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THE WATER TREATMENT PLANT SPECIALISTS

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

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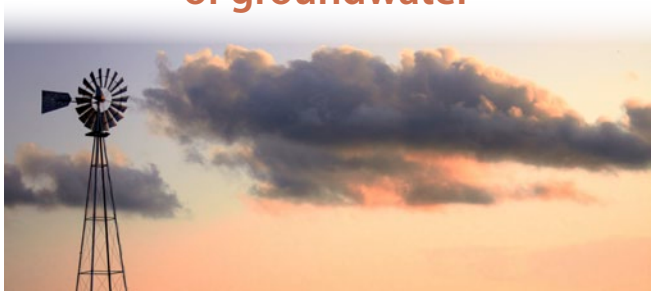
***Cover**: The government's latest water resource planning strategy report has reaffirmed how precarious South Africa's water situation is. See page 14. Cover design based on a photograph by Guy Stubbs.*

Conference to look at future role of groundwater



The call for papers is open for the next Biennial Conference of the Groundwater Division of the Geological Society of South Africa.

The conference, which is being organised in association with the International Association of Hydrogeologists, will be held in Pretoria from 19 to 21 September with the theme 'Groundwater: Our Source of Security in an Uncertain Future."

Financial, economic and environmental changes and uncertainty require innovative approaches to hydrogeological science and groundwater management. Delivery of services and environmental sustainability in the years to come will make ever-greater demands on groundwater. This challenges hydrogeologists and fellow professionals to find new ways to progress, often with limited resources.

Papers have been invited on the following topics: climate change and drought, dealing with uncertainty, water quality, merging science and policy, mapping and data, water and energy, and from pollution to remediation and protection, among others. The closing date for abstracts is 30 November. For more information, Email: confplan@iafrica.com or Visit: www.gwd.org.za

Environmental department lays down the law

The Department of Environmental Affairs has embarked on a six-month campaign to inspect compliance to environmental legislation.

The Environmental Management Inspectorate, commonly referred to as the Green Scorpions, is carrying out the compliance assessments across the country. It is expected that up to 40 environmental authorisations and 20 waste licenses will be inspected during the campaign.

According to the department, the main objectives of the campaign are to monitor adherence to conditions stipulated in environmental management plans and waste licenses as well as to improve the general status of compliance within the regulated community through taking proper enforcement actions in the event of non-compliance.

Will urine become a commercial fertiliser?

The Bill and Melinda Gates Foundation has provided a grant of US$3-million to support a joint project by the Swiss Federal Institute of Aquatic Science & Technology (Eawag) and the eThekwini Water and Sanitation Utility in South Africa to develop technical solutions for urine processing for nutrient recovery.

The separate collection of urine provides innovative opportunities for the improvement of sanitation and the recycling of nitrogen, phosphorus and potassium. The project, to be undertaken over the next four years, will study the logistics of collection and transport of urine from toilets to processing facilities. Scientists will also examine ways in which sanitation can be paid for by the production and sale of urine-based fertiliser, thus enabling a cheap, efficient and widely-accepted sanitation system to be set up.

There is a growing awareness that in many parts of the world an alternative is needed for the conventional sewer-based sanitation and central wastewater treatment system. At the same time, the global demand for fertiliser is so great that interest in local sources of nutrients is growing.

Eawag has many years of experience in the research of urine separation, and has done successful preparatory work in Nepal, which demonstrated that urine processed to make the phosphorus-based fertiliser struvite can help to close regional nutrient cycles and promote awareness of the value of the nutrients contained in urine. "This experience plus the collaboration with an extremely progressive administrative department in Durban were important reasons for developing our project in South Africa," says Kai Udert, the Eawag researcher in charge of the South African project.

Water diary

SMALL WASTEWATER TREATMENT SYSTEMS
NOVEMBER 23-24
The Second WISA Small Wastewater Treatment Conference will be held at the Regent Hotel, in East London. *Email: conference@wisa.org.za or valerian@wrc.org.za*

MINE CLOSURE
NOVEMBER 23-26
The Fifth International Conference on Mine Closure will be held in Santiago, Chile with the theme 'Responsible Closure: Living up to Communities' and Stakeholders' Expectations'. *Email: mc@mineclosure2010.com or Visit: www.mineclosure2010.com*

HYDROLOGY
DECEMBER 6-10
The School of Bioresources Engineering and Environmental Hydrology at the University of KwaZulu-Natal is hosting a course on Advanced Modelling of Water Flow and Solute Transport in the Vadose Zone: *HYDRUS at Skukuza. Enquiries: Beeh@ukzn.ac.za*

DESALINATION
FEBRUARY 9-11
The Australian Water Association 4th Membranes and Desalination Specialty Conference will take place at Crown Plaza, Surfers Paradise. *Enquiries: www.awa.asn.au*

INDUSTRIAL WATER USE
FEBRUARY 15-17
The Water in the Southern African Minerals Industry Conference will be held at the Ingwenyama Conference & Sport Resort, White River. The event is hosted by the Southern African Institute for Mining and Metallurgy (SAIMM) and will seek to explore and define water and mining-related challenges within the southern African region, propose solutions and possible funding methodologies. *Enquiries: Raymond van der Berg (Conference Coordinator); Tel: (011) 834-1273; Fax: (011) 833-8156; Email: Raymond@saimm.co.za; Visit: www.saimm.co.za*

R&D spend up, but SA still off target

Despite spending R2,4-billion more on research and development (R&D) last year, South Africa is still failing to meet the government target of spending 1% of GDP on R&D.

Presenting her department's National Survey of Research and Experimental Development report for 2008/09, Minister of Science & Technology Naledi Pandor revealed that the country's R&D spend dropped slightly to 0,92% of GDP. This was despite R&D expenditure having increased 2,2% in real terms between 2007 and 2008, from R18,6-billion to R21-billion.

According to Pandor, a key concern is that the country's number of researchers is decreasing. She said the findings of the survey indicated that the country needed to focus specifically on boosting the skills level and increasing the number of post-graduate students – which she pointed out currently stood at only 34% of all graduates.

Part of the country's challenge was that research funding was dispersed according to sectors, which meant there was not a central point of administrative control, leaving research areas largely dependent on the focus of a particular department.

The private sector accounted for 58% of spending on research with 24,4% of research spending being in the field of engineering sciences. The remainder of research spending is concentrated in natural sciences (20,6%), medical and health sciences (14,6%), information and communication technologies (13,1%), social sciences and humanities (12,5%) and applied sciences and technology (9,1%). Agricultural sciences only made up 5,5% of total R&D spend.

On a positive note, a survey by the Human Sciences Research Council did reveal that South Africa has one of the highest proportions of women researchers in the world. The survey indicated that women represent nearly 40% of researchers in South Africa, compared to 13% in countries such as Japan and 33% in Norway.

UKZN student grabs award

Masters Chemical Engineering student, Joseph Bwapwa, has received the Chemical Technology Specialisation Award in the Water Category for his paper dealing with wastewater research.

The award was handed over to the student from the University of KwaZulu-Natal at a special ceremony organised by Crown Publications and the South African Institution of Chemical Engineers earlier this year. Supervised by Dr Katherine Foxon and Prof Chris Buckley, Bwapwa is a key role-player in the Pollution Research Group's sanitation project being conducted in Durban in collaboration with eThekwini Water and Sanitation, the Water Research Commission, and the Bremen Overseas Research and Development Association (Borda).

Bwapwa's work focused on the treatment of complex wastewater generated in low-income communities using an ABR or anaerobic baffled reactor (a containerised sewage treatment system). The research team discovered that the ABR removed 80% of the pollutants and solid matter from the treated wastewater and the effluent generated was within the irrigation limits specified by the Department of Water Affairs.

It is reported that the results of the study will go a long way towards assisting the municipality in solving the issue of sewage treatment in informal settlements, as well as helping to contain waterborne diseases.

Source: UKZN

Polluters must pay, says Minister

South Africans responsible for contaminating the land must pay. So says former Minister of Water & Environmental Affairs Buyelwa Sonjica.

"We have taken the view that the cost of reducing pollution must be shared between people who are responsible for waste, the polluters. We are now saying the policy of the polluter pays will be strictly pursued without fear," the minister said. She was speaking at a waste management conference held earlier this year.

Sonjica also announced that her department had concluded the Framework for the Remediation of contaminated land. "The coming into effect of the contaminated land section of the Act is imminent. I will soon be able to identify contaminated land and order investigations to determine the extent of contamination as well as the form of remediation required."

There will be a database or register of all contaminated land which will be linked to the Deeds Register to ensure that transfers take into account information relating to the contamination of land parcels.

International water body honours Stellenbosch dean

Stellenbosch University Dean of Science, Prof Eugene Cloete, has become the first representative from Africa to be included in the new Fellows Programme of the International Water Association (IWA).

Prof Cloete, a microbiologist and inventor of the teabag water filter, is one of 34 newly elected fellows. They include researchers, water resource managers, inventors and academics from countries such as Japan, the USA, Mexico, Germany, Spain and the Netherlands.

According to the IWA, election to IWA Fellow grade one is 'one of the highest honours the association can bestow on an individual'. It recognises unusual and outstanding distinction in the profession and is conferred by the IWA Board of Directors on a person with an extraordinary record of accomplishments that has contributed importantly to the advancement of application of water science and technology and that has brought the realisation of significant value to society.

Among others, Prof Cloete currently serves on the IWA Biofilm Specialist Group, and is a past Vice-President and Board Member of the association. He is a member of the Coca-Cola World Water expert panel and is Chair of the South African Academy of Science committee on poverty and technology.

He has been dean of the Faculty of Science at Stellenbosch University since 2009, and is the driving force behind the recently established Water Institute there. He was also the founding director of a similar Water Institute at the University of Pretoria. Prof Cloete has promoted 78 MSc students and 25 PhD students at the two universities.

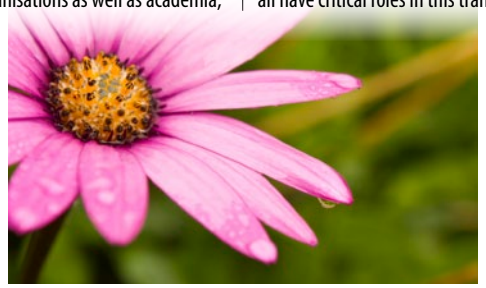
Biodiversity: Society's behaviour must change, conservationists warn

An innovative grouping of scientists and practitioners have come together to advocate a fundamental shift in the way we view biodiversity.

In their paper, which has been published in the journal *Science*, they argue that unless people recognise the link between their consumption choices and biodiversity loss, the diversity of life on Earth will continue to decline. Dr Mike Rands, Director of the Cambridge Conservation Initiative and lead author of the paper, says: "Despite increasing worldwide conservation efforts, biodiversity continues to decline. If we are to make any kind of impact, it is critical that we begin to view biodiversity as a global public good which provides such benefits as clear air and fresh water, and that this view is integrated not just into policies but also into society and individuals' day-to-day decisions."

The conservationists, from conservation organisations as well as academia, recognise that biodiversity loss is typically the result of unintended human actions and therefore raises unique difficulties. They state, "The impacts of a particular action are often distant in space and time. This makes effective regulation difficult, as no single body has jurisdiction over the world's biodiversity."

As part of the solution, the authors advocate managing biodiversity as a global public good. They argue that an appreciation of biodiversity as a global public good with economic and societal value, providing benefits that far outweigh the cost of conserving ecosystems, should be central to all policy-making that impacts on the environment."The value of biodiversity must be made an integral element of social, economic, and political decision-making, as is starting to happen with carbon and climate change. Government, businesses and civil society all have critical roles in this transition."



San benefit from bio-prospecting license

Former Water and Environmental Affairs Minister Buyelwa Sonjica has presided over the ceremonial handover of the first bio-prospecting license to HGH Pharmaceuticals in Khwa Ttu, in the Western Cape.

The license grants the pharmaceutical company local and international research rights on cultivated plant material and extracts from *Sceletium tortuosum* (known locally as Kanna, Channa or Kougoed) and to commercialise the product for central nervous system conditions. The San peoples are acknowledged as the primary indigenous knowledge holders of certain medicinal and other uses of *Sceletium*. As such the South African San Council, Paulshoek and Nourivier communities are the beneficiaries of the commercialisation of any potential products.

Sceletium has been used by nomadic pastoralists and hunter-gatherer communities as a mood altering substance for thousands of years. According to the National Environmental Management Biodiversity Act, no person may trade commercially in any indigenous biological resource from South Africa without a permit ensuring sustainable harvesting issued by the Minister.

South Africa's first protected environment declared

The first protected environment in South Africa has been declared.

This follows after MEC for Economic Development, Environment and Tourism for Mpumalanga, Jabu Mahlangu, signed the final document officially announcing that 23 000 ha of privately-owned farmland extending from Wakkerstroom to Luneberg in the high altitude grasslands of southern Mpumalanga is a protected environment. A protected environment is effectively one step below a national or provincial nature reserve, enjoying a high level of formal protection with major conservation gains.

Called the KwaMandlangampisi Protected Environment it is a critical water catchment area for South Africa that includes the headwaters of the Pongola River and the Assegaai River, which feeds the Heyshope Dam and provides clean water for national power generation. Ranging from 1 400 m to 2 000 m above sea level, it spans threatened high altitude grasslands, wetlands and indigenous mistbelt forest, and is home to threatened and endemic plant, bird and animal species, including the Oribi and South Africa's three crane species (Wattled, Grey Crowned and Blue).

"This is the most important thing that has ever happened to conservation in this country," says fifth generation Luneburg farmer, Horst Filter whose livestock farm lies within the Protected Environment. "The attention was always on game reserves and the Big Five and never on critical areas like the grasslands. I think it's very important that this whole initiative filters through to the rest of South Africa."

The World Wide Fund for Nature (WWF) and Nedbank's Green Trust has been a driving force behind the protection of this region and beyond. Recognising the critical water production role of the high-altitude grasslands between KwaZulu Natal, Mpumalanga and the Free State (which provide water to the whole of Gauteng, as well as to several of South Africa's major power stations) eight years ago, WWF/ The Green Trust agreed to fund a project spanning 1,6-million ha in this region, called the Enkangala Grassland Project.

The KwaMandlangampisi Protected Environment is situated within the Enkangala Grassland Project area.

Source: WWF

African freshwater species in perilous state

A fifth of freshwater species in Africa are threatened with extinction, putting the livelihoods of millions of people at risk, a new study has found.

In the most comprehensive assessment of its kind, more than 5 000 African freshwater species were evaluated by 200 scientists over a five-year period for the IUCN Red List of Threatened Species, including all known freshwater fish, molluscs, crabs, dragonflies and damselflies, and selected families of aquatic plants. Some of the biggest threats to African freshwater species come from agriculture, water abstraction, dams and invasive alien species.

This study highlights the perilous state of our natural environment and will provide vital information for decision-makers as they plan to greatly expand the use of Africa's inland water resources, the authors say. The results

are particularly important for resource managers as, for the first time, species have been mapped to individual river basins.

"Freshwaters provide a home for a disproportionate level of the world's biodiversity. Although they cover just one percent of the planet's surface, freshwater ecosystems are actually home to around 7% of all species," says Jean Christophe Vié, Deputy Head of IUCN's Species Programme. "This latest IUCN Red List assessment clearly shows that lakes, rivers and wetlands haven't escaped the grasp of the current extinction crisis."

Even the loss of a single species can have a dramatic impact on livelihoods. In Lake Malawi, a group of fish, known as 'chambo' by locals, forms an extremely important source of food. Of these, *Oreochromis karongae*, an endangered species, has been hugely overfished, with an estimated 70% reduction in the population over the past ten years.

In Lake Victoria, a decline in water quality and the introduction of the Nile Perch (*Lates niloticus*) have caused a reduction in many native species over the past 30 years, threatening traditional fisheries. This IUCN Red List assessment studied 191 fish species in Lake Victoria and found that 45% are threatened or thought to be extinct.

Around the great lakes of Africa, fish provide the main source of protein and livelihoods for many of the continent's poorest people. The livelihoods of an estimated 7,5 million people in sub-Saharan Africa depend on inland fisheries. These new data will be invaluable in helping to safeguard these fisheries, freshwater supplies and the many other associated resources.

