resource Material, Report No: **TT 431/09**) of *Agricultural Water Use in Homestead Gardening Systems,* Visit www.wrc.org.za or contact Publications at E-mail: orders@wrc.org.za; or Tel: (012) 330-0340. ❑

WATER & NANOTECHNOLOGY

Jacques Botha/SU

Dr Michele de Kwaadsteniet, a member of the research team in the Microbiology Department at Stellenbosch University holding a 'tea bag' filter before (right) and after use. The filter might look like a tea bag, but blocks harmful chemicals and microorganisms in water.

Most countries around the world, including South Africa, are faced with the growing challenge of access to clean, safe drinking water. Recent statistics indicate that more people are dying annually from unsafe water than from all forms of violence combined, including war. In South Africa, an estimated 5,7 million people lack access to basic water services, and about 17 to 18 million people lack basic sanitation services. These figures are likely to increase due to industrial expansion, rising population and climate change, which is set to drastically affect sub-Saharan Africa. Finding new ways to address the challenge of providing clean water has become a global priority. One of the approaches being explored in many countries, including South Africa, is the application of nanotechnology.

A NEW WAVE of science innovation is based on something really, really small, but smarter than ever before. Nanotechnology is the hottest buzz in labs around the world. Scientists are using this cutting-edge technology to develop incredible new products, but also to work towards renewable energy, clean water, safe food and smart medicines for the growing number of people on our planet.

WHAT IS NANOTECHNOLOGY?

Nanotechnology is the manipulation of materials at a very tiny scale – essentially at the atomic and molecular levels. At the nanoscale, the normal rules of physics and chemistry often do not apply, and as a result many materials display unique properties that make them well suited for treating water.

Nanotechnology provides an opportunity to refine and optimise current techniques, and also an opportunity to offer new and novel methods for treating domestic, industrial and mining wastewater. Essentially, nanotechnology can offer solutions that are tailor-made to remove a specific contaminant or solutions that 'multi-task', using different nano-based techniques. This is ideal for water purification because water contains different forms of contaminants at different locations, such as heavy metals (e.g. mercury, arsenic), biological toxins including waterborne disease-causing pathogens (e.g. cholera, typhoid), as well as organic and inorganic solutes.

NANOTECHNOLOGY IN SOUTH AFRICA

In South Africa, the National Nanotechnology Strategy (NNS) was launched in 2006, although nanotechnology has been embedded in national strategy and policy since the publication of the White Paper on Science and Technology in 1996. Water is one of six focus areas highlighted in the NSS where nanotechnology can offer the most significant benefits for South Africa. This is reflected in the high volume and quality of research at various institutions around the country.

To date, through the Department of Science and Technology (DST), the government has invested over R170-million in different aspects of nanotechnology research and development (R&D). Two nanotechnology Innovation Centres have been commissioned and have formed collaborative partnerships with industry, universities and bodies such as the Water Research Commission (WRC) to conduct cutting-edge research. Much of this has focused on water purification, and as a result, a range of water treatment devices that incorporate nanotechnology are already commercially available around the country.

A project between the Stellenbosch University and the WRC has produced a membrane and filter

system which is already commercially available in South Africa. It uses capillary ultrafiltration (UF) technology to enable the removal of metal oxides (iron, manganese and aluminium), and reduce colour. It is also suitable for pre-treatment of sea-water, desalination and the treatment of industrial water and wastewater.

A partnership between the University of North West and the Council for Scientific and Industrial Research (CSIR) has developed a treatment plant in the rural village of Madibogo in North West Province which incorporates ultrafiltration membranes to clean brackish groundwater, as the majority of the inhabitants depend on groundwater or borehole water for their water needs. Several types of membrane have been tested in this pilot study, including reverse osmosis membranes and ultra-filtration membranes to see which would most successfully remove the polluting solutes while retaining the essential nutrients.

A team at Stellenbosch University, headed by Prof Eugene Cloete, has developed a 'tea bag' filter, which can be placed in the neck of a bottle to kill disease-causing microbes as water passes through the filter, making the water safe to drink. The inside of the tea bag is coated with a thin film of biocides encapsulated with nanofibres, so as the filter traps bacteria, they are killed by the biocide coating. This may provide a very cheap solution to purify water in remote areas. It could also potentially be used worldwide by relief organisations where clean water supplies are threatened by waterborne diseases such as cholera as a result of natural disasters such as earthquakes and floods. The potential global impact is huge.

Vestergaard-Frandsen

A Kenyan school learner tests the Vestergaard-Frandsen LifeStraw, an example of a personal water purification and filtration product which allows users to drink from otherwise disease-ridden water sources. Researchers at Stellenbosch University have designed a similar product, the 'tea bag filter' based on nanomaterials.

