THE WATER WHEEL
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Elephants and water - An eternal bond

WATER RESEARCH COMMISSION

MASTERS DEGREE IN ENVIRONMENTAL MANAGEMENT

PART-TIME OVER TWO YEARS

"SUSTAINABILITY DEPENDS ON FUNCTIONING ENVIRONMENTAL SERVICES" (Prof MT Seaman)

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***Cover**: Does water hold the key to controlling elephant populations in our national parks? Read the debate on page 19.*
Cover photograph by Drinie van Rensburg.

Letter to the Editor

History article brings back memories

What a pleasant surprise I had when opening the latest *Water Wheel* to find an article on the Riviersonderend/Berg River Water Scheme ('Blood, sweat and tears at Riviersonderend', *the Water Wheel* May/June 2011).

I had the absolute privilege of being the first operator to operate this truly remarkable scheme from 1981, through commissioning until 1988. Reading all about it and seeing some pictures after twenty two years really brought back fond memories. On page 24 the top picture Mr Peter Hume, the Resident Engineer, can be seen on the right. The guys that planned, designed and built this scheme truly deserve to have

their names displayed on a plaque somewhere.

Your last sentence mentions the Assagaaibos Dam being built a few years later. As far as I am aware this dam was never built. The Skuifraam or Berg River Dam was, however, built a few kilometres below the site of the Assegaaibos.

Thanks again for a great article and a great magazine.

Maurice Durrheim, Amatola Water

Ensuring the future of SA's frogs

The new Red List and strategy document for planning the future of research in South Africa's diverse amphibian fauna is now available from the South African National Biodiversity Institute (SANBI).

Across the globe, amphibian numbers have been in fast decline since first reported in 1990. Habitat change due to anthropogenic reasons is a leading factor, but even in pristine habitats reductions in populations are occurring due to ultraviolet light, climate change and infectious diseases.

The SANBI publication, *Ensuring a Future for South Africa's Frogs: a Strategy for Conservation Research*, includes an updated Red List of the country's amphibians. It also acts as a policy document to guide researchers, policy makers and conservationists to prioritise research on threatened frogs for the next five years.

South Africa boasts at least 118 species of frogs, 43% of which are endemic. This includes the smallest (and critically endangered) micro frog in the lowland fynbos blackwater to the largest African Bullfrog in the temporary pans of the Free State, Gauteng, Mpumalanga and Limpopo. The new publication aims to ensure that the scarce resources available for the conservation of South Africa's frogs are most effectively utilised in understanding and reducing the threats to our extraordinary amphibian biodiversity.

For more information, Visit: www.sanbi.org.za

Source: SANBI

Tshwane now largest city in SA

The City of Tshwane has become the largest metropolitan municipality in South Africa.

This is after the Metsweding District Municipality, which includes the towns of Bronkhorstspruit and Cullinan, was incorporated into the metro. Tshwane now comprises an area of 6 368 km^2 and a population of just over 2,5 million.

In terms of land mass this makes Tshwane the third-largest city in the world, after New York and Yokohama. The reconfigured Tshwane now has seven regions and 105 wards.

Construction kicks off at KZN's Spring Grove Dam

Construction of Spring Grove Dam on the Mooi River in KwaZulu-Natal, part of phase two of the Mooi-uMgeni Transfer Scheme has officially started following a sod turning ceremony held in May.

The project, being undertaken by TCTA, will provide water to the uMgeni system which supplies water to people living in eThekwini, uMgungundlovu and uMsunduzi municipal districts. Other indirect beneficiaries include the Sisonke, Ugu and Ilembe district municipalities.

Spring Grove Dam will be located about 2 km south west of Rosetta. The dam will be about 1 035 ha in area when full, and will have a capacity of 141 million m^3. The dam wall will be about 38 m high with the dam site and dam basin area below the 1437 m above sea level contour.

The project, which is expected to deliver water by 2013, is being funded off-budget, and capital costs will be recovered from the revenue generated by the sale of water. Funding agreements have been signed with European development banks the European Investment Bank, Agence Française de Dévelopement and the German Development Bank along with the Development Bank of Southern Africa.

Sentencing of environmental consultant welcomed

The Department of Environmental Affairs (DEA) has welcomed the sentencing of environmental consultant, Stefan Frylinck as well as his firm, Mpofu Consulting, for contravening the Environmental Impact Assessment (EIA) regulations by providing incorrect and misleading information which led to the development of a construction site on a wetland.

The environmental consultant and his firm were sentenced in the Pretoria Regional Court in April to a cumulative fine of R160 000.

Authorisation for the Pan African Parliament in Midrand was issued in 2007. As part of the EIA process, Frylinck provided information to the DEA which specifically indicated that there was no wetland on the site. Once construction had commenced, the department was informed by provincial and local government that they were concerned that the PAP was being built on a wetland. The department then instituted enforcement action, which resulted, firstly, in a panel of specialists being employed by the Department of Public Works to confirm the existence of a wetland on the site and, secondly, in the cessation of construction activities.

Following criminal investigations, the consultant and related firm were charged and later sentenced in court. DEA spokesperson, Albi Modise, said: "The department views this ruling as a victory...it sends out a strong message to environmental consultants that the department will not hesitate to enforce the law where it is clear that such consultants have acted in contravention of their legal obligations."

Minister calls for increased support for smallholder farmers

Minister of Agriculture, Forestry & Fisheries Tina Joemat-Pettersson has called for increased support for smallholder farmers.

Speaking at a conference on rural poverty hosted by the UN's International Fund for Agricultural Development (IFAD), she said that while Africa continues to face enormous challenges in reducing poverty, 'a vision of economic renaissance' led by smallholder farmers is beginning to take hold.

"There is a growing belief that Africa can produce enough food not only to feed its own citizens, but export a growing surplus to the rest of the world," she said, adding that South Africa is spearheading a rail system which links the entire continent and allows farmers to take goods from road to rail across Africa.

There are about 500 million smallholder farms worldwide and about two billion people depend on them for their livelihoods, according to IFAD. These farms produce 80% of food consumed in Asia and sub-Saharan Africa.

Joemat-Pettersson pointed out that 47% of Africa's arable land remains uncultivated. She cited a Harvard study, which revealed that the continent could increase its food production by 1,5% a year with more support.

She said agriculture could play a significant role in economic development and job creation – adding that the agricultural value-chain had been identified in the New Growth Path as one of the key sectors to grow the country's jobs.

Agriculture would also be placed on the agenda for the COP-17 conference, which takes place in Durban in November, noted Joemat-Pettersson.

Source: BuaNews

Lower water tariff rise following successful negotiations

Successful negotiations between Agri SA and the Department of Water Affairs (DWA) have led to the announcement of the maximum increase of only 10% in water resource management and water infrastructure tariffs this year.

This is after initial proposals regarding water resource management tariffs (management and maintenance of water resources) had made provision for increases up to 179%. In the case of water infrastructure at State water schemes and irrigation boards, the initial proposal provided for increases of up to 50%.

Agri SA President Johannes Möller expressed his satisfaction with the more realistic adjustments. "This breakthrough follows our negotiations with DWA since September last year."

The organisation had, in its economic presentation regarding the situation in agriculture, informed the department that the irrigation was particularly vulnerable in terms of sustained food production given rising input costs, such as water and electricity. Möller said that against this backdrop, Agri SA had asked that water tariffs be confined to a minimum.

Although actual cost savings will differ from scheme to scheme in light of the ceiling on tariff increases (10%) and the initially proposed dispensation, an overall annual saving of at least R100-million is envisaged for the irrigation sector based on the announced tariff dispensation.

Source: Agri SA

Water diary

DESALINATION
SEPTEMBER 4-9
The International Desalination Association World Congress 2011 on Desalination and Water Reuse will take place in Perth, Western Australia. *Visit: www.idadesal.org/t-worldcongress_start.aspx*

GROUNDWATER
SEPTEMBER 8-10
The IWA Specialist Conference on Groundwater will take place in Belgrade, Serbia. Proposed themes include the preparation and implementation of groundwater component of water management plans for large river basins; the importance of the aerobic state of groundwater; climate change and its impact on groundwater; and management of urban groundwater basins. *Enquiries: Miodrag Milovanovic; Tel: +381 11 390-8135; EmailL miodrag.milovanovic@jcerni.co.rs; Visit: www.jcerni.org/activities/conferences/iwa_specialist_groundwater_conference_2011*

MEMBRANES
SEPTEMBER 11-14
The Second International Conference of the WISA Membrane Technology Division will take place at the 1on1 Gateway conference centre at Umhlanga, KwaZulu-Natal. *Visit: www.wisamtc2011.co.za*

WATER
SEPTEMBER 13-15
The Biennial AfriWater Water and Waste Exhibition and Conference will take place at the MTN Expo Centre at Nasrec, Gauteng. The co-locating conferences are organised by WISA and the International Pump User Conference. *Enquiries: Zia Tomes (Exhibition Manager); Tel: (021) 790-1337; Email: ziat@specialised.com*

AQUACULTURE
SEPTEMBER 13-16
The 10th Biennial Aquaculture Conference of the Aquaculture Association of Southern Africa will take place in Malawi. The conference is hosted by the University of Malawi in collaboration with the NEPAD Regional Fish Node and the Fisheries Department of the Government of Malawi. *Enquiries: Email: info@aasa-aqua.co.za or Visit: www.aasa-aqua.co.za*

R25-m earmarked to save schemes

Government has set aside R25-million to revitalise three irrigation schemes in Mpumalanga's Bushbuckridge area.

The financial injection is expected to boost citrus and banana production in Hoxane, Champagne and Saringwa villages, said spokesperson for the provincial Department of Agriculture, Rural Development and Land Administration, Janine Julies. "Commitment from the community will ensure that the 3 000 ha is put back into production."

More funding was expected from private investors to help with the three projects. According to Julies, the first phase of the Champagne irrigation scheme was already completed, allowing for an additional 200 ha of citrus cultivation.

Presenting the department's R969,1 million budget for 2011/12 in the provincial legislature last week, MEC Candith Mashego-Dlamini announced a further R10-million to kick-start the revitalisation of the Ngogolo, Mbhunu B, Nhlangu East and West sugarcane projects in Komatipoort. She said the money would help struggling subsistence and emerging farmers in the sugar industry.

The department was also in the process of developing a feasibility study for a fresh produce market in Mpumalanga. "This will help integrate local farmers throughout the value chain and take advantage of the developed infrastructure around the Maputo Corridor, the proximity to Mozambique, Swaziland and other South African Development Community countries," said Mashego-Dlamini.

She added that a fresh produce market would help the province tap into local and international experiences, in particular, the leading fresh produce markets in France and Spain.

Source: BuaNews

Work on acid mine-water underway

Environmental officials are working around the clock to curb the potential dangers posed by the impact of acid mine drainage (AMD) in the Witwatersrand mining area.

An expert team appointed by Cabinet to advise the inter-ministerial committee on the dangers of AMD to Gauteng warned earlier this year of the need to avert "impending crises." The team, drawn from the Council for Geosciences, Water Research Commission and CSIR, among others, identified various risk categories, including the contamination of surface and groundwater required for agricultural and human consumption.

But according to a statement issued this week by the Department of Water Affairs (DWA), "important progress" had been made by the State in implementing the immediate and short-term actions recommended in the AMD Report. It said Minister Edna Molewa had further tasked State-owned TCTA to oversee installation of pumps to extract water from the mines to on-site treatment plants and construction of an on-site mine water treatment plant in each basin.

There will also be an installation of infrastructure to convey treated water to nearby watercourses and the facilitation of the best model, which shall be proposed to the DWA, for the operations of the pumping stations and treatment works.

Treasury had made a budget allocation of R225-million in the next three years towards the design and building of an acid mine-water treatment facility, R5-million of which will be spent on a five-year plan to deal with acid mine drainage.

The statement said recent "collaborative efforts" between the department and TCTA have resulted in an investigation of existing mine water treatment infrastructure in the western and central basin mining areas, and of potential institutional arrangements with the mining companies that are active in these basins.

"The TCTA, by way of tender protocol, appointed a professional service provider to provide an intensive appraisal of the available infrastructure and to formulate appropriate engineering options to adequately resolve the AMD problem," said the department.

The highest priority is being given to the development of solutions to reduce, if not eradicate, the surface decant of AMD in the West Rand area. Also of high priority was the development of measures focused on ensuring that underground mine-water levels in the central basin of the mines do not reach the environmental critical level, which poses a threat.

The department said pumps for the central basin have been procured and are set to be delivered by the end of July. Other engineering requirements in terms of construction and electrical infrastructure will follow. In the eastern basin, the department was awaiting final announcements by the liquidators that are administering the Aurora Mining Company. "The situation is being closely monitored and, if no real solution is provided, Government intervention will be unavoidable."

Source: BuaNews

New MD for consulting engineering firm

SRK Consulting's headcount has tripled since new managing director Peter Labrum joined the business in 1989, but the professionalism that attracted him then remains at the core of his leadership mandate.

It would be hard to find an SRK partner more steeped in the culture of the firm's now global brand than Labrum, whose first stint with the firm went back to 1979 – when he spent 18 months on site as resident engineer for the construction of a rockfall shelter on Kowyn's Pass in Mpumulanga. Having left to become involved in the Garden Route arch bridges in the Eastern Cape, it was little less than a decade later, one of SRK's founders, Hendrik Kirsten, was able to attract him to re-join the head office in Johannesburg, and within a couple of years he became one the firm's partners.

At home in South Africa, as elsewhere, Labrum emphasises the need for SRK to attract and nurture young engineers, exciting them with the challenge of technical excellence in all aspects of a project. "Developing people has always been at the foundation of our company and our industry," he said, "and it will remain a priority for us going forward."

Multimillion wastewater treatment contract awarded

Veolia Water Solutions & Technologies South Africa (VWS South Africa) has been awarded a R187-million contract by the City of Cape Town's Department of Water & Sanitation to upgrade its Bellville wastewater treatment works. The upgrade is expected to relieve the strain on the existing works and improve the effluent quality.

With this upgrade, the Bellville plant will feature the largest membrane bio-reactor (MBR) in the country to date. The design and build contract, including all mechanical and electrical works, will see VWS South Africa supply a new inlet works for the MBR plant, biological reactors and six membranes. A new sludge dewatering facility will also be supplied, and the existing electrical and control systems infrastructure at the wastewater treatment plant will be upgraded.

Currently in the basic engineering design phase, the plant is due for commissioning in 2013. VWS South Africa will provide training and maintenance support for the first year of operation.

New West Cape groundwater chair announced

Dr Kornelius Riemann, principal hydrogeologist at Cape Town earth sciences consultancy Umvoto Africa, is the new chairperson of the Western Cape Groundwater Division of the Geological Society of South Africa (GSSA).

The GSSA was established in 1895 and is one of the oldest scientific societies in South Africa. It represents geologists and earth scientists with an interest in Africa, and southern Africa in particular, and has over 2 500 members and student members.

