THE WATER WHEEL

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SA's peatlands facing extinction

WATER RESEARCH COMMISSION

11th International Symposium on River Sedimentation (ISRS)
6 to 9 September 2010, Stellenbosch, SOUTH AFRICA

Sedimentation and Sustainable Use of River Systems

Organiser: University of Stellenbosch
Sponsors: International Research and Training Centre on Erosion and Sedimentation (IRTCES), World Association for Sedimentation and Erosion Research (WASER), UNESCO, ICOLD, IAHS and South African Water Research Commission (WRC)
Secretariat: University of Stellenbosch
Permanent Secretariat: IRTCES

Visit the symposium website: www.civeng.sun.ac.za/isrs
Deadline for registration is 31 July 2010

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***Cover**: Peatlands, South Africa's premier natural water and carbon stores, are threatened as never before. See article on page 14.*

Letters to the Editor

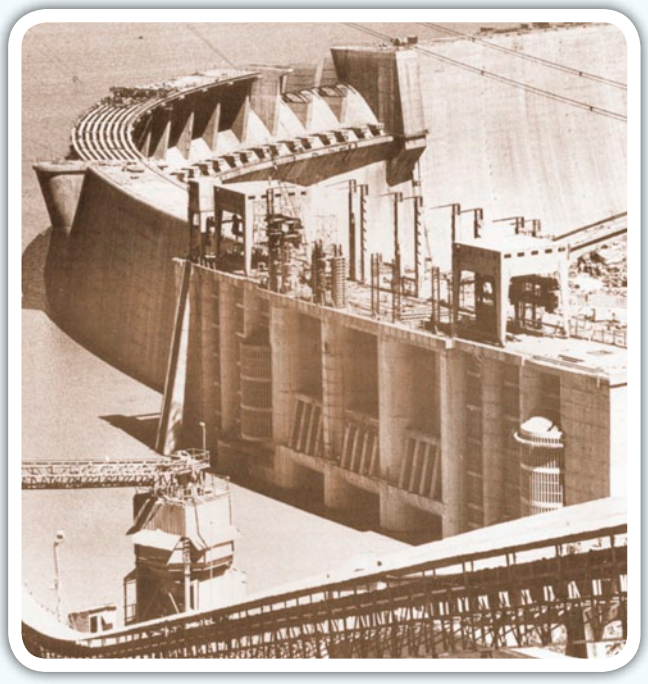
Gariep Dam: a few insights

Your article on the Gariep Dam in the latest *Water Wheel* (May/June 2010) refers. I came on to the project in May 1963 in the London design office of Sir Alexander Gibb under the direction of Dr Henry Olivier and after a spell in the design office came out to the site in 1967 and stayed until initial commissioning in August 1971. So I have a few insights and comments that may be of interest.

There were two consulting teams involved. IORCC as you mentioned, which did the townships and the French part of the consortium did the arch dam. The second firm was a British/South African team of Sir Alexander Gibb and Partners and Hawkins, Hawkins & Osborn who operated as Gibb Hawkins and Partners (GHP). We were responsible for all the hydraulic structures including the spillways and all the other outlets and control structures. We also developed the operating systems for the spillways. IORCC led the site team at Gariep and GHP led the site team at Vanderkloof.

When we started the dam was called Ruigtevallei and the Hendrik Verwoerd name came later. I am not sure whether the name Gariep is absolutely accurate as it has always been my understanding that the Gariep was that section of the Orange River downstream of the confluence with the Vaal. It may be worth checking this one. Not that I do not like the name as I actually object to dams being named after politicians. The Americans get round this in 95% of cases by naming the reservoir or lake after a politician while the dam retains its locality name. That is why their dams have such lovely names such as Hungry Horse, Grand Coulee, Oahe, Fort Peck etc.

The scope of the project as outlined in the 1962 White Paper was far greater than has actually been implemented since. This is particularly true of the extent of the irrigated areas to the west. There has been virtually no transformation of the desert. It is also worth bearing in mind that Gariep Dam is the major regulator but the canal supplies would always come from the Vanderkloof Dam and the Orange Fish Tunnel. The only water supply from Gariep was a provision for a pipeline to Bloemfontein which was never implemented.



Dam locations were determined by the Department of Water Affairs and we as consultants had no say in the choice. We did challenge the choice of dam and our analyses showed that a curved gravity dam would be about 30% cheaper. However, to quote the then Secretary of Water Affairs, "arch dams are the flavour of the month" and so we had to design a double curvature arch in a valley that is much too wide for that type of dam hence the large gravity abutments you refer to. Even then the double curvature arch is thick by normal standards and had to incorporate a special heel structure to make it work. It all added to the cost. An artist's perspective of the curved gravity dam was every bit as elegant as the present dam. The Vanderkloof site is much more appropriate for a double curvature structure.

Your reference to the February 1967 flood is rather confused. The flood peak was 8 500 m^3/s as you stated. However, the reference to the 150 mm of rain in 12 hours refers to the design storm and the 31 350 m^3/s to the peak flood for which the spillways were designed. Hopefully we will never get that but the dam will handle it quite safely. The 1967 flood did very little damage except to flood the right bank cofferdam where the foundations of the dam were still being excavated.

We also managed to persuade Eskom to enlarge the hydro-electric station from the original 62 MW to 360 MW which has proved a very wise decision as it helps with the efficiency of the high voltage power line to the Cape and can generate short-term peak power.

I need to dispel a popular myth about the pressure of the water against the dam wall. It is purely a function of the depth of the water and has nothing to do with the vast volume of water that the dam retains. Yes, the wall does deflect under the load but if you placed a strip of water 90 m deep and 1 m wide against the face of the dam the effect would be exactly the same as having 70 km of water behind the dam. All dams deflect under the pressure of the water and measuring these deflections is one of the best ways of determining whether or not the dam is behaving correctly.

I would comment also that the case study of the Orange River Project by the World Commission on Dams contains a number of factual inaccuracies which I tried to get them to correct but without success. (The same holds true for the study of the Indus Basin Project in Pakistan with which I was also involved). So I remain sceptical about the report.

Robert Blyth, Newlands

Be careful of 'tamed' rivers

I read your excellent article on 'Gariep - The dam that tamed the Great River' in the May/June 2010 issue.

While it is true that a dam provides a greater measure of regulation of the flow in a river, I am concerned that the public has a misconception that a dam "controls" or "tames" a river. The main function of a storage reservoir is to store water in periods of surplus flow and release it during periods of low flow and high water demand. Many reservoirs are able to reduce flood peaks by virtue of the temporary storage of water above the full supply level. There is a point at which the flood is so large (extreme) that the degree of flood peak reduction is relatively small. The public often has the misconception that those downstream of large dams are no longer prone to flooding and we see many instances of illegal developments within the floodplain. I therefore consider it important that we always qualify our statements in the media regarding the effectiveness of dams and point out their limitations in "controlling or taming" rivers.

Paul Roberts, Secretary: South African National Committee on Large Dams

Water by numbers

R1,4-billion – The monies owed by municipalities to water boards in May 2010, of which R704-million is debt in arrears. The water boards owed the most are Bloem Water, Botshelo Water, Bushbuckridge Water, Lepelle Northern Water and Sedibeng Water.

38 – The number of water treatment systems which obtained the Blue Drop Award for the 2010 assessment cycle. A total of 94% (787) of the country's water treatment plants were assessed.

87% – The percentage of the global population who gets their drinking water from improved sources.

751-million – The number of people worldwide who share their sanitation facilities. In sub-Saharan Africa 31% of the population share toilets.

200 000 Mℓ – The volume of bottled water produced every year in the world.

21 – The number of towns in South Africa where rate payers have declared disputes with local municipalities over non-delivery of services. In 24 towns rates and taxes are being withheld and instead being paid into trust accounts.

90% – The percentage of wastewater in developing countries that is discharged untreated into rivers, lakes or oceans, according to the UN.

672-million – The number of people who will still lack access to improved drinking water sources in 2015, according to a report released by the World Health Organisation and the United Nations Children's Fund.

98,4% – The score achieved by Johannesburg Water in the 2010 Blue Drop assessment. Johannesburg achieved the highest score in the country.

New WISA division caters for small sewage works

A new division aimed at building relationships between various stakeholders in the small wastewater treatment works sector has been established under the auspices of the Water Institute of Southern Africa (WISA).

The Small Wastewater Treatment Works (SWWTW) Division, which was officially launched in Durban earlier this year, will deal with issues and best practice around both package plants (i.e. plants built off-site prior to implementation) and small (< 2 Mℓ/day) sewage plants constructed on-site. According to SWWTW Chair Dr Valerie Naidoo, previous engagements between authorities and operators of small plants have highlighted a certain level of frustration, distrust and confusion relating to regulation, standards, and roles and responsibilities of professionals working in this field. "The new division aims to build relationships between the various roleplayers, which will ultimately lead to better consensus with regards to designing, managing, operating, maintaining, supplying and regulating small wastewater treatment works. At the same time this will lead to improved protection of the environment and society through responsible application and maintenance of appropriate technologies."

The division, which is made up of ten members and a chairperson, has undertaken to provide a number of activities, services and initiatives to this specific community within the sector. Among others, the division will be scrutinising the newly-endorsed Department of Water Affairs package plant guidelines and the Water Research Commission *Process Design Manual for Small Wastewater Treatment Works* and facilitate the rollout and review of the documents by the sector. Members will also look at the formation of a package plant supplier association, which will allow the division to engage the numerous professionals more constructively when seeking feedback for a number of planned activities.

For more information, visit: **www.wisa.org.za/TDSWWTW**

Rural produce found to be hazardous to human health

Researchers have expressed concern over the safety of fruits and vegetables grown by subsistence farmers where minimal water and sanitation infrastructure exists.

This after studies of tomatoes grown by small-scale farmers in Limpopo showed them to be riddled with disease-causing bacteria and opportunistic pathogens.

Researchers from the universities of Johannesburg and Venda examined tomatoes from communal farming fields in the Vhembe district as well as the river water used for irrigation. Communities living in the district consume fruits and vegetables such as tomatoes and cabbages which are grown in community field farming projects. The farming fields are irrigated by water from nearby rivers, which are surrounded by settlements and used by cattle and other domestic animals. No toilet facilities exist resulting in people having to defecate in the open. When it rains these wastes are washed into the rivers. People also use the rivers for drinking, bathing and recreation.

The tomatoes and irrigation water samples were tested for a host of bacteria, including faecal coliforms, pathogenic *E. coli, Staphylococcus*, *Salmonella* spp. as well as several viruses such as rotavirus and hepatitis A. A variety of opportunistic pathogens were identified from the food products as well as the water sources and indicate the potential risk of infections and diseases such as meningitis, bacillary dysentery, typhoid, respiratory infections, urinary tract infections, pneumonia, gastroenteritis and food poisoning. "This could have serious consequences if hygiene, water and sanitation infrastructure and practices are below standard in these communities," say the researchers.

The study was presented at the biennial conference of the Water Institute of Southern Africa in Durban in April.

Municipality takes ownership of wellfield

Overstrand Municipality has taken ownership of a wellfield that is set to significantly augment its existing water supply.

The wellfield, which yields 1,6 million cubic litres of high-quality water a year, was officially handed over by Umvoto Africa in May. The earth sciences consultancy originally sourced the wellfield six years ago, implementing a groundbreaking modelling, monitoring and management system that has received local and international attention.

The project incorporates a sophisticated telemetry system that enables the municipality and Umvoto staff to monitor the system from the comfort of their offices. Should there be any potential problems, the system automatically sends an SMS alarm message to staff. The project also incorporates satellite image monitoring, and modelling systems for monitoring abstraction impacts.

The Overstrand area has seen a huge increase in annual water demand in recent years – from 2 million m^3 in 2000 to 4 million m^3 in 2008. This while the local De Bos Dam can only provide an allocation of 2,8 million m^3/year to the municipality. To overcome water shortages the municipality has embarked on a two-pronged approach, namely conserving existing water supplies while searching for alternative water sources.

Interventions have included reducing water leaks, clearing alien vegetation, rolling out community awareness campaigns, and encouraging water-wise gardening. In addition, millions of litres of treated effluent are now being used to water the local golf course.

Water on the web

www.isarm.net
The worldwide Internationally Shared Aquifer Resources Management (ISARM) Initiative is an initiative of UNESCO and the International Association of Hydrogeology (IAH) aimed at improving the understanding of scientific, socio-economic, legal, institutional and environmental issues related to the management of transboundary aquifers. Since its start in 2002, ISARM has launched a number of global and regional initiatives designed to delineate and analyse transboundary aquifer systems and to encourage riparian states to work cooperatively toward mutually beneficial and sustainable aquifer development.

www.cbd.int/protected
This newly-launched website for the programme of work on protected areas under the Convention on Biological Diversity provides important information, e-learning tools and forums for the community of experts working on protected area networks around the globe. The website also provides information on the values and benefits of protected areas, as well as access to over 1 000 tools and resources sorted by goals, searching through specific topics and types as well as language and geography.

www.peatsociety.org
The International Peat Society is an international non-governmental and non-profit organisation with 1 412 members from 29 countries. It is dedicated to fostering the advancement, exchange and communication of scientific, technical and social knowledge and understanding of the wise use of peatlands and peat.

Water Diary

SUSTAINABILITY
JULY 27-28
The Sustainable Water Resource Conference and Exhibition will be held at the CSIR Convention Centre. *Visit: www.waterresource.co.za*

LIMNOLOGY
AUGUST 15-20
The 31st Congress of the International Society of Limnology will be held in Cape Town. *Enquiries: Prof Johan Grobbelaar (Congress Chair), Tel: (051) 401-2263; E-mail: grobbeju.sci@ufs.ac.za or Visit: http://sil2010.ufs.ac.za*

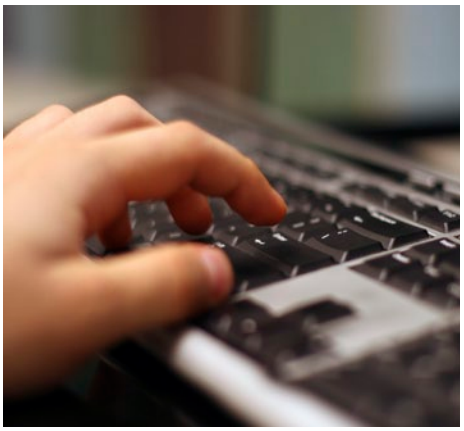
SCIENCE
AUGUST 31 – 1 SEPTEMBER
The 3rd CSIR Biennial Conference with the theme 'Science: Real and Relevant' will take place at the CSIR International Conference Centre in Pretoria. *Visit: www.conference.csir.co.za/*

MINE-WATER
SEPTEMBER 5-9
The International Mine Water Association's Annual Conference will take place in Nova Scotia, Canada. The theme for the conference is 'Mine Water and Innovative Thinking'. *Visit: www.imwa2010.cbu.ca*

WATER QUALITY
SEPTEMBER 5-11
The theme of the 2010 World Water Week in Stockholm, Sweden, is 'The Water Quality Challenge'. *Visit: www.worldwaterweek.org*

SEDIMENTATION
SEPTEMBER 6-9
An International Symposium on Sedimentation and Sustainable Use of River Systems will be held in Stellenbosch. *Enquiries: Marechia Basson; E-mail: msb@aspt.co.za; Visit: www.civeng.sun.ac.za/isrs*

Freshwater info a keystroke away with new Web resource



A valuable new data resource for freshwater practitioners is now available.

The resource, which takes the form of a Web-based database, 'Biobase', for the first time makes historical freshwater data available electronically in a single catalogue.

Research on the ecological aspects of rivers in South Africa began in the early 1950s and was followed by a number of studies in the following decades, reports Dr Helen Dallas of the Freshwater Consulting Group (FCG) at the University of Cape Town. "Availability and accessibility of these documented studies are often problematic since much of the early work was published in reports that are not readily available."