"Africa is home to an astonishing diverse range of freshwater species, many of which are found nowhere else on Earth" notes William Darwall, leader of the project and Manager of IUCN's Freshwater Biodiversity Unit. "If we don't stem the loss of these species, not only will the richness of Africa's biodiversity be reduced forever, but millions of people will lose a key source of income, food and materials."

Priority areas of highly threatened and restricted range species can now be identified. For example, in the waters of the crater-lake Barombi Mbo, in Cameroon, 11 species of fish are highly threatened and live a precarious existence as deforestation increases the risk of lake 'burping', where large levels of carbon dioxide are released from deep within the lake, suffocating the fish. Without management intervention these species, some of which are important food sources, may be lost forever.

Other freshwater species, such as molluscs, dragonflies, crabs and aquatic plants also play vital roles in maintaining functioning wetlands and these should not be ignored. In the rapids of the lower reaches of the Congo River, 11 species of mollusc, found only within a 100 km stretch of water, are highly threatened due to upstream pollution.

The findings of this assessment are also being published in a series of regional reports.

Source: IUCN

Call for Registration: WDM Specialists

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

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

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

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

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

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

Photos courtesy WRP

WDM
WATER DEMAND MANAGEMENT

DBSA Sida SADC

Study explores vulnerability of southern Cape coast

Some 44% of the Eden District Municipality coastal zones are at risk of sea level-induced coastal erosion and inundation, 69% are at risk of groundwater contamination from salt water intrusion and 44% are at risk of large storm surges.

These are the findings of a study prepared for the Western Cape Provincial Government Department of Environmental Affairs and Development Planning. The study was undertaken by earth sciences consultancy Umvoto Africa, who uncovered a number of high risk coastal zones in the Eden municipal area.

Regions most at risk of sea-induced coastal erosions include Mossel Bay and the Wilderness to Knysna area, with the highest risk ranking including Wilderness West, Sedgefield-Swartvlei and Knysna. The majority of the Eden District Municipality is comprised of hydraulically conductive and therefore vulnerable primary and fractured quartzitic aquifers, which are accessed along the coastline for water supply. In light of this, coastal areas with the highest ranking for groundwater contamination from salt water intrusion include Wilderness West, Sedgefield-Swartvlei, Knysna and Pletternberg Bay.

According to Umvoto, areas that reflect low gradient headland-adjacent or inlet/pocket bay beaches in association with high population and extensive development close to the shoreline are most at risk from extreme events such as storm surges and tsnunamis. These areas include Stilbaai, Mossel Bay and the Plettenberg Bay to Nature's Valley area.

Recommendations for each coastal hazard have already been developed. This includes a collective response from both municipalities and local residents so that long-term institutional, accommodation, retreat and soft protective measures are undertaken to manage long-term coastal evolution.

Special award for Sedgefield project

The submission 'Life beyond our rivers – a Sedgefield case study' has received a Special Recognition Award in the Technical Excellence category for SSI Engineers & Environmental Consultants, at the recent South African Institution of Civil Engineers' National Awards for Engineering Excellence.

SSI developed a demand-based solution to solve the water supply crisis in the small southern Cape town, which has been gripped in one of the worst droughts in the area in living memory. The town falls in the Knysna municipal area. The consultant succeeded in developing something that was both economical and took weeks rather than years to implement.

Sedgefield, which is home to 6 000 permanent residents (a figure which doubles during peak holidays) ran out of water when its main source of supply, the Karatara River, ran dry. Water had to be trucked in and the Knysna municipality consequently adopted SSI's approach to supplement surface supply from alternative sources.

The surface water supply from the Karatara/Hoogekraal rivers was thereafter curtailed to 1,5 Mℓ/day; while a new 0,5 Mℓ/day groundwater supply was developed. A further 1,5 Mℓ/day is provided by a small mobile desalination plant located at Mayoli beach.

To meet the long-term demand of 4,5 Mℓ/day it is proposed to supplement the surface, ground and desalination water with the re-use of final effluent from the wastewater treatment works. The additional 1 Mℓ/day is expected to provide for Sedgefield's potable water needs to 2034.

Such has been the impact of the Sedgefield scheme that SSI has provided similar solutions all along the Garden Route, including Mossel Bay, George, Knysna, and Plettenberg Bay with combinations of effluent reuse and/or desalination technologies.

Water resources study enters final year

A three-year study into availability of water resources in South Africa's northern towns has passed the halfway mark.

The Northern Regions Reconciliation Study was initiated by the Department of Water Affairs (DWA) in 2008. The study area comprises the water management areas of Limpopo, Luvuvhu and Letaba, Crocodile (West) and Marico, and Olifants.

The main objective of the study is to provide first order water supply reconciliation strategies to ensure the availability of water resources now and into the future for all towns in the Northern Planning Region. Towns must be studied in a prioritised order based on availability of water and reconciliation strategies completed in that sequence.

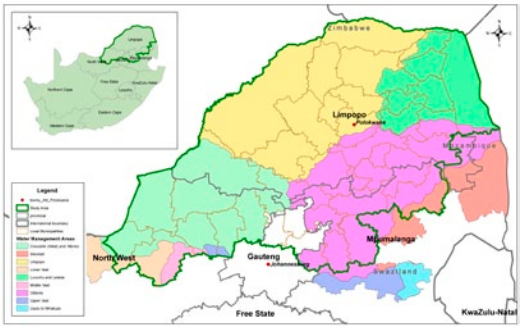
Consulting engineering firm SRK Consultants was appointed to undertake the study for DWA. According to Sarah Skinner, SRK principal scientist, most of the regions under review are water stressed. "Many dams are struggling to provide sufficient water to satisfy domestic requirements as well as water for economic growth and development. The potential for using groundwater to augment water supply is therefore of paramount importance in consideration of any water resource management strategy."

Information regarding the surface water resource used for each of the clusters, as well as the related yields of the resource were collected from previous study reports, explains Skinner. The algorithms for the water situation assessment model were applied where detailed analysis was not carried out. "Appropriate adjustments were made to account for upstream land-use activities such as small dams, abstractions and return flows," explains Skinner.

The groundwater component included a review of groundwater resources on the basis of the geographic location, potential aquifer boundaries, exploration potential of the regional aquifers, current groundwater usage for domestic and irrigation purposes and, taking cognisance of possible sources of contamination, the probable water quality.

"The study is in its second year, and a number of challenges have had to be overcome to generically identify the groundwater sources of supply in the study area while still providing sufficient information for the development of a conclusive strategy," notes Skinner. "These challenges have included the sheer extent of the study area (some 2 000 towns), disparity in data sources and contradictory information in the available data sources.

At the time of writing feasibility studies were in progress for about 80% of the area and completed for about 40% of the area.



Pollutants don't discriminate between rich and poor

Homes in low-income and affluent communities have similar levels of endocrine disrupting compounds (EDCs), according to US research. Levels of EDCs were also found to be higher in the home than outside it.

The researchers, from the Silent Spring Institute, Massachusetts, took samples of air and house dust in homes from two different communities in the San Francisco Bay area. These samples were then tested for 104 different substances, including 70 suspected EDCs. The sampling included 40 homes in an urban, industrial, low-income area and ten homes in an affluent, coastal community.

Levels were generally higher indoors than outdoors. The scientists expressed surprise at finding higher concentrations of some phthalates outdoors near urban homes contributing to higher indoor levels as well, but concluded that EDCs 'are ubiquitously common across socio-economic groups."

The study appears in the American Chemical Society journal, *Environmental Science & Technology*. To read the article Visit: http://pubs.acs.org/stoken/press-pac/full/10.1021/es100159c

Aussie farmers oppose Murry-Darling plan

A government plan to reduce irrigation diversions in the Murray-Darling Basin apparently has farmers in Australia up in arms.

Water news site, www.circleof-blue.org, reports that the draft plan, which proposes a reduction of water entitlements in the region by up to 29% to protect the river's environmental function, has been vehemently opposed by residents of the basin, with some staging public protests. The guide is reportedly the first step in a process of adopting new water use regulations in Australia's largest river system.

At the centre of the controversy are the sustainable diversion limits – the amount of water that can be removed from rivers for consumptive use. Current basin-wide diversion of 13 700 gigalitres do not leave enough water in the river system for it to function properly. The proposed cuts will affect areas that grow wheat, rice, and cotton. Agricultural areas without diversified economies will also feel the pinch.

Study on dust storms to help scientists see climate clearer

The University of Leeds, in the UK, is leading a £1-million project to study the giant desert storms of the Sahara which will help improve climate and weather prediction models.

Extreme sandstorms like the fast-moving 'walls of dust' seen in Hollywood film the Mummy may look spectacular, but their effects on weather systems and climate change are even more dramatic. These storms, known as 'haboobs', sweep large quantities of mineral dust off the sands of the Sahara into the atmosphere, where it exerts a wide range of effects on the environment.

According to project leader Dr Peter Knippertz, dust is a really important player in the climate system, for example, dust from the Sahara provides most of the nutrients needed to fertilise the Amazon rainforest. "But the harsh desert environment of the Sahara means very few measurements have ever been made there."

Dust is one of the main sources of iron to the oceans where it is important in the formation of CO_2-guzzling phytoplankton. In the atmosphere, dust particles affect how much energy from the sun enters and leaves the planet, which has a longer-term impact on climate, and dust also deteriorates overall air quality and therefore has direct implications for human health.

"We do not know for sure how much of the dust within these storms ends up in the atmosphere and how much returns to earth once the winds have died down," explained Dr Knippertz. "This project will help us answer this question and to produce a comprehensive representation of the global dust cycle with the view to developing more accurate models."

Ultimately the project team hopes that the study will help eliminate some of the uncertainties in predicting climate, weather and the impacts on human health.

Governments must ramp up action to ward off looming water crisis – UN report

With competition on the rise between humans and other species for the world's limited water supplies, governments must take environmental issues into consideration when drafting laws on the use of water to avert an impending water crisis, cautions a new United Nations report.

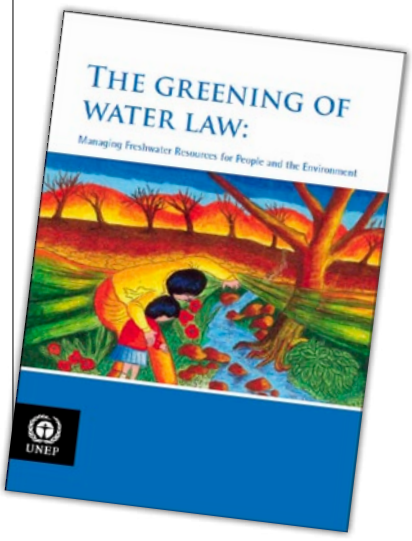
Although more than two-thirds of the planet is covered in water, only 2,5% is freshwater, most of which is stored deep underground or in glaciers, leaving only 1% available for human use. A key challenge facing countries is how to meet the water needs of a growing human population, while maintaining freshwater ecosystems and supporting environmental sustainability, says *Greening Water Law,* the new publication launched by the United Nations Environment Programme (UNEP).

If the international community does not take action to improve freshwater supplies for drinking, sanitation and hygiene, up to 135 million preventable deaths could occur in the coming decades, the report warns. The unsustainable use of freshwater also drives biodiversity loss, it says, citing the example of North America, where nearly 30% of continental freshwater fauna populations are threatened with extinction due to depleted and contaminated water resources.

"Achieving a better balance between human and environmental water needs will require significant changes in legislation – and you need legal tools to do this," reports Gabriel Eckstein, the report's lead author. In Australia's New South Wales, for example, the Water Management Act dictates that in the event of a severe water shortage, freshwater will first be allocated to meet basic domestic and municipal needs, then in response to environmental necessities and then finally for all other purposes.

The Water Resources Act in Paraguay ranks the water needs of aquatic ecosystems as second to humans but ahead of agriculture, power generation and industry. "These laws recognise the immense value of freshwater resources," notes Eckstein.

The UNEP study also points to the economic gains that can be derived from having freshwater resources protected by national law. The world's wetlands, for example, are estimated to provide as much as US$15-trillion in ecosystem services through their natural ability to purify and detoxify water.



New from the WRC

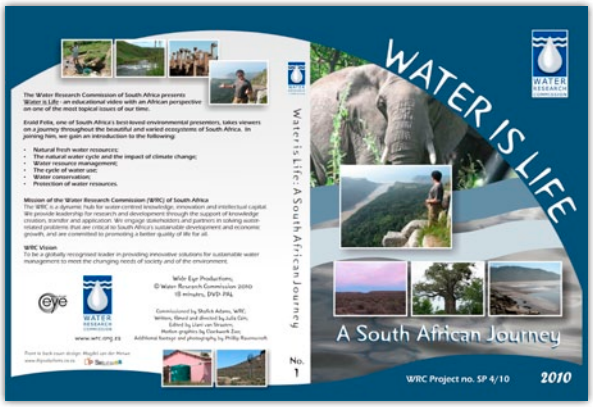
New DVD explores SA's water journey

The WRC has released a new DVD on South African water-related issues for schools and university students in the sciences.

The DVD, *Water is Life: A South African Journey*, is aimed at encouraging young people to consider future career options in the water sector. Presented by one of the country's best-loved environmental presenters, Erald Felix, the DVD 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.

Several subjects are covered in a visual, non-technical way, including freshwater resources, natural water cycle and climate change, water resource management and water ecosystems, cycle of water use, water conservation and protection of water resources. The DVD is also accompanied by an explanatory booklet providing additional background to the subjects covered on screen.

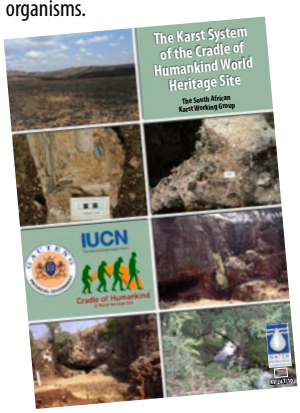
The DVD is available free of charge from the WRC in Pretoria.



Report No: KV 241/10

The Karst System of the Cradle of Humankind World Heritage Site (The South African Karst Working Group)

This document provides a summary of the current circumstances surrounding the Cradle of Humankind World Heritage Site and the underlying karst system. The Cradle of Humankind site is renowned for its unparalleled collection of prehistoric hominid and animal fossils, as well as a multitude of prehistoric tools. In addition to its palaeontological and archaeological significance, the site also lies on top of a vast karst system which is vital to the region's water supply and forms a unique ecosystem housing a variety of organisms.



Report No: 1701/1/10

Sustainability indicators in communal wetlands and their catchments (S Pollard; D du Toit; T Cousins; D Kotze; E Riddell; C Davis; S Addy; E Chuma and BB Mkhabela)

This work emerged from the growing acknowledgement of the importance of wetlands in the livelihoods of people, in particular of the rural poor in communal lands in South Africa. However, many of these wetlands, used as community-property resources, are degraded. The aim of this project was to develop and test a coherent and practicable set of indicators for an integrated approach to the sustainable use and management of communal wetlands and their catchments, with a strong focus on rehabilitation.

Report No: 1681/1/10

Modelling the Influence of Vegetation, Soil Moisture and Aerosols on Early Summer Southern African Climate (M Tadross; I Oliveira; M Mdoka; F Tummon; G Maure; N MacKellar; O Crespo; S Hachigonta; B Hewitson)

This project focused on the links between early season (September-January) rainfall and local antecedent conditions of vegetation, soil moisture and atmospheric aerosols. The majority of the project has focused on using Regional Climate Models (RCMs) to simulate the impact of changes in these antecedent conditions on rainfall. Several RCMs were used, with modelling requirements taking up the majority of the available time and work.

Report No: 1168/1/10

Groundwater/surface Water Relationships with Specific Reference to Maputaland (B Kelke & Talita Germishuyse)

This report attempts to describe the water resources and their interaction at the interface between groundwater and surface water in an attempt to overcome differences in conceptual models and to understand the process and methodologies that describe the interaction between components of these resources. The project has focused on the Maputaland Coastal Plain where there is an extremely strong interaction between the surface water features and local aquifers.

Report No: 1669/1/09

An Investigation of Innovative Approaches to Brine Handling (IW van der Merwe; A Lourens & C Waygood)

Salinisation of South Africa's public water system has been identified as the single most serious pollution threat facing the country. This situation is deteriorating and has been recognised in various recent pieces of legislation. For this reason, the WRC initiated a research project to assess the strategies to manage brine resulting from desalination processes. This report gives expression to this directive and assesses the current status of brine and sludge treatment as well as new, innovative technologies that represent the outcomes of South African technology drivers.