The GSSA Groundwater Division was established in 1978 by members of the groundwater community and the

Directorate of Geohydrology, Department of Water Affairs. It is a body of scientists and technicians with involvement or interest in the optimal development of the country's groundwater as a limited natural resource, and in the preservation of its quality. The Western Cape branch currently has 62 members.

Dr Riemann, who focuses on integrated water resource development and management at Umvoto, says his role will include communication about groundwater and related issues both within and beyond the groundwater community, and supporting the professional development of groundwater practitioners. He is currently involved in organising the Groundwater Division's bi-annual groundwater conference, to be held in Pretoria later this year in association with the International Association of Hydrogeologists (IAH).

Gaborone sewerage reticulation project passes halfway mark

Halfway through ACE GIBB's massive project to upgrade Gaborone's sewerage network, an update from the front line is that the project is cleared for success.

The refurbishments to the system are set to make a meaningful difference in the lives of Botswana citizens. According to project manager Vernon Joubert, the project involves the decommissioning of certain pump stations, refurbishment and construction of other pump stations as well as building trunk and main sewers in Gaborone to provide capacity up to the planning horizon of 2030. "Furthermore, we are tasked with provision of sewerage systems for some 6 000 remaining self help housing area plots, which currently run on septic tanks."

ACE GIBB, in joint venture with Pula Consultants, received the contract to plan, design and supervise the upgrade of Gaborone's sewerage system in 2008. China Jiangsu International Botswana is handling construction.

Initially, the completed project was to be handed over to the Gaborone City Council; however, the responsibility for sewerage systems has recently been taken over by the parastatal Water Utilities Corporation. During the construction stages of the project, locals are benefiting from employment opportunities in different areas of operation.

Water on the web

http://wwf.panda.org/who_we_are/history/50_years_of_achievements/
It has been 50 years since the establishment of the WWF, one of the world's most well known conservation organisations. To celebrate, the organisation, with its distinct panda logo, has developed a special website highlighting achievements throughout WWF's 5 decades of existence.

http://www.wrc.org.za/Pages/Learning.aspx
The Learning page on the Water Research Commission website offers learners, teachers and students a variety of material. Delve into the world of water knowledge by browsing the Water Wheel's 'water kidz' articles or download lessons pertaining to water for Grade 0 to 12. Aspiring and current students will also find the WRC's career guide here, which provides valuable information on job opportunities in the sector.

Predicting and preventing environmental collapse – it's possible, says study

By closely monitoring environmental conditions at a remote lake in Wisconsin, USA, researchers have found that the model used to assess catastrophic changes in economic and medical systems can also predict environmental collapse.

Stock market crashes, epileptic seizures, and ecological breakdowns are all preceded by a measurable increase in variance – be it fluctuations in brain waves, the Dow Jones index, or in the case of the Wisconsin lake, chlorophyll.

In a paper published in the journal, *Science*, a team of ecologists from the Cary Institute of Ecosystem Studies are apparently the first to show that by paying attention to variability in key ecosystem processes, scientists can detect the early warning signs that precede environmental collapse. Insight into regime shifts – the reorganisation of an ecosystem from one state to another – is critical in identifying ecosystems that will fail without intervention.

"Early warning signs help you prepare for, and hopefully prevent, the worst case scenario," notes contributing author Jonathan Cole. "We are surrounded by problems caused by ecological regime shifts – water supply shortages, fishery declines, unproductive rangeland – our study shows that there is promise in identifying these changes before they reach their tipping point."

The team, led by Stephen Carpenter, a limnologist at the University of Wisconsin-Madison, triggered a regime shift in a Wisconsin lake by introducing a top predator. The study lake was originally dominated by small fish living off invertebrates. Researchers destabilised the lake by adding largemouth bass. The goal was to observe the cascade of environmental changes that eventually led to a food web dominated by piscivorous fish.

Throughout the lake's three-year manipulation, its chemical, biological and physical vital signs were continuously monitored to track changes. It was in these data sets that researchers were able to detect the signals of the ecosystem's impending collapse.

As the number of bass increased, smaller fish spent more time swimming in groups near the shoreline to avoid being eaten. Freed from predation, invertebrates living in the open water shifted to forms that were larger in size. Phytoplankton, the preferred food of these invertebrates, became more variable.

More significantly, more than a year before the food web transition was complete, variance in chlorophyll measurements was found to be a reliable early warning indicator of the impending food web regime shift.

"The field experiment is a validated statistical early warning system for ecosystem collapse. With more work, this could revolutionise ecosystem management," Carpenter comments. The catch, however, is that for the early warning system to work, continuous monitoring of an ecosystem's chemistry, physical properties, and biota are required.

Such an approach may not be practical for every threatened ecosystem. However, Carpenter sites the price of doing nothing: "These regime shifts tend to be hard to reverse. It is like a runaway train once it gets going and the costs, both ecological and economic, are high."

Global population to pass 10 billion by 2100, UN projections indicate

The world's population is projected to surge past 9 billion before 2050 and then reach 10,1 billion by the end of the century if current fertility rates continue at expected levels, according to the latest UN figures.

Most of the increase will come from so-called 'high fertility countries' mainly in sub-Saharan Africa, but also in some nations in Asia, Oceania and Latin America, the figures reveal. The 2010 Revision of World Population Prospects prepared by the Population Division at the UN's Department of Economic and Social Affairs, shows that a small variation in fertility could lead to major long-term differences in the size of the global population.

Based on the medium projection, the number of the people in the world – currently close to 7 billion – should pass 8 billion in 2023, 9 billion by 2041 and then 10 billion at some point after 2081. However, a small increase in fertility could mean a global population of as much as 15,8 billion by 2100, while a small decrease could result in an eventual overall decline in population to 6,2 billion by the end of the century.

Source: UN News

Hydrofracking changes water wells

American researchers have found high levels of leaked methane in well water collected near shale-gas drilling and hydrofracking sites.

The scientists from Duke University collected and analysed water samples from 68 private groundwater wells across northeastern Pennsylvania and New York.

Hydraulic fracturing (also known as hydrofracking or fracking), involves pumping water, sand and chemicals deep underground into horizontal gas wells at high pressure to crack open hydrocarbon-rich shale and extract natural gas. South Africans were recently introduced to the technology when Shell announced plans to introduce fracking to the Karoo. To the relief of opposition groups government has since placed a moratorium on fracking in the country.

Interestingly, the Duke University study found no evidence of contamination from chemical-laden fracking fluids, which are injected into gas wells to help break up shale deposits. "However, we found measurable amounts of methane in 85% of the samples. Levels were 17 times higher on average in wells located within a kilometre of active hydrofracking sites," noted Stephen Osborn, post-doctoral research associate at Duke's Nicholas School of the Environment.

By using carbon and hydrogen isotope tracers the scientists could distinguish between thermogenic methane, which is formed at high temperatures deep underground and is captured in gas wells during hydrofracking, and biogenic methane, which is produced at shallower depths and lower temperatures. The latter is not associated with fracking.

"Methane in water wells within a kilometre had an isotopic composition similar to thermogenic methane," explained Avner Vengosh, professor of geochemistry and water quality. "Outside this active zone, it was mostly a mixture of the two."

The scientists confirmed their finding by comparing the dissolved gas chemistry of water samples to the gas chemistry profiles of shale-gas wells in the region using data from the Pennsylvania Department of Environmental Protection. "Deep gas has a distinctive chemical signature in its isotopes. When we compared the dissolved gas chemistry in well water to methane from local gas wells, the signatures matched," noted Robert Jackson, Nicholas Professor of Global Environmental Change.

Methane is flammable and poses a risk of explosion. In very high concentrations, it can cause asphyxiation. Little research has been conducted on the health effects of drinking methane-contaminated water.

The team's findings have appeared in the Early Edition (dated 10 May) of the *Proceedings of the National Academy of Sciences.* To view the article, Visit: http://www.pnas.org/content/early/2011/05/02/1100682108

Will extreme climate now become 'regular'?

Dramatic climate swings behind both last year's Pakistan flooding and this year's Queensland floods in Australia are likely to continue as the world gets warmer, scientists predict.

Researchers at the universities of Leeds and Oxford have discovered that the El Niño Southern Oscillation (ENSO), the sloshing of the warmest waters on the planet from the West Pacific towards the East Pacific every two to seven years, continued during the Earth's last great warm period, the Pliocene.

Their results suggest that swings between the two climatic extremes, known as El Niño and La Niña, may even have occurred more frequently in the warmer past and may increase in frequency in the future. extreme ENSO events cause droughts, forest fires, and floods across much of the world (including South Africa) as well as affecting fishery production.

Lead scientist Nick Scroxton from the University of Oxford said: "We know from previous studies that the mean state of the Pacific during the warm Plioecene (which lasted from 5 to 3 million years ago) was similar to the climate patterns observed during a typical El Niño event that we see today. However, until recently it was believed that a warmer Pacific would reduce the climate swings that cause the dramatic weather extremes throughout the region leading to a permanent state of El Niño. What we didn't expect was that climatic variability would remain strong under these warmer conditions."

The team combined experiments performed on the Met Office Hadley Centre climate model, HadCM3, with the analysis of the chemical composition of lots of individual shells of small organisms, known as foraminifera. These were collected from a deep sea sediment core in the East Equatorial Pacific, and provided a record of temperature in the upper layer of the ocean through time. They discovered that the range of temperatures experienced by these organisms during the Pliocene, was higher than what would be expected from just the seasonal cycle.

The extra variation in temperature can be explained by the additional extreme temperature swings provided by the El Niño/La Niña system. The authors say the agreement in findings from both ocean data and modelling leaves little doubt that ENSO will persist in a warmer world.

The study has been published in the journal *Paleoceanography* (http://www.agu.org/pubs/crossref/2011/2010PA002097.shtml)

Water by numbers

- **88%** - The number of people in the Western Cape who have access to basic services – the highest in the country. This is according to the Universal Household Access to Basic Services Index.
- **26** – The number of directives against polluters issued by the Department of Water Affairs last year. A total of 25 cases are currently before the courts.
- **2 litres** – The average person's daily drinking water requirement. However, it takes between 2 000 ℓ and 5 000 ℓ of water to produce one person's daily food.
- **277 million hectares** – The extent of land under irrigation in the world, about 20% of all cropland.
- **40%** - The percentage of the world's food production gained from irrigated agriculture.
- **10%** – The percentage of the world's irrigated lands suffering from waterlogging and salinisation as a result of poor drainage and irrigation practices.
- **2 million tons** – The amount of human waste that ends up in the world's water courses every day, according to the UN.
- **21** – The number of water management inspectors now working for the Department of Water Affairs. The number is up from 14 last year.
- **2** – The number of people who joins the global urban population every second.
- **1,8 billion** – The number of people who have gained access to improved drinking-water sources since 1990.
- **95%** – The percentage of urban population growth that will take place in the developing world over the next decade.

Pesticide to be eliminated after placed on UN list of hazardous chemicals

An insecticide widely used in agriculture for pest control has become the latest hazardous chemical to be added to the United Nations' (UN's) list of persistent organic pollutants (POPs) targeted for elimination from the global market.

According to the UN, Endosulfan, an organochlorine insecticide, has been added to the POPs list as it is known to cause reproductive and developmental damage in both animals and humans. The chemical is mainly used as a pest control agent in cotton, coffee and tea farms worldwide.

"[It has been recognised] that financial and technical support is required to facilitate the replacement of the use of Endosulfan in developing countries and countries with economies in transition," noted Achim Steiner, UNEP Executive Director. "In establishing a consultative process on finance for the chemicals and waste conventions, UNEP has responded to the need of those countries by seeking to make the sound management of hazardous chemicals a development priority of the green economy in which all countries can fully and fairly participate."

Source: UN News

Scientists detect Earth-equivalent amount of water within the moon

The moon has much more water than previously thought, US scientists have discovered.

First-time measurements of lunar melt inclusions show that some parts of the lunar mantle have as much water as the Earth's upper mantle. The results may change the prevailing theory about the Moon's origin as well as shed new light on the origin of water at lunar poles.

Lunar melt inclusions are tiny globules of molten rock trapped within crystals that are found in volcanic glass deposits formed during explosive eruptions. The new funding shows lunar magma water contents 100 times higher than previous studies have suggested.

The result is the culmination of years of investigation by the research team searching for water and other volatiles in volcanic glasses returned by NASA Apollo missions in the last 1960s and early 1970s.

Compared with meteorites, Earth and other inner planets contain relatively low amounts of water and volatile elements, which were not abundant in the inner solar system during planet formation. The even lower quantities of these volatile elements found on the Moon has long been claimed as evidence that it must have formed following a high-temperature, catastrophic giant impact. But this new research shows that aspects of this theory must be reevaluated.

"Water plays a critical factor in determining the tectonic behaviour of planetary surfaces, the melting point of planetary interiors and the location and eruptive style of planetary volcanoes," said Erik Hauri, a geochemist with the Carnegie Institution of Washington and lead author of the study.

The study also puts a new twist on the origin of water ice detected in craters at the lunar poles by several recent NASA missions. The ice has been attributed to comet and meteor impacts, but it is possible some of this ice could have come from the water released by eruption of lunar magmas.

Source: Brown University

Third of world's food wasted – study

More than a billion tons of food – roughly one third – produced in the world for human consumption every year gets lost or wasted, according to a study commissioned by the Food and Agriculture Organisation of the United Nations (FAO).

Other key findings from the document, *Global Food Losses and Food Waste*, published earlier this year, are that developed and developing countries dissipate roughly the same quantities of food – respectively 670 and 630 million tons; and that every year, consumers in rich countries waste almost as much food as the entire net food production of sub-Saharan Africa. Significantly, the amount of food lost or wasted every year is equivalent to more than half of the world's annual cereals crop.

Food losses, which occur at the production, harvest, post-harvest and processing phases, are experienced more by developing countries, while food waste is more of a problem in industrialised nations. The FAO study shows that per capita waste by

consumers is between 95-115 kg a year in Europe and North America, compared to 6-11 kg in sub-Saharan Africa and South and Southeast Asia.

Food loss and waste amount to a major squandering of resources, including water, land, energy, labour and capital and needlessly produce greenhouse gas emissions, contributing to global warming and climate change.

Interestingly, at retail level, large quantities of food are wasted due to quality standards that over-emphasise appearance. This while surveys show that consumers are willing to buy products not meeting appearance standards as long as it is safe and tastes good. Customers thus have the power to influence quality standards and should do so, the report said.

In addition, good use for food that would otherwise be thrown away should be found. Commercial and charity organisations could work with retailers to collect, and then sell or use products that have been disposed of but that are still good in terms of safety, taste and nutritional value.