Many recent studies use historical data from earlier studies, which enable comparisons of biological and/or physico-chemical data between current and historical conditions to be made and the degree of change in, for example, water quality, to be ascertained. In 1998 a database was developed comprising biological (macroinvertebrate) and physico-chemical data derived from documented studies of riverine ecosystems within South Africa. This first version of Biobase used Microsoft Access 97 as a software platform. Unfortunately, the software became obsolete resulting in the database becoming inaccessible to most users.

The Biobase has now been upgraded to run on the same platform as the Rivers Database – the national data management and storage facility for river health data collected in South Africa. The Rivers Database was originally developed for the River Health Programme (RHP). "Access to the Rivers Database is free and readily available via registration on the Rivers website (www.riv.co.za/Rivers). Once registered and logged on, users can select 'Biobase' on the menu bar," explains Dr Dallas.

"There is also a user manual available for download from the Biobase menu bar option." The user manual, developed by the FCG and Soft Craft Systems, is also available in hard copy from the Water Research Commission.

The database, which collates a vast amount of information pertaining to riverine macroinvertebrates and physic-chemistry, has several useful applications. These include, among others, deducing ranges of different physic-chemical parameters for different taxa; assessing changes in community structure using historical records; examining biotope preferences of specific taxa; assessment of water quality guidelines and input into the Ecological Reserve; determination of macroinvertebrate reference conditions; development of conservation targets; and determination of the geographic distribution of taxa.

By linking the two information databases, valuable data in Biobase has now become available to all users. To further enhance the value of the data, Biobase sites within 5 km of RHP sites are indicated in the Rivers Web application. "By combining the entry point for the two databases, both the RHP practitioners and all other water sector contributors will benefit by having access to the Biobase and the vast amount of historical information it contains," says Dr Dallas. "The data in the Biobase are of huge value, particularly as it would be logistically and financially impossible to obtain a similar set of data today," concludes Dr Dallas.

Quest for biofuels ignoring biosecurity impacts – CSIRO

Important biosecurity issues are being ignored in the global push to develop new non-food crops for biofuels and industrial and pharmaceutical uses.

This is according to a report published by Australian science body, CSIRO. The report, compiled by representatives of ten developed countries who attended a recent biosecurity summit in Canberra, focuse on the broad biosecurity consequences of the twenty-first century non-food agriculture.

"The exponential growth in non-food crops could compromise conventional agriculture if it ignores issues such as the potential invasiveness of new crops, the effects of abandoned plantings of trial crops, new pests and diseases and pest management," reports CSIRO Entomology Scientist Dr Andy Sheppard.

According to Dr Piero Genovesi from the Italian Institute for Environmental Protection and Research, the European Union is becoming more aware of the risks associate with invasive species. "It is crucial that this new awareness leads to a revision of current biofuel legislation so that the biosecurity risks caused by mandatory targets for replacing fossil fuels with renewable energy are addressed."

The report stresses the role of science in developing and regulating sustainable crop-based biofuels. It also highlights the need for a global vision for future agricultural development around biofuels and international standards and certification for the industry to avoid repeating the environmental harm previous agricultural 'revolutions' have caused. The report also recognises that developing countries will need assistance to develop best management practices, protect their environment and undertaken risk assessments.

"While it is clear that biofuel-based rural industries can be beneficial, new non-food crops must meet the triple bottom line – people, planet, profit – criteria," concludes Dr Sheppard.


Samantha Setterfield

New tools to tackle wetland degradation

A new set of integrated tools to improve the management and rehabilitation of South Africa's wetlands are now available from the Water Research Commission (WRC).

The so-called *WET Management Series* of handbooks stems from the National Wetlands Research Programme, an initiative of the WRC. A number of partners contributed to the compilation of this set of tools, including the Department of Environmental Affairs, the South African National Biodiversity Institute, the Department of Water Affairs, Mondi Wetlands Project, provincial conservation agencies, universities and private enterprise.

Wetlands are fascinating and dynamic ecosystems that provide indispensable ecosystem services. They constitute about 7% of South Africa's surface area and support a range of ecosystems and services.

Because wetlands are transitional between aquatic and terrestrial ecosystems, they are vulnerable to impacts on both. In addition to direct impacts, such as draining for pastures and crops, or the construction of infrastructure such as roads that impede and concentrate water flows, there are also several ongoing impacts from pollution and erosion in catchments as well as from excessive water abstraction, loss of vegetation cover, climate change and land use change. Up to 60% of the country's wetlands have already been lost to degradation.

It is hoped that the *WET Management Series* will do much to safeguard the wetlands we have left. The series of booklets offer a sound scientific basis for planning, implementing and evaluating wetland rehabilitation, providing guidelines to develop an overall planning framework; assessing the condition of catchments and individual wetlands; assessing the functions and values of individual wetlands; evaluating the need for rehabilitation; identifying why wetlands degrade and what rehabilitation interventions are appropriate; guiding the selection and implementation of rehabilitation methods; and monitoring the success of rehabilitation projects.

To order any of these booklets (Report No: **TT 334/09** to **TT 343/09**) contact Publications at Tel: (012) 330-0340; or E-mail: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.

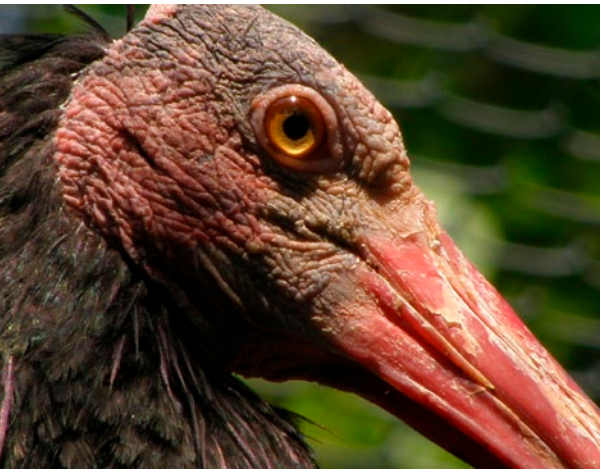
Water diary (continued)

GROUNDWATER
SEPTEMBER 12-17
The 2010 Congress of the International Association of Hydrogeologists will take place in Krakow, Poland.
E-mail: office@iah2010.org or Visit: www.iah2010.org

WATER
SEPTEMBER 19-24
The IWA World Water Congress & Exhibition will be held in Montréal, Canada.
E-mail: 2010montreal@iwahq.org

INDUSTRIAL WATER
SEPTEMBER 22-23
The WISA Industrial Water Conference will be held at Maccauvlei, Vereeniging.
Enquiries: Joey Swart (Conference Chair); E-mail: joey.swart@sasol.com

DAMS
SEPTEMBER 28-30
The 2nd Int. Congress on Dam Maintenance and Rehabilitation will be held in Zaragoza, Spain. Organised by the Spanish Society of Dams and Reservoirs in collaboration with the Ministry of Environment of Spain. *Visit: www.damrehabilitationcongress2010.com*



Global event highlights plight of migratory birds

Thousands of people in more than 40 countries across the globe participated in an UN-backed event in May to celebrate World Migratory Bird Day.

The day, held on 8 May, celebrated the beauty of bird migration and drew attention to the threat of extinction that some species of migratory birds face as a result of human activity. "The threat of extinction faced by individual bird species is a reflection of the larger extinction crisis threatening other species and the natural diversity that underpins all life on Earth," reported Bert Lenten, Executive Secretary of the African-Eurasian Migratory Waterbird Agreement and initiator of the World Migratory Bird Day campaign.

An estimated 1 227 or 12,4% of the total 9 865 bird species in the world are classified as globally threatened, and 192 of these are considered critically endangered. "World Migratory Bird Day is an opportunity to draw international attention to migratory birds around a central theme each year. The focus on the most threatened migratory birds in 2010 acts as yet another reminder to governments that more needs to be done internationally to conserve these species across their migratory ranges," said Executive Secretary of the Convention on Migratory Species, Elizabeth Maruma Mrema.

Some prominent examples of migratory birds in crisis include the slender-billed curlew, the northern bald ibis, the sociable lapwing, the waved albatross and the orange-bellied parrot, all of which are migratory and listed as critically endangered. The birds face a range of mainly human-driven threats, of which agriculture and invasive alien species are the most important. Hunting and trapping, logging, urbanisation, pollution and fisheries are also significant threats, with climate change increasingly becoming a factor.

Report a wake-up call to countries' failed efforts to secure biodiversity

The outcome of a recent study reporting on the failure by world leaders to make good on their commitments to reduce the global rate of biodiversity loss by 2010 should be used as an opportunity for countries, such as South Africa, to benchmark themselves against global progress.

This is according to South African researcher Prof Melodie McGeoch, one of the 41 co-authors of the paper, *Global Biodiversity: Indicators or Recent Declines*, published in the journal *Science* earlier this year. The paper found that specific targets made by world leaders through the 2002 Convention on Biological Diversity (CBD) have not been met, and that there is instead an alarming decline in biodiversity worldwide.

Prof McGeoch, a scientist at South African National Parks and an associated of the Centre of Invasion Biology (CIB) at Stellenbosch University, contributed insights about the influence of invasive species on global biodiversity along with colleague, Dr Di Spear, also of CIB.

Compiling over 30 indicators, including changes in species' populations and risk of extinction, habitat extent and community composition – the study found no evidence for a significant reduction in the rate of decline of biodiversity, and that the pressures facing biodiversity continue to increase. The synthesis provides overwhelming evidence that the 2010 target to reduce biodiversity loss has not been achieved.

"Our analysis shows that..biodiversity is still being lost as fast as ever, and we have made little headway in reducing the pressures on species, habitats and ecosystems," said lead author Dr Stuart Butchart, of the United Nations Environment Programme (UNEP) World Conservation Monitoring Centre and BirdLife International. "Our data show that 2010 will not be the year that biodiversity loss is halted, but it needs to be the year in which we start taking the issue seriously and substantially increase our efforts to take care of what is left of our planet."

"Since 1970, we have reduced animal populations by 30%, the area of mangroves and sea grasses by 20% and the coverage of living corals by 40%," reported UNEP Chief Scientist Prof Joseph Alcamo. "These losses are clearly unsustainable, since biodiversity makes a key contribution to human well-being and sustainable development, as recognised by the UN Millennium Development Goals.

The results from this study fed into *Global Biodiversity Outlook 3*, the flagship publication of the CBD, released in May, when government representatives from around the world met to discuss the 2010 target and how to address the biodiversity crisis.

Demand for frogs rising in West Africa

The demand for frogs for human consumption is rising dramatically in parts of West Africa. This is according to a report in the latest Bulletin of the Wildlife Trade Monitoring Network (TRAFFIC) .

In Burkina Faso, almost all frogs collected are consumed locally, with the African Tiger Frog (*Hoplobatrachus occipitalis*) the most frequently eaten species. Frogs are usually sold to market traders who fry the specimens for sale.

In Benin and Nigeria, frogs are transported to south-west Nigeria for sale. Thirty-two traders between them handled around 2,7 million frogs per year, most originating from the northern savannah regions of Nigeria and from neighbouring Benin, Chad and Niger.

In Malanville, Benin, frogs are collected exclusively for the Nigerian market. There, many fishermen have recently switched to catching frogs, not because of their higher profits, but because frogs can be sold in batches, providing a lump sum of income – around US$20 per sack.

There are already indications that this trade in frogs is unsustainable, e.g. in Burkina Faso, western Cameroon and eastern Nigeria, local people are reporting decreasing catches of frogs. While frogs are clearly an important food source in the region, currently there are no regulations in any West African country governing the harvest.

The authors have called for investigations into the farming of large species, such as the African Tiger Frog in West Africa in order for wild populations to be protected and to provide a source of local income.

Algae advances as 'green' alternative for improving water quality

Algae could be put to use as an eco-friendly option to remove nitrogen and phosphorus in livestock manure runoff, reports US scientist Walter Mulbry of the Agricultural Research Service.

In 2003, Mulbry set up four algal turf scrubber (ATS) raceways outside dairy barns in Beltsville, US. The shallow 30,5 m raceways were covered with nylon netting that created a scaffold where the algae could grow.

For the next three years, from April to December, a submerged water pump at the end of the raceways circulated a mix of fresh water and raw or anaerobically digested dairy manure effluent over the algae. Within two to three weeks after the ATS system was started up every spring, the raceways supported thriving colonies of green filamentous algae.

Algal productivity was highest in the spring and declined during the summer, in part because of higher water temperatures and also because the raceways provided snails and midge larvae ample opportunity to graze on the algae.

Wet algae was harvested every 4 to 12 days, dried and then analysed for nitrogen and phosphorus levels. Mulbry's results indicate that the ATS system recovered 60% to 90% of the nitrogen and 70% to 100% of the phosphorus from the manure effluents.

He also calculated that the cost for this capture was comparable to other manure management practices – around US$5 to US$6 for each pound of nitrogen that was recovered and around US$25 for each pound of phosphorus that was recovered.

To read more about this research Visit: http://www.ars.usda.gov/is/AR/archive/may10/algae0510.htm

Scientists study ecological impact of Katrina

Hurricane Katrina, which caused widespread devastation in 2005, has left behind significant ecological damage, according to US scientists.

The study, published in a special issue of *Environmental Toxicology and Chemistry*, reveals how chemical concentrations across coastal areas varied, but within New Orleans elevated concentrations of lead, arsenic and other chemicals were found, particularly in the most disadvantaged areas of the city following Hurricane Katrina.

The Hurricane remains the costliest and deadliest hurricane ever to hit the US. When the category five hurricane hit land, the resulting surge extended six miles inland, breaching the levees of New Orleans and causing flooding to 80% of the city to depths of 6 m. Around 1 800 people died, with at least 700 declared missing and one million people displaced.

To discover the impact of chemical contamination, Dr George Cobb from Texas Tech University led a team who studied 128 sampling sites from across the city. Maps were then compiled from the resulting data to reveal chemical distribution across the city.

Elevated concentrations of arsenic and lead were demonstrated to exist throughout New Orleans, with the highest concentrations observed in soils from the poorer sections of the city. The team also discovered that lead concentrations exceed the regulatory threshold for safety, with the highest concentrations found in the older parts of the city. This poses a significant health risk to the residents who returned to their homes following evacuation, especially children.

While the team's findings indicated that the levels of lead frequently exceed regulatory threshold, further research showed that many of the contaminants were present in high concentrations before the storm season and that lead may have posed a significant risk to New Orleans residents for years before Hurricane Katrina. The results also revealed elevated concentrations of arsenic in surface soils and flood sediments across New Orleans, caused by sediment deposition or from flooded buildings materials.

"Our evaluation of contaminants in New Orleans was critical in determining whether storm surges and resultant flooding altered chemical concentrations or distribution," concluded Dr Cobb. "Our results show how long-term human health consequences in New Orleans are difficult to attribute to chemical deposition or redistribution by Hurricane Katrina and Rita, yet reveal how chemical contamination is a historical problem for old cities in the US."

Ocean salinities show an intensified water cycle

Evidence that the world's water cycle has already intensified is contained in new research by Australian scientists.

The stronger water cycle means arid regions have become drier and high rainfall regions wetter as atmospheric temperature increases. The study shows the surface ocean beneath rainfall-dominated regions has freshened, whereas ocean regions dominated by evaporation are saltier. The research also confirms that surface warming of the world's oceans over the past 50 years has penetrated into the ocean's interior changing deep-ocean salinity patterns.

"This is further confirmation from the global ocean that the Earth's water cycle has accelerated," notes CSIRO scientist Paul Durack. "These broad-scale patterns of change are qualitatively consistent with simulations reported by the Intergovernmental Panel on Climate Change. While change in salinity would be expected at the ocean surface (where about 80% of surface water exchange occurs), sub-surface measurements indicate much broader, warming-driven changes are extending into the deep ocean," he reports.