Report No: TT 450/10

Integrated Water Quality Management: A Mindset Change (L Boyd; R Tompkind; R Heath)

In developing countries in general – and in South Africa particularly – implementation of national legislation and enforcement of its provisions is an acknowledged area of weakness. The aims of this project were to develop a conceptual model for

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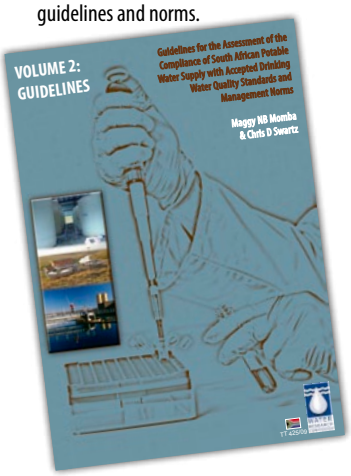
aligning the management of the quality of water resources with that of drinking water quality in order to support the effective management of water use in the interest of all water users.

Report No: TT 425/09

Guidelines for the Assessment of the Compliance of South African Potable Water Supply with Accepted Drinking Water Quality Standards and Norms (Volume 2) (MNB Momba & CH Swartz)

This report contains the guidelines and procedures that were developed for water services providers (WSPs) and water supply authorities (WSAs) to assist them with assessment with the compliance of their drinking water supply systems with accepted drinking water quality standards and management norms. These guidelines are aimed at providing South African potable water providers with the required water quality targets and a set of other operational and management norms, and a tool that could be used to identify the reasons for non-compliance and suggest solutions to any problems experienced which are preventing compliance to these guidelines and norms.



Report No: 1413/1/10

The Valuation of Estuary Services in South Africa Specifically Regarding Changes to Estuary Services as a Result of Reductions to Fresh Water Inflows – Main Report (SG Hosking)

The two main research objectives of this project set out to achieve were to generate information that would be useful in guiding the efficient allocation of river water to South African estuaries and to test selected hypotheses on factors that explained willingness to pay for river inflows into South African estuaries. In pursuing these objectives this project followed on and extended some of the findings from a similar WRC project published in 2004 (Report No: 1304/1/04).

Report No: 1249/1/10

Evaluation and Validation of Geochemical Prediction Techniques for Underground Coal Mines in the Witbank/Vryheid Regions (B Zhao; BH Usher; B Yibas & W Pulles)

This project has involved the extensive application and review of the use of geochemical assessment tools that are available for making predictions of future water quality impacts from mining sites. The tools that were evaluated in this research project represent the full range of tools available for assessment of this nature and specifically include those tools most commonly used.

Report No: 1212/1/10

A Model for Rapidly Assessing the Impact of Waste Discharge on Downstream Water Quality (CE Herold; K le Roux; J Blight; A Rowse and S Dladla)

Authorities require a rapid means of assessing the impact of waste load discharge permit applications and the required degree of change to permit conditions to meet water quality objectives. WQ2000 already provides such a tool for salinity. However, non-conservative pollutants are also of paramount importance to water quality managers. This research is aimed at improving a simple to apply evaluation tool capable of making good use of the new water quality data and of simulating the effects of both conservative and non-conservative pollutants, taking account of both point and diffuse inputs.

Report No: KV 235/10

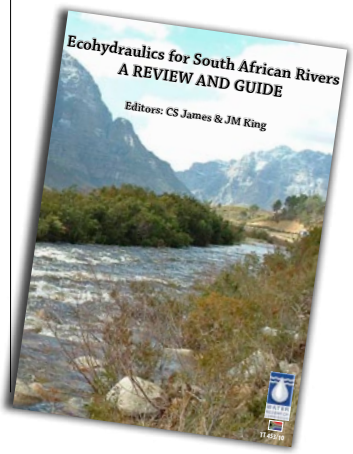
Systematics and Phylogeography of Suckermouth Species (Chiloglanis) with Emphasis on the Limpopo River System and Implications for Water Management Practices (MJ Matlala; IR Bills; CJ Kleynhans and P Bloomer)

The genus *Chiloglanis* includes 45 species of which eight are described from southern Africa. These so-called suckermouths are typically found in fast-flowing waters but over varied substrates and water depths. This project focused on three species, namely *Chiloglanis pretoriae, C. swierstrai* and *C. paratus,* all of which occur in the Limpopo River system. The suckermouth catfishes have been extensively used in aquatic surveys as indicators of impacts from anthropogenic activities and the health of river systems. Where these fish species occur naturally in the river systems, they are used in the determination of environmental flows and also as part of the fish assemblage assessment. The main aims of this project were to update records on the distribution of the three *Chiloglanis* species in the Limpopo and associated river systems; assessing within and between *Chiloglanis* species variation based on morphological and genetic analysis; and formulate management recommendations to water resource managers based on the results and analysis.

Report No: TT 453/10

Ecohydraulics for South African Rivers – A Review and Guide (CS James and JM King)

Ecohydraulics is defined as the study of the linkages between physical processes and ecological responses in rivers, estuaries and wetlands. Over the past 20 years in South Africa, a great deal of knowledge on ecohydraulics, related to both research and application, has been gained through several projects involving the WRC, the Department of Water Affairs and other institutions. This project was prompted by the realisation that existing information and knowledge are fragmented and often inconsistent across various centres and disciplines. The objective, therefore, was to provide a synthesis of existing knowledge on ecohydraulics in South Africa in a logical and accessible format.



Water by numbers

- **R125 000** – The cost to the City of Cape Town every year to purchase 20 888 bottles of water for council meetings, according to *the Times*. The municipality has now decided to replace the 'luxury item' with jugs of tap water.
- **70 Mℓ/day** – The estimated volume of acid mine-water that could end up in the Vaal River system should no action be taken against rising acid mine drainage levels in Johannesburg. A team of specialists appointed by the former Minister of Water & Environmental Affairs is currently looking at ways to remedy the situation.
- **R18,9-billion** – The amount by which municipalities underspent their budgets in the 2009/2010 financial year, according to National Treasury. Underspending was highest in the Free State and North West. Capital budgets were underspent by R8,5-billion, indicating weaknesses in the ability of municipalities to compile credible budgets or to manage the implementation of their infrastructure programmes.
- **67 m** – The sea level rise that would occur if all the ice in the Antarctic was to melt.
- **60%** – The saving in water consumption achieved by the Mossel Bay Municipality over the last year. According to the municipality, the saving can be ascribed to the water restrictions which are currently in force as well as the cooperation of consumers.
- **900 million tons** – The estimated rainfall that the planet receives every minute of the day.
- **9 000 ℓ** – The volume of water wasted per year by a tap that leaks one drop of water per second.
- **1 mm/year** – The average rainfall of the driest place on Earth, Arica, in northern Chile.

Better water supply at the click of a mouse

The Water Research Commission (WRC) has teamed up with Emanti Management, developers of the international award-winning Electronic Water Quality Management System (eWQMS) to incorporate water safe plan guidelines into this system.

The WRC published its guidelines for the development of a generic water safety plan last year (**Report No**: TT 415/09). This step-by-step assessment and risk management tool deals with all aspects of risk, from where the water is taken from the catchment to where it is delivered to the consumer. The guidelines assist municipalities in developing the planning and management aspects around safe and sustainable water supply, helping to build the necessary knowledge to understand the general characteristics of the water and the land surrounding their water source, as well as mapping all the real and potential threats to water quality. This is key to ensuring the delivery of clean, safe and reliable drinking water.

A Web-based reporting program that distributes a complete water quality management system over the Internet, the eWQMS has been successfully rolled out nationally, and is already assisting many municipalities around the country to manage their water quality.

The system provides municipalities with the key to successful water quality and related environmental management through the correct identification of risks and the setting up of procedures to eliminate or control those risks. It is now being updated to include sections that must be completed by the user by filling in data boxes which will then report back and highlight the areas with the highest risks, so that organisations know what to prioritise in order to complete a water safety plan.

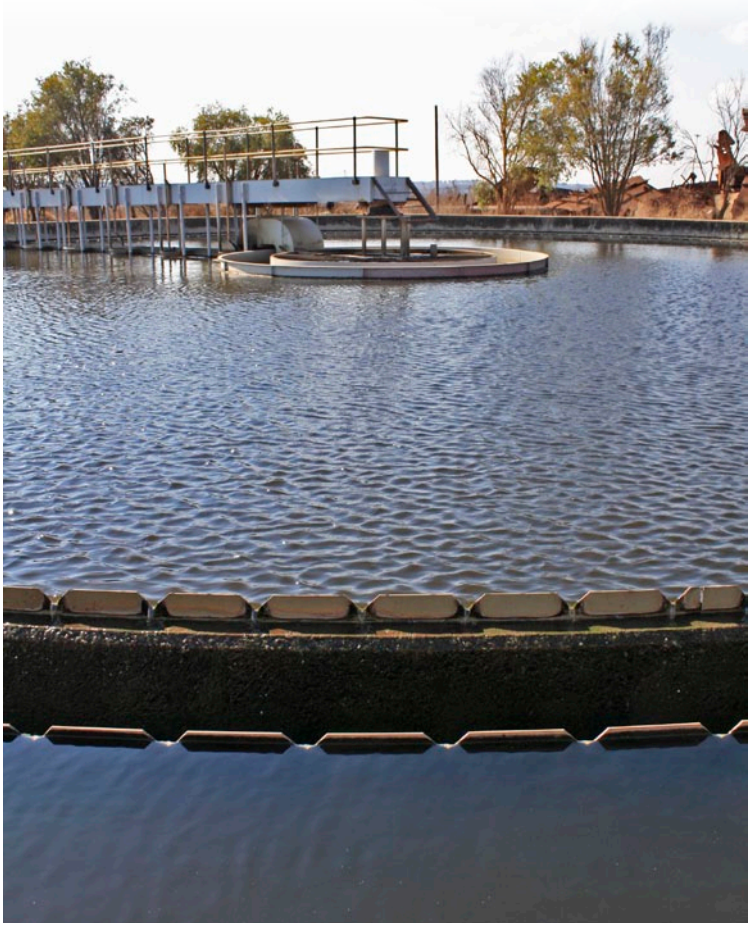
According to WRC Research Manager Dr Jo Burgess, the eWQMS was the obvious vehicle for water safety plans as so many water companies and water service authorities are already making use of the system. "The system makes it possible for people to input relatively simple pieces of information which the programme then correlates into a matrix which feeds back a table with the risk profiles colour coded, so people can focus on any items which pop up in red. In addition, because it is Internet based, it can be accessed anywhere in the country."

At present, the eWQMS is mainly used for, among others, monthly review of legislative compliance, identification of areas requiring urgent attention, quarterly summary review (trend analysis, effectiveness of remedial actions etc), reporting to stakeholders and tracking and managing water quality and related environmental and health risks.

The Department of Water Affairs' Blue Drop/Green Drop certification process already requires a water safety plan, and the WRC is now also developing a similar process nicknamed the wastewater safety plan, which will facilitate achievement of Green Drop status of wastewater treatment works. Using this tool properly will enable users to achieve Blue Drop and Green Drop certification.

All water service providers have access to the eWQMS and tools that reside there. By incorporating water safety plans onto the eWQMS (via a downloadable file and Web enablement of the application), the water safety plan would easily be available to a wide audience.

The development phase is currently underway, and it is hoped that the system will become fully functional towards the end of next year. ❑



Lani van Vuuren

The incorporation of the WRC's water safety plan guidelines into the Electronic Water Quality Management System is expected to help municipalities earn their Blue Drop and Green Drop certification.

Vaalharts scoops international award

Vaalharts Water User Association (Vaalharts Water) Head Water Control Officer Kobus Harbron won South Africa's third WatSave Award from the International Committee on Irrigation and Drainage (ICID).

The award in the 'Innovative Management' category was presented at the organisation's 61st International Executive Council Meeting, held in Jogyakarta, Indonesia, in October this year.

Situated at the confluence of the Harts and Vaal rivers, Vaalharts irrigation scheme was established by the government during the 1930s and, with a total scheduled area of close to 29 181 ha and around 1 900 abstraction points, remains the largest irrigation scheme in the country. Vaalharts Water took over the water management of the government water scheme in 2003.

By replacing the manual administrative system with the digital Water Administration System (WAS) developed with funding from the Water Research Commission, Vaalharts Water has managed to decrease losses on the scheme from 32% to 26,7%. This 5% saving, which is equivalent to 17,5 million m^3, was realised in the first year after implementing the WAS program at Vaalharts Water. This is quite an achievement, especially considering the size of the scheme and the age of the infrastructure.

This saving is the equivalent of an additional 1 920 ha to be irrigated or 74 farms (25,7 ha in size). The judges were impressed by the organisation's strong presentation. "[The presentation] made it credible that this saving is sustainable and capable of further improvement and expansion to another scheme," the judges said.

The WAS system has improved operations at Vaalharts in various ways. Among others, water orders are now captured directly on computer, calculations are done automatically thus eliminating errors, water distribution sheets can be quickly recalculated in cases of water order changes, all water control officers are now computer literate, canal leaks and breakages can easily be monitored, and water use efficiency reports are now generated automatically.

Lani van Vuuren

In addition, Vaalharts Water has purchased a digitising tablet which is used to digitise and import measuring station data from measuring stations that still use chart recorders. This method has proven so fast and accurate that all the old data has been re-done electronically. Volumes are now quantified on a weekly basis and not monthly as done in the past.

As the proficiency and knowledge of the personnel increase with WAS the accuracy of supplying the correct amount of water to the right place at the right time improves and more savings are expected. Due to the fact that the Vaalharts irrigation scheme and the adjacent Taung scheme are interlinked, the innovation will also be introduced to the Taung scheme under the guidance and supervision of Harbron.


Lani van Vuuren

Top: *Vaalharts, the largest irrigation scheme in the country, has been rewarded for its water saving efforts.*

Above: *Vaalharts Water Head Water Control Officer Kobus Harbron.*

For more information on the Vaalharts scheme, see *the Water Wheel* **8** (6) (November/December 2009), and *the Water Wheel* January/February **9** (1) (January/February 2010). ❑

FROM A FLOOD TO A TRICKLE – Water for all but only if we start saving

South Africans need not fear that their taps will run dry any time soon, but whether what comes out will be a stream or a trickle will depend on their willingness be more conservative in their use. This is one of the main messages emanating from the Department of Water Affairs' latest water resource planning strategy report. Article by Lani van Vuuren.

Over the past few years the Department of Water Affairs (DWA) has embarked on several reconciliation studies in water systems across the country, including the Vaal River system, Crocodile (West) system, KwaZulu-Natal coastal metropolitan areas, the Western Cape water supply system, the Algoa and the Greater Bloemfontein water supply area, to name a few. Together the systems investigated carry more than 75% of the country's population and generate over 80% of the national gross domestic product.

The studies examined the future water requirements in these areas in terms of availability of water to meet those requirements, the challenge being to develop interventions timely so as to ensure demand never outstrips supply. A new document has emanated from these studies, namely *Integrated Water Resource Planning for South Africa – Situation Analysis 2010*. The associated costs and energy requirements to extend supplies were also the main subject of a twin report, *An Assessment of the Ultimate Potential and Future Marginal Cost of Water Resources in South Africa*.

DWA Director: National Water Resource Planning, Johan van Rooyen, explains the reasoning behind the reports: "South Africa has enough water only if it uses its resources carefully and plans to meet future water requirements well in advance. Recognising that almost all major sources of readily available water have already been harnessed, the reports set out to review the situation and indicate how the country is to be supplied with water over the next 25 to 30 years."

WE NEED TO START SAVING

What is glaring from the documents is that South Africans have historically been far too liberal in their use of water. "Every water management institution and every individual must adopt and implement water conservation/water demand management (WC/WDM) with great seriousness," says Van Rooyen. "It is absolute essential that we reduce our water requirements."

This responsibility trickles right down to the local repair of leaky taps. The reconciliation studies indicate that many towns do not measure their water use properly. This means that municipalities generally have a limited knowledge of their water use, not to mention losses, which can be as much as 50% or more. Another key cause of losses is ageing municipal infrastructure as well as poor plumbing, especially in low-cost housing.

The situation is exacerbated where water use by households is not metered and payment for use above the free basic allowance is not enforced. This has led to a per capita use of up to 300 ℓ/person/day while the basic allowance is set between 25 and 50 ℓ/person/day, with supplies planned on this basis.