To download the document, *Global Food Losses and Food Waste*, Visit: http://www.fao.org/fileadmin/user_upload/ags/publications/GFL_web.pdf

New from the WRC

Report No: 1852/1/10

An investigation of the potential use of ocean colour remote sensing to assess the influence of variations in freshwater inputs to coastal ecosystems: Phytoplankton and sediment dynamics of the Natal Bight (S Bernard & M Smith)

New Case 2 ocean colour projects from the Medium Resolution Imaging Sensor (MERS) have been analysed for the first time in South Africa, providing a preliminary qualitative ability to synoptically map phytoplankton biomass, suspended sediment and dissolved organic material in the Natal Bight. Preliminary findings indicate that the default MERIS 'Algal 1' and 'Algal 2' products are not effective in the Case 2 waters of the Natal Bight and that the Case 2 Regional processor is more accurate and robust in these inshore water types, but appears to function less well in mesotrophic and oligotrophic waters, among others.

Report No: 1800/1/10

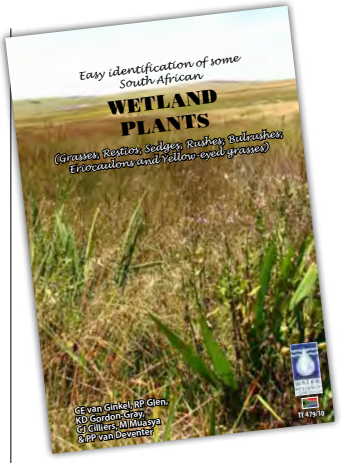
Knowing, caring and acting: Making use of socio-cultural perspectives to support biophysical 'conservation' initiatives (K Nortje, I Jacobs, M Aucamp, N Funke, WF Strydom, J Clover, M Patrick, E van Wyk, B de Wet & E Masekoameng)

Among others, this three-year project sought to investigate local socio-cultural perspectives of conservation, and specifically water conservation; to develop a conceptual understanding of the theoretical underpinnings that explain why individuals and society do not know, or care or act in the context of freshwater conservation; and to examine how the conservation planning process is influenced by the knowing, caring, acting dynamic and local socio-cultural perspectives.

Report No: TT479/10

Easy identification of some South African wetland plants (CE van Ginkel, RP Glen, KD Gordon-Gray, CJ Cilliers, M Muasya & PP van Deventer)

Wetlands are recognised as one of the richest and most productive ecosystems on earth. Associated with wetlands are



a wide range of specially adapted plant species giving food and shelter to a variety of animal life. While a list of wetland plants in southern Africa had been published in 2010, there was until now no field guide available for the layman or student on wetlands plants in the country. This field guide focuses primarily on obligate wetland plants, paying special attention to grass-like plants. In total, 290 species of plants are covered.

The book is printed on high-quality paper and includes many colour photographs and illustrations. It sells for R200.

Report No: KV 248/10

Biologically enhanced primary settlement: A scoping study to determine bioflocculant opportunities for locally grown crops and their associated waste for COD, N and P removal in small rural WWTWs (C Lutchamma-Dudoo)

This scoping study was undertaken into the roles that biological flocculants can play in municipal wastewater treatment. Extensive jar testing with different products and extraction methods showed that the products tested were capable of enhancing the reduction in the COD of the water from around 30% to over 60% when compared to conventional sedimentation. Other benefits include the reduction in suspended solids and turbidity.

Report No: 1692/1/10

A comprehensive investigation of the Kuils-Eerste River catchment's water pollution and development of a catchment sustainability plan (A Thomas; W Chingombe; J Ayuk & T Scheepers)

This research seeks to address issues regarding water quality arising from land cover type change and urban sprawl in a predominantly agricultural catchment in Cape Town. The Kuils River and Eerste River are two important rivers that run through the eastern part of the Cape Metropolitan Area. Although these catchments form part of urban developments, significant portions of the Eerste-Kuils river catchment have agricultural lands; hence it has both urban and agricultural sources of non-point source pollutants. The study aimed to develop a working document for adapting the catchment into a sustainable system.

Report No: 1543/1/10

Industrial wastewater remediation via wet-air oxidation using immobilised transition metal catalysts (SF Mapolie; S Ray; J Darkwa & J van Wyk)

Industrial effluents are routinely polluted with a range of organic materials, many of which are toxic and difficult to remove. Various approaches have been employed to remediate these industrial effluents. Included among the methods used is wet air oxidation. All of these methods are energy intensive and are usually carried out under extreme conditions. This project investigated the potential use of catalytic wet air oxidation.

Report No: 1677/1/10

A guide to the development of conservation plans for threatened southern African fish species (JA Venter; PSO Fouché; W Vlok; NAG Moyo; P Grobler & S Theron)

WRC funding was granted to develop a conservation framework applicable to threatened fish species in southern Africa's highly diverse and important freshwater ecosystems. There are a number of factors threatening the ecological functioning of rivers in southern Africa. The effluent and seepage from mines, industries, agriculture and human settlements have already caused serious, and sometimes irreversible, changes in water quality in river systems.

A substantial number of freshwater fish species from South Africa are on the IUCN Red List. Among others, the project aimed to determine the current distribution of *Opsaridium peringueyi* (Southern Barred Minnow) and other species in the genera in its historical distribution range; to characterise the habitat and habitat preferences of the species and determine threats to its survival etc. Ultimately, a generic conservation framework has been drawn up for threatened African fish species.

Report No: 1718/1/10

An operational information tool for the efficient operation and maintenance of small water treatment plants (CD Swartz)

Among others, this project investigated the existence and characteristics of operational information management systems used by other countries, which could serve as a basis for a South African system; aimed to developed an operational information tool for South African small and medium-sized water treatment plants; and develop training aids for the application of this information management tool.

Report No: 1719/1/10

The development of an analytical system for ß-N-Methylamino-L-Alanine and investigation of distribution of producing organisms and extent of freshwater contamination (TG Downing)

The neurotoxin ß-N-Methylamino-L-Alanine (BMAA) has been identified as a potential risk to human health as it is implicated in Alzheimer's disease, Parkinsonism and Amyotrophic Lateral Sclerosis. The possibility of sustained exposure to BMAA via drinking water supplies prompted the establishment of local analytical capacity for the neurotoxin, urgent verification of the production of BMAA by free-living cyanbacteria, the evaluation of the distribution of BMAA producing free-living cyanobacteria in South Africa and the extent of BMAA contamination of surface waters. Since biotoxins are often present in low concentrations, large volumes of water needed to be concentrated to be able to quantify BMAA.

In order to assess the extent of free BMAA contamination of water, a concentration method needed to be developed.

Report No: KV 255/10

A review of studies on the Mfolozi Estuary and assocated flood plain, with emphasis on information required by management for future reconnection of the river to the St Lucia system (GC Bate; AK Whitfield & AT Forbes)

This report is aimed at gaining an understanding of how the Mfolozi/Msunduzi river and floodplain link with the functioning of the St Lucia ecosystem. Structured around 14 contributions from various scientific disciplines, the end result is an endorsement for the relinkage of the Mfolozi and St Lucia estuaries and the implementation of measures that will reduce any excessive input of sediment from the former into the latter system.

Report No: 1540/1/06

The influence of sludge conditions on the soil conditioning properties of sewage sludge (JJ Schoeman & M Murigwathoho)

The objectives of this investigation were to determine the various conditioning agents (organic and inorganic) used in sludge treatment at different concentrations on the properties of sewage sludge; and to develop an operating guideline for the use of dewatering agents for sewage sludge treatment.

Report No: 1624/1/10

Chemical sampling and analyses for environmental risk assessment using the Wits Basin as a case study (E Chihobvu; B Zhao & W Pulles)

In South Africa there has been limited work done on the development of methodologies for determination of sample size and quantifying uncertainties in geochemical sampling and analyses. This, in turn, may result in lack of confidence in the long-term predictions of geochemical modelling for Environmental Risk Assessment and problems in obtaining approval of mining authorisations, water use licenses and mine closure plans. This report addresses this deficiency in geochemical sampling and analyses and proposes two methodologies: one for quantifying uncertainties in geochemical sampling and analyses as a function of sample size and analyses and the other for determining the optimum sample size to ensure data quality.

Report No: 1640/1/10

Ambient temperature ferrite process: Adapting the laboratory-scale process to treat acid mine drainage (WV Alexander & N Ristow)

The Ambient Temperature Ferrite Process (ATFP) was developed at laboratory scale using a synthetic mine-water made up of ferrous sulphate, sodium sulphate and hydrochloric acid. The pH adjustments were made using sodium hydroxide, and aeration was achieved using bottled air. Calcium was identified as an inhibiting ion in the formation of ferrite. In order for the ATFP to operate 'properly', the removal of ferrous iron from solution and the production of ferrite from this ferrous iron precipitate needs to occur. In order to determine the economic feasibility of this process developed in the laboratory, a larger-scale operation was required treating real acid mine drainage and reagents more likely to be used on a larger scale. The researchers were therefore contracted to determine, among others, the most suitable site for the pilot-scale test; to prove the technology at laboratory scale treating actual AMD; to design and construct a portable pilot scale plant; and to prove the technology at pilot scale at a mine and develop design and operating parameters to allow for confident up-scaling to full-scale plants.

Report No: 1830/1/10

Scoping level assessment of how water quality and quantity will be affected by mining method and mining of the shallow Waterberg coal reserves west of the Daarby fault (PD Vermeulen; M Bester; L-M Cruywagen & GJ van Tonder)

The Lephalale region of the Waterberg contains the third-largest coal reserve in South Africa. The study area is located west of the town of Lephalale and stretches to just west of the town of Steenbokpan in the west and all the way to the border of Botswana. A need was identified to determine the potential impact of planned expansion of the mining enterprises in the area, which is characterised by low rainfall and limited water resources. Among others, the scoping level study sought to consolidate existing information on the different aquifers in the study area and their geohydrological parameters; pre-mining water quantity and quality of water resources associated with the Waterberg coal field; the acid generating potential of the geology found in the study area; and predict what the impact will be of additional mines in the area.

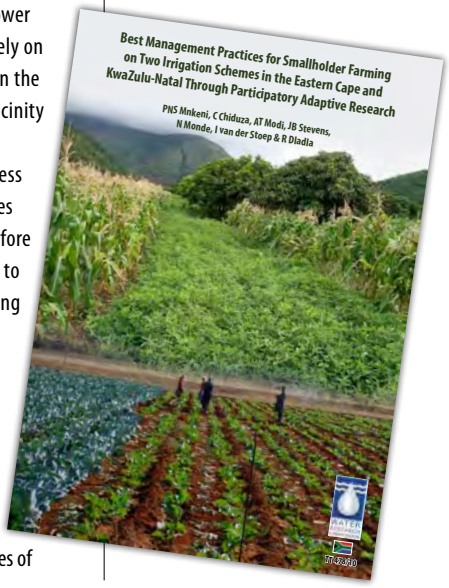
Results indicated that some areas were more prone to acid generation; however decant models indicated that there was no possibility of the pits ever reaching decant levels, with the highest recorded rise being between seven metres 50 years after mining has stopped. It was concluded that the most effective way to preserve the water quality was to keep acid generating material dry as it would not be possible to flood this material once the mine closes due to the small volumes of water in the study area. The additional mines and power stations will impact negatively on the quality of groundwater in the area, and boreholes in the vicinity of the mines are likely to be dewatered. Due to the aridness of the region, these boreholes are unlikely to recover, therefore precautions should be taken to minimise the impact of mining on the groundwater.

In summary, the study concludes that the addition of new mines to the area will have a deleterious effect on the quantity and quality of groundwater in the study area. The already small volumes of water that is available in the study area will be reduced further by the excavation of new mines.

Report No: TT 478/10

Best management practices for smallholder farming on two irrigation schemes in the Eastern Cape and KwaZulu-Natal through participatory adaptive research (PNS Mnkeni; C Chiduza; AT Modi; JB Stevens; N Monde; I van der Stoep & R Dladla)

This project was commissioned by the WRC in 2004. Its main objective was to carry out research in Zanyokwe and Tugela Ferry irrigation schemes with a view to develop and implement technologies and knowledge useful for farmers in order to improve their livelihoods and those of surrounding communities. Participatory research methodologies were employed where the smallholder farmers and other stakeholders were involved in project activities from the initial stage to the end. Weak or poor institutional arrangements, lack of stable markets, dysfunctional irrigation infrastructure and poor crop management were found to be factors leading to poor performance of the schemes. Based on these findings, an action research programme was developed aimed at getting a better understanding of the underlying causes of the constraints and ways to address them.



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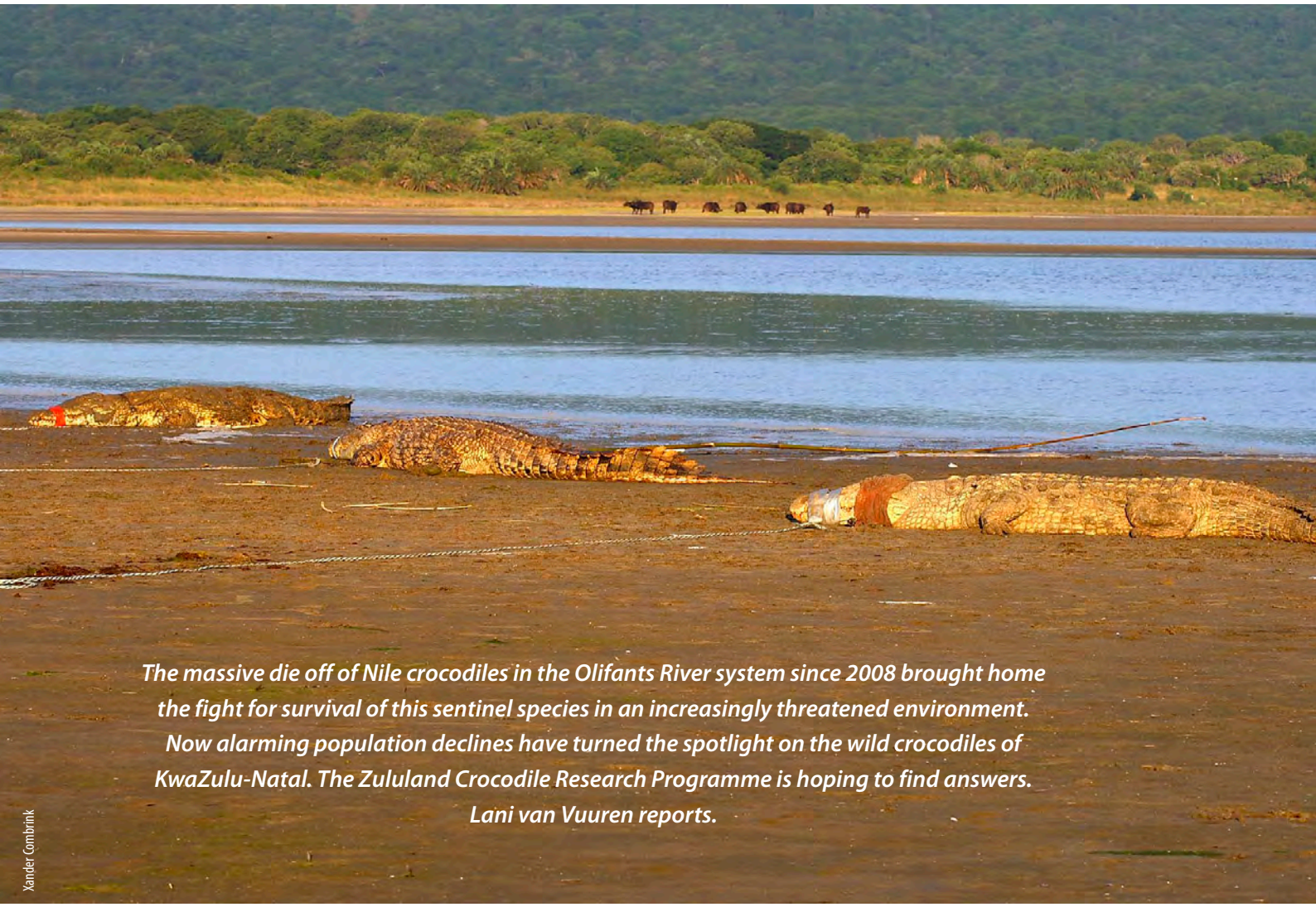
KwaZulu-Natal: IT'S MAN VERSUS CROC



Xander Combrink

The massive die off of Nile crocodiles in the Olifants River system since 2008 brought home the fight for survival of this sentinel species in an increasingly threatened environment. Now alarming population declines have turned the spotlight on the wild crocodiles of KwaZulu-Natal. The Zululand Crocodile Research Programme is hoping to find answers. Lani van Vuuren reports.