The study finds a clear link between salinity changes at the surface driven by ocean warming and changes in the ocean subsurface which follow the trajectories along which surface water travels into the ocean interior.

The ocean's average surface temperature has risen around 0,4°C since 1950. As the near surface atmosphere warms it can evaporate more water from the surface ocean and move it to new regions to release it as rain and snow. Salinity patterns reflect the contrasts between ocean regions where the oceans lose water to the atmosphere and the others where it is re-deposited on the surface as salt-free rainwater.

"Observations of rainfall and evaporation over the oceans in the 20th century are very scarce. These new estimates of ocean salinity changes provide a rigorous benchmark to better validate global climate models and start to narrow the wide uncertainties associated with water cycle changes and oceanic processes both in the past and the future," says Durack.

Unprecedented warming threatens Lake Tanganyika

Lake Tanganyika's surface waters are currently warmer than at any time in the previous 1 500 years, according to US researchers.

The rise in temperature during the 20th century is driving a decline in the productivity of the lake, which hosts the second-largest inland fishery in Africa. "People throughout south-central Africa depend on the fish from Lake Tanganyika as a crucial source of protein," reports Prof Andrew Cohen of the University of Arizona. "This resource is likely threatened by the lake's unprecedented warming since the late 19th century and the associated loss of lake productivity."

This is the first detailed record of temperature and its impacts on a tropical African ecosystem that allows scientists to compare the last 100 years with the previous 1 400 years, says Cohen. The team attributes the lake's increased temperature and the decreased productivity during the 20th century to human-caused global warming. "We have got a global phenomenon driving something local that has a huge potential impact on the people that live in the region and on the animals that live in the lake."

The annual catch of Lake Tanganyika fishery is estimated at about 198 000 t/year. The nations of Burundi, Tanzania, Zambia and the Democratic Republic of Congo border the lake, which is the longest lake in the world and the second deepest.

Lake Tanganyika's surface waters are its most biologically productive part. For the 1 400 years before 1900, those waters were no warmer than 24°C. Since 1900, the lake's surface waters have warmed, reaching 26°C in 2003, the date of the researchers' last measurement.

The researchers used sediment cores from the lake bed to reconstruct the 1 500-year history of the lake. The cores were analysed for chemicals produced by microbes and left in the sediments to determine the lake's past temperature and productivity. The instrument record of lake temperatures from the 20th century agrees with the temperature analyses from the core, reports Cohen.

As Lake Tanganyika warms, the upper waters become less dense. Therefore, stronger winds are required to churn the lake waters enough to mix the deeper waters with the upper layer. As a result, the upper layers of the lake are becoming increasingly nutrient-poor, reducing the lake's productivity.

Other lakes in Africa are showing similar effects to those the team found in Lake Tanganyika, says Cohen. The findings have implications for lakes in more temperature climates.

Climate threatens trout and salmon

Trout and salmon are among the world's most familiar freshwater fishes, but numbers have fallen over recent decades – in some areas, dramatically.

Pollution, habitat loss and over-fishing have all been blamed in the past, but new evidence from Cardiff University in the UK shows that climate change could be a major factor, putting both species at risk. The scientists studied populations of young salmon and trout in the River Wye in Wales, traditionally one of the UK's best angling rivers. Prof Steve Ormerod and colleagues from the Cardiff School of Biosciences found salmon numbers fell by 50% and trout numbers by 67% between 1985 and 2004 – even though the river itself became cleaner.

The fish were hardest hit following hot, dry summers such as in 1990, 2000 and 2003. The results suggest that warmer water and lower river levels combine to affect both species. As both salmon and trout favour cool water, they face potentially major problems if climate warming continues as expected in the next few decades.

"Huge efforts have been put into bringing salmon back into Europe's formerly polluter rivers such as the Taff, Thames, Clyde, Seine and Rhine, so these results are a major worry," reported Prof Ormerod. "Salmon and trout fishing also generate many jobs and large economic benefits. In Wales alone, salmon fishing contributes around £90-million annually."

A paper on the findings has been published in environmental journal *Global Change Biology*.

Household detergents may form harmful substance in wastewater

Scientists are reporting evidence that certain ingredients in shampoo, detergents and other household cleaning agents may be a source of precursor materials for formation of a suspended cancer-causing contaminant in water supplies that receive water from sewage treatment plants.

The study sheds new light on possible environmental sources of this poorly understood water contaminant, called NDMA, which is of ongoing concern to health officials. William Mitch and colleagues from the Department of Chemical Engineering at Yale University report that scientists have known that NDMA and other nitrosamines can form in small amounts during the disinfection of wastewater and water with chloramines. Although nitrosamines are found in a wide variety of sources – including processed meats and tobacco smoke – scientists know little about their precursors in water.

Past studies with cosmetics have found that substances called quaternary amines, which are also ingredients in household cleaning agents, may play a role in the formation of nitrosamines.

Mitch's laboratory research showed that when mixed with chloramines, some household cleaning products – including shampoo, dishwashing detergent and laundry detergent – formed NDMA. Sewage treatment plants may remove some of quaternary amines that form NDMA. However, quaternary amines are used in such large quantities that some still may persist and have a potentially harmful effect in the effluents from sewage treatment plants.

New desal plant augmenting town's water supply

Water supply to Knysna has been augmented with the supply of a 2 Mℓ reverse osmosis (RO) water augmentation plant by VWS Envig.

The fast-tracked project was commissioned in April. The heart of the plant consists of three RO skids. Due to the fast delivery times required, the skids were manufactured by a sister company of VWS Envig in Spain. The remainder of the system was manufactured and procured from the Cape region.

"The skids are fitted with energy recovery turbines to utilise the energy in the brine and thus save on electricity consumption and reduce the carbon footprint of the plant," reports Abrie Wessels, VWS Envig GM, Cape region. Raw water is sourced from beach wells at Loerie Park Sports Ground near Knysna lagoon.

The plant was constructed at the Knysna Wastewater Treatment Works. This allows the desalination plant to take advantage of the existing infrastructure and blend the outfall from the conventional sewage treatment plant with the reverse osmosis brine. The blended water will have a salinity lower than that of seawater and thus the cooperation of the two plants is a major benefit.

The drinking water from the plant will be pumped back into the existing Knysna potable water reticulation system. VWS Envig will operate and maintain the plant for three-years for the Knysna Municipality.

Groundbreaking study examines climate change effects on dam yields

Consultants have concluded a first-of-its-kind study for the Metolong Authority in Lesotho to research the potential impacts of climate change on the long-term yield of the proposed Metolong Dam.

Arcus GIBB and Jeffares & Green were appointed to look at the possible effects of climate change on an infrastructure that will need to stand for at least the next 100 years.

"The issue of climate change and its impacts on water resources is not new, but planners are increasingly concerned about the possible negative impacts of climate change on the utilisable yields from dams and water resource systems," reports Gerald de Jager, Associate of Jeffares & Green and a key member of the study team. "Emphasis is now being placed on the need to implement special adaptation measures to mitigate such impacts and to consider how such efforts can fit within the mainstream of developmental strategies. We are now taking into account the fact that the useful life of larger water infrastructure is often measured in multiple decades, and investments that are made today will still be operating under new climates of the twenty-second century."

The proposed Metolong Dam will be located on the South Phuthiatsana River in the Lesotho Lowlands, some 35 km outside Maseru, and it forms part of a larger US$370-million project that includes treatment and conveyance infrastructure to supply water to domestic users as well as for industrial use, particularly textile factories. International funding has been secured for the design and construction of the dam. The Metolong Authority is the project implementing agent.

"Estimates on dam yields are traditionally based primarily on historical climatic behaviour and the observed occurrence of precipitation and stream flows in upstream catchment areas. However, scientists and engineers are now developing new ways of assessing yield and, in particular, the possible impacts of precipitation and stream flow changes caused by climate change," explains Darryn Knoesen of Jeffares & Green's Earth Sciences division.

To provide the Metolong Authority with information on the possible impacts of climate change on the yield of Metolong Dam, the study team modelled the behaviour of the dam for a range of different future situations. Each of these assumes an alternative set of inflows to the dam based on the climate change scenarios developed Climate Systems Analysis Group (CSAG) at the University of Cape Town. The result of the analyses is a range of possible changes in yield which can be used by planners as an indication of future trends.

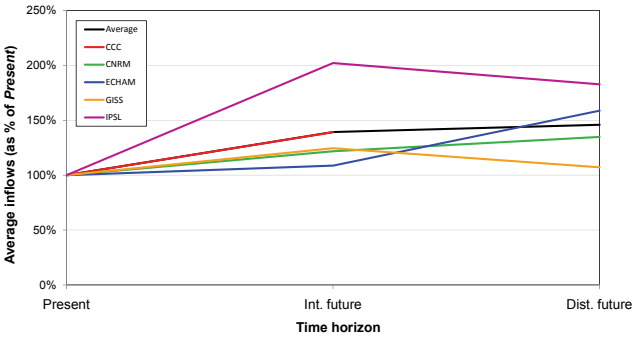
Inflows used for the analyses were developed by the School of Bioresources Engineering and Environmental Hydrology at the University KwaZulu-Natal based on CSAG scenarios and using the daily time-step ACRU hydrological model. Inputs into the ACRU included, among others:

- Daily rainfall for each climate change scenario;
- Daily minimum and maximum temperatures for each scenario;
- Soils information; and
- Land cover information, which was assumed to be under natural conditions.

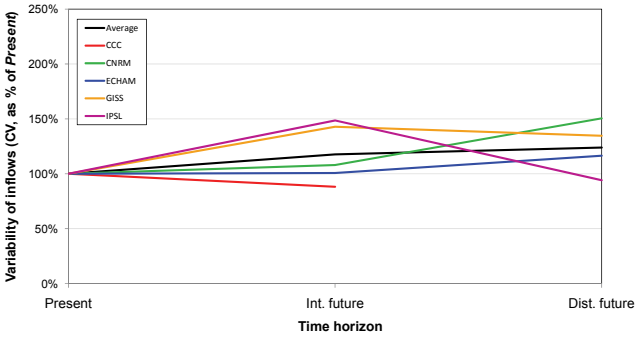
Resulting future inflow scenarios for Metolong Dam suggest that, in the intermediate future (i.e. 30 to 50 years from now) the average inflows to the dam are likely to increase moderately to significantly, together with some increase in variability.

This means that the available long-term yield of the Metolong Dam is highly unlikely to decrease in the intermediate future. In this case, therefore, no special adaptation measures will be required to account for the impacts of climate change on the yield of the dam over a 50-year planning horizon.

However, since projected inflows to the dam, as well as their variability are expected to increase, design engineers should account for the possibility of associated increases in the magnitude and the severity of extreme flood events in the future.



Averages of possible future inflows to Metolong Dam.



Variability of possible future inflows to Metolong Dam.

New from the WRC

Report No: TT 418/09

Effective Groundwater Management in Namaqualand: Sustaining Supplies (Kevin Pietersen; Rian Titus; Jude Cobbing)

Supplying water becomes difficult in arid environments with limited surface water and groundwater resources. This is particularly true in the region of Namaqualand. In response to this challenge, the WRC has supported a number of groundwater research projects in the region over the last few years to build up a knowledge base aimed at successfully exploiting the groundwater resources of the region. The purpose of this guide is to translate the scientific and technical knowledge gained through research on the hydrogeology of basement aquifers into a user-friendly format for use by the Department of Water Affairs, local authorities and end-users.

Report No: TT 420/09

A Reflective Assessment Process for Promoting Multi-agency Cooperation: Towards Achieving Cross-sector Policy Objectives for Conserving Freshwater Ecosystems (DJ Roux; K Murray; L Hill; HC Biggs; CM Breen; AL Driver; E Kistin; M Levendal; KH Rogers; H Roux)

Formal South African cross-sector policy objectives exist for conserving freshwater ecosystems. These need to be achieved by multiple agencies, each with their own roles and responsibilities. The nature of the objectives requires effective cooperation between these agencies. Cooperation is multi-faceted with many factors needing to be in place for it to be effective. Accordingly, a reflective assessment process is proposed that involves a multi-agency workshop in which representatives, both individually and collectively, reflect on and score the factors affecting cooperation.

Report No: 1529/2/09

Water Education and Training: WET-Programme (M Hlophe and MD Venter)

This water education manual emanates from a WRC-funded project which tested a membrane technology unit for the effective treatment of groundwater in Madibogo village, in North West. During the project the need to inform community members about water and water treatment issues was identified, culminating in the development of the WET-Programme. The manual tackles various issues in a user-friendly way, including the water cycle, water purification and storage of water, responsibilities of users of water and water policies, such as the concept of Free Basic Water, among others.

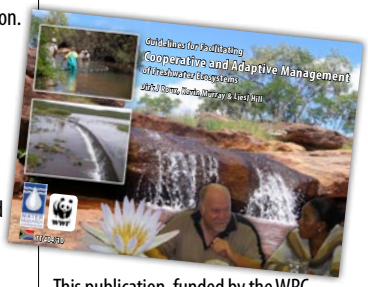
Report No: 1428/1/09

Methods and Guidelines for the Licensing of SFRAs with Particular Reference to Low Flows (GPW Jewitt; SA Lorentz; MB Gush; S Thornton-Dibb; V Kongo; L Wiles; J Blight; SI Stuart-Hill; D Versfeld; K Tomlinson)

This project arose in response to a realisation that the low flow components used in assessing streamflow reduction activity (SFRA) license applications was in need of review and refinement. Furthermore, there is increasing concern regarding the potential for large-scale land use change, and associated potential water resources impacts, driven by factors, most notably the need to improve livelihood security through improved dryland crop production and the recent interest in large-scale biofuel production. Thus the aims of the project considered the need to improve the existing modelling tools for hydrological analyses of land use change, but also the need to develop management protocols to utilise these.

Report No: TT 404/10

Guidelines for Facilitating Cooperative and Adaptive Management of Freshwater Ecosystems (DJ Roux; K Murray; L Hill)



This publication, funded by the WRC and the World Wildlife Fund South Africa, targets those responsible for the management and conservation of freshwater ecosystems. The guidelines therein acknowledge the general complexity of freshwater ecosystem management. This complexity, and the associated unpredictability, is not only a characteristic of natural systems. It is also acutely associated with the realities of the multi-stakeholder environment and overlapping organisational cooperation. This demands participative sense-making, effective coordination and multi-dimensional cooperation. These guidelines suggest practical steps for someone interested in facilitating useful change towards a purposeful learning and adaptation process to achieve this.

Report No: 1574/1/10

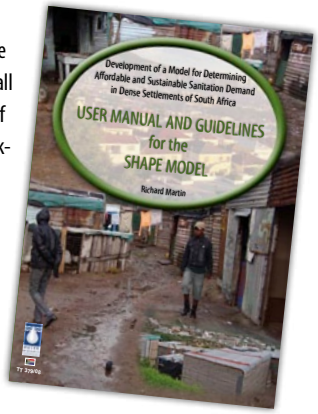
Adapting the Wetting Front Detector to Small-scale Furrow Irrigation and Providing a Basis for the Interpretation of Salt and Nutrient Measurements from the Water Sample (RJ Stirzaker; JM Steyn; JG Annandale; GT Adhanom; M vd Laan; CM'Marete)

The wetting front detector (WFD) was originally developed as a simple irrigation scheduling tool to fill a perceived gap in the market. The FullStop WFD is a funnel-shaped device that is buried in the soil and provides a visual signal when the soil water suction falls to 2 kPa during an irrigation event. Thousands of units have been sold worldwide. This project report focuses on areas requiring further work, including the re-design of the WFD for furrow irrigation and using the WFD to act as a passive lysimeter for soil solution monitoring.