The reconciliation studies show that most South African cities and towns can reduce their water requirements by between 15% and 30%. Van Rooyen is encouraged that flowing from the reconciliation studies have been strategy steering committees comprising local stakeholders, and that WC/WDM is now recognised and planned for as a key strategy.

The agricultural sector remains the largest user of water in South Africa (more than 60%). Even small savings here could make large volumes of water available for additional use.

LOOKING AT THE ALTERNATIVE

Beyond WC/WDM the situation and the solutions to providing water are not uniform across the country. Key to ensuring that we have enough water is having a realistic understanding of the situation, and what it takes – and what it will cost – to meet the requirements, notes Van Rooyen.

Innovative thinking is required if South Africa is to adapt to the realities of a water-scarce country. Water resource planners are shifting focus away from the construction of large bulk water schemes towards the

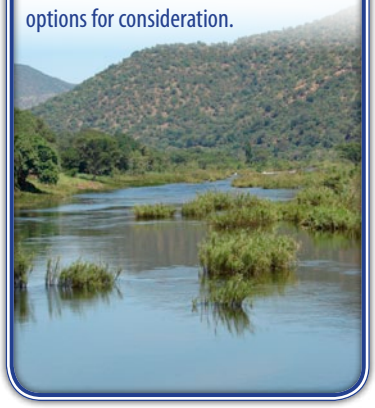
"Every water management institution and every individual must adopt and implement water conservation/water demand management with great seriousness."

THE OLIFANTS RIVER SYSTEM – AN AREA IN NEED

Recently completed reconciliation studies have raised alarm bells over the water supply situation in the Olifants River system in Limpopo/Mpumalanga.

The area is experiencing extremely rapid growth and the system has been severely overused in the past. The De Hoop Dam is currently under construction on the Steelpoort River (a tributary of the Olifants) and completion is targeted for 2012. However, while the dam will ease the pressure in the short term, it will not be possible to meet all the requirements of the Environmental Reserve from this dam, and, as growth and requirements continue to rocket, additional water, or a way of accommodating these severe shortages, will have to be found.

A Water Resource Conciliation Strategy Study is now underway and it is hoped that this will offer a range of options for consideration.



WHAT ARE THE OPTIONS?

Build more dams

More than 70% of South Africa's current available water is received from surface water resources (i.e. dams and direct abstraction from rivers). The limits to the development of surface water sources have almost been reached, and the opportunities for the economic siting of new dams are few and far between. There are still a few large dam projects in the pipeline, though. The De Hoop and Springrove dams are currently being constructed, with phase 2 of the Lesotho Highlands Water Project in the planning phase, among others.

Make use of groundwater resources

At present, groundwater use around the country totals around 2 000 million m^3/year, with a potential 5 500 million m^3/year more available for use. Groundwater is a particularly attractive option for smaller towns, villages, mines and individual users. Aquifers can also be used as a way of storing surplus water through artificial recharge.

Desalination

Desalination is becoming a more attractive option, especially to meet water requirements close to the coast. Desalination plants can provide additional fresh water at a high but affordable cost, with a rapid implementation time possible. Energy costs – a traditional inhibitor to

the use of this technology – has decreased greatly over the last few years. The energy requirement for seawater reverse osmosis, for example, has come down from 22 kWh to produce a cubic metre of water in 1970 to 8 kWh in 1990 and 4 kWh today.

Increase water re-use

The re-use of water only accounts for about 14% of all available water at present. Increasing the percentage is an important water reconciliation strategy, especially for mines and industry. The reclamation and re-use of effluents after treatment is now becoming financially attractive compared to other water resource developments.

Rainwater harvesting

The potential of rainwater harvesting as a water resource has not yet been quantified in South Africa, and at present it is mostly applied in rural households. However, it could become an important source of drinking water, livestock and irrigation water, or to refill aquifers through the recharge of groundwater. Several municipalities now have experience with roof rainwater tanks for domestic use, which have been found to be particularly effective when used conjunctively with other water supplies.

Reallocating water use

Water may be moved from a less efficient to a more efficient use, traded from low value to high value use, or there can be a switch from a high consumptive use to a less demanding requirement. This changing use can affect whole sectors (for example, agriculture) and must be carefully considered for its consequences and planned over time to make water available where it is more needed.

Water conservation and water demand management

Considered the foremost strategy in reconciling the water balance, it is believed that water use in larger systems could be reduced by up to 30% through water conservation and water demand management. Water losses of up to 50% have been recorded in smaller towns and many are still not measuring water use properly. Addressing these issues could go a long way towards securing South Africa's water future.

***Source**: Integrated Water Resource Planning for South Arica – A Situation Analysis 2010*

Water conservation and water demand management have to be implemented in all areas as a matter of urgency.

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careful management and optimisation of existing use, increased use of groundwater resources, the re-use of water, as well as the desalination of brackish groundwater, mine-water and seawater.

Planning will not only have to be done at a national level, but also at a local and sectoral level. District and local municipalities, for example, will have to ensure that attention is given to water resources in integrated development planning, something which is often lacking. It is believed that the reconciliation strategies should go a long way towards addressing this.

THE COST OF WATER

Despite attention shifting to alternative ways of enhancing water supply more bulk water schemes will have to be considered in some areas. Advanced planning here is crucial as such schemes can take anything from

ten to fifteen years from initiation to completion. Plans for Phase 2 of the Lesotho Highlands Water Project (LHWP), the raising of the Clanwilliam Dam, the Mokolo and Crocodile River (West) Water Augmentation Project as well as a dam on the Mkomaas River to supply Durban are well underway. Other schemes being considered include the Nwamitwa Dam on the Great Letaba River, the Vioolsdrift Dam on the Orange River, and the iSithundu Dam on the Mvoti River.

The costs of most of these dam building options are very high, and much higher now that the more accessible sites have all been utilised. "We have long known that water is growing scarcer and that it will get more and more expensive. What we did not know was just how expensive this water would be, and how much augmentation costs would differ for different centres," Van Rooyen tells *the Water Wheel*. "Most particularly, increasing supplies to the Olifants water management area will be exceptionally costly."

The Situation Analysis also shows that unit cost of water from options for increasing the water availability in the Vaal River system, whether the processing of acid mine drainage for potable use, Phase 2 of the LHWP, or the Thukela Water Project are all estimated to be in the order of two to ten times the cost of the most recently undertaken new resource developments. Water supply to the

Lani van Vuuren

The needs of the environment is a serious consideration in modern water resource planning and management.

Cape coastal cities is also expected to be costly over the long term, and here desalination of seawater will probably become a serious consideration.

"Not surprising perhaps is that the unit cost of water from many new developments will substantially exceed the economic value it currently has for some existing water users," notes Van Rooyen. "Changing the use of this water may be far more sensible than implementing new schemes – but these are not decisions to be taken lightly. The future cost of water can be expected to become a major incentive with regard to the location of growth and development nodes."

WATER FOR THE ENVIRONMENT

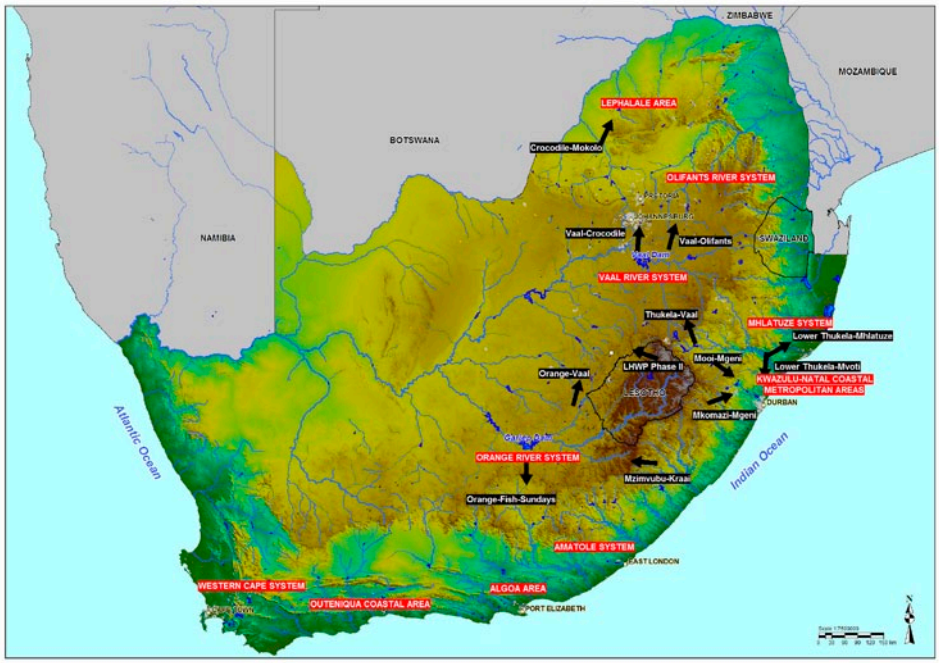
Something else that requires much more consideration is water to meet the Ecological Reserve. "As a nation we have already, for many rivers, taken more water than is good for the functioning of those rivers," says Van Rooyen. "We have an obligation to try and restore the balance if our rivers are to continue to provide ecosystem services."

Recognition of the Environmental Reserve and the volumes of water that have been set aside or declared necessary to meet those requirements have meant that users have not been allowed to squeeze every last drop out of the system. Less water is being made available than might otherwise have been the case.

"As planners our thinking has changed to the extent that we now understand that this water never was, in reality 'available' – we are using water that was not ours to use," explains Van Rooyen. "In some systems far too much water has already been put to use, and it is going to be very difficult to reverse the situation and make the necessary water available to meet the requirements of the Reserve."

There will be difficult choices in a number of systems. New infrastructure can be built in order to provide ecological flows in the dry season, or users may be required to return some of their water to the system.

South Africa has enough water to stay in business but the country must accept that the days of plenty are over. The documents will now serve as background to spatial and sectoral development planning at national scale, and guide development options. Says Van Rooyen: "It is our hope that these documents will place the issue of water resource planning and management firmly on the national agenda so that together we can take the necessary steps to ensure that we will never run out of water." ❑



DWA

Walter Knirr/SA Tourism

Above: *The remaining bulk infrastructure development options.*

Left: *Desalination of seawater is becoming an attractive option for coastal communities.*

RELATED DOCUMENTS

To access the reports:

- *Integrated Water Resource Planning for South Africa – Situation Analysis 2010*
- *An Assessment of the Ultimate Potential and Future Marginal Cost of Water Resources in South Africa,*

Visit: http://www.dwa.gov.za/Documents/Default.aspx and click on the relevant document.

In addition, an explanatory booklet, *Integrated Water Resource Planning for South Africa* is available from the Department of Water Affairs.
Enquiries: Patricia Viljoen;
E-mail: viljoenp@dwa.gov.za

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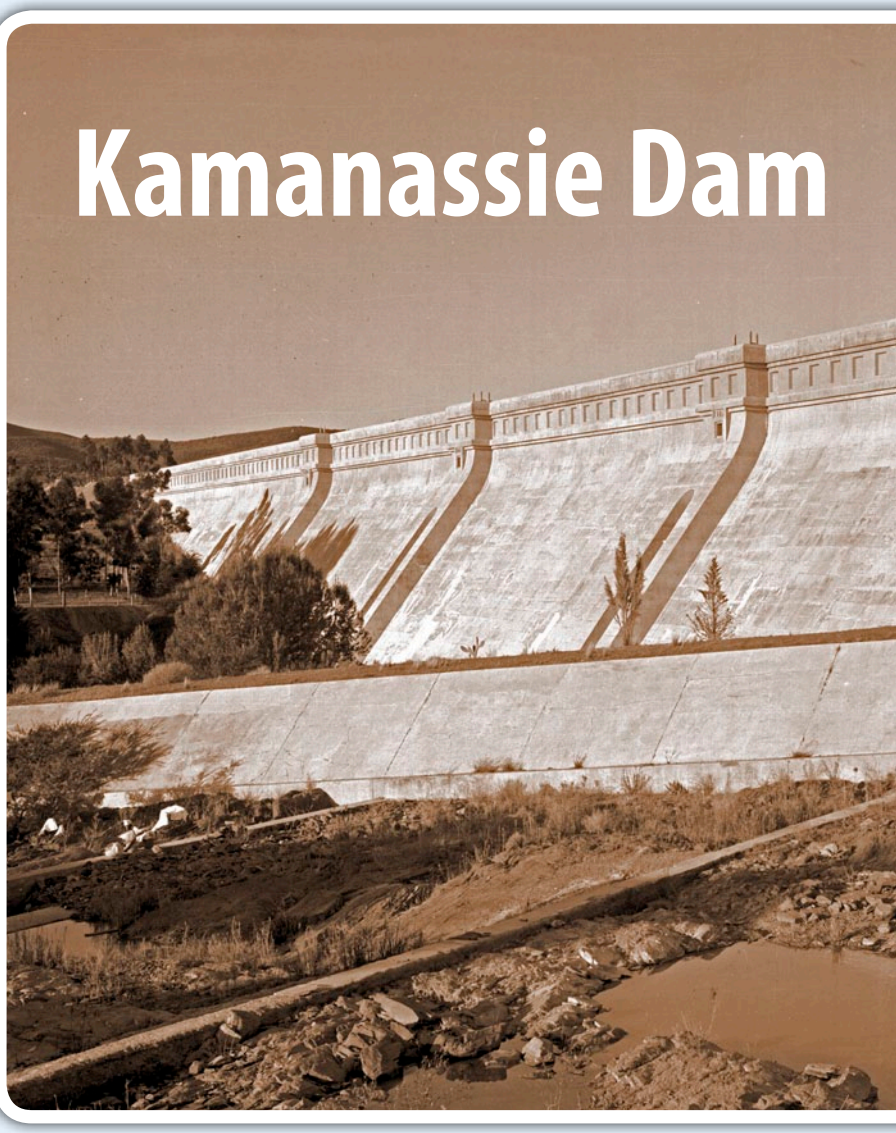
Kamanassie Dam



Like much of the early infrastructure in Oudtshoorn, Kamanassie Dam has the ostrich feather industry to thank for its construction. Lani van Vuuren traces the history of this dam, one of the first large dams to be built in South Africa.

It might be known today as the ostrich capital of the world, but long before the domestication of the 'golden camel bird' Oudtshoorn was renowned, at least in South Africa, for its irrigation. The town originally grew around the Dutch Reformed Church established near the Grobbelaar's River in 1839 to serve farmers in the area. Almost a decade later a number of erven irrigated by furrows led from the river were surveyed and sold. It is thought that the town got its name from Geesje Ernestina Johanna van Oudtshoorn, wife of the first Civil Commissioner of George, Egbertus Bergh.

Like many towns in the Little Karoo the young Oudtshoorn struggled to thrive. In the 1860s drought threatened the existence of the town and drinking water had to be delivered to erfholders with carts. Then the drought was broken by floods that washed away large parts of town.

It was the domestication of the ostrich with the invention of the incubator that saved the town from ruin. Ostriches thrived at Oudtshoorn; the climate was dry and warm, the soil with its salt and lime agreed with the birds and the well watered valleys were ideal for lucerne fields, which was introduced as a fodder crop by Oudtshoorn magistrate Mr Scholtz. He imported the seeds and planted a small plot to feed his ostriches.

The birds thrived on this diet and soon all the farmers started planting lucerne followed by the construction of irrigation schemes to water ever greater fields of crops. In 1875, the district possessed only about 2 160 ostriches, by 1893 this figure had risen to 27 000.

LEADING THE WAY

The Oudtshoorn district was reportedly streaks ahead of other areas in South Africa as far as irrigation was concerned. In his 1901 report on irrigation possibilities in South Africa, William Willcocks describes Oudtshoorn as the Cape's "Garden". At that stage, at least 971 ha of land was being cultivated with water from the Grobbelaars River. Most irrigation was done through diversion weirs In addition to lucerne, farmers in the area produced tobacco, potatoes, with orange groves, vineyards and fruit gardens in abundance.

While the ostrich feather sector grew, the need for water deepened. When the Cape Colony's neighbours were preparing to engage in a destructive war with England, the southern colony experienced one of the greatest periods of affluence in its known history. Next to gold, diamonds and wool, ostrich feathers became the Cape's largest export product.