BENEFITS OF USING NANOTECHNOLOGY

Nanotechnology offers a number of benefits to the water sector, for instance, by enabling more effective removal of contaminants at lower concentrations due to increased specificity and 'smart filters' tailored for specified uses. Novel reactions at the nano scale due to increased numbers of surface atoms may also enable the removal of contaminants that were previously very difficult to treat. The number of treatment steps, the quantity of materials, as well as the cost and energy required to purify water could be radically reduced using nanotechnology – making it easier to implement in remote rural areas.

WHAT ARE THE RISKS?

There are concerns that the same properties (size, shape, reactivity etc) that make nanoparticles so useful could also make them harmful to the environment and toxic to humans, for example, if they enter and build up in drinking water supplies and the food chain. Risk assessment research is crucial for establishing the potential impact of nanoparticles upon human health and the environment: the technology's benefits must be balanced against any unintended consequences.

The government, through DST, is funding a research platform to investigate the environmental, safety and health impacts of nanotechnology. This will include an inventory of nanoparticles in production or use in South Africa, as well as focused research and development of the required infrastructure and human capital. An ethics committee is also being established by government, made up of diverse stakeholder representatives to ensure that the technology adheres to ethical principles. It is important that nantechnology be developed in a safe, responsible, acceptable and sustainable manner.

THE FUTURE OF NANOTECHNOLOGY

Although substantial initial investment would be required to incorporate or switch to nano-technology-based water treatment methods, once adopted, maintenance costs would be considerably lower over the long term and a higher-quality water product would be provided, particularly to rural communities. It is vital that the water sector should become familiar with this technology as it is set to change how water is cleaned, and clearly stands to offer significant advantages for a country such as South Africa.

"South Africa is heading for an era of great nanotechnology discoveries," predicts Mthuthuzeli Zamxaka, programme coordinator of the Nanotechnology Public Engagement Programme (NPEP). "We have the opportunity to use nanotechnology to supply specific solutions to African problems."

The NPEP is an initiative funded by the DST and implemented by the South African Agency for Science and Technology Advancement (SAASTA), a business unit of the National Research Foundation. Launched in 2008, the NPEP aims to promote credible, fact-based understanding of nanotechnology through awareness, dialogue and education to enable informed decision making on nanotechnology innovations to improve the quality of life.

Written by Mthuthuzeli Zamxaka (Mthuthuzeli@saasta.ac.za) and Joanne Riley (joanne@saasta.ac.za) for the SAASTA Nanotechnology Public Engagement Programme (NPEP).

WATER Kidz

Special day explores link between WETLANDS AND FORESTS

World Wetlands Day is celebrated on 2 February every year. This year, the theme for international celebrations is 'Forests for Water and Wetlands'.

This theme is particularly appropriate since the United Nations has declared 2011 the International Year of Forests. For the wetland community it offers an ideal opportunity to focus on a very particular type of forest – those that are often or always wet. These wetland forests include mangroves, flooded forests, and peat-swamp forests, to name a few.

According to the Ramsar Convention (an international body of member countries focused on protecting wetlands of international importance), a wetland forest or swamp forest can be defined as any wetland with woody vegetation. A total of 825 out of 1 891 Ramsar sites have at least some forested wetlands within their boundaries.

Swamp forests can range in size from one to two metres to as much as 50 m tall. Inland swamp forests protect catchments while coastal swamp forests protect coasts against storms and rising sea levels in some cases. All swamp forests provide fish and many other aquatic foods, both animal and plant, consumed by humans the world over; they provide diverse habitats for an impressive range of animal and plant species, thus contributing significantly to global biodiversity; and importantly, they provide livelihoods for local communities.

For more information on World Wetlands Day 2011 Visit: www.ramsar.org. Apart from valuable information, the site contains various promotional material for download (free of charge), including posters, brochures, and cartoons.

Forested wetlands offer refuge to numerous animal and bird species.