Report No: TT 379/08

Development of a Model for Determining Affordable and Sustainable Sanitation Demand in Dense Settlements of South Africa – User Manual and Guidelines for the SHAPE Model (Richard Martin)

The SHAPE (Sanitation and Housing Applied Priorities Enquiry) Model presents the costs of sanitation and housing services in such a way that any variable may be considered in real time, so that beneficiaries may make informed decisions. For the first time, this model allows for a comparatively accurate estimate of the actual cost of all components of a housing package (i.e. stand size, servicing, house size, and standard of fittings and finishes). This report serves as the user manual and guidelines for the model software which is available on the WRC website: www.wrc.org.za/ResearchReports/ProjectSoftware/SHAPE



miniSASS

The latest version of miniSASS is now available for download from the WRC website for use to monitor the health of a river and measure the generally quality of the water in that river. The scoring system uses the composition of macroinvertebrates (tiny insects) living in rivers and is based on the sensitivity of the various animals to water quality. To download go to www.wrc.org.za/Pages/DisplayItem.aspx?ItemID=8726&FromURL=%2fPages%2fDefault.aspx%3f. For hard copies, contact Publications at the WRC.

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

FOR PEAT SAKES –
Can SA afford the demise of its natural carbon & water stores for the sake of short-term economic gain?

Despite local and international efforts, South Africa's peatlands continue to be threatened by an array of social and economic pressures. Lani van Vuuren investigates the importance of these natural water and carbon stores.

Bog, mire, fen. These are only some of the terms used to describe what is arguably the most intriguing and remarkable wetland-type in the world.

Peatlands refer to those wetland ecosystems characterised by the accumulation of organic matter (or peat) derived from dead and decaying plant material under conditions of permanent water saturation. Globally, peatlands are extremely widespread, covering an estimated 3% (4 million km^2) of the terrestrial and freshwater land surface.

Peatlands are known for their ability to mitigate global climatic impacts through their capacity to store carbon. They also act as huge stores of water – around 10% of the world's freshwater is contained in peatlands. Furthermore these wetlands are hotspots for biodiversity and home to many endangered species.

Millions of people live in and depend on the world's peatlands for their livelihoods from grazing cattle and harvesting reeds to cultivation and catching fish. Unfortunately, these wetlands – like other natural

Lani van Vuuren

systems – are subject to increased exploitation and degradation. Globally, peatlands are being destroyed at a rate of about 4 000 km²/year mainly as a result of agriculture, forestry and peat extraction. It is estimated that a quarter of all the peatlands on Earth have already been destroyed.

Above: *Peat can hold up to a 1 000 times its weight in water.*

Below: *The degradation and draining of the palmiet peatlands of Goukou in the Western Cape have led to severe erosion and washing away of precious agricultural land.*

UNIQUE WETLAND TYPE

By far the majority of peatlands occur in the Northern Hemisphere and less than 1% of the world's peatlands are found in southern Africa and South America. In South Africa, peatlands are a rather rare and unique wetland type. It is estimated that only about 10% of South Africa's wetlands contain peat.

Still, despite the low global percentage, South African peatlands are to be found in a variety of landscapes contributing to a rich diversity of peatlands and mires, explains South African peatland expert Piet-Louis Grundling. "These vary from the interdune tropical swamp forests on the east coast to percolation mires in the interior on the southern African plateau and the palmiet peatlands in the Cape Fold Mountains."

While in the Northern Hemisphere, most peatlands consist of *Sphagnum* moss, South African peatlands are mainly formed by reeds, sedges and grasses. This is significant, as it contributes to a much slower peat accumulation rate. In South Africa peat accumulates at an average rate of only 0,5 mm to 1 mm a year compared to a world average of 1 mm to 2 mm a year. Most of our peatlands are less than 10 000 years old.

"We still know very little about the vegetation composition, structure, and functioning of these swamp forests due to their remoteness and inaccessibility."

Eleven peatland eco-regions have been described and occur mainly in the (wet) eastern, central and southern parts of South Africa. More than 460 peatlands can be found in these eco-regions, the vast majority (60%) occurring in Maputaland. The largest peatland in the country is the Mkhuze Delta which, together with the Mbazwana swamp forest, form the largest mire complex in South Africa (about 8 800 ha in extent). Also to be found in this region is South Africa oldest peatland – the Mfabeni Mire, which at 45 000 years old, is one of the oldest active peat accumulating wetlands in the world.

Japie Buckle

Ricky Taylor

Ricky Taylor

Top left: *A peat fire in a swamp forest as a result of the lowering of the groundwater table. The fire causes the roots of the swamp forest trees to burn causing them to fall over.*

Bottom left: *Sphagnum moss, seen growing here in Maputaland, while the main contributor to peat in the Northern Hemisphere, is rare in South Africa.*

BENEFITS FORGOTTEN

Apart from the rich biodiversity they support, their water filtering and storage capabilities are perhaps the most important functions derived from peatlands in South Africa. "Peat acts as a sponge, storing water for long periods and releasing it in times of low flow when the downstream water requirement is at its peak," explains Grundling. "Peat also acts as a natural filter, making it highly effective in removing sediment, pollutants and pathogens."

In the Tshwane Metropolitan Area intense rehabilitation has restored the Rietvlei wetland complex which had lost much of its function due to past agriculture, water abstraction and peat mining.

"While it is recognised that the local communities depend on this ecosystem for survival, the continued damage to swamp forests will not only destroy the ecosystem and its biodiversity, but also the subsistence base of the communities depending on them."

Research has shown that these wetlands – through their water purification function – reduce algal growth thereby reducing the city's water treatment costs.

Rural communities have long relied on peatlands to provide them with clean drinking water and, historically, small wells were dug on the edge of peatlands and fenced off to prevent muddying by livestock. People also use peatlands for subsistence agriculture and grazing of livestock. In addition, the reeds and sedges that grow on peat have traditionally been harvested and used for weaving and thatching.

These activities are sustainable when undertaken on a small scale, but with larger economic pressures South Africa's peatlands are being degraded at an unprecedented rate. Today, around 40% of the rehabilitation of Working for Wetlands (WfW) is centred on peatlands.

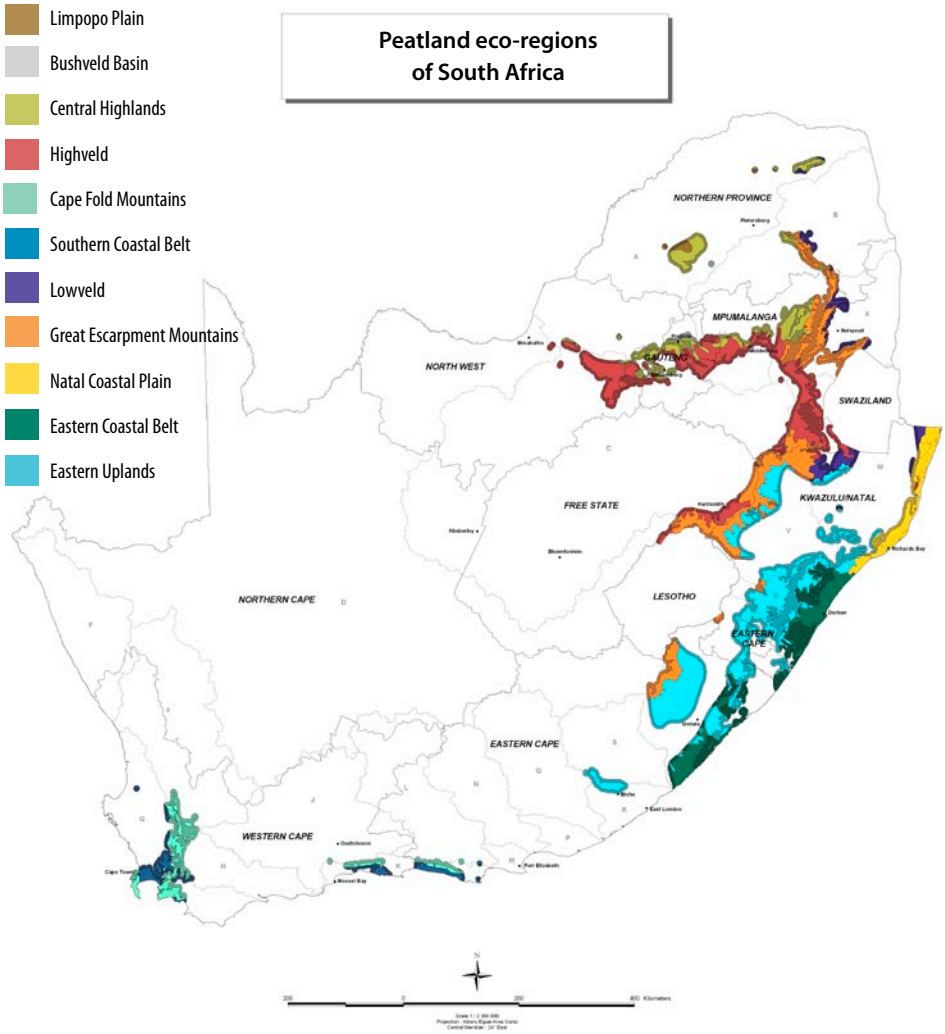
Agricultural and forestry activities have traditionally been the greatest threats to South Africa's peatlands. Forestry, a stream-reducing activity, targets the high-rainfall areas where peatlands are normally found while in agriculture wetlands were, until recently, viewed as 'wastelands' of no value unless drained, excavated or cultivated.

The important role of peatlands as part of the natural landscape is often not realised until it is too late. The Cape Fold Mountains are home to a unique set of wetlands characterised by palmiet and peat. These wetlands play a crucial role in flood attenuation, trapping sediment and slowing down water flow. When cultivation and urban infrastructure led to the draining and degradation of the peatlands, it severely altered their flood attenuating ability leading to severe erosion and the washing away of precious agricultural land.

Tens of thousands of tons of peat have been extracted from South Africa's karst fens outside Ventersdorp and Potchefstroom for the mushroom and horticulture industries. Historically, more than 90% of

peat used in the mushroom sector was mined locally. However, thanks to a decision by the South African Mushroom Farmers Association (SAMFA) in 2007 to cease the use of South African peat local demand has dropped significantly and only two peat-mining operations remain.

Since peatlands are interdependent on the surrounding landscape they are vulnerable to not only direct impacts but indirect influences as well. Excessive groundwater abstraction has caused the Bodibe peatlands in North West to dry out. Burning for grazing by the local community caused the peatlands to start burning. While multi-million Rand rehabilitation efforts managed to temporary cease the fire, the peatlands are now burning again. Not only is the local community exposed to smoke from the fires, it is also endangering their lives as well as the lives of their livestock.



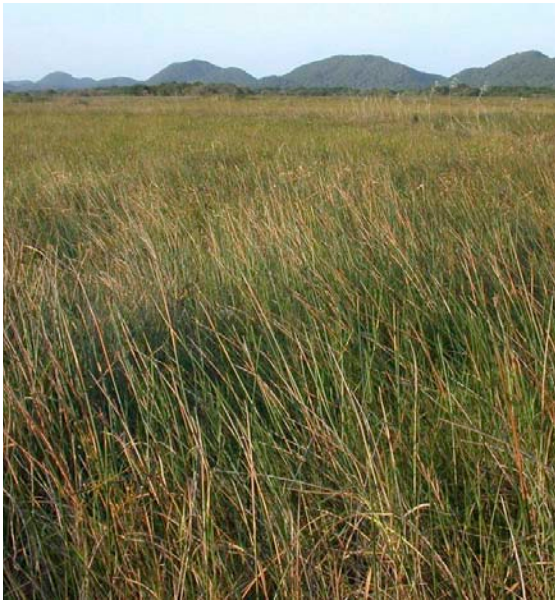
PEATLANDS AND CLIMATE CHANGE

Peatlands are a critical part of the global climate regulation system. Acting as organic sinks, these wetlands store at least 550 gigatons of carbon – twice as much carbon as the biomass of the world's forests. When peatlands are cleared or drained, the organic carbon that was built up over thousands of years and is normally under water, is suddenly exposed to the air. It decomposes and turns into carbon dioxide which is released into the atmosphere.

It is estimated that the present clearing, draining and setting fire to peatlands emit more than 3 billion tons of carbon dioxide every year – equivalent to 10% of global emissions from fossil fuels. There are strong international calls to preserve remaining peatlands to not only protect the biodiversity and ecosystem services they support, but also to prevent more carbon dioxide from degraded peatlands entering the atmosphere. It is believed that investments in conservation and restoration of peatlands can be up to 100 times more cost-effective as other carbon sequestration measures.

NEW ONSLAUGHT

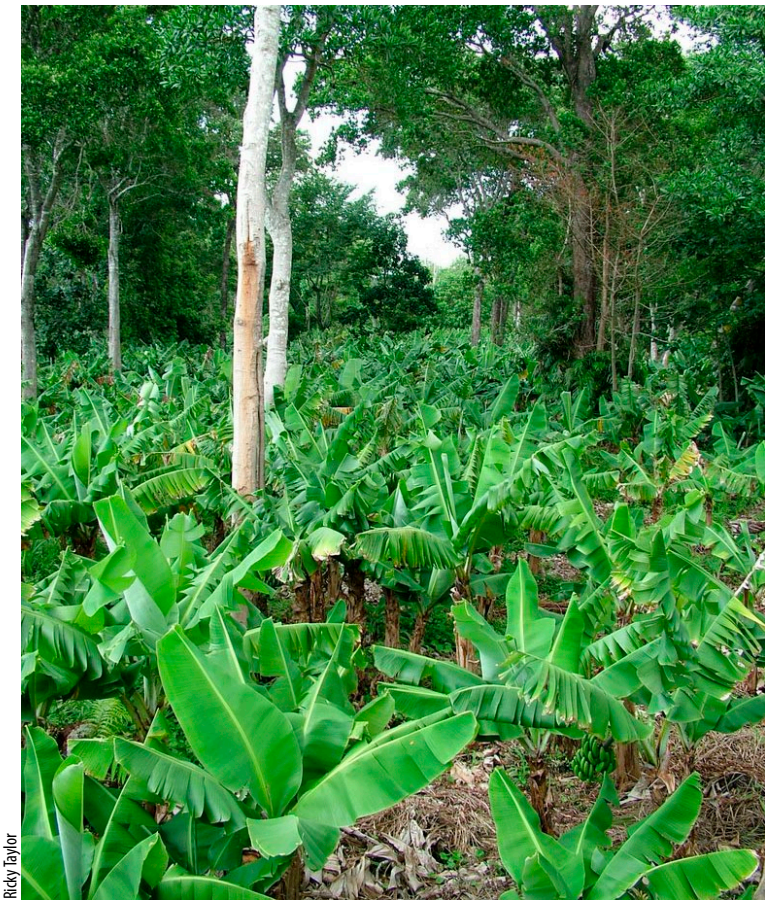
The country's hunger for resources and commodities is putting many previously untouched peatlands at risk, especially in the Highveld and Central Highveld peatland eco-regions. Uncontrolled exploration for diamonds and coal has already caused damage to many peatlands in these areas. Among the peatlands under threat from prospecting and mining licence applications is the Chrissiesmeer Lake District, Wakkerstroom, the



Piet-Louis Grundling

At around 45 000 years old the Mfabeni Mire on South Africa's east coast is one of the oldest active peat accumulating wetlands in the world.

Piet-Louis Grundling



Ricky Taylor

Above: *Starved of water as a result of excessive groundwater extraction, the Bodibe peatland in North West has burnt for several years.*

Left: *Bananas growing in an area that was previously swamp forest in Maputaland. Note the commercial scale of the plantation.*

Verlorenvlei Ramsar site and the Lakenvlei Wetland Complex.

One of South Africa's larger peatlands, Lakenvlei, provides an important habitat to several important species, such as the rare white-winged flufftail (*Sarothrura ayresi*) which migrates from Ethiopia. The other South African peatland frequented by this shy bird, the Watervlei mire, on the Drakensberg escarpment, will be inundated by Eskom's Ingula Pumped Storage Scheme.

"It seems mining companies are given carte blanche to prospect as they please," says Grundling. "Permits are being issued without due consideration for the environment or the long-term needs of society in terms of water. These mines compete directly with wetlands and impact severely on water quality and quantity."