Historically, crocodiles were abundant throughout the lower lying and coastal areas of KwaZulu-Natal, but today the last remaining wild crocodiles are restricted to the north-eastern corner of the province, from the Tukhela River northwards in an area known as Zululand. Within Zululand, viable crocodile populations are found north of the Mfolozi River with Lake St Lucia and Ndumo Game Reserve hosting two of the three largest populations in South Africa. The diversity of crocodile habitat found here, which include rivers, streams, large natural lakes and estuaries, swamp forests, pans and wetlands, is unrivalled in southern Africa.

Lake St Lucia, which is part of the iSimangaliso Wetland Park World Heritage Site, is a particularly important conservation area for crocodiles, as it hosts the largest number in a single water body in South Africa. It is also the largest viable estuarine crocodile population in Africa. Around 900 crocodiles (greater than 1,2 m) call the lake home.

RESEARCH PROGRAMME

Crocodiles are recognised as a top predator and iconic flagship species of these aquatic habitats. Increasingly, these animals are also viewed as an environmental sentinel and important indicator of aquatic

Captured crocodiles on the banks of Lake St Lucia waiting to be marked, measured and weighed. Blood and urine samples are collected and each crocodile is fitted with coloured tail tags.

Roger de la Harpe/Africa Media Online

ecosystem health. If crocodile populations are sick it is a serious reflection on the health of associated water bodies and other sub-apex organisms in the food web – as has been illustrated by the death of hundreds of crocodiles from Pansteatitis (a disease which results in the hardening of the crocodile's fat reserves) in the Olifants River gorge in 2008.

Concern about the conservation status of crocodile populations in KwaZulu-Natal prompted the University of KwaZulu-Natal (UKZN), together with Ezemvelo KZN Wildlife (EKZNW), to initiate the Zululand Crocodile Research Programme in 2009. The programme is focusing on Lake St Lucia, Ndumo Game Reserve and Pongolapoort (Jozini) Dam.

The programme, which will run until 2012, is multi-faceted. It aims to improve understanding of the reproductive and feeding ecology, movements, genetics, population dynamics and toxicology for the three mentioned focal areas. For ecotoxicology analyses, tissue samples have also been collected from Moçambique and Malawi.

Above: *A baby crocodile hatches at Lake St Lucia. Destruction of nesting habitats are increasingly putting the park's crocodile population at risk.*

Below: *For every captured crocodile, blood samples are collected from the post-occipital sinus at the dorsal base of the skill and sent to a lab for analysis.*

Dale Hancock

The programme is led by Prof Colleen Downs of the School of Biological and Conservation Sciences of the University of UKZN. Three PhD students are involved in the leg work (Xander Combrink, Jonathan Warner and Peter Calverley) as well as a MSc student, Gareth Champion. Dr Ricky Taylor of EKZNW and Prof Jan Myburgh of the University of Pretoria are acting as co-supervisors. Additional funding has been received from the Hans Hoheisen Charitable Trust and the Mazda Wildlife Fund has sponsored a vehicle. The project team is also collaborating with the crocodile research project at the Kruger National Park running in parallel.

According to Prof Downs, working at several sites concurrently offers a better understanding of the different pressures present at each site as well as how the ecology varies with habitat type. "The connectivity between systems is also important, especially at Ndumo." Here female crocodiles are suspected to move across the border into Moçambique during breeding season.

PEOPLE VS CROCODILES

As in the Kruger National Park, Zululand crocodiles are increasingly under pressure. However, here the problem is not large-scale pollution of water sources per se, but rather the large-scale interaction between people and crocodiles.

Numerous waterbodies in Zululand remain unfenced with unrestricted access by people. When people and crocodiles share the same resource conflict is bound to occur. At least one person is caught by crocodiles here every year, although many more crocodiles are killed in the same period.

In addition, crocodile body parts and blood are considered to be powerful "muthi" used in traditional rituals, adding to the demise of this majestic creature as a result of illegal killings. "In a number of areas, crocodile populations have

been reduced considerably and, as a result of disturbance and destruction of nesting sites, crocodile numbers will not recover naturally," Combrink tells *the Water Wheel*.

People have to start realising the importance of crocodiles as part of freshwater and estuarine ecosystems. "Possibly the only way to secure their survival is to attach some kind of value to crocodiles and linking that value directly back to the users," says Combrink. Other possible management options include creating fenced drinking areas for livestock, boreholes around waterbodies for water collection and fishing jetties.

ECOLOGY AND POPULATION DYNAMICS

Despite previous studies on certain ecological aspects of crocodiles in Zululand, this is the first time a number of populations are being investigated simultaneously in terms of movements, breeding, habitat use and population dynamics. At Lake St Lucia, GPS-GSM transmitters are being used to reveal detailed movement data for male and female adults and sub-adults throughout the different seasons. In turn, crocodiles in Ndumo Game Reserve and Pongolapoort Dam have been fitted with VHF (radio transmitters). Calverley plans to extend the Ndumo study to southern Moçambique, also using GPS-GSM technology.

To date, 20 crocodiles have been fitted with transmitters at Lake St Lucia to monitor detailed movement and habitat use. These data are retrieved via the cellphone network. For a larger sample, less detailed information on movements are recorded when captured crocodiles (marked with plastic tail-tags) are re-sighted on subsequent occasions.

The crocodiles are also being counted as part of the study. At Lake St Lucia, EKZNW employs aerial surveys using fixed-wing aircraft at least once a year as part of its crocodile

Jelger Herder

Right: *Subsequent to capture, a unique sequence of coloured tags are fitted to the tail of each crocodile for future identification during subsequent sightings.*

Below: *A crocodile captured from a wetland on the eastern shores of Lake St Lucia.*

Xander Combrink

monitoring programme which started in 1972. The results of these surveys are now incorporated into the Zululand Crocodile Research Programme.

In winter three to four surveys are also conducted in the course of one week as part of the research programme using Microlight aircraft. Microlights fly slower and are more manoeuvrable than fixed-wing aircraft, making it easier to spot crocodiles. However, they can only be used during winter when flight conditions are more stable. Winter is also considered the best time of the year to count crocodiles as they leave the cool water to bask on sandbanks.

In addition, the project team is counting crocodiles at night from boats. "Spotlight counts are often a more accurate method for counting crocodiles, with the added advantage of better information on sizes, especially smaller animals," notes Combrink. Because of the large number of animals that are being caught and released as part of the programme the fieldwork component is extremely time consuming.

In addition to tracking the movement of the adults, nesting surveys are done during breeding season. Information such as the number and position of each nest, as well as a suit of other habitat characteristics are recorded. During the 2011/12 breeding season it is planned to extend the nesting surveys into Mozambique. Many of the challenges experienced by breeding crocodiles have already been exposed by these surveys, such as the destruction of nesting areas by people and their cattle and increasing infestation by invasive alien plants, which make nesting difficult. On the positive side, Pongolapoort Dam, although man-made, has been identified as an important breeding population. However, nests here are vulnerable to flooding.

Another interesting aspect of the research project pertains to the study of the nutritional ecology of the Zululand Nile crocodiles through the use of stable isotope analyses. "Stable isotope analyses is an increasingly popular and effective method used in animal nutrition studies in a variety of habitats and ecosystems," explains Warner. "While these analyses do not provide direct dietary information, i.e. type and number of organisms consumed, they rather indicate what the long-term strategies of the animals being studied are by reflecting the biogeochemical materials assimilated by the animals." In addition, stable isotope analyses can detect feeding interactions which would otherwise be impossible to observe using other methods.

ECOTOXICOLOGY

Crocodiles are good models for understanding the impacts of environmental contamination on ecosystems because they are long-lived predators that prey on both aquatic and terrestrial prey. There are several threats to the environment prevailing at the study sites which require attention.

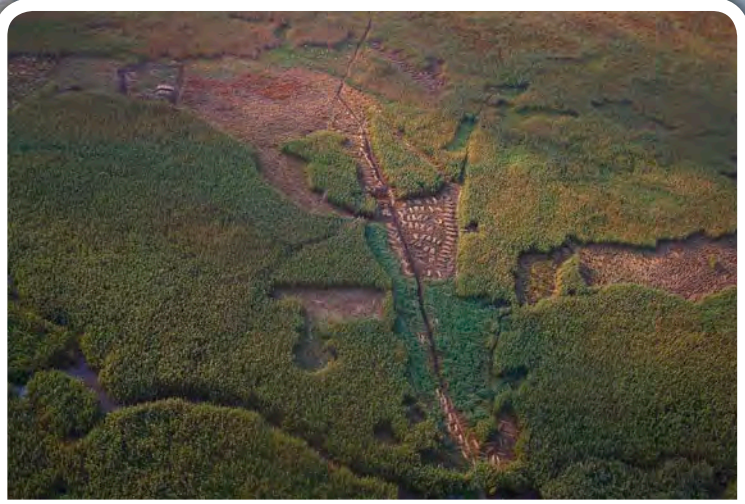
At Ndumo, a potential threat to the aquatic environment is the regular spraying of DDT to combat malaria. DDT is a known endocrine disruptor, i.e. it interferes with the normal functioning of the endocrine system. Agrochemicals from intensive sugarcane, fruit farming and forestry often ends up in the aquatic systems with negative consequences for wildlife. The pollutants are especially prevalent in the sediment.

At Lake St Lucia, a traditional fishing area, lead pollution might be a possible threat to the health of crocodiles. Crocodiles swallow stones and at Lake St Lucia, lead sinkers have been found in the stomachs of crocodiles. The reason for swallowing stones and sinkers are not fully understood, one theory is that it could serve a hydrostatic function to assist with diving or possibly as an aid to digestion. Among others, the isotopic signature and toxicity of

Xander Combrink

Microlights are used to count St Lucia's crocodiles during winter months.

A marked crocodile makes his way back into St Lucia after being captured and released.



Xander Combrink

Habitat transformation in the Mkhuze swamps of Lake St Lucia.

Jon Warner

Above: *Researchers remove a steel cable from the neck of a captured crocodile. Numerous crocodiles are killed in KwaZulu-Natal for their organs which are used in traditional rituals.*

Below: *A captured crocodile is fitted with a GPS transmitter to track detailed long-term movements.*

Xander Combrink

lead in crocodile body tissue at Lake St Lucia is to be assessed to provide answers in this regard.

GENETICS

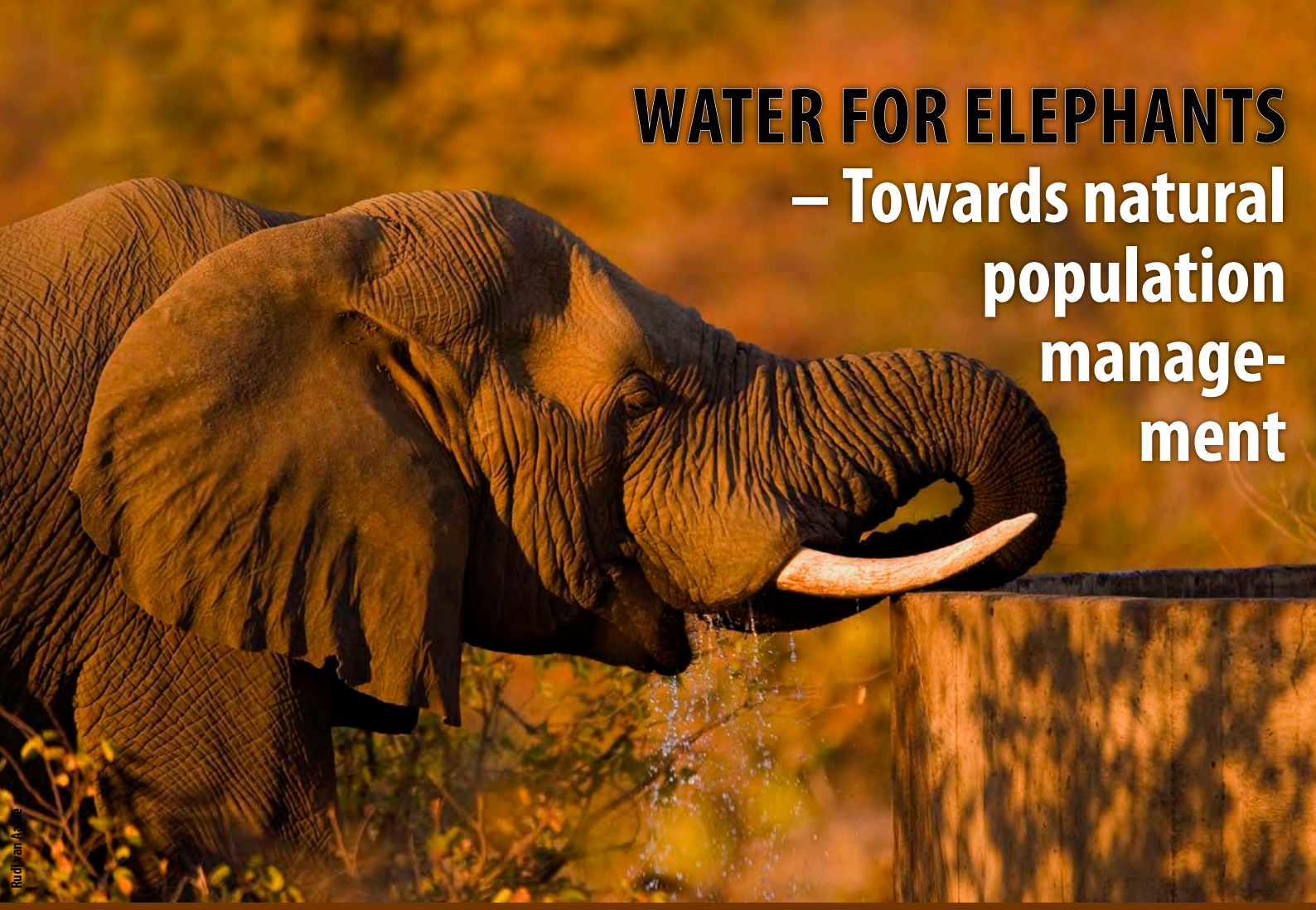
Warner explains that the wild crocodiles of Zululand are not expected to show a high level of genetic diversity. "Although some subpopulations are probably genetically isolated, this has not been the case historically."