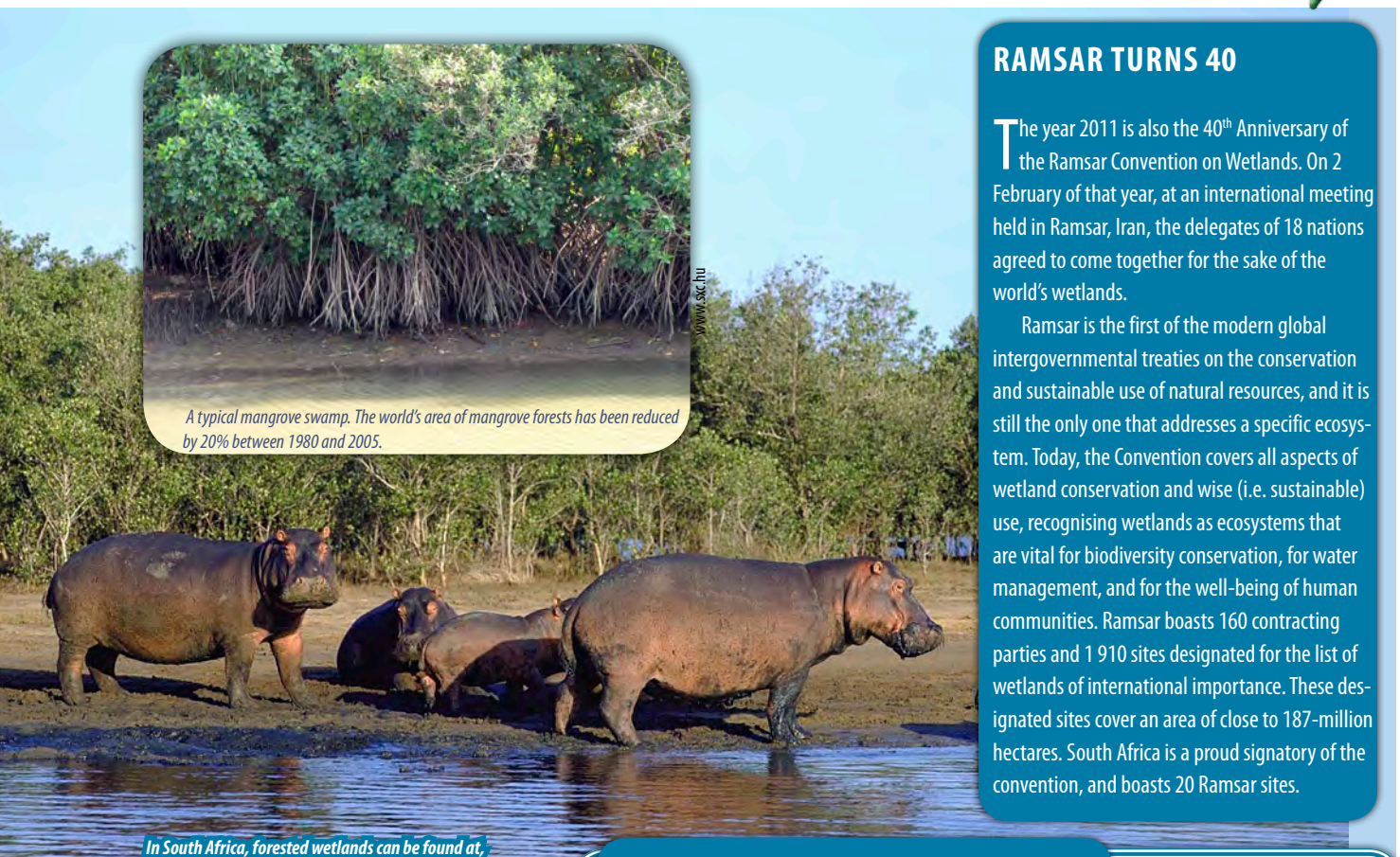
WWW.SXC.HU

FORESTED WETLANDS IN DIFFERENT SHAPES AND FORMS

Internationally, three types of forested wetlands are generally recognised:

- Intertidal forested wetlands (e.g. mangrove swamps)
- Freshwater, tree-dominated wetlands (e.g. freshwater swamp forests and wooded swamps); and
- Forested peatlands

Source: Ramsar



A typical mangrove swamp. The world's area of mangrove forests has been reduced by 20% between 1980 and 2005.

www.sxc.hu

In South Africa, forested wetlands can be found at, among others, iSimangaliso Wetland Park, on the KwaZulu-Natal coast.

SA Tourism

RAMSAR TURNS 40

The year 2011 is also the 40th Anniversary of the Ramsar Convention on Wetlands. On 2 February of that year, at an international meeting held in Ramsar, Iran, the delegates of 18 nations agreed to come together for the sake of the world's wetlands.

Ramsar is the first of the modern global intergovernmental treaties on the conservation and sustainable use of natural resources, and it is still the only one that addresses a specific ecosystem. Today, the Convention covers all aspects of wetland conservation and wise (i.e. sustainable) use, recognising wetlands as ecosystems that are vital for biodiversity conservation, for water management, and for the well-being of human communities. Ramsar boasts 160 contracting parties and 1 910 sites designated for the list of wetlands of international importance. These designated sites cover an area of close to 187-million hectares. South Africa is a proud signatory of the convention, and boasts 20 Ramsar sites.

Unfortunately, just like other wetland types, swamp forests are threatened by a variety of factors. The need for land for urban development, conversion for agriculture and aquaculture, oil extraction, and excessive abstraction of water upstream are some of the threats facing these special wetland types.