By the end of the century nearly 500 000 pounds of ostrich feathers were exported a year. But there was no abundance of water in the Little Karoo. The year 1896 was one of the driest on record and, by 1899, the Oudtshoorn municipality had to collect water from 18 km away. This water was sold to residents at over sixpence a bucket. To alleviate

DWA/eWISA

the problem Danie Nel, owner of the farm *Rust-en-Vrede* was persuaded to sell his water rights and work immediately began to pipe water to town.

When there was water scarcity conflict followed. Such a situation was uncovered by Cape Hydraulic Engineer John Gamble when he visited Oudtshoorn in 1877. At that time the town was dependent on water supply taken directly from the Grobbelaar's River, led in furrows and shared by about 300 erfholders. Each erfholder was entitled to 12 hours of water a week. Gamble wrote in a report to government: "There is a great deal of fighting, those who have not time to look after the water-leading frequently give up what is an unequal contest with others who have time to watch the sluits, and see that they get their due share of water."

It was during this time that the first serious proposal was made to construct a storage dam on one of the rivers outside Oudtshoorn. ETL Edmeades, owner of the farm *Kamanassie*, proposed an irrigation dam to be constructed on the Kamanassie River, a tributary of the Olifants River. But while the ostrich palaces were being constructed in town nothing came of the idea.

Above: *A close-up photograph of the Kamanassie Dam wall, taken in 1936.*

Top right: *The Kamanassie Dam shortly after its completion.*

Bottom right: *Kamanassie Dam as seen from the air.*

DAM PLANS REVIVED

In 1913 the ostrich feather industry reached its climax only to be followed by a complete collapse of the sector with the outbreak of the First World War. Farmers who had pulled out their tobacco crops and orange trees to make room for ostriches now had to return to their crops. With the emphasis on lucerne the need for irrigation had become more apparent, and so the Kamanassie irrigation scheme was again revived.

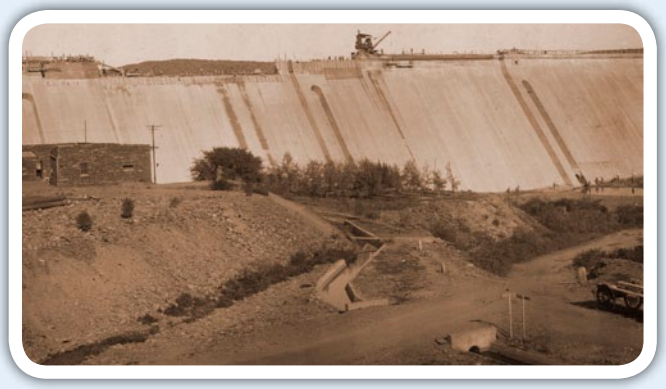
CP Nel Museum

In 1916 an irrigation district was established and the Irrigation Department was approached with the view of preparing a suitable irrigation scheme. The irrigation board subsequently accepted the project proposed by the department and FT Patterson was appointed Resident Engineer to carry out the work with a loan granted by Parliament.

Construction of Kamanassie Dam only started in June 1919 as the First World War curbed the Irrigation Department's spending tremendously. Work on the canals was carried out simultaneously. The design called for a mass concrete gravity section dam with a crest height of 44 m above deepest foundation and 35 m above riverbed. The dam wall was to be 386 m long. The main spillway was to be on the right flank and 91 m wide with a waste weir wall 183 m long. An emergency spillway was to be constructed on the right flank. This spillway was to be 91 m long and was to discharge into a channel 46 m wide.

Patterson worked according to a strict programme that called for the storage of water to start by December, 1921. Work and finance were controlled from a central

DWA/eWISA



CP Nel Museum

Above left and right: *Kamanassie Dam at an advanced stage of construction. Note the use of donkey carts and cocopans.*

OSTRICH FARMING AND IRRIGATION SCHEMES

Hein van Hörsten/SA Tourism

While cooperative irrigation settlement failed to take off in the nineteenth century something else did which forever changed the face of South African agriculture and lead directly to the construction of the first large dams in the country – the ostrich feather industry.

It is thought that as early as the eighteenth century farmers caught ostrich chicks in the wild and reared them as pets. However, before the domestication of ostriches between 1857 and 1864 the only way to the birds' plumes was to kill them and pluck the carcasses, and thousands of ostriches were hunted down at the start of the ostrich feather trade. In fact, in many areas the species was almost totally eradicated prior to its eventual domestication. In South Africa this destruction was checked to some extent by the passing of a special law for the preservation of wild ostriches in the Cape Colony in 1870.

Several farmers in the Karoo and Eastern Cape succeeded more or less simultaneously in breeding and rearing ostriches from the 1860s. The development of the incubator allowed the sector to grow in leaps and bounds, and soon everyone was keeping at least one ostrich in their backyard. This can clearly be seen in the increase in numbers of tamed birds and sale of ostrich feathers. The total weight of feathers exported from the Cape in 1865 was 17 522 pounds, which came mainly from wild birds, the 80 tame birds supplying only 120 pounds. Ten years later there were more than 32 000 tame ostriches in the colony. By 1895, this figure had grown to 253 000.

Effective selection and clever cross-breeding improved the quality of South African ostrich feathers until plumes from the tip of Africa became the most sought after in the world. By 1880, Cape feathers were sold at an average price of £5,8 per pound, chicks at £10 to £16, breeding pairs at £200 and exceptional birds at £1 000 each. More than 3 600 pounds of feathers were exported from the Cape in that year. Next to gold, diamonds and wool, ostrich feathers became the colony's largest export producer. By 1910, there were 800 000 tame ostriches in South Africa.

Farming with ostriches became extremely popular not only because it was so profitable but because it was so much easier than other agricultural pursuits. It required comparatively little capital and less work and stock increased fast with the aid of artificial incubation. An average ostrich farm could also be managed well with few labourers.

Ostriches were difficult to herd and it was more efficient to enclose flocks in a paddock and provide them with fodder. And so ostrich farming introduced a new crop to the country – lucerne. Introduced to the Cape in the 1870s by Oudtshoorn magistrate Mr Scholtz to feed his ostriches, it is this crop that greatly boosted irrigation and the development of dams in the country. By 1907, a lucerne farmer earned £9 to £20 per acre a year (based on sales of baled lucerne hay). If he did not bale it, but used it on his farm for feeding stock (not only ostriches), his profits were even greater. With such returns, farmers, especially in the Karoo and Eastern Cape, were encouraged to lay out capital on irrigation works and lay their hands on lucerne. Lucerne gave a higher yield and protein content than grain crops grown for fodder. Once established, it was a perennial crop, so that annual sowings were unnecessary. In fact, in regions such as Oudtshoorn, one planting could last for more than seven years. No wonder then that early farmers dubbed lucerne 'a miracle crop'. By 1920, South Africa produced more than 83 000 tons of lucerne a year.

The ostrich feather sector peaked in 1913, resulting in the export of a million pounds of plumes at £3-million. Then the First World War broke out and ships exchanged their loads of feathers for guns and soldiers. The market slumped, then crashed completely. Farmers chased their flocks into the veld and turned back to conventional crops, now boosted by the development of irrigation infrastructure.

CP Nel Museum

Left: *Construction at the Kamanassie site progressed according to a strict programme set up by the Resident Engineer. Due to the inaccessibility of plant, mostly second-hand machinery was used.*

Far left: *Machinery used to crush rock for the Kamanassie Dam.*

office at the Kamanassie Dam and sub-offices on the canals. The work schedule was set down in detail in a diagram, a copy of which was supplied to each member of staff so that responsibility and control could be clearly defined. It is interesting to note that CJ Langenhoven, author of *Die Stem*, acted as legal advisor to the Kamanassie Irrigation Board (he set up practice as an attorney in Oudtshoorn in 1902), while famed water engineer Ninham Shand was Assistant Engineer on the project.

SEPARATION OF CLASS AND RACE

As was the norm at the time, two separate labour camps were constructed. The white labour camp was constructed on the one side of the river, while the black labour camp was constructed on the other. All the houses in the white village had 457-mm masonry walls, however, while single men's, married gangers' and some of the artisans' quarters had flat roofs, the first class artisans', foremen and staff quarters all had pitched roofs with porches. On the other hand, the black labour camp comprised 24 *rondawels* (traditional thatched round huts), also with 457 mm-thick walls, 5,5 m in diameter and 2,4 m high to the eaves.

The white labour camp also featured a school, a combined mess hall and recreation room and sports facilities, such as a tennis court and a rifle range. There were no such amenities available at the black labour camp. Black labourers were very rarely allowed to bring their families with them on site, as was usually the case with white labourers. Apart from the conventional recreation and educational facilities, there was also a post office. At the height of construction there were 1 800 men working on the scheme.

SECOND-HAND MACHINERY

The board capped plant expenditure at £25 000. As construction was started at a time when it was impossible to obtain machinery from either Europe or America promptly and at reasonable prices the irrigation board decided to purchase second-hand engines and machinery and only import what could not be located in South Africa. This included concrete mixers and an air compressor. A three-ton capacity, 335 m-span cableway was obtained from Calitzdorp Dam (which had just been completed), together with a 40 HP suction gas engine, a few small crushers and other odd plant. In addition, three five-ton locomotive cranes were required from a mine in Johannesburg.

While all the machinery was finding its way to site, workers set about throwing an earthen coffer dam around the right half of the foundation on the riverbed. Excavation for the foundations was done entirely by hand. Interestingly, it was decided that all staff appointments should be advertised. There were 15 staff members in all. All white employees were to be recruited from the Oudtshoorn district and housing was provided for 30 single men and 30 families. Unskilled (black) labour was recruited from the Eastern Cape.

By the end of November, 1919, 43 580 m^3 of concrete had been placed in the dam and earthworks of 48 km of canals had been completed. And on 6 May 1920, the first concrete was poured for the dam wall. The event was marked by a ceremony in which all staff and children attending the works school dropped small stone 'plums' into the first concrete placed in the foundation. Despite the good start the rate of construction was hampered severely by the curtailment of funds, and in the end the project was only completed towards the end of 1925. ❑

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- Thanks to CP Nel Museum in Oudtshoorn and eWISA for photographs

Salt precipitates on the surface. These are commonly associated with patchiness in wheat fields.

DRYLAND SALINITY:
Threatening water resources in the semi-arid Western Cape

Increased dryland salinity in the Swartland and Overberg regions poses a threat to the bread basket of the Western Cape, water resources in an already water-stressed area, water supply to the industrialised Saldanha region as well as the ecology of the Berg River system. So report Richard Bugan, Willem de Clercq and Nebo Jovanovic, who have been undertaken a Water Research Commission-funded study in the area.

The Berg River, which flows between Franschhoek and Velddrif, is an important freshwater resource to the Western Cape. In the 1980s, the Department of Water Affairs (DWA) measured an increase in salt concentrations, particularly in the mid- to lower reaches of the river, thereby impacting on drinking water quality and agriculture.

Dryland salinity poses a major threat to water quality, particularly in semi-arid areas. It is usually associated with the mobilisation of inorganic salts from the landscape and the consequent increase in salt concentrations in receiving water bodies. Dyland salinity is not new to this area. Wheat lands in the Swartland and Overberg regions are widely known to contain *brak kolle* (saline scalds) where the wheat will not germinate.

ARE CHANGES IN LAND USE THE MAIN CAUSE?

Findings from several research projects in the semi-arid wheat lands of the Western Cape indicated that changes in land use over the last century or more, from extensive pastoral use to intensive cropping, may have triggered the same process of salt decantation that is so widespread in Australia.

The key question is whether the dryland salinity in catchments such as that of the Berg River is more intense now than it was several decades ago and is still intensifying? If so, the consequences for the management of

water quality and water supply could be enormous, since any current assessment of the salinity load, on the basis of which impoundments and canal schemes are planned, could be incorrect and may thus require adjustments in the future.

HISTORICAL RESEARCH

A cycle of research projects has been initiated to investigate the salinisation of water resources and the issue of dryland salinity in the Berg River catchment. For example, in 1995 the then Department of Water Affairs & Forestry studied the salinisation trend in the Sandspruit River catchment, a tributary of the Berg River.

Water bodies within this catchment were investigated to identify and quantify their salinity dynamics. It was reported that groundwater and interflow from the weathered shale and soils contributed to river salination based on the findings that the bulk annual atmospheric deposition of salt accounted for only a third of the total salt output from the catchment.

The WRC has funded projects in this region for several years. Among others, a pilot study (**Report No**: **1342/1/04**) was undertaken to investigate the extent of dryland agricultural impacts on river salinity in the Berg River catchment. It was reported that dryland salinity is extensive and that it is likely to have a significant impact on the water quality of the Berg River. In another project (**Report No: TT 252/06**), the influence of irrigation return-flow on the water quality of the Berg River was assessed and it was reported that its contribution to the salt levels in the Berg River was minimal when compared to the consequences of dryland salinisation.

It is therefore clear that dryland salinity is affecting the water quality in the Berg River catchment and that mitigation strategies need to be identified. Findings from previous research suggest that a thorough assessment of the influence of land use practices, e.g. cultivation versus grazing, vegetation type, tillage practices, erosion control etc. on salt mobilisation is required.

CURRENT RESEARCH

Between 2005 and 2009 researchers investigated the impact of land use practises on salinity in the Berg River at three locations:

- **Goedertrou farm:** The water and salt dynamics were investigated in the soil and vadose zone of a 16 ha small-scale catchment, exhibiting evidence of dryland salinity and representative of semi-arid conditions in the Berg River catchment. At this site, salt sources and storage were studied and also groundwater fluxes and catchment runoff with the view of informing future catchment-scale modelling and to guide the development of on-farm management practices.
- **Voëlvlei Nature Reserve**: An experimental site was established to allow for a comparison of hydrology and salt balances between winter wheat and restored Renosterveld.
- **Sandspruit catchment**: Salt and water discharge into the Berg River were monitored in this 152 km^2 catchment.

WHERE DOES THE SALT COME FROM?

The unconsolidated material overlying the bedrock in this semi-arid coastal region contains an abundance of stored salts of marine origin that have accumulated through atmospheric deposition over a very long period. It is hypothesised that during this period the climate may have been drier than at present and/or a vegetation cover prevailed that allowed less water to be discharged from catchments than currently occurs under the prevailing land use (mainly winter wheat), because of greater water extraction and/or smaller overland flow. Evidence for the deposition of oceanic salts by wind and rainfall is provided by the chemical signature of groundwater and stream flow in these parts of the Berg River catchment.

Analysis of the solutions of a number of fresh, regional Malmesbury shale samples, collected in the mid- to lower-reaches of the Berg catchment, further suggests that salt of such composition and quantity is not present in the rocks. The salts discharging from catchments such as the Sandspruit must therefore have accumulated through atmospheric deposition.

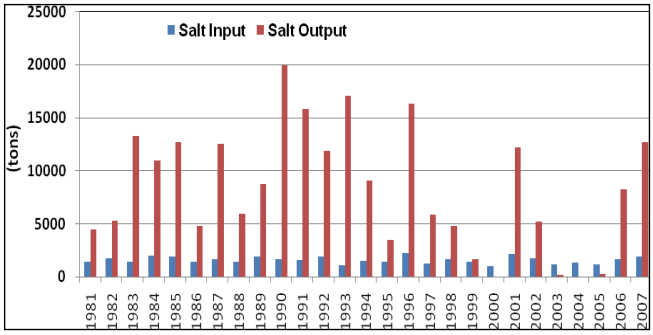
SALT DISCHARGE

Findings from current research indicate that the severity of the salt discharge is lessened by the fact that most of it is released during periods of high flow so that considerable dilution occurs. The salinity hazard is magnified seasonally, however, by evaporation from the river and storage dams and by more concentrated salt seepage into the lower reaches during periods of low flow and greater water demand.

The rate of salt discharge is affected by both the prevailing climate and agricultural practices (land use, soil conservation practices, etc). This study has provided valuable information concerning the water and salt fluxes in overland flow and the unsaturated zone from different land uses.

The Goedertrou small-scale catchment: the dominant land use in the mid-to-lower reaches of the Berg River is winter wheat.

Current rates of salt discharge have the potential to remain unchanged, to the detriment of water users. An initial rough estimate suggests that the unconsolidated soil horizon above the bedrock contains approximately 200 t of salt per hectare, stored mainly as a bulge in the unsaturated zone above the water table and below the soil zone. This salt bulge discharges mainly through lateral leaching by groundwater when water tables rise in winter.