Still, establishing the genotype of wild Nile crocodiles will be useful in comparison with the many farm-raised (and often inbred) animals in the province that are expected to show little or no genetic variation. "If genetic diversity among a subpopulation does exist, concurrent morphometric analyses during this study may help better identify unique phenotypes," notes Warner. Unfortunately, historical relocation of crocodiles among populations as well as 'dumping' of farmed animals into wild ecosystems seriously hamper crocodile genetic studies in the province.

Although there is an inevitable delay in getting back some of the laboratory results, other findings and recommendations are made available to managers for immediate implementation. There is no doubt that the outcomes are playing an important role in the way crocodiles are managed going forward. "I believe that the programme will certainly provide a knowledge base that will enable us to apply more effective management for the conservation of crocodiles in KwaZulu-Natal," says Dr Taylor, EKZNW Regional Ecologist: North Coast, one of the initiators of the programme.

"The continuing decline of a number of crocodile populations in South Africa is alarming," notes Combrink. "Conservation of this top predator in KwaZulu-Natal is not only beneficial to the protection of other species in the food web, it is also critical to conserving the rich natural heritage of this province."

WATER FOR ELEPHANTS – Towards natural population manage-ment



Rudi van Aarde

Could a return to natural water availability be changing the face of conservation and management of one of our most beloved species? Article by Petro Kotzé.

The challenges faced by conservation management to safeguard biodiversity placed under their protection are, by and large, not new. However, the solutions are undergoing a major paradigm shift, and include new thinking on artificial water supplementation for game. In South Africa, environmental management has agrarian roots, ran by people who fought a constant battle against the elements and outside threats – they created waterholes in times of drought, erected fences when hunters devastated populations and, in some cases, controlled species' numbers if they were perceived to become too many to be supported by the available habitat.

The world-renowned Kruger National Park (KNP) is an example. Proclaimed a Government Wildlife Park by Paul Kruger in 1898 (and later expanded into the KNP in 1926) the initial goal was to control hunting and protect a diminishing number of animals. To further curb the spread of disease, facilitate border patrolling and stop animals from moving into areas where poaching was problematic, the park was fenced. By 1960, the southern boundaries along the Crocodile River, western and northern boundaries were fenced, followed by the eastern boundary with Mozambique in 1976.

From 1911 waterholes were also increased to ensure reliable water in an environment that was perceived to be 'drying out', reaching a peak of about of about 300 by the 1990s. Water provision also included catchment dams in seasonal streams. Many animals flourished under the enhanced protection, including the African elephant. Indeed, about 17 000 elephants were culled over a period of 27 years until a moratorium was placed on culling in 1995. The reasoning behind the culling operations rested on knowledge of nutritional requirements and a concern about the effect of a growing number of elephants on the environment (including the appearance and ecological functioning of the landscape and the potential impacts on other plants and animals).

Conservation management today is looking towards scientific research to inform management policies and actions, and a tolerance of nature as an environment in constant flux is being advocated. Among others, this entails a return to more natural water availability and elephant roaming areas, both of which are having consequences for much of the fauna and flora within many conservation areas, including the KNP.

Census information suggests that, since 2003, following the closure of more than two thirds of the KNP's boreholes and the creation of Africa's super wildlife park, the 35 000 km² Greater Limpopo Transfrontier

Rudi van Aarde

The Olifants River in the Kruger National Park. Research shows that elephant densities increase along large rivers during dry seasons.

Park (GLTP), the annual population growth rate of the African elephant is declining. Furthermore, research elsewhere indicates that elephant distribution can potentially be altered by the manipulation of water availability.

CHANGING TIMES, CHANGING WATER DISTRIBUTION

In a partially fenced system like the GLTP, management agrees that the provision of water still has a role to play. However, regardless of its good intentions, the previous even distribution of water across the landscape over the years seems to have had a number of negative side-effects. Many of these were facilitated by the fact that throughout the park, permanent sources of water were within walking distances for animals throughout the year. As a result management had to deal with over-grazing, veld degradation and erosion during droughts. Furthermore, catchment dams silted up, while an excess of hippo dung facilitated outbreaks of cyanobacteria, poisoning animals that drank there.

Current guidelines include that water should not be provided in areas that are naturally dry, or be provided too evenly across the landscape. Water provision is still condoned in certain areas to cater for tourist expectations and because of remaining fences (inhibiting a complete return to natural water availability). However, for the most part, synthetic water points are being closed down, certain dams breached and rehabilitated and in a few relevant cases water points opened up again. In effect, vegetation and animal distribution patterns are allowed to recover so that seasonal variation between times of water availability and drought can fulfil their natural function.

While not the only species affected, the African elephant has received a lot of public attention. The elephant 'issue' is complex and, says Danie Pienaar, SANParks head of Scientific Services, few other species have been the topic of more studies. One of a number of institutions that have studied the species in partnership with SANParks is the University of Pretoria's Conservation Ecology Research Unit (CERU), under the leadership of Prof Rudi van Aarde. This collaborative research effort aims to develop novel solutions to manage southern Africa's elephant populations through the implementation of ecological principals. Evaluation of the role of water distribution plays one key role in this effort.

In theory, population growth is determined by death and birth rates as well as immigration and emigration between areas, explains Prof van Aarde. These elements were explored to try and explain why the GLTP elephant population's numbers seems to be stabilising. He says that census counts across neighbouring areas

could not put the blame on dispersal, thus pointing towards a change in the birth and death rates as possible answers.

WATER AND ELEPHANT POPULATION STABILISATION

By measuring their back length, says Prof van Aarde, researchers could determine an elephant's age which, in turn, enabled them to determine age specific breeding and survival rates for elephants living across a range of environmental conditions in southern Africa. Data was then compared to areas' rainfall variability. Through these methods researchers found that 22 of the 36 populations across southern and East Africa have stabilised in numbers (i.e. when annual population growth rates centre on zero even though populations are fluctuating from year to year) and, among these, found a direct relationship between elephant number stabilisation and rainfall, says Prof van Aarde. The higher the rainfall, the higher the level at which a population stabilised. The greater the variability in rainfall, the lower the level at which the population stabilised. This knowledge enabled them to predict the level at which a given population would stabilise compared to rainfall variability.

Combined with details on yearly rainfall and reproductive and survival rates for the 22 elephant populations across southern Africa, explains Prof van Aarde, researchers could now predict the numbers where elephant populations should theoretically stabilise but, there were disparities between the actual and predicted numbers. The answer seemed to lie with the resources (like waterholes) the populations were using. Researchers found that the larger the difference between observed and expected elephant numbers, the larger the resource availability, and *vice versa*. In other words, where significant resources, like surface water, were available over long periods of time, elephant numbers would stabilise at much higher numbers.

Rudi van Aarde

Researchers have found a direct correlation between elephant numbers and rainfall.

This knowledge enabled assessment of whether decreased water resource availability would, in turn, induce declines in reproductive output and survival. Preliminary analyses show that of the 16 unmanaged populations from across southern Africa, elephant numbers appear to be limited through resource availability as it affects breeding and survival rates (especially those of newly weaned calves aged four to eight years).

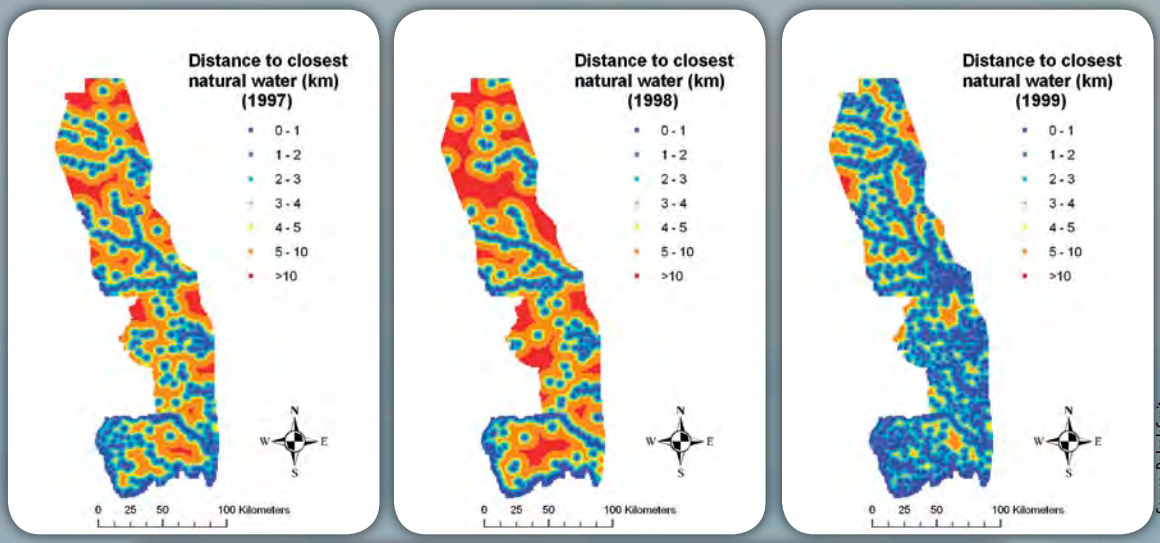
"We know from our intensive satellite tracking studies that breeding herds in these populations walk longer distances when resources become scarce and when elephant numbers are high," explains Prof van Aarde. "These increased distances also explain an increase of death rates of weaned calves." Notably, this pattern of self-regulation did not seem to occur in managed populations, where water was provided and roaming is inhibited by fences.

Research has also investigated the link between water distribution and elephant movement, although, according to the summary for policy makers of the *Elephant Assessment*, to which more than 60 experts contributed, any possible conclusions are yet to be proven in practice. The *Elephant Assessment* postulated that water manipulation as an elephant management tool would possibly only be feasible in very large reserves with sparse natural distribution of water.

In fenced parks where water is supplemented by water holes and drinking troughs the overlap of wet season and dry season elephant roaming areas is greater than in open parks with natural water availability, notes Prof van Aarde. Such management interventions thus have major consequences, he adds. For instance, in Khaudum Game Reserve in northern Namibia where management installed 12 waterholes over an area of some 3 000 km^2, elephants roam close to the waterholes during both wet and dry seasons. Their numbers also increased from 80

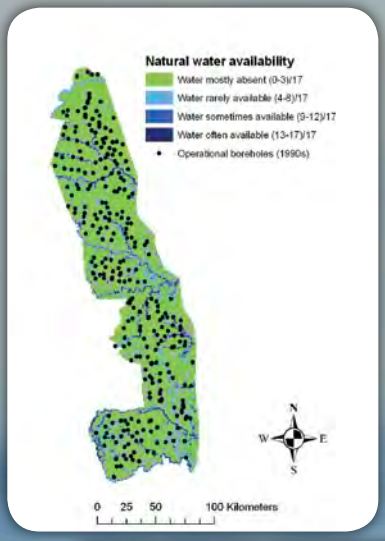
Rudi van Aarde

Elephant breeding herds walk longer distances when resources become scarce and when elephant numbers are high.



Source: Dr Izak Smit

The distance to the closest surface water source during the early dry seasons of different years (1997, 1998 and 1999) differ tremendously. The impact of the current SANParks management plan (limiting artificial water provision) will be clearer following the next severe drought.



Source: Dr Izak Smit

Since 1911 borehole-fed water points were installed in the KNP totalling some 300 by the 1990s. By 2008, more than two thirds were closed, mimicking a more natural water distribution system.

Rudi van Aarde

The African elephant is not the only species affected by artificial water provision but it has received the most public attention, particularly in the Kruger National Park.

in 1976 to 3 500, as the water also attracted elephants from neighbouring Angola.

Some studies also indicate a difference in the roaming patterns of breeding herds and bulls. As breeding herds need to drink every day, they seldom move more than 16 km from surface water. Bulls, on the other hand, drink less frequently and roam further. In theory, if a large enough area could be rendered free of surface water for large parts of the year, they would be only lightly and seasonally used by elephants.

It is, however, not easy for these theories to be tested in practice as this depends on availability of sufficient space and time for ecosystem processes and functions to play out over increased scales.

MEGAPARKS AND METAPOPULATIONS

In theory, the interplay between increasing and decreasing elephant populations could induce regional stability, despite local elephant population fluctuations. In this picture, elephant populations act as sub-units that together form a metapopulation. Environmental conditions differ from one sub-population to the next, but there is interaction and movement, and a dynamic interplay between different birth and death rates. Some would have a positive growth, while others a negative, but as a whole, the metapopulation numbers remain stable.

So-called 'megaparks' could provide space for ecosystem processes and functions to play out over increased scales. Furthermore, this could provide for seasonal changes in elephant impacts across space and aid in the maintenance of biological diversity, possibly contributing to the stabilisation of elephant populations at these large scales. At regional and smaller scales, cautions Dr Stefanie Freitag (General Manager of the Savanna & Arid Research Unit of SANParks), it is also important to know how the elephant impacts are distributed across space and time and how these impacts affect other values and objectives (eg. biodiversity, livelihoods).

But how big a megapark is big enough? And would the GLTP, for example, fit the bill?

According to Prof van Aarde, recent assessments in the GLTP suggests that the demographic profiles and predicted growth rates for elephants differ greatly between areas. For instance, population growth rates in the south seem to be negative while those in the north, positive. Paradoxically though, the south has more permanent water than the north of the GLTP. These differences may be due to differences in resource availability, but when combined, the overall predicted trend from present breeding and survival rates, at this stage, equates to zero – indicating the size of the population across the park is stabilising. However, cautions Dr Freitag, in a complex system, change, even dramatic change, should always be anticipated.

Does the correct plan for biodiversity management then entail letting fences around our protected areas rot, and not supplementing water provision? Currently, SANParks is embracing a holistic view to ecosystem management in large parks such as the GLTP, with an increased landscape approach to conservation management. "We believe, however, that any management action should also be seen as an experiment in order to learn," says Pienaar. Furthermore, he adds, the KNP currently hosts about 14 000 elephants, the Limpopo National Park about 1 500 and Gonarhezou about 9 000 elephants. Private and provincial parks around the GLTP have another 3 000, totalling about 27 500 elephants for the whole Greater Limpopo Transfrontier Conservation Area. "Management objectives and conservation values differ in these areas and the KNP elephant management policy has to take cognisance of this bigger picture."