Swamp forests are pretty rare in South Africa. Most of the country's remaining swamp forest (more than 60%) lie in the iSimangaliso Wetland Park, a World Heritage and Ramsar Site. Incidentally, the name means 'miracle and wonder' – an apt description for this unique place on the eastern coast of southern Africa.

Unfortunately, South Africa's swamp forests are highly threatened as more areas are cleared for cultivation and the planting of commercial and community woodlots (for more information, see *the Water Wheel*, July/August 2010).

Forested wetlands, just like other wetland types, need to be appreciated and conserved. ❑

EXAMPLES OF FORESTED WETLANDS AROUND THE WORLD

- **North-Livonian Transboundary Wetland Complex, northern Europe:** These forested and non-forested peatlands cover an area of close to 18 000 ha. These wetlands play an important role in maintaining water quality in the area and in water storage. They are also home to a diverse range of plant and animal species, most notably wolf, brown bear, and elk.
- **Rio Del Rey, Cameroon**: This Ramsar site not only covers half the country's mangrove area it is also home to a number of endemic and threatened species, including the Goliath frog, which weighs in at 3 kg, while providing spawning ground for fishes.
- **Berbak, Sumatra:** This Ramsar site is the largest peatswamp forest in Sumatra. Known for its flagship species of Sumatran tiger (below) and Malay tapir (a large, pig-like mammal), Berbak also plays a significant role in carbon storage and regulation of water flows.

Source: Ramsar

Excellence in Water Research Awards

The CSIR International Conference Centre in Pretoria played host to the Excellence in Water Research Awards 2010. This year the young researcher awards went to Traci Reddy for her work on eutectic freeze crystallisation and Dr TG Barnard for his work on molecular biology techniques on water quality testing. The two young researchers got to present their work alongside experienced water professional, Dr Rivka Kfir, CEO of the Water Research Commission, who presented the memorial lecture.

WISA President Dr Kevin Pietersen hands over the award to Dr Rivka Kfir of the WRC.

Leanie and Arno de Klerk of CSIR National Resources and the Environment.

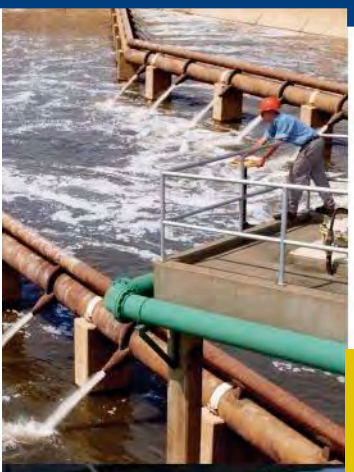
All photographs Lani van Vuuren

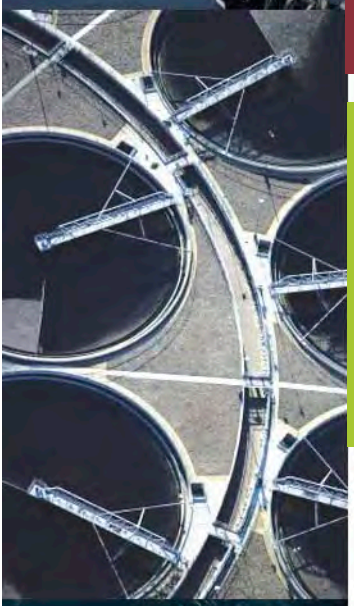
Harshad Bhikha from Sasol with award winner Traci Reddy of the University of Cape Town.

Young award winner Dr TG Barnard of the University of Johannesburg delivers his presentation.

Excellence awards winners Dr Rivka Kfir, Dr TG Barnard and Traci Reddy.

Mihloti Taka; Zinzi Mboweni, and Simphiwe Chabalala from the Department of Water Affairs also attended the event.






Short Courses from the Department Of Chemical Engineering,

Water Utilisation Division,
University of Pretoria

Short Course on Environmental Management (P001828)
14 - 17 March 2011

The course covers aspects of environmental engineering and management. It comprises of a knowledge review, discussion forum and case studies.

Course fee: R8 580.00 per person.

Short Course in Industrial Waste Management (P001396)
9 - 11 May 2011

Through this course delegates will be able to evaluate technical and legal aspects of waste handling and disposal, as well as make informed decisions about waste handling and disposal.

Course fee: R4 070.00 per person.

Short Course on Operation of Water and Wastewater Treatment Plants (P001013)
20 - 24 June 2011

The course provides useful hints on the solutions of the most commonly encountered problems at existing water and wastewater treatment plants in South Africa.

Course fee: R9 250.00 per person.

Entry requirements: In order to enrol for these courses delegates need undergraduate education in sciences and engineering as well as professional experience in the water sector.

Registration and administrative enquiries:

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Water Research Commission

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- 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:

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- Water and Economy
- Water and the Environment
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WATER RESEARCH COMMISSION