SHORT-TERM GAIN, LONG-TERM LOSS

On the east coast of South Africa, peatlands are steadily being destroyed through uncontrolled activities of local communities. Encroachment by local farmers increasingly threatens the survival of the country's peat swamp forests.

Grundling explains that swamp forests are highly threatened ecosystems in South Africa, being the second-rarest forest type in the country. It is only found in isolated patches from the Mozambique border to just south of the Msikaba River, in the Eastern Cape. "We still know very little about the vegetation composition, structure, and functioning of these swamp forests due to their remoteness and inaccessibility."

But will we ever get the chance to study them? Every day more of this unique habitat – a haven for several rare species – is being drained, burnt, and farmed. Fields of bananas, amadumbes and other crops – some up to commercial scale – are becoming a common sight, some being planted inside proclaimed conservation areas. After a few years the sites become unsuitable for cultivation, so that the damage steadily affects new areas. Aerial surveys have also revealed an increasing number of community *Eucalyptus* woodlots. The trees tap into the regional water table of the primary aquifer, resulting in the desiccation of the wetlands, and in some cases, the burning of the peat.

This is not only affecting the cover vegetation but also the hydrology of the peatlands. The peatlands are an important source of fresh

water and thus draining them inadvertently affects the water supply of the local population, especially in times of drought.

"Peat as a resource for clean drinking water is probably much more important than any of the other uses, especially in remote rural areas. Its value in terms of commercial exploitation must be weighed up against the value of permanent and clean water," says Grundling. "While it is recognised that the local communities depend on this ecosystem for survival, the continued damage to swamp forests will not only destroy the ecosystem and its biodiversity, but also the subsistence base of the communities depending on them."

The Water Research Commission (WRC) is funding projects worth several million Rand in peatlands, including the Mfabeni Mire. According to Director: Water-linked Ecosystems, Dr Stanley Liphadzi, the knowledge gained through these projects is contributing significantly to the international peatlands knowledge base.

Among others, WRC research has shown that water from the Mfabeni Mire flows into Lake St Lucia, providing freshwater refuge for biota in times of drought. "With looming climate change wetlands such as this will play an even more important role in maintaining the biodiversity of this World Heritage Site," notes Dr Liphadzi. "We cannot afford for such a system to be degraded up to the point where valuable ecosystem services are lost."

Among others, current research is focusing on quantifying the water balance of the peatland, the contribution of freshwater to Lake St Lucia and evaluating the effects of climate change and land use on the water flux.

MINING FOR MUSHROOMS

Peat mining has resulted in the severe degradation of wetlands, especially those outside Ventersdorp, Potchefstroom and Tarlton. In South Africa peat extraction is quite a simple process. Since our deposits are relatively young and usually occur close to the surface, the water table is lowered. As water drains from the peatlands the peat is excavated using small excavators. For larger deposits larger excavators on barges are used, which can take peat out to a depth of 7 m to 9 m.

Historically, the greatest consumers of local peat have been the horticulture (potting soil) and mushroom sectors. Its water holding capacity and structural properties make peat an ideal casing material for mushroom growing.

In consultation with conservationists and the government, the South African Mushroom Farmers Association (SAMFA), which represents the vast majority of the sector, has made an active decision not to support the use of local peat. It is reported that today, none of the large producers of mushrooms use local peat. Instead *Sphagnum*-based peat is imported from countries such as Ireland and Germany where it is removed to make way for, for example, housing developments.

"We as an industry simply do not believe that depleting natural resources can be a sustainable practice, we needed to find a workable alternative," explains SAMFA Chair Ross Richardson. "Our decision to look towards the Northern Hemisphere for a solution is not the perfect answer in the long term, but because of the abundance of peat there, we believe that it is the only solution for our industry until a suitable local substitute is found."

As a result local peat mining has fallen drastically, and there are only two peat-mining operations still remaining. There are still mushroom producers in South Africa who use local peat, but they are believed to make up far less than 5% of the sector. The *Sphagnum* peat is also of higher quality than South African reed-based peat leading to increased production.

The move to use international peat has resulted in a 10% cost increase of mushrooms, mainly as a result of import and transport costs, but, says Richardson, this has largely been accepted by retailers and consumers. At the same time, the sector is supporting programmes investigating effective casing alternatives to peat. This has proved easier said than done, however, with cost playing a major role. "If we can find a suitable alternative material the South African mushroom sector will be one of the first in the world not to make use of peat at all," notes Richardson.

CO-GOVERNANCE QUAGMIRE

Wetlands are adequately protected under the legislation of the Departments of Agriculture, Forestry and Fisheries (DAFF), Water Affairs (DWA) & Environmental Affairs (DEA). However, the lack of capacity to apply the legislation and regulations are contributing to the present exploitation of South African peatlands. Action is further hampered by the apparent inter-provincial variations in interpreting and implementation of applicable legislation and policies.

"The major problem of peatlands is the lack of skilled resources on the ground. When culprits are caught in the act, it becomes difficult to obtain convictions."

Peat extraction is now a listed activity under the National Environmental Management Act, which means that any intention to extract peat must be foregone by an Environmental Impact Assessment. Even this admirable legislation does not appear to have improved matters.

It is reported that the challenges regarding coordination between national departments as well as provincial departments which must implement legislation results in a situation where our peatlands are at risk. The Peat Working Group (PWG) was established in 1997 to

monitor and/or co-regulate peat mining in South Africa. While the PWG did not have an official standing, it was an informal arrangement that handled peat mining-related issues and applications. The PWG did manage to stop several illegal peat-mining operations. However, this group is no long functioning.

The major problem of peatlands is the lack of skilled resources on the ground. When culprits are caught in the act, it becomes difficult to obtain convictions. Achieving cooperation between State departments in these cases is often a nightmare.

The management of subsistence farming on communal land is a grey area and, in many cases, a political hot potato. This is situation is exploited by unscrupulous developers who drain and cultivate large tracts of peatland in communal areas. While they rake in huge profits, the affected community loses the benefits of an ecosystem they depended on for hundreds of years.

At the time of writing, there was a draft Memorandum of Understanding (MoU) regarding cooperative co-governance awaiting signature by the relevant authorities. This is seen as a positive step in the right direction. The MoU aims to formalise legal mandates and protocols between Working for Wetlands, DWA, DEA and DAFF, developed to formalise wetland-related rehabilitation funded by WfW.

South Africa's peatlands should be regarded as non-renewable. It is hoped that efforts to protect what is left will succeed and so prevent the extinction if this precious natural resource. ❑

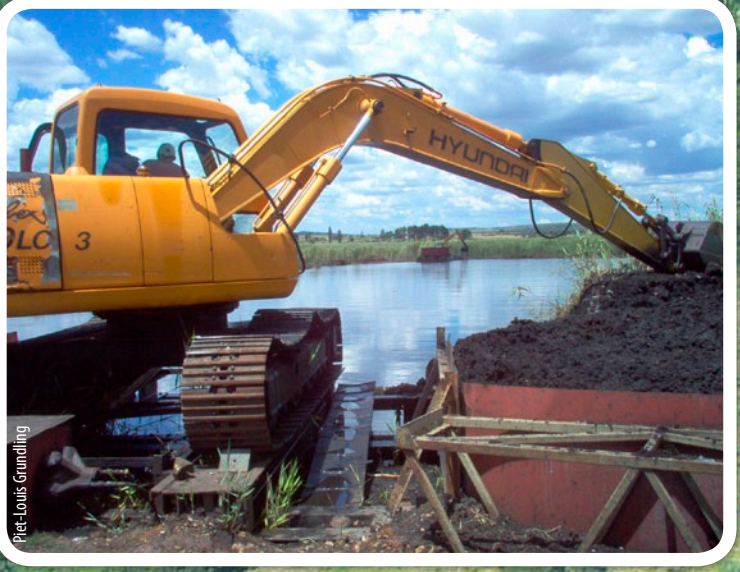
Piet-Louis Grundling

The illegal and uncontrolled expansion of Eucalyptus plantations pose a severe threat to wetlands in Maputaland. The trees tap into the regional water table of the primary aquifer, resulting in the desiccation of wetlands.

Peat swamp forest is one of the rarest wetland types in South Africa. Uncontrolled draining and cultivation of swamp forests have brought them to the brink of extinction outside the boundaries of conservation areas. Note the lighter green areas (bananas) within the remains of the swamp forest.

Below: *Peat is extracted in the Mooi River catchment using excavators.*

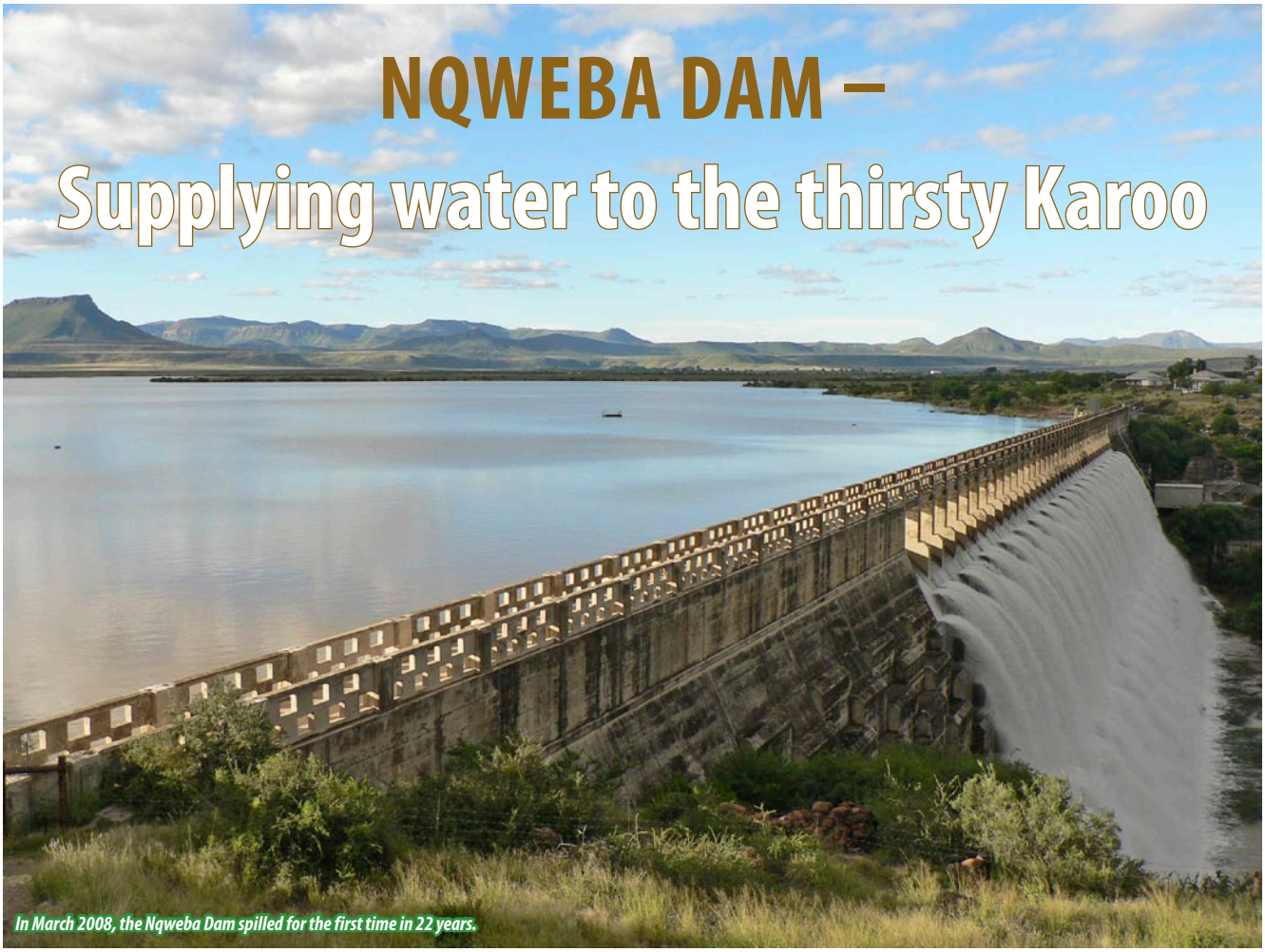
Bottom: *Restoration of the peatlands in Rietvlei Nature Reserve is saving the City of Tshwane millions of Rands in water treatment costs.*



Piet-Louis Grundling

Lani van Vuuren

NQWEBA DAM – Supplying water to the thirsty Karoo



SanParks

In March 2008, the Nqweba Dam spilled for the first time in 22 years.

For more than 80 years, the Nqweba Dam (formerly known as Van Ryneveld's Pass Dam) has been the main water supply to Graaff-Reinet, in the Eastern Cape. Lani van Vuuren takes a look at the history of this water engineering marvel, one of the first large dams to be constructed in South Africa.

The idea of constructing a dam across the poort at the Van Ryneveld's Pass on the Sunday's River outside Graaff-Reinet was discussed among eager irrigators and thirsty townsfolk for many years. But it was not until 1918 that any attempt was made to investigate the possibilities of a storage scheme here.

In that year, a preliminary survey of the basin was made under the supervision of CH Warren, an engineer with the Cradock branch of the Irrigation Department. The results of this survey showed that a scheme was feasible and a detailed survey followed. In 1919, an Irrigation District was proclaimed under the Irrigation and Conservation of Waters Act of 1912. Under this Act farmers could apply for easy loans and obtain engineering assistance to construct large water schemes.

Irrigation Department engineer KR Shand was promptly seconded to the site as Resident Engineer. The scheme was to comprise a concrete storage dam a little less than two kilometres north-west of Graaff-Reinet, three pick-up weirs and about 97 km of canals.

The Van Ryneveld's Pass Irrigation Board was eager to start construction, however, the Second World War had just ended, and obtaining plant and materials proved excessively difficult (almost everything had to be imported) and expensive. The Irrigation Department, who at that time had quite a few big water schemes under construction, including the Hartbeestpoort Dam, decided to tighten its belt and loans were held back for new schemes.

The lack of funds meant that from November 1920 to July 1921 the only construction that could be done at Van Ryneveld's Pass was the erection of quarters for staff and employees, installation of water supply and construction of works roads.

STAFF HOUSING

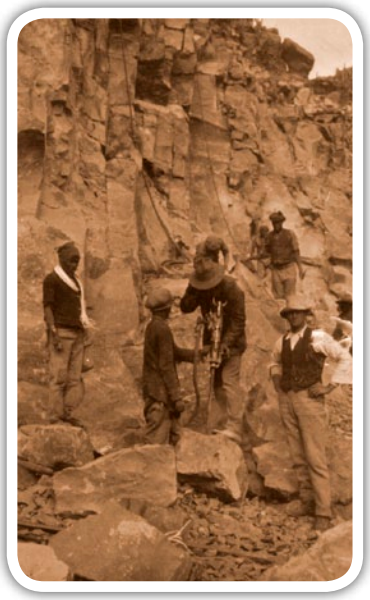
Unlike many other large dam sites at the time, the Van Ryneveld's Pass Dam site was quite close

to a town, "a 20 minute walk" as Shand put it in an Irrigation Department magazine article in 1924. As a result not nearly as many amenities were required as at other dam construction sites.

As was typical of that time, one's position and one's race very much dictated what lodgings one would be afforded on site. All white (skilled) quarters were constructed of brick under an iron roof. The married quarters consisted of pairs of semi-detached cottages with flat roofs while single quarters comprised single rooms with small kitchen attached. The staff (mainly engineers) lived in single cottages with pitched roofs. All the houses had water laid on to near the kitchen door and were supplied with electric light.

Black employees, who made up the whole of the unskilled work contingent, were housed in two brick compounds, each capable of accommodating 200 men. When the number of black staff rose to 700 between July-November 1923 the extra men had to be accommodated in huts made of cement bags.