This graph represents the input and output of salts from the significantly saline Sandspruit catchment. The net salt discharge (a maximum of 20 000 t/year, however averaging at 6 700 t/year) is close to 0,5 t/ha/year.

THE CONSEQUENCES OF DRYLAND SALINITY

Consequences of dryland salinity in the Berg River catchment are mostly associated with increases in soil, stream flow and groundwater salinities. Soil salinity has the tendency to increase in winter, possibly due to precipitation of salts in summer and subsequent dissolution and mobilisation in winter. The patchiness observed in wheat fields was interpreted to be associated with high soil salinities. Further increases in the electrical conductivity of the soil are likely to cause further loss of productive soils.

The electrical conductivity in a farm dam and groundwater was monitored in the Goedertrou small-scale catchment from April 2005 to October 2007 and during July 2007 respectively. The electrical conductivity of stream flow was also monitored at the Sandspruit gauging weir. The electrical conductivity increases as one moves downstream and also showed strong seasonal influences, i.e., it increased in summer and decreased in winter.

Variable	Min EC (mS/m)	Max EC (mS/m)	Average EC (mS/m)	Comment
Groundwater*	68	375	174	Increases in EC with decreases in water table elevations
Sandspruit River**	400	2000		The minimum was generally recorded in July and the maximum in November

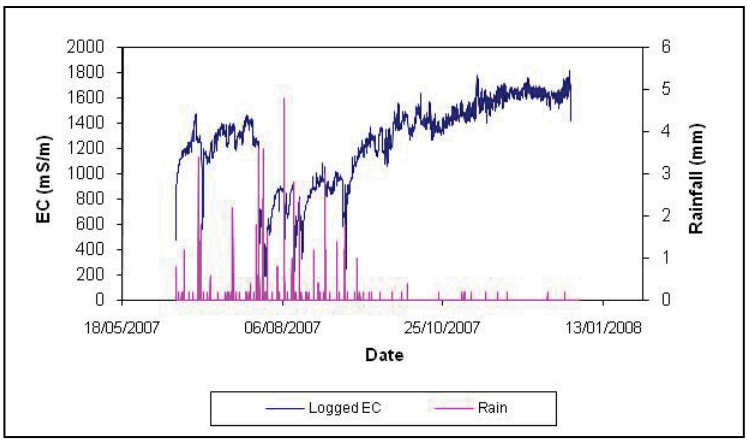
** 7 boreholes drilled in the Goedertrou small-scale catchment*

*** measured at DWA gauge G1H043*

Generally, when referring to the DWA quality guidelines for domestic water supplies, groundwater in this part of the Berg River catchment and the Sandspruit River is predominantly unfit for human consumption, especially when it is shale-derived. Domestic water supplies are mainly reticulated from Voëlvlei Dam and the Misverstand Weir. Irrigation using this water is also not recommended as it may lead to crop loss and further land degradation. As a result, many farmers in these regions practice dryland and livestock farming.

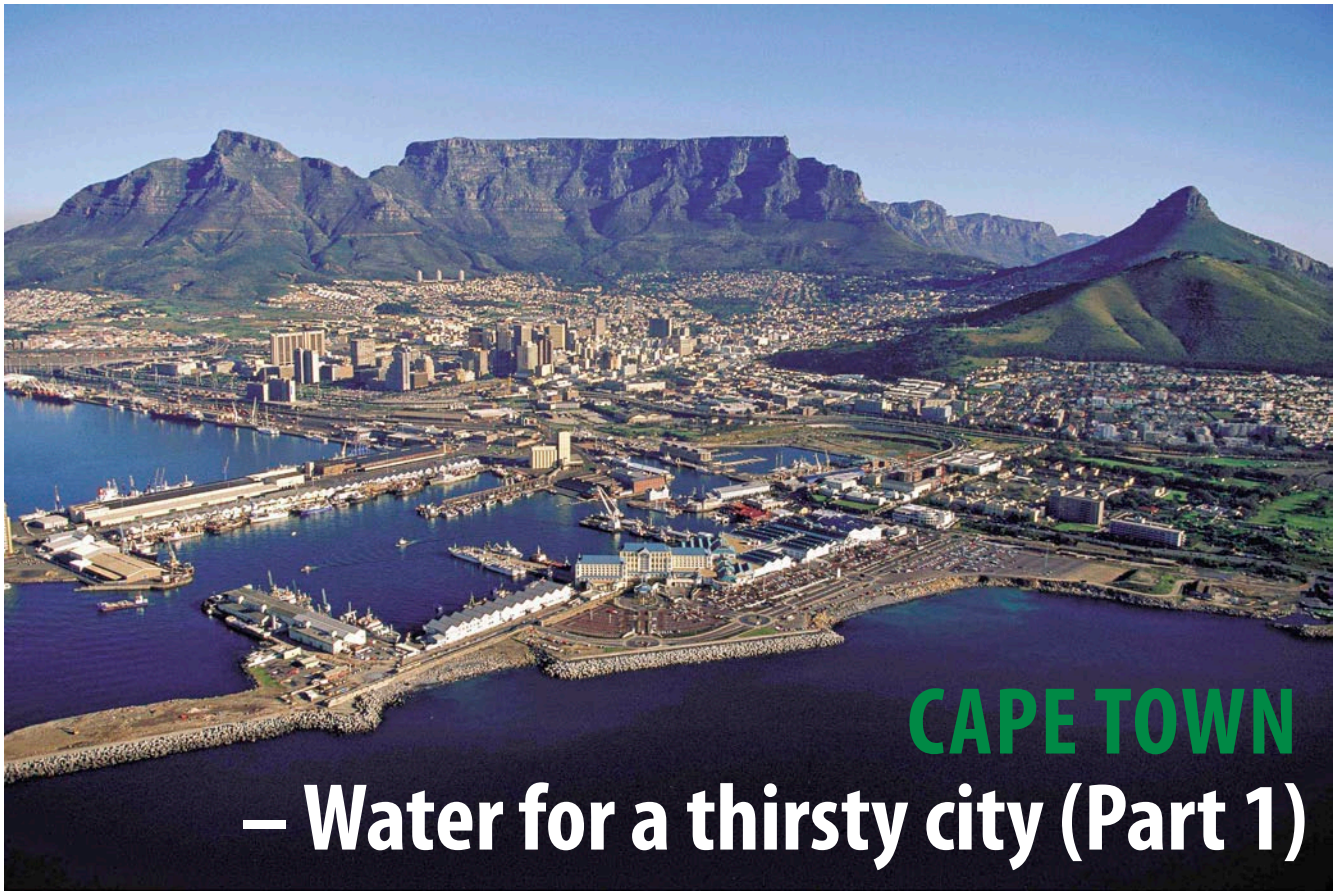
THE WAY FORWARD

The results of the current research provide a clear need to address the issue of dryland salinity and to identify ways of managing it. The next phase of the research is to develop guidelines for regulating land use in an attempt to reduce the mobilisation of salts to the Berg River. Catchment-scale hydrological models will be used for scenario simulations. The Sandspruit catchment is being used as a pilot catchment due to its significantly saline nature. ❑



Above: *During the rainy winter period, in-stream salinity responded dramatically (within hours) to rainfall events. Rainfall events resulted in the dilution of salts. During dry periods in summer, the salinity tends to increase.*

Left: *The Sandspruit River is a significantly saline tributary of the Berg River.*



Mark Skinner/SA Tourism

CAPE TOWN – Water for a thirsty city (Part 1)

From the time of its inception, Cape Town has always been a thirsty city. In this part one of a two-part series, Petro Kotzé traces the early history of water supply in the Mother's City.

It was water that first drew visitors and settlers to the Cape and, like the changing phases of its biennial rivers and streams, Cape Town itself has had many faces during the centuries. The traditional name for the area where the Mother City now stands is *Camissa* – a Khoi word meaning 'the place of sweet waters'. The abundance (or scarcity) of this resource is what has defined the lives of those seeking to make a living at the foot of Table Mountain.

WATER RESOURCES

Believed to be one of the oldest mountains on Earth (six times older than the Himalayas), Table Mountain is an excellent source of water. Moisture laden fronts sweep across the south Atlantic and pour down the Table Mountain chain, while the heavy condensation of the south east clouds, the famous table cloth, contribute further.

The greatest single catchment area drains into what used to be known as the Backwater Stream, and runs through Upper and Lower Disa gorge, down Orange Kloof and into the sea at Hout Bay. The main river of the city bowl has its source at the top of the Platteklip Gorge on Table Mountain, the Platteklip Stream. It drains the northern parts of Table Mountain.

Today, the tributary of this stream that used to flow down Buitekant and Maynard Streets disappears into a culvert at the foot hill zone of the mountain and becomes a sub-surface storm water channel that spills out, polluted, into the Atlantic Ocean. The city's history is intimately linked with this stream, and as early as 1488 the presence of Khoi had been observed by the newcomers in the Cape coastal region. It is believed that the Table Valley was used by the Khoi during spring and summer, as it provided good vegetation for their herds.

THE PLACE OF SWEET WATER

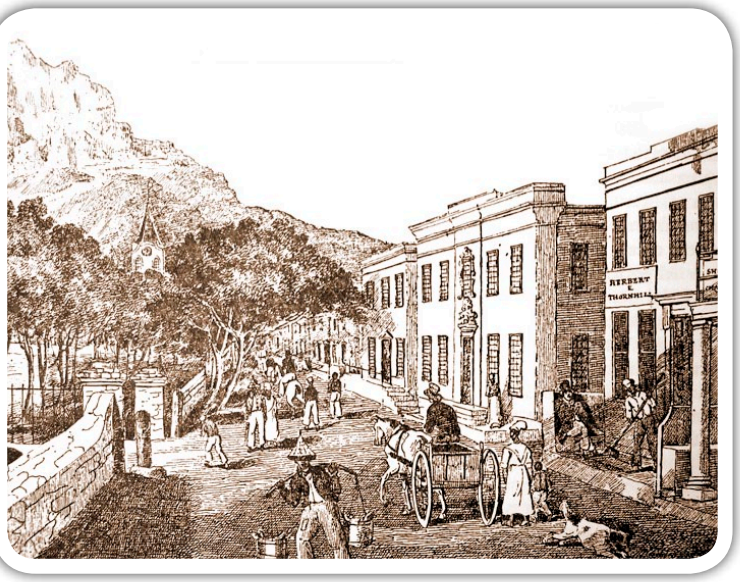
In 1647, the Verenigde Oost Indiesche Compagnie (VOC) ship *Haarlem* was wrecked at the Cape. The stranded crew settled just below where the Platteklip River naturally splits in two, on the banks of the stronger tributary, named the *Varsche* (Fresh) River. They prepared ground, sowed seed and soon had a good supply of vegetables. They also bartered for livestock with the Khoi. The men were picked up by the passing *Coningh van Polen* in 1648. It is said that it was upon the report

Top right: *The streams flowing from Table Mountain were for a long time the main sources of water for the first citizens of Cape Town.*

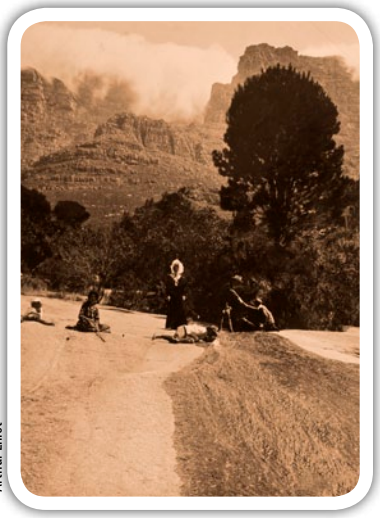
Middle right: *The old Heerengracht circa 1832 in what is now Adderley Street.*

Bottom right: *The Platteklip Stream, photographed in 1900.*

Walter Knirr/SA Tourism



Courtesy Jenny Day



Arthur Elliot

of these men that Jan van Riebeeck was sent to establish a refreshment station at Table Bay in 1652.

Van Riebeeck immediately set to work, but his challenge was not easy. He landed at the Cape during a drought and three months later, the first vegetable beds were flooded. His arrival also signalled the advent of another source: pollution. In 1655, a letter communicated complaints that the crew from a passing ship fell ill after taking on water from the Cape. This led to the issuing of Placaat 12 of 1655, considered South Africa's first piece of environmental legislation, which forbade settlers to bathe or wash upstream from where the water was being collected. Instead, they had to wash and bathe near the cattle kraal.

EARLY WATER RESOURCE DEVELOPMENT

Van Riebeeck's first engineering project entailed a water supply system for passing sailors. It consisted of a jetty and a 'walkway' of thick planks on which the barrels of water were rolled from the Fresh River. The first fort was also built on the banks of this river in 1656 (it was replaced by the Castle in 1679).

The VOC's gardens, which were to supply Dutch ships with fresh fruit, vegetables and herbs, formed the central axis of the expanding settlement. The garden's water came from the Oranjezicht springs, which originated at the top of Platteklip gorge. From the springs the water was gravity fed by opening sluice gates and taken across the contour in a ditch along Orange Street to the top of the gardens. A canal was dug on each side of the garden in 1654, and water from the Fresh River was left into it, in part to prevent wild animals from entering and ruining the crops.

A system of monitor furrows for irrigation was also installed – the country's first modern irrigation system. In October 1657, the lower course of the Fresh River was altered as its ancient channel was likely to damage the garden when it overflowed in winter. A new, broader channel was built, entering the sea some distance from the fort.

Water scarcity in 1661 prompted Van Riebeeck to start construction on the country's first modern reservoir. Waegenaer's Dam, was eventually completed by Van Riebeeck's successor in 1663. All able bodied persons were called on to help build the reservoir, the remains of which was unearthed during the construction of the Golden Acre building in the1970s.

The Fresh River was also used for its motive power. In 1657, the first

mill was constructed on the site of Cape Town High School. A number of mills were erected through the years, and stood between the town and the mountain with water led to them via pipes raised on wooden supports. In addition to the watermills along the old Platteklip Stream, the Gortmolen (a barley mill) and Twistniet Mills were also erected. Muct later, in 1856, a windmill was erected between Twistniet and Zorgvliet mills.

FRESH WATER SUPPLIES

Until 1891, the whole of Cape Town's water came from springs on Table Mountain. The early streets ran parallel and at right angles to the streams that followed the course of the Fresh River to the fort. Lined with *stoeped* (patio) houses of the burghers the streets had been widened by 1767 into a fashionable oak-lined promenade, described by some 'as the beautiful streets'. Heerengracht was augmented by a stream along Plein Street, while a cross canal along Strand Street drained from the slopes of Signal Hill.

Other canals flanked Strand Street, Whale Street, Queen Victoria Street (then called Tuinstraat) and Long Street. The Kaisersgracht along the present Darling Street was built in 1693. The flow of the water was regulated by sluice gates which property owners were allowed to keep open for a limited time each day. There were also around 36 fountains in town, the most impressive of which was designed by Thibault and stood in the parade.

However, the *Kaapsche Vlek* (as the Cape settlement was known) paid a high price for these developments, and the canals soon changed from a source of pride to one of dismay. Trash was dumped in it, mosquitoes and frogs bred in stagnant pools and every now and again, a drunken sailor met his end in it. There was no waste removal service to speak of, with the taking away of refuse being mostly left up to the South Easter, slaves, open ditches, hyenas and the sea.

ORANJEZICHT FARM – THE FIELD OF SPRINGS

The suburb known as Oranjezicht was once a lush and successful farm, blessed by an abundance of springs, owned by the Van Breda family. The farm's main income was the sale of fruit and vegetables, and it boasted views of its abundant orange trees growing in Table Valley (hence the name). Later, terraces for the cultivation of vines were included. More than 300 slaves were employed to work the lands.

The *Stadsfontein* (or Main Spring), was situated on the farm, and the Van Breda's enjoyed full water rights, given to then in 1769. After complaints from the neighbours a system of sluices to regulate access to water was installed. Main Spring dates back to 1686 and it supplied Cape Town's first water pipe even before 1789. It was covered with a vault in 1813, and in 1853 another collection chamber (New Main Spring) was built for all the springs in the area.

By 1859 a bill was published that stated that all the fountains, streams and other sources of water supply within the boundaries of the municipality of Cape Town and Green Point shall be solely and exclusively vested in the board of commissioners constituted by this Act. In essence, the entire Oranjezicht farm's water supply would be owned by the Board, which had to obtain the land on which the springs were situated. The Van Breda's petitioned, but to no avail.