"Science," concludes Dr Freitag, "is not value-free and does not have 'the answer'. " It is, she says, "a complex, value-based endeavour in its own right, much like the complex KNP ecosystem." An integral question is rather how to make sense of apparently conflicting findings and arguments. Even more so, the effect of a different management paradigm, as with the first, when even water distribution across the landscape was advocated, will only be evident in retrospect. ❑

SOURCES

- www.theelephant-assessment.co.za (Summary for policy makers)
- *Biodiversity – Conservation in times of change* (published by SANParks)

Searching for clues inside the claws

New research is investigating whether the time dimension provided by crocodile claws can indicate if previous food web disturbances caused the 2008 croc mortalities in the Kruger National Park – and unexpected results are already on the cards. Article by Petro Kotzé.

The exact reason for the alarming crocodile mortalities that occurred in the Kruger National Park's (KNP) Olifants Gorge and Lower Letaba River in 2008 continues to be evasive. Post-mortem examinations revealed that the deaths were caused by pansteatitis (hardened fat in the tails and abdomen) but, says Danie Pienaar KNP's Head of Scientific Services Department, even though it is clear that the crocodile deaths were symptomatic of serious environmental problems in the Olifants River system, the exact mechanisms of what took place remain uncertain.

Mortality peak rates of 20 crocodiles per week were reached during the winter months of June and July of 2008 (totalling 170 carcasses recorded by November of that year, although, because carcasses sink and are consumed by other crocodiles, the exact number is likely to be more than

Dr Stephan Woodborne of the CSIR taking a sample from a crocodile claw.

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Top: *While crocodile mortalities have declined each winter in the Kruger National Park since the massive die-offs experienced in 2008, the exact cause of the deaths continue to baffle researchers and managers alike.*

Bottom: *Members of the SANParks staff remove crocodile carcasses from the Olifants River gorge in late 2008.*

that). Even though the mortalities have since decreased every winter, Pienaar cautions that the root problem is still present.

In order to establish a clear cause-effect relationship, a multi-institutional collaborative research programme, known as the Consortium for the Restoration of the Olifants Catchment (CROC) was established. It includes representatives from SANParks, the Department of Water Affairs (DWA), research organisations, universities, independent consultants, NGOs and the Water Research Commission. CROC's research focus is centred on analysis of the water and sediment, fish pathology, water chemistry and algal composition of the river water, the population dynamics of the crocodiles in the Olifants and Letaba river systems, clinical blood parameters of the affected crocodiles in comparison to unaffected crocodiles, invertebrate and fish population dynamics and research into populations of fish-eating birds (for more information, refer to the January/February 2009 edition of the *Water Wheel*).

A unique research project under the CROC umbrella is now experimenting with a novel technique to try and establish what caused the mortalities – by isotopic analysis of crocodile claws. Project leader and CSIR Senior Researcher, Dr Stephan Woodborne says that the study explores the idea that the crocodile deaths might not result from something that can be seen or detected now, but rather something that happened in the past. The foundation for the study was laid during an earlier research programme relating to the crocodile deaths, of which Dr Woodborne formed part.

AN ISOTOPIC FOOD WEB ANALYSIS

A group of CSIR researchers have been commissioned to conduct one of the largest assessments of its kind on the progressive eutrophication and chemical pollution of the Olifants River and the implications for aquatic ecosystems and human health (other parties included the Universities of Pretoria and Stellenbosch, the Mpumalanga Tourism and Parks Agency (MTPA) and the Department of Water Affairs (DWA) – for a full update on this project see elsewhere in this issue). For comparison the group duplicated the study in the pristine Waterberg area. The results obtained from these studies included an isotopic food web analysis that can be used to better understand crocodile ecology.

But what is an isotopic food web analysis? In the simplest terms, carbon and nitrogen isotopes (atoms of a chemical element whose nuclei have the same atomic number, but a different numbers of neutrons giving them different atomic weights) act as markers that can be tracked as they move, for example, through a food web. For instance, grass takes carbon and nitrogen gas from the atmosphere. An impala, in turn, acquire these elements from eating the grass, while a lion, in turn, attains it from eating the impala. Every time the elements are taken up by a different form, it undergoes a slight isotopic change. As these changes are measurable and known to scientists, it can be used as a point of reference to see where in the food web a specific specimen fits in.

A number of results were obtained from the study. First, it was evident that, due to pollution, nitrogen isotope contamination in the Upper Olifants River falls outside of the natural range that was observed in the Waterberg. Furthermore, Dr Woodborne elaborates, the study enabled them to identify the isotopic food web up to the rank of fish. This would later enable them to categorise where crocodiles fit into the food web and, more specifically, what a fish-eating crocodile would look like isotopically.

The researchers now had a bigger picture, showing the isotopic 'image' of both fish-eating crocodiles, and those that occur in heavily polluted areas. However, he says, some of the dead crocodiles matched the profiles, while others didn't. This is because crocodiles don't only eat fish. It was then necessary to determine a number of different options, and researchers continued to map the isotopic differences between crocodiles with aquatic, versus those with terrestrial diets.

ADDING A TIME-DIMENSION

After Dr Woodborne was presented with a crocodile claw, the idea for the unique approach to uncover the root of the crocodile

deaths was born. Seeing as claws (like nails) grow with time, researchers theorised that, through isotopic analysis of the claws, they could pick up food chain turbations in the past that might have been responsible for the relatively more recent mortalities.

A crocodile claw forms microscopic layers on its inner side as it grows, almost similar to a series of stacked paper cups. Chemical analysis along the growth of the axis of the claw provides researchers with the opportunity to 'look' into the past at the conditions under which the crocodile grew and where it fitted into the food web. Even more so, by reading the isotopic time series, scientists are able to trace if the reptile changed its diet at any stage of its life. The first sets of exploratory results were received about a year ago, and after these demonstrated the potential of the technique, more claws were received from St Lucia, the University of KwaZulu-Natal and the KNP. The resulting study took place in collaboration between the CSIR, SANParks, Uzemvelo, Prof Colleen Downs from the University of KwaZulu-Natal and several other people, notably, Dr Jan Myburgh from Onderstepoort.

Results from the St Lucia crocodile claws suggest that lake levels and probably the corresponding changes in salinity have a strong influence on the nutrient supply, but that trophic level relationships (the position that an organism occupies in the food chain) do not change. A substantial turbation that took place in the Lake St Lucia food web system is evident, and is believed to be the result of the 2007 breaching of the estuary mouth after five years of closure. This caused a significant water level rise and temporary drop in salinity.

In KNP the isotopic time series from crocodiles in the Olifants Gorge were compared with crocodiles from other river systems. "When we plotted the isotopes we could pick up the differences between those crocodiles with an aquatic, and those with a terrestrial diet," says Dr Woodborne. In addition some of the claws contained regular nitrogen isotope pulses that may relate to seasonal biology of the animals, and can therefore be used as a time marker. With the calibration of the time dimension the results showed that during times of extreme droughts, the diets of two crocodiles from the Olifants Gorge (from three analysed) changed from those living in a riverine habitat to those frequenting dams. The isotopic analysis indicated that they converted back to riverine diets at a later stage.

According to Dr Woodborne, the results indicate that the two crocodiles in question were living in the Olifants Gorge, moved to a dam environment (which could include large pools, which can 'act' as dams) during drought, and then returned to the gorge under more favourable circumstances. SANParks has some data that suggest that, under conditions of drought, crocodiles will probably move upstream. Even though the Massingir Dam (downstream) is large enough, the variability in habitat preferred by crocodiles (for example nesting opportunities and shelter for their young) are not present. The closest dam upstream from the gorge is the Engelhard Dam in the Letaba River where, says Dr Sam Ferreira (SANParks Large Mammal Ecologist), crocodiles were noticed that had earlier been marked in the gorge.

Notably, Dr Woodborne's study shows that from the three crocodiles sampled, the two crocodiles that displayed these possible movement patterns were the ones that developed pansteatitis.

Stephan Woodborne

CSIR

Left: *This picture is of a croc claw that has been sampled along the growth axis starting at the base (left) which is the most recent growth, and ending at the tip (right) which grew sometime in the past. The largest claws that have been analysed seem to record about 12 years of growth.*

Below: *A close-up of the crocodile claw sampling process.*

THE WAY FORWARD

Dr Woodborne emphasises that "the interpretation of the time dimension of a crocodile's position in the food web as an indication of mobility and changing river ecology is a hypothesis at the moment." Pienaar also adds that the technique is very new, and much work is still needed in order to fine-tune it and get the desired results.

Among others, possible future research will aim to characterise the isotopic profiles of apparently healthy crocodiles from different environments (like fresh water lakes and rivers) in order determine if food web turbations are responsible for the crocodile deaths.

In general, there are three aspects that should be explored in further research. Space (testing the hypothesis on more crocodile claws), time (asking if pansteatitis is caused by something that happened in the past, and developed gradually, or not) and an unexpected third aspect, age.

To date, says Pienaar, it has been difficult to gauge crocodiles' exact age as an older crocodile exposed to a specific diet might be smaller than a younger one exposed to other dietary elements. Dr Woodborne's method could, however, dispel this problem by providing a more specific method. When analysing the claw, scientists can pick up an annual pattern, when a crocodile's metabolism slows down during winter months (metabolism is temperature-dependent). This knowledge can be applied to estimate a crocodile's age.

In order to take the concept further, Dr Woodborne is calling for more scientists to become involved and develop both a strategy and set of approaches that can exclude certain hypotheses. Continuing research is, however, dependent on funding, for which proposals have been submitted. It is hoped that such research might provide the answers to the evasive crocodile mortality questions by simply unlocking the past. ❑

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Left: *SANParks staff removes crocodile carcasses from the Olifants River gorge in late 2008.*

Below: *While crocodile mortalities have declined each winter in the Kruger National Park since the massive die-offs experienced in 2008, the exact cause of the deaths continue to baffle researchers and managers alike.*

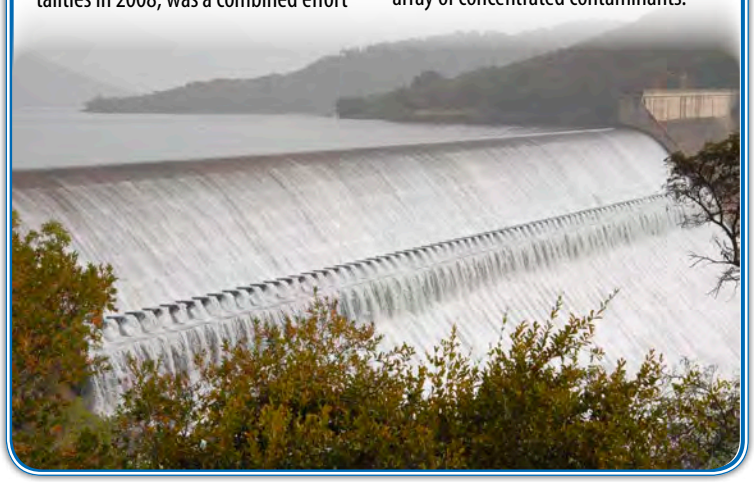
SANParks

LAST BOW OF THE LOSKOP DAM NILE CROCODILE POPULATION

Recent counts revealed that the Loskop Dam population of crocodiles have all but died out as the mere two reptiles that were located during recent surveys are too small to breed. These finding were presented at the 9th Annual Savanna Science Network Meeting that took place at the Kruger National Park in March (at the time of the presentation, a total of four crocodiles were observed in the Loskop Dam). Presenter MTPA herpetologist, Dr Hannes Botha, reported back on a study that aimed to determine the distribution, status, vulnerability and general health of Nile Crocodiles in the Olifants River, also part of the CROC umbrella of collaborative research projects.

The count, the most comprehensive done since the massive crocodile mortalities in 2008, was a combined effort by the Centre for Wildlife Management (University of Pretoria), The DWA, the University of Florida and the MTPA. It included the Blyde River Poort, Loskop and Flag Boshielo Dams as well as the Olifants River Gorge in the KNP.

An average 1 140 crocodiles were counted during two aerial surveys. The Olifants River gorge in the KNP, the Flag Boshielo Dam, the area between the Blyde River and the Western boundary of the KNP and the area between the Loskop Dam and the Flag Boshielo Dam were found to be preferred habitat areas and critically important to their nesting success. The Elands River was confirmed as an important refuge area. Unfortunately, their preferred habitat in the river inflow zone, especially in the Loskop Dam, exposes them to a wide array of concentrated contaminants.



OLIFANTS RIVER – Pioneering catchment-wide study reaches halfway mark

CSIR

It has only reached the halfway mark, but the Olifants River study has already yielded some surprising results. Lani van Vuuren reports.

It has been a year since *the Water Wheel* first reported on the study of the Upper Olifants River catchment ('All eyes on Olifants as experts search for answers', *the Water Wheel* May/June 2010). Led by the CSIR, the study is funded by the Olifants River Forum and involves some 30 researchers from various disciplines and organisations, all focused on pinpointing the pollution sources that has earned the river its reputation as one of the most polluted in South Africa.

The purpose of the study is to identify the critical variables in the Upper Olifants River and its tributaries, and to determine their thresholds by making use of a novel set of molecular techniques that provide accurate estimates of the ecosystem health in the study area. In addition to identifying the sources of different stressors, these data is particularly useful to develop and refine appropriate water quality management responses, decision making processes or remediation measures for the rivers in the Upper Olifants River catchment.

Among others, samples taken regularly throughout the catchment have been analysed in terms of water quality, bioaccumulation of selected heavy metals in sediment, algae and invertebrates, aquatic health, microbial contamination and the presence of endocrine disrupting compounds. Ecotoxicological bioassays have also been undertaken.

'SURPRISING' RESULTS

According to project leader Dr Paul Oberholster, while it was common knowledge that the river was polluted prior to the start of the study, the levels of pollution have, in

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Left: *CSIR senior researcher Dr James Dabrowski taking sediment samples of Loskop Dam as part of the Olifants River study.*

Below: *Local people crossing the Brugspruit – one of the worst polluted streams in the Olifants River catchment. Poor communities in the catchment make use of the river to irrigate their crops and water their cattle, putting their health at risk.*

Lani van Vuuren

some cases, been surprising. Particularly unexpected has been the level of eutrophication in the river, specifically in the main stem. Here, algal mats (the result of increased algal productivity as a result of high nutrient levels) have been found to be extensive – highlighting the severity of nutrient pollution in the river.

The high nutrient loads originate mainly from wastewater treatment works in the catchment. "Phosphate loads in these works are unacceptably high. This is a result of a combination of poor management and ageing infrastructure," says Dr Oberholster. The problem is particularly persistent during periods of low flow.

"While a well designed acid mine drainage management plan would increase short-term costs for mining companies, it would create long-term benefits to the community, local government and other stakeholders, and reduce risks to the environment."

These sewage treatment works, along with informal settlements in the catchment, also contribute to microbial pollution and associated pathogens (e.g. Vibrio cholera and Shigella) in the river. High levels of endocrine disrupting compounds have also been identified. Continuous pollution from closed mines has been equally disturbing, with receiving streams characterised by low pH, extremely high dissolved metals and salt contents. One year's monitoring and sampling does not provide enough evidence on its own of deteriorating conditions, however, and the project team hopes to shed more light on the relative contribution of the anthropogenic impacts from different sources in the catchment in upcoming months.