Graaff-Reinet Museum



Left: *Workers drilling rock during excavations for the foundations.*

Far left: *Donkeys haul sand during the excavation of the dam. About 27 432 m of soil were taken out by means of donkeys and scrapers.*

All white employees paid rent and contributed to a special medical fund. Black employees did not pay rent but did contribute to the medical fund. Water was obtained from a 136 kℓ service reservoir above the camp supplied by a small pumping plant on the riverbank. A sanitary service removed sanitary buckets and rubbish twice weekly.

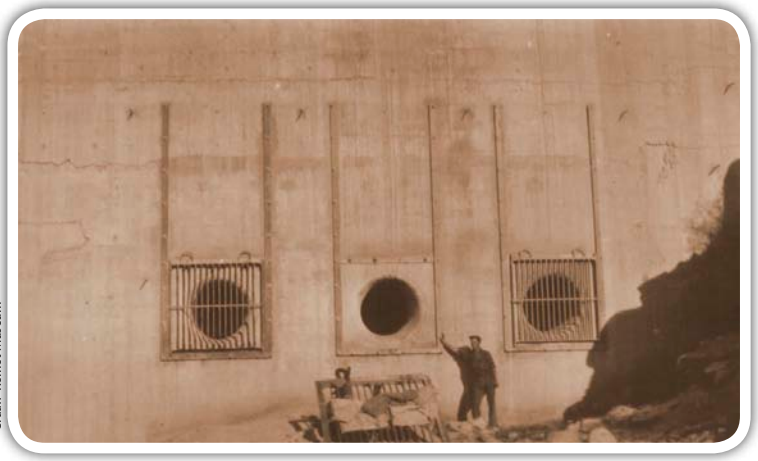
DONKEY AND LEG POWER

A start was made on the foundations of the dam in July 1921. Excavation work was carried out in four sections: left flank, base excavation, river section and right flank. About 27 432 m of soil were taken out by means of donkeys and scrapers. "This method proved very economical as long as the scrapers could be worked at right angles to the wall of the dam, which meant that a load was taken out going and coming, dumping both up and downstream," wrote Shand.

After going down 3 m the pull up became too steep; a cut was then made in the riverbank, scrapers taken through this and dumped in the riverbed. This meant a long haul and an empty trip back, so this method was confined to that portion of the excavation close to the riverbank. At the far end, inclines and light track were put down and cocopans hauled up the inclines by means of donkeys and then pushed out through the cut in the riverbank.

The dam now forms part of the Camdeboo National Park, and these days it is more noted as a tourist attraction than a main water supply.

The riverbed did offer some resistance in the form of large boulders, up to about a cubic metre, which had to be removed with pick and shovel as the purchase of a steam shovel proved too inhibitive. The donkeys were later replaced with large mechanical plant. Practically all the machinery on the works was electrically driven, the power being generated at a central power station located alongside the railway siding for easy handling of coal. Excavation



Graaff-Reinet Museum

The three main irrigation outlet valves are placed on the downstream side of the wall.

was completed at the end of September 1923.

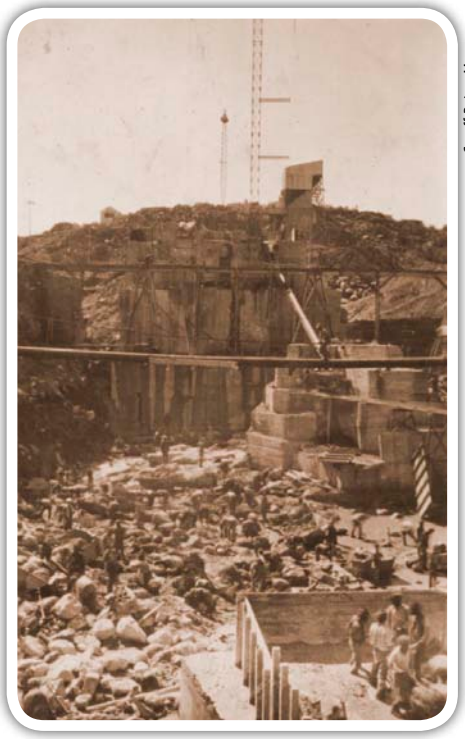
Concrete work started in November 1922 and by November 1923, 52 754 m³ of concrete had been placed. The great part of this concrete was placed by means of tip trucks; when work was below ground surface level, the trucks were run out on the side of the excavation, and concrete tipped down chutes into trucks at a lower level.

These trucks ran on rails resting on gum poles which, in turn, were carried by the shuttering: a day's work was shuttered off in pockets 4,2 m by 5,5 m wide by 1,4 m high. Once the wall reached ground surface level, the trucks were run out directly on the shuttering.

The steel shuttering was built into panels 6 m by 3 m and 4,6 m by 3 m for the upstream and downstream faces respectively and was used only on these faces. The upstream panels weighed about 227 kg and were handled by cranes. When a crane was unavailable these panels had to be lifted by 'sheer legs and chain blocks.'

The dam was completed towards the end of 1924. In total, nearly a quarter of a million bags of cement were used in the construction of the wall and over 80 km of steel rods were cut, bent and assembled and placed in the superstructure.

Work on the canal structure was kicked off early in 1924 and supervised from the dam. The scheme was constructed for around £400 000, the costs of the canals being a fifth of the total cost of the scheme.



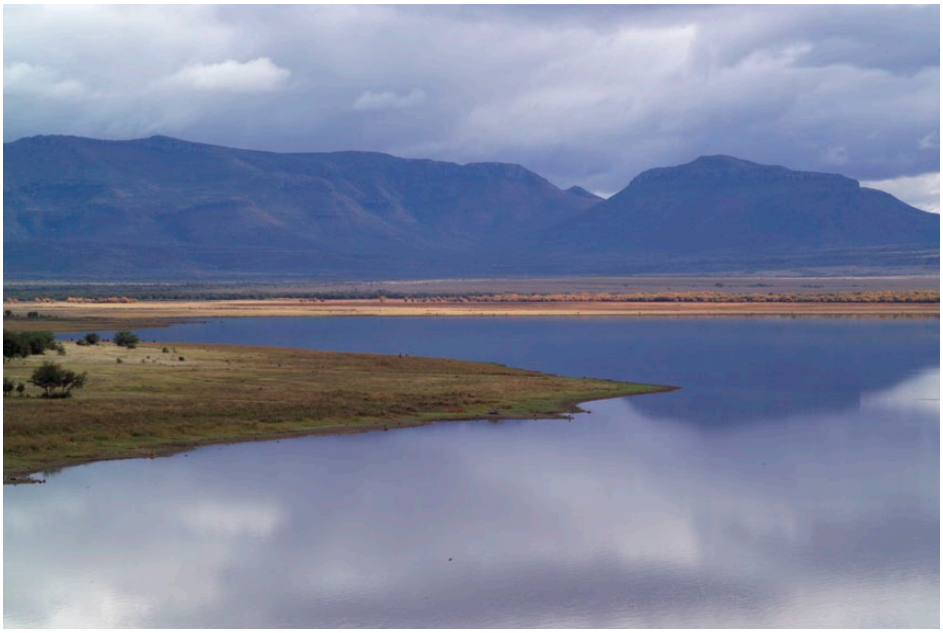
Graaff-Reinet Museum

Left top and bottom: *The dam under construction in July 1923. More than 700 men worked to construct the dam in less than four years – a record for that time.*

Below: *Nqweba Dam (formerly Van Rynevelds Pass Dam) was one of the first large dams to be constructed in South Africa in the 1920s.*

A HERO'S BURIAL

One famous name connected with the Nqweba Dam is that of Gideon Scheepers. Among others, the Boer Commandant participated in the battle of Magersfontein and escaped when General Piet Cronje surrendered at Paardeberg. He further led a commando of 150 men to take on British forces in the Cape Colony during the South African War (1899-1902). Becoming seriously ill he was captured on a farm in Prince Albert in October 1901 and sentenced to death by firing squad in Graaff-Reinet. Scheepers was executed on 18 January, 1902, and buried in an undisclosed location. Legend has it that his remains now lie under the waters of the Nqweba Dam.



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THE WATER WOES OF GRAAFF-REINET

The fourth-oldest western settlement in South Africa, Graaff-Reinet was established by the Dutch occupiers of the Cape in 1786. As was common with many colonial settlements at that time, the site, on a loan farm belonging to Dirk Coetsee, was selected mainly for its defensive potential, being surrounded by the Sunday's River on three sides. The town was named after Governor Cornelis Jacob van de Graaff and his wife Cornelia Reynet.

Despite its proximity to the river, the problem of water supply remained a dominating theme in the life of Graaff-Reinet for centuries. In 1797, John Barrow found the appearance of the town "as miserable as that of the poorest village in England."

In the decades after Barrow's visit circumstances got a little better. As Graaff-Reinet grew into a bustling trading centre a temporary dam of driftsand and brushwood was constructed in the Sunday's River. From this dam a furrow was led to the outskirts of town, where it was channelled into a number of canals for distribution to the gardens of the town's inhabitants, called erfholders. These erfholders used the water to grow produce, particularly vines.

In 1820, another dam and furrow, which became known as the upper dam and furrow, were constructed. The original works then became the lower dam and furrow. The making of a dam higher up in the river would reduce the flow of water into the lower dam so to compensate lower furrow users, a proportion of the water of the upper furrow was turned over the district mill located at the top end of town and into the lower furrow. However, the volume of water from the upper furrow that should be turned over the mill was a contentious issue and conflict over water between upper and lower sections of the town continued for decades.

The very system by which Graaff-Reinet was supplied with water also became an increasing source of dissatisfaction to the people in town. The two temporary dams in the Sundays River were washed away every time the river came down in flood, and both furrows became choked with mud. This meant that there was no water going into town until the dams were reconstructed and the furrows cleaned. This could take between a few days to a few weeks.

For those inhabitants who did not have wells or rainwater tanks on their properties, this was quite a concern. They had to rely on so-called 'brand-dams' or fire-dams for their drinking water. These dams were formed simply by a widening of the furrows into squares of 3 m to 4 m and served, to a certain extent, as drains. According to *the Herald* newspaper when these dams were cleaned "the accumulated filth which is exposed and thrown out was sufficient to turn the stomach of even a municipal commissioner."

Decades of financial difficulty prevented the municipality from improving the situation until 1873 when the municipal board decided to test the water from a groundwater source known as Mackie's Pitt. Unfortunately tests revealed that the underground water was connected with the Sunday's River. This meant that the municipal board could not use this water without consent of the erfholders, who were entitled to all the water in the river above the two dams.

During November and December 1974, heavy rains not only washed away the dams, but almost completely destroyed the lower furrow. The damage was considered to be permanent. Graaff-Reinet applied to Parliament for a loan of £12 000 to improve its water supply and in December 1875 Government Hydraulic Engineer John Gamble met with the municipal board to investigate possible schemes.

After many investigations and much discussion a plan was construed to sink two wells at Mackie's Pit and construct a concrete culvert to carry the water by gravitation to the mill; here the water would be divided between the upper and lower furrows. The fall from the upper to the lower furrow would be used to drive a turbine to pump 227 kℓ of water a day to a service reservoir. Water from this reservoir would be used for household purposes as well as in the case of fires.

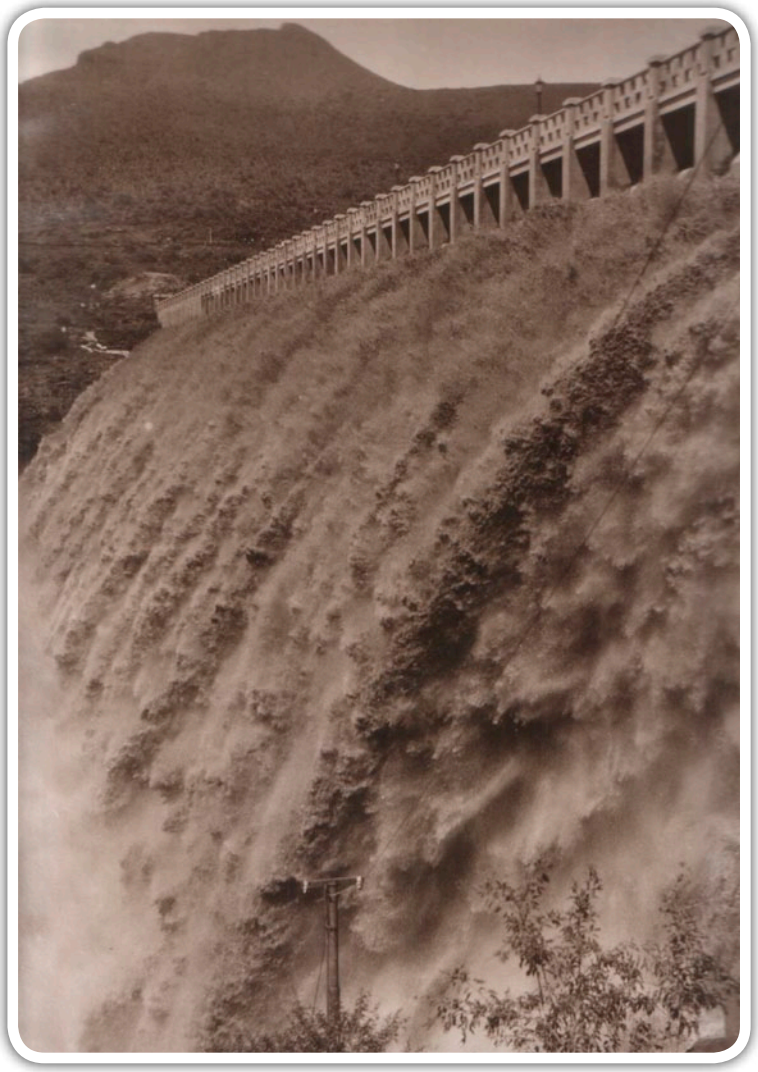
At a town council meeting in 1881, it was decided to carry out only part of Gamble's scheme – that wells be sunk at Mackie's Pit and a furrow constructed to the upper furrow. The works were completed in November 1882. A decision was then made to continue the works a little further so that they would be secure against a flooding of the river (however, the in-fighting became so bad that these plans were never completed).

By 1908, people were thinking in terms of a weir across the Sunday's River and it was in this direction that further attempts were made to improve the water supply of Graaff-Reinet, which culminated in the construction of the Nqweba Dam in 1921. The wells of Mackie's Pit were covered by the dam.

The Graaff-Reinet Municipal Board at the new town water scheme in 1884.

Graaff-Reinet Museum

Graaff-Reinet Museum



The dam spilling for the first time. The downstream face is made up of staggered steps, which break up the mass of floodwater spilling over the crest.

ENGINEERING FEATURES

The dam consists of a mass concrete wall of gravity section, straight in plan of the overspill type. The upstream face is vertical and the downstream face stepped (a novel feature at the time). These steps are staggered to break up water coming over the crest in case of high floods and so reduce the pounding action on the toe of the dam and foundation.

No special provision was made to form a water cushion as it was anticipated that a natural water cushion would be formed with a certain amount of surface material being scoured away, leaving a standing pool at the toe.