This was the first in a series of Acts, so that later the municipality had rights to virtually all water on the estate. The farm became effectively useless to its owners, and was eventually sold for £40 000 to a speculative villa building company. By 1900 the area became a suburb of tree-lined avenues.

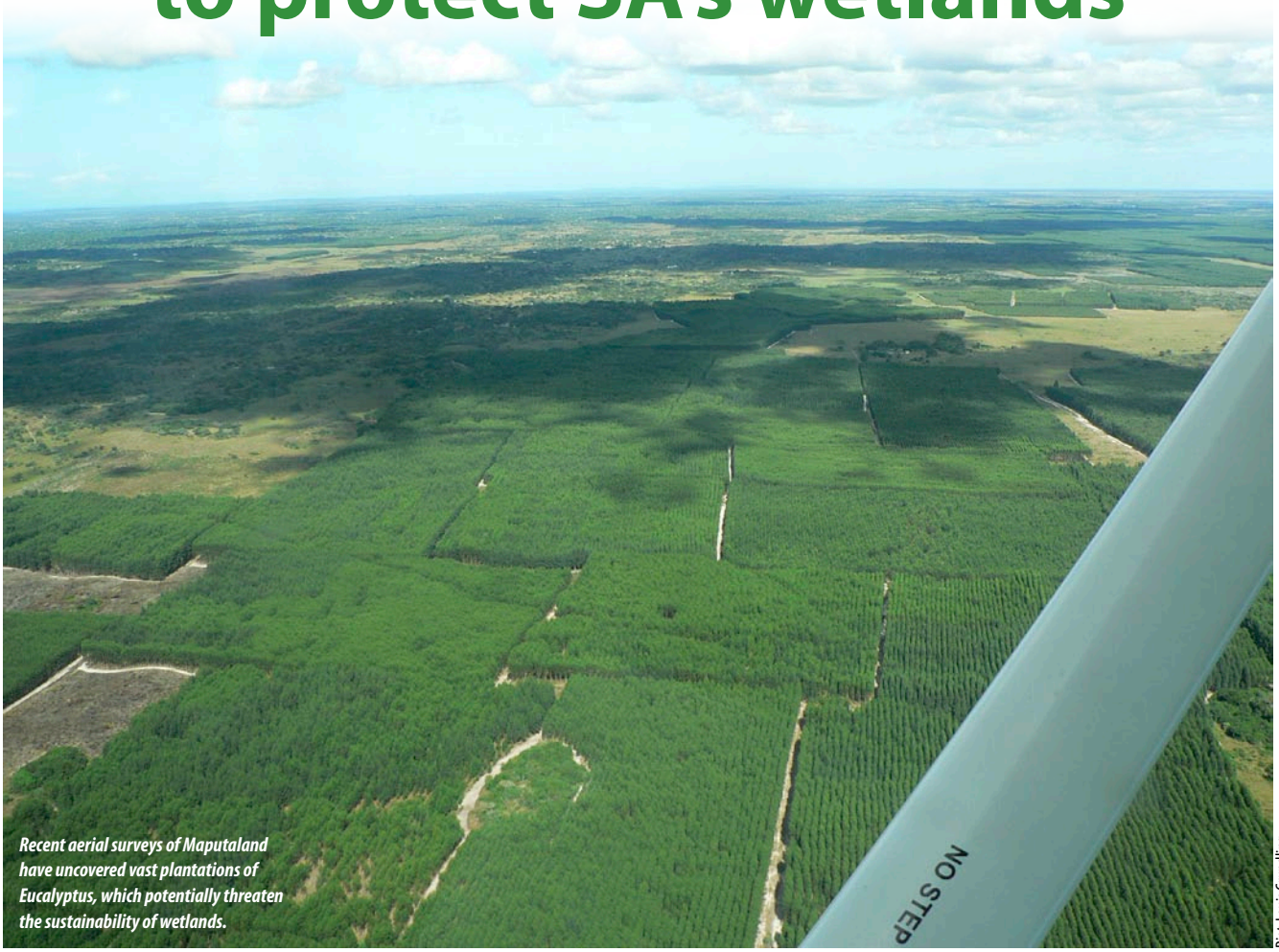
A placaat of 1714 called for slaves to dump waste in the sea, but the long distances they had to walk usually meant that the canals were used as dump sites instead. The once pure Fresh River, the reason for the establishment of the VOC's supplies station, became unfit for drinking purposes.

In 1707, van der Stel procured 200 lead pipes from the VOC to bring fresh water from the foot of Table Mountain to the jetty. A four-jet fountain supplied local needs and Cape Town was, once again, as far as water was concerned, considered to be well catered for. A well in Greenmarket Square was the main source of water when the fountains ran dry. As the population increased, slaves had to collect water for their masters from springs on the mountainside.

By the end of the era, the once mighty VOC declined into near bankruptcy, leaving no money for improvements of the half-way stop to the East on the southern tip of Africa.

- **In the next issue, read about water supply under British rule and the work of non-governmental organisation Reclaim Camissa and others to transform water resource management in Cape Town.** ❑

WORKING TOGETHER to protect SA's wetlands



Recent aerial surveys of Maputaland have uncovered vast plantations of Eucalyptus, which potentially threaten the sustainability of wetlands.

Piet-Louis Grundling

Wetlands remain among the most undervalued water resources in South Africa. But the close working relationship between government's Working for Wetlands and non-government organisation The Bateleurs is helping to ensure that these precious water resources get the attention they deserve. Lani van Vuuren reports.

Surveying is an important part of identifying and prioritising wetlands which require rehabilitation and conservation. In South Africa, the process is led by Working for Wetlands, managed by the South African National Biodiversity Institute (SANBI). However, due to the extent of some wetlands, as well as their natural inaccessibility, it is not always possible, or logical, to survey an entire wetland, and its catchment, on foot.

Aerial surveys provide a clearer, 'birds eye', view of the extent of threats or problems facing each wetland and are used as precursors to ground surveys conducted during detailed planning by Working for Wetlands. Potentially, the hiring of aeroplanes and pilots to conduct these surveys could cost hundreds of thousands of Rands annually. However, thanks to The Bateleurs, who provides this service free of charge, this money can now be applied to the actual rehabilitation of wetlands.

The Bateleurs was established in 1998 by well-known environmentalist, the late Nora Kreher. It is one of the largest environmental, flying, not-for-profit organisations in Africa. With over 145 volunteer pilots and aircraft, it has coordinated hundreds of missions, throughout ten countries, in support of environmental issues.

CLOSE WORKING RELATIONSHIP

Both parties agree that the relationship built between The Bateleurs and Working for Wetlands over the last four years has been a fruitful and productive one. "We flew our first mission for Working for Wetlands in August 2006, and since then we have flown a number of missions for them every year," notes The Bateleurs' Joan Cameron.

"Both organisations share a mutual vision of protecting the environment," says John Dini, SANBI Director: Freshwater Programme. "Without The Bateleurs, we would have a tough time establishing an aerial perspective of catchment condition and degraded wetlands that may be candidates for rehabilitation. In addition, the funding that would otherwise be used for aerial reconnaissance is now channelled towards additional rehabilitation work, which allows more people to be employed and the programme's social and environmental benefits to be expanded."

Between six and 15 surveys are conducted across the country each year. Information gathered from these surveys is used to plan rehabilitation projects in succeeding years. In 2010, reconnaissance was undertaken in the Spitskop, Harts and Borakalalo catchments in North West, the Maputaland Coastal Plain in KwaZulu-Natal, the Mutale catchment and Waterberg area in Limpopo and the Maluti catchment in the Free State. The aerial surveys have enabled degraded wetlands to be systematically prioritised for closer investigations, saving planning teams literally weeks of tedious and expensive time on the ground.

COLLECTION OF CHALLENGES

One of the most significant benefits of aerial reconnaissance it that it gives Working for Wetlands planners a clearer picture of the overall state of the catchment. "Often the source of a problem impacting a wetland may be some distance away, and seeing things from an aeroplane rather than on the ground sometimes makes it much easier to link cause with effect," says Dini. Historical impacts such as old channels dug to drain wetlands also become easier to see from the air. "At times these channels have become overgrown by vegetation and one might never find them on the ground unless one accidentally falls into them."

"The funding that would otherwise be used for aerial reconnaissance is now channelled towards additional rehabilitation work, which allows more people to be employed and the programme's social and environmental benefits to be expanded."

By far the most common reason for wetland degradation surveyors come across is erosion, either in the wetlands themselves or upstream of them. While erosion is a natural process, poor land management and badly designed infrastructure can easily trigger or exacerbate the problem, which leads to soil loss many times greater than the natural baseline. As they usually occur at the lowest points in catchments, wetlands are also on the receiving end for sediment and pollutants originating from higher up in the area.

Each region also produces its own challenges. In the swamp forests of Maputaland, for example, slash and burn practices impact heavily on wetlands, while other wetlands are impacted more heavily by overgrazing, agricultural activities, urban development, bush encroachment and/or illegal damming or mining practices.

"It is important to realise that the wetland degradation we see during flights is never because of just one impact, rather it is a fusion of factors and excessive demands placed on natural resources," notes Dini. While Working for Wetlands can rehabilitate the wetlands, it will continue to work with and support other government entities and stakeholders to take action against the factors which caused degradation in the first place. ❑

From the air the extent of environmental destructive activities such as mining can clearly be seen.

The Bateleurs

www.sxc.hu

The importance of producing IMPACTFUL RESEARCH

'Getting science heard' and 'being real, relevant and impactful' are rhetoric that scientists are faced with on an ongoing basis. But how does one successfully cross the science-policy divide? Shanna Nienaber and Nikke Funke explore the options.

The pressure to achieve impact is related to three main issues. Firstly, the South African water sector faces many challenges that need to be addressed through effective policy development and implementation. Thus, sound evidence, based on researched consideration of issues and solutions, is an important input to policy development and implementation.

Secondly, impact is often related to fulfilling a personal desire to 'make a difference' with our work. Thirdly, pressure to achieve impact stems from the more pragmatic issue of funding. Funding agencies, organisational leadership and policymakers need scientists to prove that the science we produce makes enough of an impact to merit further funding in future.

This emphasis and pressure around achieving impact has led to a policymaking discourse known as evidence-based-policymaking (EBPM), which aims to align science and policy to generate responses that are relevant, real and impactful to the multiple challenges, needs and issues facing society today. This rhetoric has become prominent in many countries, and is evident in many of our government departments in South Africa.

Traditionally, the EBPM discourse has constructed policy development as follows:

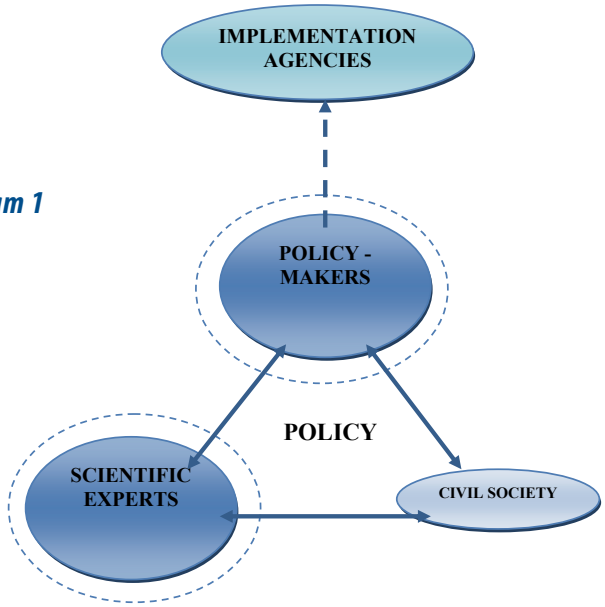


Diagram 1

Diagram 1 illustrates that policy is seen as the result of interaction between three groups of actors. Official policymakers formulate policy, with the support of inputs from civil society and scientific experts. Once formulated, this policy is handed over to implementation agencies (which serve official policymakers) to be implemented. Significant to this conceptualisation is the reality that science is seen to have a privileged place in terms of input to policy. It is seen as something removed from broader civil society.

However, despite the obvious value of incorporating robust evidence into policy, and over a decade of research about EBPM, there is an ongoing lack of scientific evidence being utilised in policymaking processes. Achieving impact with science is proving to be easier said than done.

RESPONDING TO THIS PROBLEM

Our research suggests that inadequate evidence uptake into policy occurs due to simplification and misconstruction of the complex environment in which evidence input into policy takes place and plays out. To remedy this, it is necessary to have a more detailed and holistic understanding of the multiple actors, linkages and power relations in the policy process.

Diagram 2 essentially poses a challenge to the traditional EBPM policymaking construction by suggesting that there are not three, but two complex groups of actors who formulate policy: official policymakers and civil society/non-government actors.

What are the implications of this recommended reconstruction of how to interpret policymaking? Research no longer holds a privileged position in the policymaking process. It is recognised to be part of (rather than distinct from) the many civil society inputs into policy. Those actors interested in water policy issues all have differing amounts of power and ability to influence and thus have to compete and collaborate to 'be heard'.

APPLYING THE COMPLEX POLICYMAKING MODEL

The development of policy in democratic South Africa is a complex process. Successful policy development necessitates that a variety of very different actors are all given a platform to voice their ideas and needs. All these actors need to develop positions on the issue, work together to develop the policy, make compromises when there are

"Research no longer holds a privileged position in the policymaking process."

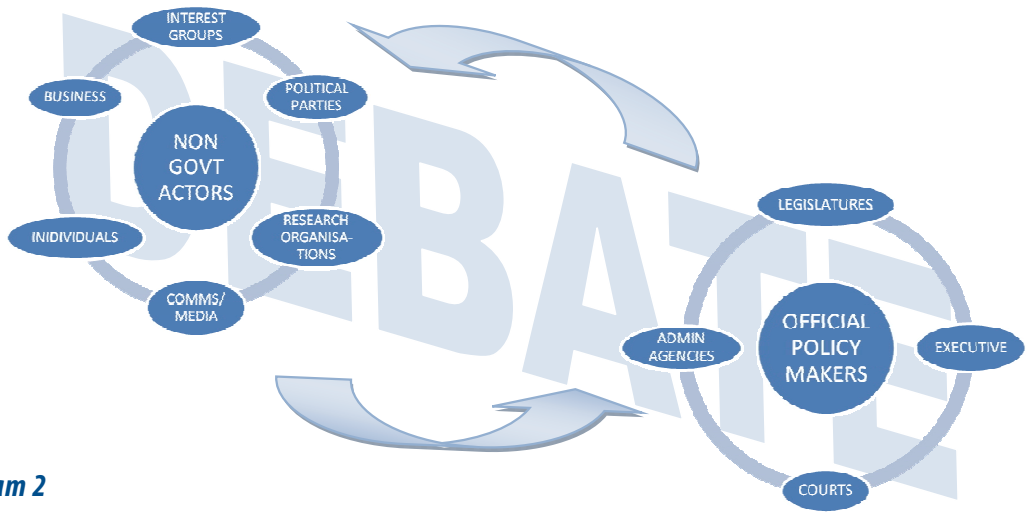


Diagram 2

Institutional weaknesses – Department of Water Affairs	Lack of inter-sectoral coordination	Lack of stakeholder participation
• High rate of staff turnover results in an overstressed government departments. • Loss of staff members means that existing knowledge is not being transferred to new recruits.	• Although water- and land-use are linked to each other, they are administered under different legislation and line departments. • The DWA has very little control over land-use activities.	• No strong culture of participation in South African government processes exists and where stakeholders do participate, some have considerably more power than others.
Result: This negatively impacts on the department's ability to implement water policy mechanisms, such as water licensing.	**Result:** This fragmentation results in a lack of holistic planning and management when it comes to land-use activities (such as agriculture, mining, construction) that impact on water quality and quantity. The effects are serious environmental problems such as acid mine drainage and eutrophication.	**Result:** This may be one of the reasons why the catchment management agencies, which are based on the principle of stakeholder participation, are for the most part not yet functioning actively.
Implications for scientists • Scientists can find it very frustrating to engage with a government department that is not functioning effectively. A problem also exists with relationship building and knowledge transfer because of the high staff turnover. • It is difficult for scientists to communicate research findings aimed at addressing cross-cutting problems of land- and water-use to policymakers from different sectors if the different sectors do not cooperate with each other. • Scientists will find it difficult to influence policy in a situation where many actors are competing to make their voices heard and get their interests onto the agenda.		