The study has underlined the importance of effective management

and planning of mines to minimise the effects of this problem in the future though. If left unmitigated – as experienced in the Olifants River – the impacts of acid mine drainage impose costs to the wider community of water users; often these costs will need to be borne for decades or generations. On the other hand, while a well designed acid mine drainage management plan would increase short-term costs for mining companies, it would create long-term benefits to the community, local government and other stakeholders, and reduce risks to the environment. "Recognising the nature of these costs over time, relative to the desired and anticipated benefits, is critical to the development of an acceptable solution to the current water quality situation in the Upper Olifants River catchment," says the project team.

The catchment has recently been blessed with high levels of rain, which dilute the pollution to some extent, however, this effect is only temporary. Higher rainfall also means increased sediment, which brings with it its own challenges as the team explains: "Sediment on its own is a physical polluter and also transports absorbed pollutants (i.e nutrients, metals and organics). Increased sediment yields associated with high rainfall can therefore result in an accumulation of sediments and associated pollutants in sinks, such as Loskop Dam." The dam acts as a storage facility for these pollutants which may eventually be mobilised at a later stage.

Rainwater samples have also been collected at a number of sites across the Upper Olifants River catchment and tested for their acidity. Fifty-nine percent of the samples tested were found to be acidic. This revealed that the quality of rainwater could potentially have a major effect on the surface water quality on the Upper Olifants River system as a result of both direct inputs of pollutants through wet deposition and the mobilisation of pollutants (i.e. heavy metals) through acidification of soil.

CSIR

More intensive investigations of acid precipitation are planned in phase two of the study. It is hoped that this will provide insight into the extent of the impact of acid rain on contamination of the Upper Olifants River system.

HEALTH RISK

The research team has expressed its concern over the potential impact of this pollution on communities living in the catchment. In general, water quality of natural resources should not be managed to meet drinking water standards, the team points out. However, given the large numbers of people living in poverty along the Olifants River with very little to no basic services it is inevitable that people will make use of the natural water resources available to them. Members have witnessed first hand the use of

Above: *Stretches of algal mats – the result of eutrophication – found in the main stem of the Olifants River have highlighted the severity of nutrient pollution in the river.*

Below: *Pretty as a picture yet Loskop Dam contains a cocktail of pollutants, which have manifested in fish and crocodile deaths as well as toxic cyanobacterial blooms.*

CSIR

untreated water from the Olifants River and its tributary streams for washing fruit and irrigating subsistence crops, increasing the chance of accidental exposure or ingestion of this water. Given the high levels of pollutants in some these stretches of the river, health risks are high.

There is hope for the Olifants River yet. Results are shared with stakeholders continually, especially members of the Olifants River Forum, as well as national authorities such as the Department of Water Affairs (DWA). There is a general consensus that the river is under serious threat from anthropogenic activities, and the reaction is generally one of concern. "Initially, members of the public apportioned most of the blame to the mining industry, however, our first year of study has highlighted that mining is not the only problem in the catchment," notes the project team. "It is becoming increasingly clear that pollution in the Olifants River is varied in terms of its nature (i.e. heavy metals vs. nutrients) as well as its source (i.e. mining, industry, wastewater treatment works, and agriculture)."

This concern has, in turn, resulted in positive outcomes in that stakeholders have become more amenable to sharing information and allowing access to their properties for sampling etc. DWA has also set up a task team to tackle some of the issues in the catchment.

The Olifants River study team's focus has now moved towards looking at possibilities of rehabilitation and remediation. This includes the establishment of artificial wetlands and the restoration of existing wetlands in the Upper Olifants River catchment in conjunction with organisations such as Working for Wetlands.

In the end it is quite clear that saving this catchment and others like it will require a truly collaborative approach between government, water resource managers, business and communities. ❑

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Above: *Cattle drinking from the Brugspruit, a tributary of the Olifants River. The stream receives acid mine drainage from closed coal mines.*

Right: *Industrial pollution has killed all aquatic life in this stream which eventually reaches the Olifants River, effectively rendering it sterile.*

Lani van Vuuren

WAGENDRIFT – A symbol of local engineering innovation

DWA/eWISA

Constructed during South Africa's golden era of dam-building in the 1960s, Wagendrift Dam, in KwaZulu-Natal, is a showcase for local engineering ingenuity.
Article by Lani van Vuuren

Sites for possible water storage in the Upper Thukela River and its tributaries were first investigated by the Irrigation Department after the Second World War. The resultant report, published in 1948, sited the Bushmans River above Estcourt as a particularly good spot to build a dam to stabilise water supply to the town and irrigation farmers in the area. Estcourt, which began its life as a modest trading store established by its first inhabitant Clem Heeley in 1847, had by then flourished into the largest industrial and commercial centre in the Midlands region. It was thought that by providing additional water resources, these enterprises could be expanded.

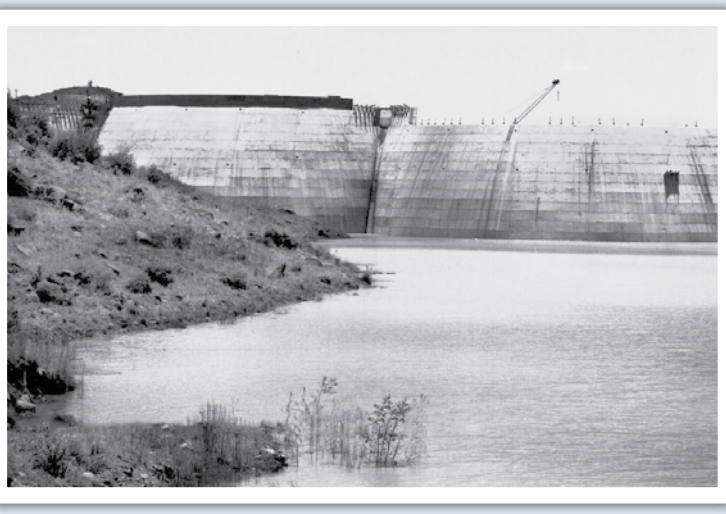
The potential of the Upper Thukela as a potential stimulator of the economy was noticed even then. "It [is] apparent that the rivers of Northern Natal, properly regulated, represent extremely important water resources in the national economy which, in point in fact, exceed the requirements of all possible agricultural development in their valleys and reasonable industrial use," wrote Department Director LA Mackenzie in his 1948 report. Of course, the Thukela River would later become one of South Africa's strategically most important river systems with the construction

Top right: *Wagendrift Dam from the air. It was the first structure of significance to be constructed in the Upper Thukela River system.*

Middle right: *Wagendrift Dam rises in the Bushman River. The dam had an original maximum capacity of 58,4-million m³.*

Bottom right: *Wagendrift's unusual design was selected to retain the economics of an arch structure while fitting a wide-bottomed site. The dam wall is 281 m long from flank to flank.*

DWA/eWISA



DWA/eWISA

DWA-eWISA

of the Thukela-Vaal Transfer Scheme to supply water to Gauteng.

The 1948 report recommended that initial operations be focused on establishing a dam on the Bushmans River above Estcourt and so work was undertaken in this regard by DWA. Various possibilities were investigated, including establishing the dam on the farm *Groot Mielietuin*, but the department eventually settled for a dam site on the farm *Wagendrift* – some 6 km upstream and south west of Estcourt. The farm takes its name from the drift through the Bushmans River used by transport wagons on their way from Port Natal to the goldfields of the Witwatersrand. This site was thought to have good storage

"It [is] apparent that the rivers of Northern Natal, properly regulated, represent extremely important water resources in the national economy which, in point in fact, exceed the requirements of all possible agricultural development in their valleys and reasonable industrial use."

characteristics and be well placed in respect of the water resources available. In addition, it would inundate relatively undeveloped areas. The primary objective of the dam would be to 'stabilise the flow of the Bushmans River to overcome the seasonal shortages experienced by irrigators lower down the valley at Weenen and to provide an assured supply for municipal and industrial use in Estcourt'.

The proposed scheme was approved by Parliament in 1959, and work on the construction camp began that same year. The department had managed to obtain 20 railway construction houses in Estcourt for housing a large

proportion of its employees, and so only 19 additional houses had to be erected at the dam site. By the end of March, 1960, the camp and works buildings had been completed and a start was made on excavation – 6 116 m^3 of excavation was done that first year.

In total, some 96 000 m^3 of soil was excavated and 73 00 m^3 of rock, while some 54 000 m^3 of concrete went into the dam wall. By the end of July, 1960, it was possible to cast the first concrete in the central buttress and a year later the river was brought under control of the structure – the concrete work having been completed for the full bed width of the river section. The dam was eventually completed in 1963 and officially opened on 14 March, 1964 amidst great fanfare. The final dam is a 40 m-high multiple double-curvature arch dam – believed to be the first of its kind in the world. The design retained the economics of an arch structure while fitting a wide-bottomed site at the same time. Wagendrift had an initial storage capacity of some 58,4 million m^3. Like many other South African dams, this dam was also designed in such a way to allow for future raising.

During the final design stage the initial arches were modified to domes – the latter being more economical than arches and also offering the added possibility of simplification of the outlet and scouring arrangements. The final structure had four domes supported by five buttresses spanning the major section of the river. The flanks have been closed off by means of half-domes with the crown thrust from the half-domes carried to the foundation and flanks by means of prestressed cantilever thrust blocks. One of the greatest challenges of the project was the shuttering – while the type of shuttering used at Kariba Dam was applied it took a considerable time before proficiency in application of a flat plane to a warped or curved surface was achieved.

DWA designers had to design a dam that would be able to withstand extremely variable flow, from as little as about 0,1 m^3/s to in excess of 28 m^3/s. High flood discharge is carried over the two central domes which provide a spillway length of 107 m, but low floods and service requirements are accommodated by the outlet works contained in the central buttress. The whole structure is symmetrical about the central buttress which has been split on its centre line to provide for the outlet works. The buttress is virtually a mass gravity structure but has been reinforced near the upstream face by means of post-tensioned stressing cables. A 2,7 m by 3 m radial gate was installed for desilting purposes. This was originally operated by means of an electrically drive rack-and-pinion winch. The normal service openings were provided in the form of three sets of 0,9 m-diameter pipes so connected that they are able to discharge water through one set of outlets. Designed and constructed by the Department of Water Affairs the dam is a prime example of local engineering innovation. ❑

Below: *The Dam nearing completion. Some of the shuttering can still be seen. The dam used the same type of shuttering as that applied on the construction of Kariba Dam.*

Bottom: *Wagendrift Dam spilling. Today, the dam makes a magnificent site for motorists passing on the N3 highway.*

DWA/eWISA

WRP

Science helps Eastern Cape village deal with future disasters

Paula Hay

Measuring social vulnerability and risk in relation to water and infrastructure in the Eastern Cape town of Cala has revealed specific vulnerabilities, causes and ways in which the town could address future community needs. Article by Erin Bosenberg and Paula Hay.

Situated in the Eastern Cape hinterland, the rural area of Cala is likely to experience severe drought every ten to twenty years. Most of the villages in the area are served by groundwater, and are susceptible to seasonal drought (when springs dry up). When this occurs the municipality pumps or trucks water to tanks scattered around the village, however, when this is not done regularly or when insufficient water is pumped, the effects of drought are felt more frequently and severely, as has occurred in the last five to ten years.

The situation has been found to be worst in the village of Tsengiwe, which receives its water from three springs (the latest two of which were brought on line in November last year). Water is stored in a large tank and transported through pipelines to a series of standpipes. Each of these taps is shared by up to 40 households. When the springs run dry the municipality fills the water tank manually by truck, however the two available trucks have found to be insufficient to feed the present water demand.

A specific methodology, tailored by hydrogeology and disaster risk reduction company Umvoto Africa, was applied for this case study and included literature research, interviews and fieldwork. The case study formed part of a larger project funded by the Water Research Commission to investigate the social vulnerability of people and their livelihoods as well as their response to water infrastructure.

The UN/ISDR's Hyogo Framework for Action (HFA) was also integrated as an important element identifying key indicators. The HFA is a practical global blueprint to make communities more resilient to hazard and disaster, thus preventing loss of life and infrastructure, economic loss and negative social impact. Results of the Cala case study were presented in a report providing identification of necessary steps to further reduce risk and increase community support and growth.

The Masiphile Project in Cala was found to be a key resource for the most vulnerable, with a specific focus on support for those infected with HIV/AIDS. The project is made up of a small group of women in the upper and lower outlying village of Tsengiwe. All women volunteer their time and, although not designated as a disaster risk organisation, are often involved with water distribution. "We are not involved in disasters," said a Masiphile member, "but we go to people with tanks during drought periods and ask them for water for those that don't have it."

Infrastructure and institutional support within the Sakshisizwe Local Municipality containing Cala and outlying villages is present, but communication between institutions is divided, operations and maintenance lacking, and infrastructure scattered. Umvoto's fieldwork was focused on the upper and lower village of Tsengiwe, which provides good representation of other nearby Cala villages. In Tsengiwe there is little economic activity aside from a few trading stores and some agricultural activity. There is one clinic, but

it is short staffed and many community members have little trust in its management, and so do not take advantage of services.

Institutionally there is little communication between the Sakhisizwe Local Municipality water services department, integrated development department and municipal disaster management personnel. This communication gap provides a perfect breeding ground for higher risk, resulting in unaddressed vulnerability. In particular, disaster management personnel, while holding one or two meetings each month at schools and for the community, are not involved in preventative measures related to drought. "We do an assessment of damage but no risk assessment before disaster. Just early warning," said disaster management staff member Nomgqibelo Niwzi.

Cala's community radio station, Vukani Community Radio, used to send out important weather warnings, but is no longer doing this. "We send reporters to major events such as disasters but we don't do early warnings," said station manager, Xola Mozewi. "The radio used to make weather announcements and the previous district communication officer would make announcements and send SMS [messages] to community leaders for announcements to be made."

During the data-collection phase of the project some problems were encountered. Some data had not been collated and so did not exist, some data were unavailable for research purposes (not given) and communication with responsible authorities was arduous and inaccessible. Despite these problems data were gathered from the following sources:

- Statistics South Africa
- District and Local Municipalities and non-governmental bodies
- Field work.

Based on a thorough investigation, available data and an assessment through all available means, the following key indicators were identified as strategies to decrease vulnerability and strengthen communication and community infrastructure:

- Decrease in sickness, deaths and property damage
- Increase in education material on hazard mitigation
- Communication strategies in place for early warning
- Decrease in response time to disasters
- Increase in number of projects with community members as partners
- Number of community members on steering committees
- Increase in community attendance of meetings
- Improved understanding of information by public.

The make-up of the Sakhisizwe community, in terms of age distribution and HIV/AIDS infection, is particularly relevant to the community's economic development and social stability. With 45,6% of the population below the age of 19, and 34,5% below the age of 15, there is a high demand for more educational facilities and resources.