The spillway over the main wall is 169 m long and an auxiliary spillway on the left flank 69 m long. A removable reinforced concrete

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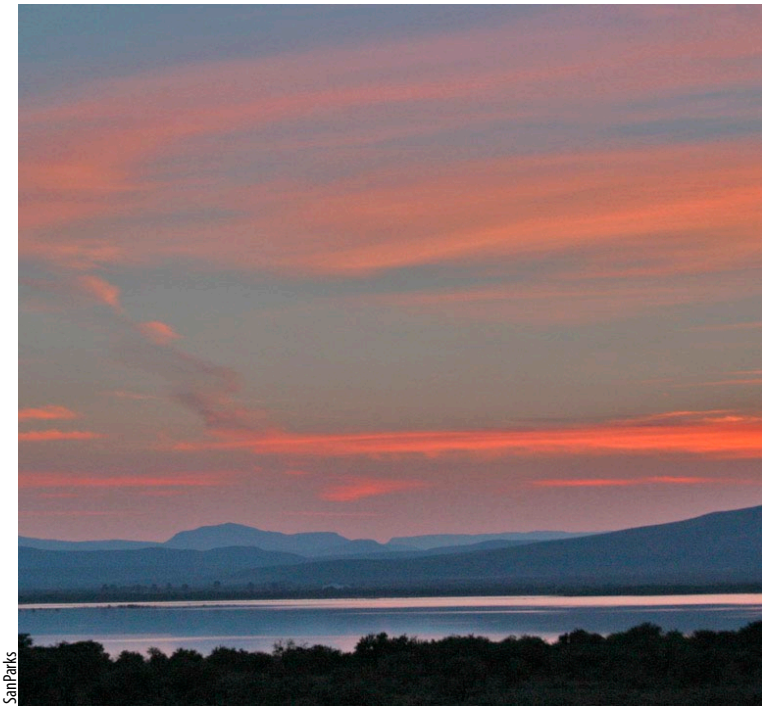

Water from Nqweba Dam is no longer used for irrigation. The dam falls within Camdeboo National Park and is a major tourist attraction in the area.

SOURCES

- *Notes on some of the more important irrigation and multi-purpose schemes built and/or controlled by the Department of Water Affairs, September 1969*, Compiled by the Department of Water Affairs
- *Van Ryneveld's Pass Irrigation Scheme. Souvenir of the official opening of the works, 14th July, 1925* by the Van Ryneveld's Pass Irrigation Board
- Van Ryneveld's Pass Irrigation Scheme in *South African Irrigation Department Magazine*, Vol. 3 No 1, March 1924
- *From frontier to midlands: A history of the Graaff-Reinet District, 1786-1910* by KW Smith
- www.graaffreinettourism.co.za/index.php?page_name=more&menu_id=1
- www.sahistory.org.za/pages/places/villages/eastern-Cape/graafReinet.htm
- Thanks to Graaff-Reinet Museum, Camdeboo Municipality and SanParks for photographs.

superstructure, 381 m long with a pedestrian walkway around 2 m wide, extends over the entire length of the top of the wall.

The main irrigation outlet valves are placed on the downstream side of the wall, and discharge into the riverbed. As the dam also serves as a storage reservoir for Graaff-Reinet, a valve tower on the upstream side of the wall draws off the water for the town. Initially three pipelines served the town's requirements.

AN UNEASY FUTURE

Like other dams in the area, Nqweba Dam has lost much of its capacity due to excessive siltation. This, in addition to an increase in soil salinity, has made irrigated agriculture a high-risk activity in the catchment, and over the years many farmers have gone out of business.

However, the dam still provides much needed water to the town of Graaff-Reinet, and when the Van Ryneveld's Pass Irrigation Board was dissolved in 2001/02 the ownership of Nqweba Dam passed on to Camdeboo Municipality. The dam now forms part of the Camdeboo National Park, and these days it is more noted as a tourist attraction than a main water supply.

The future of the dam is uncertain, however. A safety inspection of the dam in 1998 classified it as 'one of the most unsafe dams of its size in South Africa' as it is reportedly unstable under flood conditions. Investigations into various options are still being weighed to improve this situation – in the extreme case the cost to decommission the dam and replace it with another source to supply water to Graaff-Reinet may have to be considered if the structural measures are found to be too expensive. ❑

MAIN FEATURES OF NQWEBA DAM

Dam type: Mass concrete gravity section overspill type
Maximum height of concrete wall above riverbed: 33 m
Length of dam at crest: 356,6 m
Crest width (overall): 3 m
Footway: 2 m
Maximum excavation depth: 14,4 m
(Original) gross capacity at full supply level: 78 843 Mℓ
Quantity of concrete in main wall: 99 392 m^3

PAIN – The price our daughters pay for water

The burden of carrying water is putting South Africa's rural women and children at risk of a lifetime of pain and discomfort. This is according to a study by South African and UK researchers. Lani van Vuuren reports.

The regular carrying of heavy containers filled with water over long distances has long thought to be potentially damaging to the bodies of especially women and children, yet few global investigations have been undertaken in this regard. In turn, muscoskeletal injury or disorders are a known risk factor in occupational settings. These disorders can cause severe impairment and functional disability, hampering quality of life.

In South Africa, basic water services require a maximum acceptable distance for a communal tap no more than 200 m from a person's house. This means that, even if people have access to an improved water supply someone – usually a woman or child – still has to carry that water from the tap to the door. In a rather unusual study, undertaken by Jo-Anne Geere and colleagues of the Faculty of Health at the University of East Anglia, in the UK, and a team from the Department of Environmental Health at the Tshwane University of Technology led by Prof Paul Jagals, looked at the way water carrying is performed in rural South Africa, with a view to identifying the potential health risk factors. The study was funded by the Water Research Commission.

Data was collected from six villages in Limpopo's Vhembe district, purposely selected to include a range of water service situations and environments which have different physical effects or expose people to different risk factors for injury or disease. Among others, the study sought to identify the main carriers of water, how this water was carried, what factors posed risk of injury

or disease and looked at the pain symptoms experienced by those carrying water.

A WOMAN'S WORK

The study again confirmed that carrying water is the work of women and children, with very few males observed undertaking this task. Children as young as six were observed carrying heavy containers of water, weighing 19,5 kg on average. "The weight of these containers is quite significant, especially considering that the minimum body weight we measured was only 16 kg," noted Prof Jagals. "The average weight of the people in the study was 49 kg."

The research team found that the characteristics of the terrain over which this water had to be transported very much dictated the way in which people carried it, whether on the head, by rolling the container along the ground or using a wheelbarrow. This study suggests that women and children are more likely to carry water on their heads, which focuses and transmits forces through the cervical spine. The average distance travelled was 337 m.

The mean container weight as percentage of body weight for head loading was 41,4%. It was not uncommon to find especially children carrying more than half their body weight in water on their heads and a mean container weight as percentage of body weight of up to 77,8% was observed. When using equipment, such as wheelbarrows, people transported up to 200% of their body weight (up to five containers).

This water weighs heavily on the heads and necks of those who carry it. "The weight of the water alone generates an average of 191 Newtons of compressive force through the cervical spine," noted Prof Jagals. "In a healthy person this compression force may not exceed tissue tolerances if applied briefly. However, malnutrition and chronic illness, both prevalent in poor rural areas such as Limpopo, can reduce these tolerances." The mere lifting of this heavy load on to the head is a health risk, even for adults.

Millions of South African women and children spend hours a day collecting and carrying containers of water to the detriment of their health.

Guy Stubbs

Children as six were observed carrying water.

TUT

"It was not uncommon to find especially children carrying more than half their body weight in water on their heads."

Up to 70% of people interviewed complained of spinal pain (pain reported in the head, neck or back). Of interest is that the study found that the distance walked by those who reported pain was significantly less than those who did not. "These results may indicate pain-related disability, as people with spinal pain may experience difficulty carrying water over long distance and be more likely to continue to carry water only if it is accessible close to home," said Prof Jagals.

Factors such as low taps (leading to awkward body positions), load weight, an unwieldly load, physical obstacles, traffic, age and gender, are some of the other potential health risk factors identified during this study.

These findings highlight the potential impact that carrying water may have on health. "More research is required to understand the physical risks of water carrying and so reduce the burden on our women and children," concluded Prof Jagals. ❑

NAMIBIA'S TREKKOPJE

Keyplan

– A desal plant built tough

Southern Africa's largest seawater desalination plant, the 55 000 m³/d Trekkopje plant in Namibia, is now operational. Lani van Vuuren reports.

First announced in 2007, the Trekkopje desalination plant, situated near Wlotzkasbaken, about 30 km north of Swakopmund, was constructed to mainly serve Areva Resources Namibia's new Trekkopje Uranium Mine. Namibia is the world's fifth-largest producer of uranium, while also boasting abundant resources of diamonds, copper, silver, tungsten and lead.

However, Namibia has one of the driest climates in the world, and water – or the lack of it – has been a significant inhibitor to development in the country to date. When Areva Resources sought to open its new opencast uranium mine in Namibia's Erongo region, it explored several water supply options, including groundwater and surface water. However, these sources proved insufficient to meet the mine's initial 20 million m³/year requirement, and a decision was taken to develop a desalination plant instead.

"The availability and advances in desalination technology, such as high efficiency membranes and energy recovery devices, have made seawater desalination a viable solution for water supply in mining applications where a high assurance of supply is required, reports Martin Pryor, Process Manager at Keyplan, which designed and constructed the Trekkopje desalination plant.

The Trekkopje desalination plant has become of great strategic importance for the Erongo region and for Namibia. Studies undertaken for the provision of water revealed that there are insufficient water resources to provide for existing development levels in the region much beyond 2010. Thus, at the inception of the project, the desalination plant was designed not only to accommodate the mine's requirements, but also for possible future water supply to other users in Erongo.

Above: *The seawater reverse osmosis high-pressure pumps and energy recovery. The plant only consumes 4,1 to 4,5 kW of energy for every cubic metre of water produced, comparable to the best in the world.*

ENVIRONMENTAL CONSIDERATIONS

As the area of development is highly regarded for its wide open vistas and expansive desert views, the siting of the desalination plant had to be carefully selected. An already disturbed site (an abandoned borrow pit) was therefore chosen for construction of the plant. Any further disturbance to the area was minimised by, for example, prohibiting off-road

driving outside the designated construction area. The permanent water pipeline and power line traverse inland along an existing quarry road to the Trekkopje mine.

Even the plant itself has been built in such a way as to blend in with its natural surroundings. "The relatively flat nature of the area meant that the skyline would be easily broken by development. We therefore appointed an architect to design the building in such a way that it would blend in with the natural slopes of land as much as possible, used neutral colours and avoided the use of, for example, face brick," Pryor tells *the Water Wheel*.

Furthermore, a 185 km^2 lichen field is located to the north-east of the site. This field is considered one of the best expressions of these lichens along the coast. The whole area was demarcated and access strictly prohibited. In fact, the pipeline now acts as an additional barrier to the lichen fields.

TECHNICAL DETAILS

Construction a high-tech plant in such a corrosive environment was no mean feat. Among others, the engineers had to overcome a relatively unprotected coastline, where the water temperature and salinity levels vary; changes in water quality and delivery of the required quantity of fresh water over a distance of about 50 km to an altitude in excess of 500 m above mean sea level. "This is one of the toughest environments in the world to work in," notes Pryor.

The overall project infrastructure consists of:

- Two 1 200 m seawater in-take pipelines and a 600 m brine disposal pipeline;
- A seawater transfer pump station;
- A desalination process plant;
- Three treated water transfer pump stations and pipeline to the mine;
- A 54 000 m^3 terminal water storage reservoir at Trekkopje mine; and
- A 132 kV power line from the Kahn sub-station to the desalination plant (Only the seawater transfer pumpstation and desalination process plant was installed by Keyplan).

Key features of the Trekkopje desalination plant

Desalination plant design capacity	20 Million m^3/y (54 794 m^3/d)
Desalination plant installed power	12 724 kW
Intake system designed supply	45 million m^3/year
Eleven parallel UF trains	17 760 m^3/d each
Nine parallel SWRO trains	7 008 m^3/d each (operating at 63 bar pressure)
Power consumption (desalination plant)	4,1-4,5 kW per m^3 of water produced
Power consumption (SWRO system)	2,58 kWh per m^3

Source: Keyplan

The seawater intake system is designed to draw in a volume of 15 076 m^3/hour, which caters for a future potential water demand at 45 million m^3/year. The carbon steel intake pipes each received a concrete weight coating on the outside and suitable corrosion protection on the inside. With its total capacity of 55 000 m^3/year the plant is the largest ever to be constructed in southern Africa.

A seawater intake structure was installed with 40 mm-inlet screens which can be removed for cleaning or replacement. The intake and brine pipelines were placed in a 1,5 m-deep trench in the sea bed rock, through the surf zone for which a 400 mm-long temporary jetty was erected. In order to minimise the potential marine ecology impact of the brine disposal, discharge via a pipeline into deep water

Keyplan

Keyplan

Top left: *The low-pressure feed pump gallery for the seawater reverse osmosis plant.*

Bottom left: *The ultrafiltration feed pump gallery.*

Keyplan

was specified. The marine intake works and brine discharge was constructed by M & R Marine.

PRE-TREATMENT

Since the water quality of seawater along the Namibian coast is nutrient rich, has high plankton levels and contains kelp forests, pre-treatment of the seawater is required. In addition, macro-fouling from mussels, crabs, oysters, sea anemones and barnacles, combined with micro-fouling from bacteria, slime and algae, greatly restrict the flow of water along pipelines and in process equipment.

"Swakopmund is subject to an infrequent phenomenon 'red tides' and upwelling of low oxygenated water together with hydrogen sulphide from decaying organic material which raises seabed sediments," notes Pryor. "When these events occur, the desalination plant is managed accordingly to ensure that effective water treatment can be achieved."

Three pre-treatment technologies were selected. Firstly, irregular shock dosing of chlorine is applied to control biofilm and macro-fouling. The treatment of sulphides and upwellings will also be treated by chlorination. Secondly, chemical coagulation using ferric chloride is used to assist in plankton and colloidal particle removal. Lastly, seawater entering the desalination plant will pass through a set of screens less than 100 micron to capture the fine sediment and organic debris.

MEMBRANE PROCESSES

The desalination plant uses ultrafiltration (UF) followed by reverse osmosis (RO) to clean the water. Both the UF and RO membranes, as well as much of the other specialised equipment, were sourced from abroad.

The UF membranes remove turbidity, plankton and bacteria in the system. Eleven parallel UF trains were installed each capable of producing up to 740 m^3/hour of filtered seawater. Scale and fouling is controlled by anti-scalant dosing, and a specially developed anti-scalant, with good biodegradable properties, was selected for this application.

The seawater (SW) RO process uses spiral wound, thin-film composite polyamide membrane elements. Nine independent parallel SWRO trains were installed. Following the UF, a lower pressure supply pump conveys water through a single pipe to the high pressure pump and energy recovery devices. Each SWRO train has a design production capacity of 7 008 m^3/day.

An overall recovery rate of 38% to 40% is achieved, meaning that 40% of the seawater is converted into treated water, while the remaining 60% is returned to the sea. The plant was constructed in a modular fashion to allow for future expansion to meet future commercial and industrial needs.

The ultrafiltration plant and backwash piping. Eleven parallel UF trains were installed each capable of producing up to 740 m^3/hour of filtered seawater.

POST TREATMENT AND WATER TRANSFER

The permeate from the SWRO is marginally corrosive due to low calcium and alkalinity. A limestone remineralisation filter containing marble chips, followed by a small dose of soda ash is used to ensure water of optimum quality.

The stabilised water then flows into a 2 000 m^3 small on-site pump station surge tank before being pumped overland to the mine 50 km away. The water is transported via two booster pump stations to a 54 000 m^3 terminal reservoir at the mine at an elevation of 520 m above mean sea level.

The plant started delivery in March in preparation for mine activities to begin, and Keyplan has been awarded a ten-year operations and maintenance contract to run the desalination plant. This project is set to pave the way for similar future developments in the southern African region where water scarcity is a barrier to development. ❑

LEARNING AND CAPACITY BUILDING – Building a two-way bridge

CSIR

When it comes to conservation, there is much to learn from one another, as a recent project funded by the Water Research Commission (WRC) shows. Article by Inga Jacobs and Karen Nortje.

The loss of intellectual assets, skills flight and the resultant institutional memory loss are major threats to effective water management, particularly in water-scarce countries such as South Africa where the onus is on the scientific community to find technological solutions. According to Agenda 21: "a fundamental goal of capacity building is to enhance the ability to evaluate and address the crucial questions related to policy choices and modes of implementation among development options, based on an understanding of environment potentials and limits, and of needs perceived by the people of the country concerned.