"It is one thing to be present in a debate; it is another thing to have a voice that will be listened to, considered and respected."

conflicts of interest, and in reality need to 'jostle to be heard'.

When analysing a policy development process and outcome it is critical to be aware of issues of representation. Who was present and who was not? Similarly, issues of 'voice' or 'quality of consultation' need to be considered. It is one thing to be present in a debate; it is another thing to have a voice that will be listened to, considered and respected. This relates closely to issues of power.

The development of post-1994 water policy in South Africa is an excellent way of illustrating the complex spectrum of actors competing to be heard in a policy debate. In many ways this policy development process is considered to be highly successful as a large number of stakeholders, legal practitioners, environmental scientists and politicians agreed on a set of world-class, highly-progressive water principles to accommodate environmental protection and socioeconomic development priorities.

IMPLEMENTATION CHALLENGES FACING SOUTH AFRICAN NATIONAL WATER POLICY

Despite the fact that the water policy developed in South Africa is considered to be world class, a number of challenges to implementation remain. These also have implications for scientists trying to influence policy implementation (see table above).

RECOMMENDATIONS FOR FUTURE PROGRESS

Despite the obvious challenges and complexity around this issue of impact and evidence uptake into policy remains an important aspiration. There is no clear cut solution as to how the science-policy divide can be bridged. This being said we leave you with a few last reflections about how to begin to overcome this divide both in out minds and in practise.

- Building relationships and networks with actors in the policymaking arena is critical to achieving impact. Only by building alliances can research interests hope to tip delicate balances of power in their favour.
- Scientific research must recognise that it does not necessarily hold a more privileged position than any other actor in civil society. It is not isolated from others in the policymaking process.
- Building relationships, networks and trust to bridge the science policy divide is a time-consuming process. Research organisations need to create space and career incentives for scientists to pursue this task.
- Stakeholder engagements, integration and networking needs to be included in research from its planning phases in order to foster commitment, understanding, co-operation and trust.
- Scientists and other civil society actors need to work at deepening their understanding of the complexity of the policymaking arena and process. ❑

Darian Pearce

CLIMATE CHANGE in a climate of change

These days the terms 'climate change' and 'integrated water resource management' are bandied about with total abandon. However practical knowledge and experience of these concepts, and especially how they interrelate are often still lacking. Words by Darian Pearce.

While climate change is not a new concept, knowing what the term means is a far cry from understanding the specific impacts this phenomenon might have. The general consensus is that it is going to get hotter, the glaciers will melt and sea levels will rise, but it is from this point onwards that the opinions begin to diverse.

Integrated water resource management is in essence a big high five to the realisation that our dependence on and relationship to clean drinking water permeates through every level of our human society and that in order to be managed effectively we need to adopt a holistic approach. While most water professionals understand the logic behind this concept, knowledge gaps remain.

Darian Pearce

Prof Yongxin Xu, head of the UNESCO Groundwater Research Group at the University of the Western Cape welcomes attendees to the course.

The identification of gaps in the knowledge market was the key motivator that spurred the University of the Western Cape's (UWC's) Groundwater Research Group to organise the Climate Change and Integrated Water Resource Management short course. The course, organised in collaboration with the Water Research Commission, was conducted at the university's Belville campus in August this year.

Heading up the organising committee for the course were Extraordinary Professor of Geohydrology, Eberhard Braune of the University of Pretoria and Prof Yongxin Xu, head of the UNESCO Groundwater Research Group hosted by the Department of Earth Sciences at the UWC.

The course was held over three days, and drew a wide range of attendees from as far afield as Mozambique, Malawi, the Democratic Republic of Congo, and Sudan, among others. According to assistant member of the organising committee, Zayed Brown, they were inundated with applications right up until the closing date. "There is a real hunger out there for knowledge about climate change, and it is good to know that there are people willing to work for the betterment of Africa."

The presenters, a true reflection of integration, represented a wide range of expertise and organisations. Prof Roland Schulze, Professor Emeritus of Hydrology at the School of Bioresource Engineering and Environmental Hydrology at the University of KwaZulu-Natal conducted a remarkable presentation as he delved into the complex mechanisms of the weather and climate systems that drive hydrology. In turn, Dr Gina Ziervogel of the Climate Systems Analysis Group at the University of Cape Town expanded on her group's work aimed at understanding the vulnerability of impoverished communities to climate change and natural disasters.

A plenary session by Prof Braune on the final day of the course provided an opportunity for the attendees to provide feedback and to give their impressions on the course in general. A comment that recurred time and time again was that there needs to be a greater effort, in South Africa, and Africa in general, to apply the knowledge that we produce through our research. It was stated that in Africa, too often scientists take their lead from the politicians, and that it was time for politicians to take more advice from scientists.

Short courses such as this one, akin to conferences, seminars and similar academic exercises, present an excellent opportunity for industry professionals to immerse themselves in a wealth of expertise. Conversation, it seems, may the first and most essential step on the road towards integration. ❑

WATER Kidz

Rain, rain don't go away!

It is summer again and over the majority of the country this means time for summer rains.

Unlike many other countries, South Africa is not well endowed with water resources. This has much to do with our annual rainfall, at a yearly average of only 464 mm much less than the world average of 860 mm.

Over much of South Africa, summer (mid-October to mid-February) is characterised by hot, sunny weather – often with afternoon thunderstorms that clear quickly, leaving a warm, earthy, uniquely African smell in the air. The Western Cape, with its Mediterranean climate, is the exception, getting its rain in winter.

Unfortunately, South Africa is also known for its extreme climatic events, such as floods and droughts.

SO HOW DOES RAIN FORM?

Rain is a form of precipitation, just like snow, few, frost, hail and the like. Water droplets form from warm air, which rises in the sky and then cools. Water vapour (invisible water) always exists in the air, especially in warm air, which can hold more water than cold air. When enough of these droplets collect, we see them as clouds. If the clouds are big enough and have enough water droplets, the droplets form even bigger drops. When these drops get heavier, they fall as rain.

WHY IS RAIN IMPORTANT?

Water is the most important substance needed to sustain life. Water, in the form of rain, forms an integral part of the hydrological cycle. It feeds the rivers, fills in oceans and seeps into the ground. Without rain we will not be able to keep our rivers flowing, fill our dams, grow our crops, or feed our underground resources.

CLIMATE PHENOMENA

In South Africa, our rainfall (or lack of it) is often influenced by climate phenomena such as El Niño and El Niña. The Pacific Ocean is a huge mass of water which can control many climate features in its region, since changes in the ocean result in characteristic changes in the atmosphere. In turn, this alters climate and weather patterns across the globe (including South Africa).

El Niño (Spanish for 'little boy') is the warming of sea-surface temperatures in the

MAKE A CLOUD IN A GLASS

For his experiment, you will need:

1 A clear glass
2 Warm water
3 Ice
4 Metal dish

Instructions:

1 Place the ice into the metal dish.
2 Pour a small amount of warm water into the bottom of the glass.
3 Wait until the fish is really cold. Then place it on top of the glass.
4 Watch the inside carefully. You should see a 'cloud' form near the top of the glass.

Source: WMO

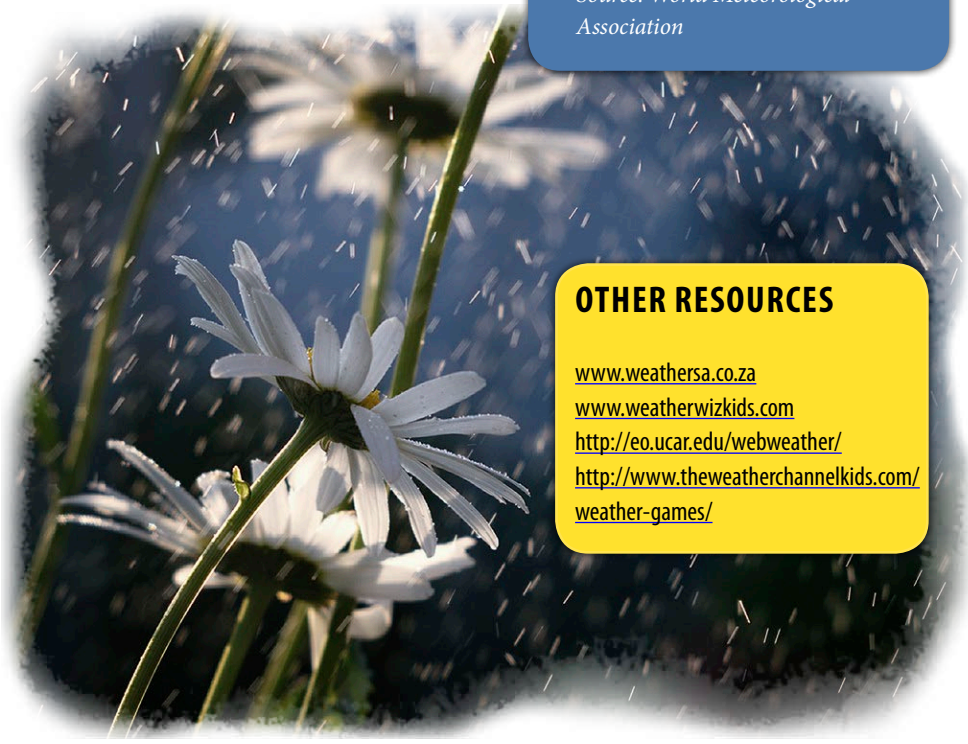
equatorial Pacific Ocean which influences atmospheric circulation, and consequently rainfall and temperature. For South Africa this usually means hot temperatures and less rainfall. In other parts of Africa, notably on the eastern coast, the El Niño phenomenon has been known to cause heavy rainfall and floods.

El Niña (Spanish for 'little girl') is the cooling of sea-surface temperatures in the equatorial Pacific Ocean which influences atmospheric circulation, and consequently rainfall and temperature in specific areas around the world. The effects of El Niña tend to be opposite to those of El Niño.❑

DID YOU KNOW?

- Every minute of the day the Earth receives about 900 million tons of rainfall.
- Réunion, a small island in the Indian Ocean, holds the record for receiving the most rain in a week's time. It was set in February 2007 when a powerful storm poured more than 5 metres of rain on the island.
- The lowest recorded rainfall in the world is in Arica, northern Chile. On average, less than 1 millimetre of rain falls every year.
- The heaviest annual rainfall in the world was recorded at Cherrapunji, India, where 26 470 millimetres of rain fell between August 1860 and 8 January 1861.

Source: World Meteorological Association



OTHER RESOURCES

www.weathersa.co.za
www.weatherwizkids.com
http://eo.ucar.edu/webweather/
http://www.theweatherchannelkids.com/weather-games/

SEE A RAINDROP

For this experiment, you will need:

A shoebox lid
Flour
Fine mesh sieve
Ruler
Bowl

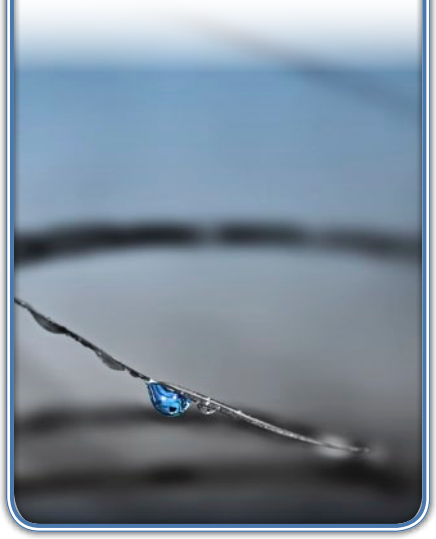
Instructions:

1 Fill the shoebox lid with flour.
2 Use the ruler to smooth out the top, so that it is level.
3 When it rains, hold the shoebox lid out in the rain until about 15 to 25 raindrops have fallen into the flour. Bring the lid inside to see what you have found.
4 Set the sieve over the bowl. Carefully pour the flour from the lid into the bowl. Shake the sieve gently.
5 The little lumps left behind are preserved raindrops. Carefully dump them out onto a table and measure them.

Explanation:

Most raindrops are relatively small because big ones usually break apart as they fall. Raindrops usually vary in size from 0,2 mm to 0,6 mm in diameter. The world's biggest raindrop fell near Hilo, Hawaii. It only measured 8 mm across (that's smaller than your baby fingernail).

Source: www.weatherwizkids.com

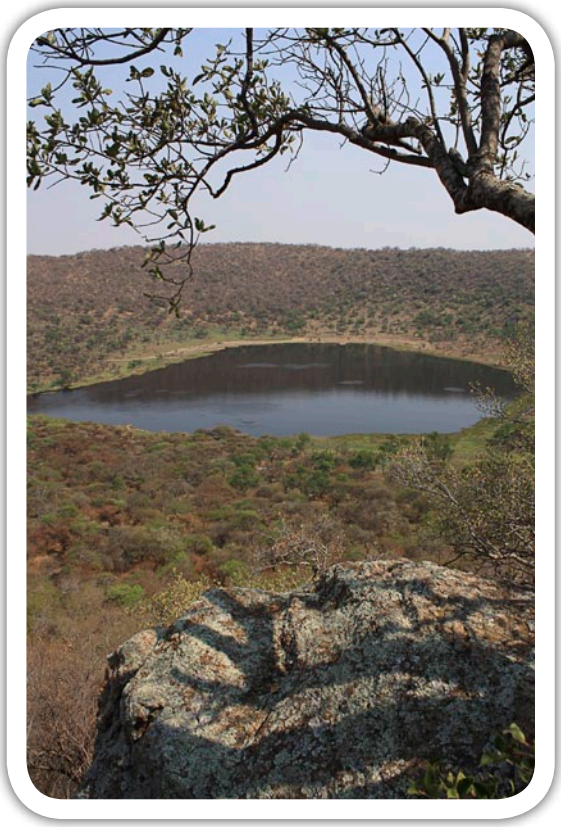


Heritage-biodiversity link celebrated at historical site

The historical Tswaing Crater Museum outside Pretoria served as the venue for the Biodiversity and Heritage Seminar held earlier on 17 September. The event, with the theme 'Biodiversity is life – biodiversity is our life' was organised jointly by the Department of Water Affairs, the Water Research Commission (WRC) and Ditsong Museums of South Africa. All of the speakers pointed out that South Africa's biodiversity should be regarded as just as important as the heritage of the nation's different cultures, and that all people should be able to enjoy the country's rich natural resources with sustainability in mind. During the event the WRC publication, *The Journey of Mma Tshepo*, about the life and work of social activist Tshepo Khumbane, was also launched.

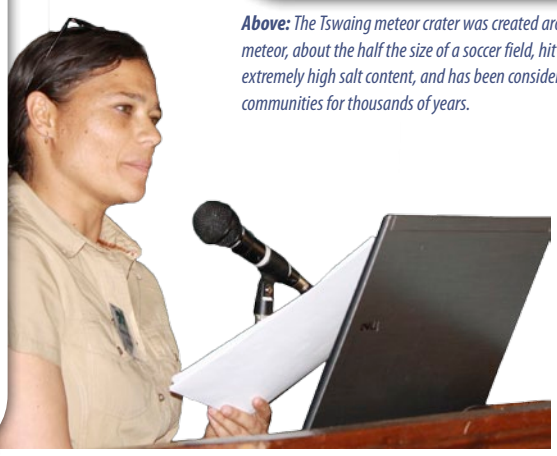
Above: *Delegates were treated to a tour to view the Tswaing meteor crater. Leading the tour was Julia Barns (with yellow T-shirt).*

Left: *Social activist Tshepo Khumbane addresses the crowd following the launch of the book on her life.*



Above: *The Tswaing meteor crater was created around 200 000 years ago when a meteor, about the half the size of a soccer field, hit the Earth. The crater lake has an extremely high salt content, and has been considered a holy place by indigenous communities for thousands of years.*

Left: *Traditional healer Japhta Semenya demonstrates how roots and other plant material are collected from the area around Tswaing. Healers often come to pray at the crater lake, while the salts from the water are used for medicinal purposes.*



Left: *Keynote speaker Eleanor McGregor, Director: Conservation at the Gauteng Department of Agriculture and Rural Development.*

All photographs by Lani van Vuuren

THE WATER WHEEL

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- Water Use and Waste Management
- Water Utilisation in Agriculture
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