This definition not only speaks to the ability to draft well-informed, relevant policy and developing implementation strategies, but also requires that these take into account, and are in fact, based on locally defined needs. One WRC-funded project sought to do just that, but unravelled the multiplicity of benefits of capacity building for various individuals by ensuring that capacity building objectives are a focus of project design as opposed to a mere positive byproduct.

In fact, the most powerful benefit realised was that by designing the project around capacity building objectives, the project was enriched by two-way learning exchanges between researchers and university students; project members and community members. Additionally, this approach produced holistic and integrated findings as well as policy recommendations that were locally driven but also provincially, nationally and regionally applicable. In so doing, the project sketched the social complexity of the issue at hand – multiple understanding of conservation.

CHALLENGING CONVENTIONAL UNDERSTANDING

The project, 'Knowing, Caring and Acting (KCA): Making Use of Socio-Cultural Perspectives

to Understand and Improve Conservation', headed by CSIR Senior Researcher Karen Nortje, aimed to develop a conceptual understanding of:

- local socio-cultural perspectives of conservation, which translated into the various ways in which people know and care about conservation, and the various ways in which people act on this; and
- how the conservation planning process is influenced by the knowing, caring, acting dynamic and local socio-cultural perspectives.

planning occurs should be taken into account. In response to this statement the KCA project team took the research of freshwater conservation to the local communities of Hazyview and Bushbuckridge in Mpumalanga.

At the outset, the project questioned the implicit dichotomy of western-scientific understandings of conservation and local socio-cultural realities and the perceived moral superiority of existing conservation planning models as processes of 'teaching' conservation practises to 'uninformed local community members'.

When we learn from one another, be it community member or researcher, a bridge is built – one that connects science, policy and communities.

There is a growing recognition that there is an implementation crisis in the field of conservation. Simultaneously, there has been an ever-growing realisation that solutions for this crisis can only be found outside the conservation process and beyond the confines of the natural sciences. For this reason, the broader socio-economic and political context within which conservation management and

The view that society should be influenced by, and should adjust their knowledge systems, their values and behaviours in greater support of conservation, is an enormous socio-cultural and socio-political challenge. While unsustainable and environmentally damaging practices are rife at the local level, this view undermines the needs and challenges of local communities.

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CSIR Senior Researcher Dr Inga Jacobs (wearing cap) with Anthropology students Innocentia Mduli and Sibongile Bambisa and Developmental Studies student Marida Aucamp are guided by a local woman to interview sites.

Because of the need to map out the multiplicity of understanding of conservation, the project team (comprising CSIR researchers and students from the Department of Development Studies and Anthropology at the University of Johannesburg), used the notion of capacity building as methodology through participatory, collective learning approaches including focus groups, theme-based interviews and participant observation.

The emphasis on a participative process ensured locally-relevant findings, and not merely a literature review of scientific best practice. In addition, it promoted two-way exchanges of information on conservation and sharing of experiences of conservation practices.

The KCA project had several capacity building components. Firstly, students were employed to assist with fieldwork research and as such gained valuable hands-on experience of conducting qualitative research in the field. Secondly, interviews/questionnaires were completed by several hundred school children and interactive participatory exercises were conducted to create awareness around conservation practices. Thirdly, focus groups were held in communities where researchers exchanged ideas with community members on conservation and the perceptions people have on it – in essence – we learned from them.

GOOD LEARNING EXPERIENCE

Through research-focused mentoring, Marida Aucamp, a Development Studies Honours student, was able to base her Honours Dissertation on the KCA project and worked side by side with the researchers, obtaining hands-on experience of qualitative research methods in the field, working with institutional representatives and communities. Fieldwork development training

was also provided to Sibongile Bambisa and Innocentia Mdluli, two Honours students in Anthropology. Acting in the capacity of translators, they also contributed substantially to the depth of project findings.

"The experience presented me with a lot of learning opportunities. Most of all, with the opportunity to learn from experienced researchers how to do fieldwork; how to conduct interviews and focus groups," notes Aucamp. For Bambisa it was also an eye-opening experience. "Doing research in the area was exciting, but difficult at the same time. As a Zulu woman, I found it hard asking some questions, such as people's age, education background and marital status. In most Nguni cultures it is forbidden to enquire about your elders' age and educational background as it is regarded as disrespectful. However, such questions had to be asked because I was not there as a Zulu woman but as a student and a research assistant."

This project is a good example of where the WRC's effort to create the space of capacity building in the field of water research has been immensely successful at different levels. For the students, it has been a good learning experience which will help them in their future careers as social scientists. For the CSIR team it has also been rewarding to be able to share one's own experience and knowledge, but also to engage with community members and learn of the socio-cultural perspectives that often contradict scientific understanding of conservation.

"It was interesting to go back where I did part of my growing up and do research about something simple that is actually complicated, water. I was an insider all the way during the field work and this made it easier for people to communicate their thoughts with me," says Mdluli. "I learnt that some people put themselves above nature which makes it difficult for them to understand that nature is to be shared by all living organisms and that it should be looked after."

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Anthropology Honours Student Innocentia Mduli engaged in a semi-structured interview with a curio vendor.

SOCIO-CULTURAL PRACTICES

The second capacity building component of the project involved conducting surveys and participatory exercises with 231 primary and high school learners. The third capacity building component involved the sharing of experienced around the wise use of water, the value of water, and the importance of water to local communities. Here, inter-generational reflections and childhood stories were shared about the nearby river.

In this instance, it was time for researchers to learn about socio-cultural practices, belief systems, the compartmentalisation of conservation and the non-linear nature of the knowing, caring, acting dynamic. Essentially, knowing about conservation may not lead to caring, and thus may not necessarily translate into acting. Other socio-cultural, political and socio-economic factors determine the nature and sequence of this dynamic.

Through a learning-by-doing approach, multi-dimensional capacity building research frameworks, such as the one exemplified in the KCA project, have much value to offer the water sector. Qualitative research methods are best able to operationalise such frameworks, and allow for the expansion in time and space of the background knowledge that informs policy and planning processes. As we learn from communities, we are able to produce issue-relevant, impactful and sustainable solutions that are in tune with the needs of communities.

In most Nguni cultures it is forbidden to enquire about your elders' age and educational background as it is regarded as disrespectful.

Social or collective learning, capacity building, or something resembling ubuntu? Whatever term we choose to give it, addressing capacity challenges in the water sector requires a two-way learning approach. When we learn from one another, be it community member or researcher, a bridge is built – one that connects science, policy and communities. ❑

WATER Kidz

BIODIVERSITY:

Taking care of creatures great and small

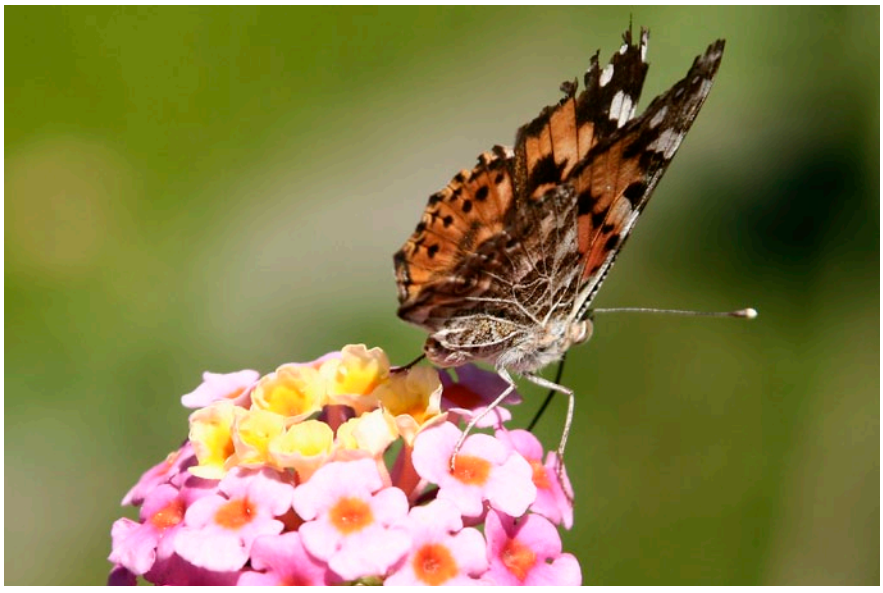
On 22 May we celebrate the diversity of life on Earth, from the tiniest insects to the largest animals that make our planet the special place it is.

From the hot arid deserts of the Sahara in Africa, through the lush green rainforests of the South American Amazon, to the ocean depths and bright corals, our natural world is a marvel of different landscapes, materials, colours and textures. Every year we celebrate the International Day for Biological Diversity to remind us of the important role of the variety of life on our planet in providing for our wealth, health and well-being.

The Earth consists of many millions of distinct biological species – the product of four billion years of evolution. According to the latest count, scientists have described over 1,5 million species of animals, plants and algae, with new species being discovered every day. These species are like little parts in a complex machine (the planet) – everything even the lowliest microbe plays a part in keeping this machine running smoothly.

We do not always realise it, but these species, whether they be plants, animals or insects, play a very important role in our lives. We depend on nature for our food, water, and shelter – even medicines. Medicines such as painkillers, penicillin and inoculations are all based on natural organisms. Wild plants are also constantly being screened in search of new cures.

To date, however, humans have not done a very good job in protecting biodiversity. We are responsible for the fact that every 24 hours between 150 and 200 species become extinct. This is mainly because of increased pressures on natural systems due to human population increase, habitat



WWW.SXC.HU

A WEALTH OF LIVING THINGS

- South Africa has more than 20 300 species of flowering plants. one of the six most significant concentrations of plants in the world is the Cape Floral Kingdom, with its distinctive fynbos vegetation.
- The country boasts 243 species of mammals. A total of 17 of these are threatened, including the black rhino, pangolin and giant golden mole. The riverine rabbit, roan antelope and wild dog are endangered.
- Of the more than 800 bird species found in South Africa, 26 are threatened, including the African penguin, Cape vulture, martial eagle, bateleur and Cape parrot.
- In total, 370 reptiles and amphibians occur in South Africa.
- The country boasts 220 freshwater fish, of which 21 are threatened. There are more than 2 000 marine fish species.

Source: Department of Environmental Affairs

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destruction, overexploitation (such as hunting and fishing), pollution and the introduction of invasive alien species. Once species and habitats are lost they can never be replaced.

South Africa is considered the third most mega-diverse country in the world. With a land surface of 1,1 million km^2 – representing just 1% of the Earth's total land area – the country contains almost 10% of the world's total known bird, fish and plant species, and over 6% of the world's 6% of the world's mammal and reptile species. This is because of South Africa's wide range of climatic conditions and its many variations in topography (from narrow coastal plains, to steep escarpment, and large plateaus).

What can the ordinary person in the street do to protect biodiversity? Well, according to the World Wildlife Fund (WWF) there are quite a few things. Firstly, if you are on holiday (even in South Africa) be careful of buying souvenirs made from skin, fur, bone, shell, beak or hooves, as these might be from endangered species.

Secondly, question where your garden furniture or wooden flooring comes from – every year some 13 million hectares of natural forest are lost. It's best to buy wood and wood products that come from a sustainable legal source. We can also protect biodiversity by reducing our paper consumption and using recycled paper. Every ton of 100% recycled paper saves 24 trees.

One of the biggest threats to the marine environment is our insatiable demand for seafood. By dialling the SASSI FishMS number, **079 499 8795** (in South Africa), you can determine whether that fish on your plate is endangered or not. The South African Sustainable Seafood Initiative (SASSI) has also created a seafood database containing information on the conservation status of fish species (http://sassi.icecream-lovestheweb.com/home.asp?m=7&s=2).

BIODIVERSITY WORDS

Biodiversity: Biological diversity or biodiversity refers to the number, variety and variability of all living things on Earth.
Biological resources: Those components of biodiversity of direct, indirect or potential use to humanity.
Biome: A major portion of the living environment of a particular region characterised by its distinctive vegetation and maintained by local climatic conditions.
Ecosystem: A dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit.
Endemic: Restricted to a particular area, used to describe a species or organism that is confined to a particular geographical region.
Habitat: The place or type of site where an organism or population naturally occurs.
Invasive alien species: Those species which occur outside their natural range and threaten the existence of native plants and animals.
Source: WWF

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WEB RESOURCES

http://wwf.panda.org/about_our_earth/biodiversity/
http://science.howstuffworks.com/evolution/mass-extinction1.htm
www.cbd.int/idb/
www.deat.gov.za
www.unep.org/iyb/
www.wwfsassi.co.za

Water gathering attracts over a thousand

More than 1 300 delegates attended the WISA 2010 Biennial Conference in Durban in March confirming the conference's status as the biggest of its kind in southern Africa. Delegates were stimulated with a range of topics, including potable and industrial water treatment technologies, wastewater treatment, education and training, communication water supply, management and institutional issues. In addition to other conference activities, the week also saw the presentation of the 2010 Blue Drop Awards and the launch of the WISA-Netherlands Water Partnership.

All photographs by Lani van Vuuren

Kitty Foxon and Prof Chris Buckley of the Pollution Research Group at the University of KwaZulu-Natal with Ronel Augustyn of Sasol Technology R&D.

Deputy Minister of Water & Environmental Affairs Rejoice Mabudafhasi, WISA President Kevin Pietersen and WISA CEO Junior Potloane at the opening session.

As usual the WRC stand attracted a great number of visitors.

TC Nemutudi; Mulimisi Nekudzhiga; Zucharia Maswuma and Moloko Matlala, all from the Department of Water Affairs.

Glenn Burton-Durham, PCI Africa; Lebo Rathebe, PCI Africa and Prof Bhekie Mamba of the University of Johannesburg.

Mahadi Mofokeng and Wendy Ralekoa, both from the DWA.

CSIR
our future through science

Water Institute of SA WISA

YWP YOUNG WATER PROFESSIONALS

WATER RESEARCH COMMISSION

The Forum for Young Scholars (YSF) in Transboundary Water Governance in SADC, in collaboration with the Young Water Professionals Gauteng Chapter presents its First Annual Symposium in association with WISA and IWA.

29-30 November 2010, Council for Scientific and Industrial Research (CSIR), Pretoria

Call for Abstracts

Exploring transdisciplinarity to address change in the SADC Water Sector: Establishing the role of social scientists in this vision

In order to address new and emerging challenges and complexities, such as climate change, increasing water scarcity, skills flight and social inequality, more integrated levels of ingenuity and expertise from a diverse set of disciplines are needed. Creating a balance between technical, natural and social science is critical to developing relevant and impact driven solutions for the water sector in the Southern African Development Community (SADC).

YSF, an issue-driven initiative by the Young Water Professionals (YWP) Gauteng Chapter invites you to its first annual symposium on the benefits of interdisciplinary collaborative exchanges in addressing change in the SADC Water Sector. This workshop offers a number of exciting opportunities to interested young professionals:

- It will bring together a broad spectrum of young scientists, from different backgrounds, to workshop the theme above.
- It offers a theme-specific presentation opportunity to young professionals
- It will offer an opportunity for inter-generational learning as a 'community of elders' or more experienced professionals will be present to engage young professionals on their work.
- Publishing opportunities for selected papers will be explored.

We encourage the submission of abstracts that look innovatively at transdisciplinarity as a means to addressing the region's emerging change and challenges, specifically targeting the following sub-themes: **Climate Change; Acid Mine Drainage; Water and Health; and Governance.**

Abstracts should be a maximum of 350 words, font size 12, Times New Roman and single spaced. Papers in each sub-theme should include innovations and experiences in water resources planning and management and river basin management at different institutional and spatial scales and in view of global changes.

Please email all abstracts to:
Dr. Inga Jacobs:
ijacobs@csir.co.za

Due Date for all abstracts:
30 August 2010




Water Research Commission

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

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

Impact areas address the following key issues:

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

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