Following this trend are high unemployment rates with very few supporting very many. Many elderly people support children with their old age pensions and child grants (approximately 20% of people rely on social grants as their primary source of income). Health-related data and infection rates were difficult to obtain but, based on provincial statistics, the HIV/ AIDS infection rate in the area is estimated around 50 to 80%. Without the added infrastructure and intensive institutional support the population of Cala and outlying suburbs cannot become a sustainable resource for development in the area.

Drought periods and a lack of access to adequate water, coupled with societal vulnerability, form a base by which the latter is sustained and could get worse if not addressed by community and government effort.

Coping capacity is a key element of risk reduction that needs to be improved upon. At the local municipality level a hazard monitoring database exists but is not well maintained; while the water services department and disaster management personnel claim to hold community meetings, disaster risk reduction is not mentioned in their Integrated Development Plan. Despite the Masiphile project's dedication and ability to bring down HIV/AIDS infection, their continual efforts should be complemented by others.

By virtue of necessity the Masiphile Project volunteers are already forming informal communicative ties between lesser and more privileged community members via informal water distribution. The Masiphile Project is a particularly significant resource in Cala and could become a community catalyst to obtain Key Outcomes: Reducing vulnerability and increasing coping capacity through social elements and improving communication. ❑

Paula Hay

Left: *Tsengiwe village Headman, Nsimphiwe MsenGana.*

Paula Hay

Below: *Water trucks are used to bring water to residents in times of drought.*

Water from Stone:

The video, *Water from Stone: Groundwater in South Africa*, has been designed to provide an introduction to groundwater-related issues for students (particularly through its use by high school and university educators); the public; journalists and policy makers at various levels of government (particularly local government) wherein a general understanding of groundwater issues in South Africa will be of benefit.

AIMS AND OBJECTIVES

In order to reach its different target audiences, Water from Stone provides an introduction to the following subject areas related to groundwater resources in South Africa:

- What is groundwater;
- Permeability and porosity;
- Groundwater flow in the hydrological cycle;
- The importance of groundwater to our ecosystems;
- Groundwater aquifers in South Africa;
- Groundwater use and technology;
- Groundwater for municipal, rural and agricultural users;
- Groundwater management for sustainable supply;
- Protecting groundwater for use in the water mix; and
- Artificial recharge of groundwater.

WHAT IS GROUNDWATER?

Groundwater occurs as part of the water cycle. It is formed by precipitation that infiltrates down into the soil, that is not taken up by plants, but that percolates deeper underground. Groundwater is thus water that is found in the spaces between sand and soil particles or within the cracks in hard rock underground.

The large underground areas in sandy soils or fractured rock that allow water to be accessed at a usable rate are called aquifers. The area of an aquifer that is filled with water is called the saturated zone and the top of the saturated zone is known as the water table. If an aquifer is depleted, the saturated zone decreases and the unsaturated zone increases.

PERMEABILITY AND POROSITY

Permeability is the capacity or property of a porous media (sediment, rock or soil) for transmitting a fluid and is mainly a function of the interconnectedness of the pores. Permeability is a measurement of the rate of infiltration that a type of soil allows. Highly permeable soils, such as sandy soils, allow easy movement of water. i.e. a high degree of infiltration. Soils with low permeability, such as clay, do now allow easy movement of water, i.e. they do not allow good infiltration.

Porosity is a measurement of the percentage of void space (i.e. the amount of open space) in the material of the underground soil or rock. The ability of an aquifer to store water is related to its porosity.

Primary porosity is the void space that originated when rocks were first formed in geological history e.g. sandstone is very porous rock with a high percentage of void space within the rock itself.

Secondary porosity is the void space that forms after rock is originally formed e.g. the void space formed by fractures and cracks in rock.

GROUNDWATER FLOW IN THE HYDROLOGICAL CYCLE

Groundwater flow refers to the different groundwater flow paths that form part of the hydrological cycle from infiltration to underground storage and flow, through to discharge back to the earth's surface.

When groundwater infiltrates into soils, it moves downwards until it reaches an impermeable layer where it is then held within an aquifer. Within unconfined aquifers, groundwater flows underground based on the slope of the water table (i.e. hydraulic gradient) until it eventually discharges at either a spring, river, wetland or the sea. Confined aquifers, by contrast, are under pressure and are generally sandwiched between two layers of impermeable rock.

Simplistically, if aquifers have the same hydraulic gradient then the rate of flow is faster within an aquifer of higher permeability – and slower within an aquifer of low permeability.

THE IMPORTANCE OF GROUNDWATER TO OUR ECOSYSTEMS

Groundwater plays an important role in maintaining the balance of a variety of South Africa's ecosystems, including springs, streams, rivers, wetlands and estuaries. Springs are the visible discharge point of underground aquifers. Springs provide high-quality fresh-water to the environment.

Groundwater also discharges into streams, rivers, wetlands and estuaries. Groundwater makes up a significant amount of the water in our rivers, such that the only water in a river in the dry season is supplied by groundwater.

Wetlands are at least partially dependent on groundwater. As topographic depressions where the water table meets the earth's surface, wetlands allow both groundwater discharge and recharge – enabling natural streamflow regulation and flood control.

Even groundwater discharge to oceans is important – it is often groundwater that contributes the fresh-water flow into the unique ecosystems of estuaries.

GROUNDWATER AQUIFERS IN SOUTH AFRICA

Different types of aquifers are found in different areas of South Africa. One of the largest sources of good groundwater in South Africa are the Table Mountain Group, known as the TMG aquifer. These are mostly sandstone aquifers, the most important of which are fractured quartzites.

There are also smaller sandy coastal aquifers that are found mostly in the Western Cape. Dolomitic aquifers are another large and important source of groundwater.

The Karoo aquifers are made up mainly of the sedimentary and igneous rocks of that area. Basement aquifers are made up of metamorphic and igneous rocks and are found primarily in the Limpopo area.

GROUNDWATER USE AND TECHNOLOGY

There is a long history of groundwater use in South Africa, from the time of the San who discovered reliable springs in the arid areas, to the early European settlers who founded small towns next to these 'fonteine' (fountains). Early development also took place on alluvial plains where wells could be dug easily by pick and shovel. Advances in both

Groundwater in South Africa

drilling and pumping technology then enabled the drilling of thousands of boreholes from the late 1800s to today.

Abstracting water from boreholes now happens in a variety of ways, for example, windpumps, handpumps, diesel or electrical pumps. Eco-friendly innovations such as solar pumps are also on the increase.

GROUNDWATER FOR MUNICIPAL, RURAL AND AGRICULTURAL USERS

In South Africa, groundwater users include municipal, rural, and agricultural users. Up to 65% of our population depends on groundwater – mostly in the rural areas. The biggest percentage of groundwater is used for irrigation (78%).

Groundwater is normally safe to drink without treatment in unimpacted areas as the sand and soil it passes through naturally filters it of any pathogens. However, groundwater quality is affected by its underground environment in that it may dissolve some of the minerals in the rocks with which it comes in contact.

In order to maintain sustainable groundwater resources, groundwater management systems are required. Over-abstraction is a threat to groundwater resources and can have far-reaching effects on the water table, local vegetation and the ecosystem. Groundwater mining is the term used to describe what happens when groundwater is pumped out at a higher rate than it is recharged.

Because of both the importance of groundwater and the far-reaching consequences of its over-use, more policies and strategies have come into effect since the National Water Act was passed in 1998. Prior to this, groundwater was considered private water under the law – the owner of the land had right of its use. Now the Minister of Water & Environmental Affairs is the custodian of all water resources, including groundwater. And any use above the needs of basic human use requires a registration of use and licensing.

GROUNDWATER MANAGEMENT FOR SUSTAINABLE SUPPLY

There is a common misconception that groundwater is unreliable and unsustainable. This is due to a history of groundwater use in South Africa that has lacked proper monitoring and management systems, which have led to both aquifer and borehole failures. While groundwater gets the blame, in most cases it is because of a lack of operation and maintenance of the infrastructure.

Developing sustainable groundwater supply should include some level of modelling, as well as the development of monitoring and management systems. Pumping schedules in particular need to be both monitored and managed. Telemetric systems are becoming more common – these systems allow schemes to be monitored remotely, and can also be used to send automated alarm messages to the appropriate people when, for example, water levels drop too low.

PROTECTING GROUNDWATER FOR USE IN THE WATER MIX

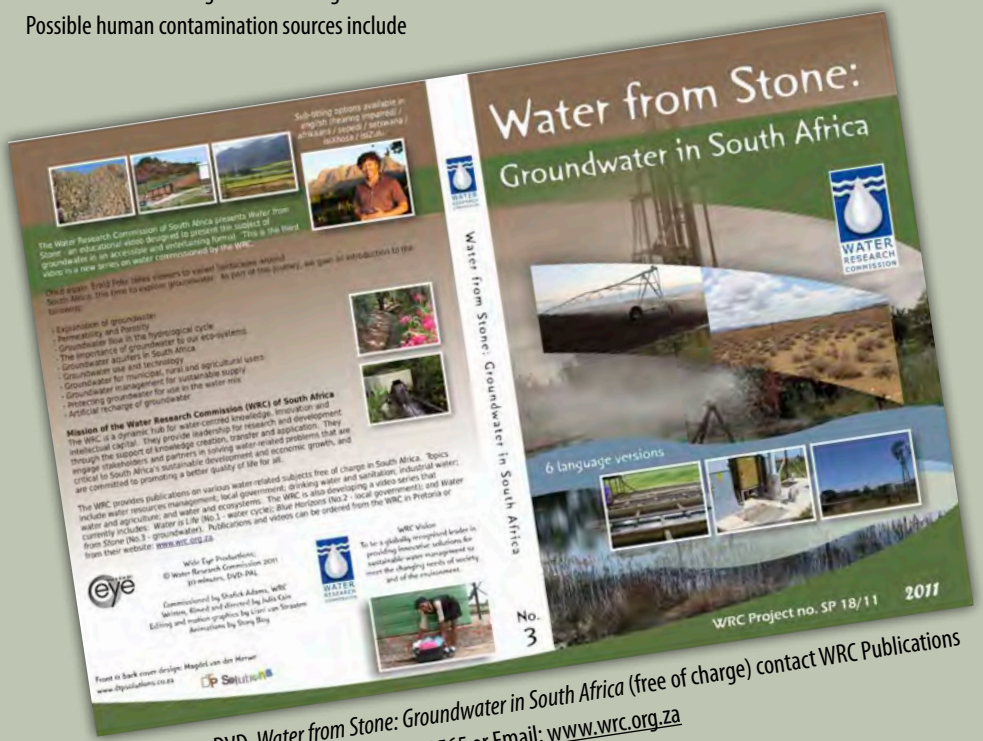
Developing a 'water mix' so that municipalities are not dependent on one source has become more of a priority throughout South Africa. Incorporating groundwater into this mix can thus help ensure greater water security.

Protecting groundwater is vital. Contamination from surface sources occurs when pollution infiltrates down through the soil into groundwater. Possible human contamination sources include landfill sites, industrial waste, agriculture, sewage and leaky petroleum tanks or pipelines. Boreholes themselves can provide a conduit for pollution directly into groundwater. For this reason, boreholes need to be constructed properly; abandoned boreholes need to be properly sealed; and protection zones around boreholes and aquifer areas need to become better implemented.

Contamination from below occurs when aquifer depletion causes poorer quality water to be 'pulled' in, for example, when coastal aquifers are overpumped it can cause salt water from the sea to intrude. Any contamination of groundwater is extremely difficult and expensive to address – and often impossible to fix.

ARTIFICIAL RECHARGE OF GROUNDWATER

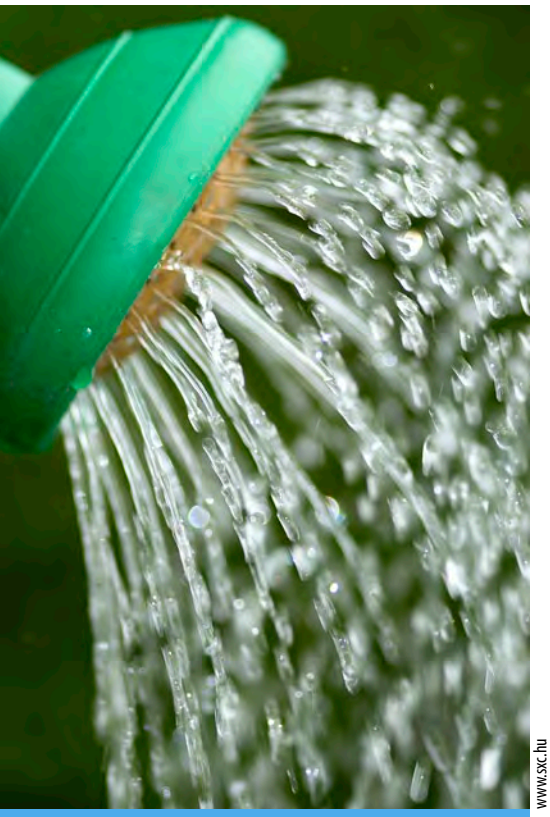
Artificial recharge describes the practice of taking excess surface water when it is available and redirecting it so that it fills up groundwater aquifers at a higher rate than would happen naturally. Artificial recharge can be done in different ways. For example, water can be diverted to recharge basins where it the naturally infiltrates into aquifers. Alternatively, water can actually be pumped down boreholes to fill up aquifers when there is excess water available.



To order the DVD, *Water from Stone: Groundwater in South Africa* (free of charge) contact WRC Publications at Tel: (012) 330-0340; Fax: (012) 331-2565 or Email: www.wrc.org.za

WATER Kidz

DON'T BE A WATER GUZZLER!



Some hoses use up to 30 litres of water a minute.

www.sxc.hu

It is general knowledge that South Africa is a water scarce country. No matter where we live we can all do our bit to save this precious resource.

South Africa has been blessed with a lot of rain lately, but we should not be fooled into thinking that this improves the country's overall water situation. Water will always be scarce here (after all we are one of the 30 driest countries in the world). This means we all need to do our bit to save water. In this issue of Water Kidz, we give some tips on how to save a lot of drops.

SAVING WATER AT HOME

Doing little things at home can go a long way in saving water. Did you know that a dripping tap losing one drop a second will waste 15 litres of water a day? Dripping taps and leaky toilets can account for as much as 5% of all water used inside the home. This means fixing those leaks will not only save water, but money as well. If it is a hot water tap that is leaking it is even more expensive since the water replacing the leaking hot water in the geyser needs to be heated. Luckily most leaks are relatively easy and inexpensive to repair.

The toilet is one of the biggest sources of leaks in the home. In fact, a leaky toilet can waste up to 100 000 litres of water a year. That is enough to take three full baths every day! If you hear water trickling into the bowl long after you have flushed the toilet, it is leaking. Another way to check for leaks in the toilet is to try and press a piece of toilet paper against the inside back surface of the bowl. If the paper gets wet, there is a leak. You can also put a few drops of food colouring into the toilet cistern. Watch the water in the bowl. If after a while it becomes coloured, then you have found a leak!

Bathing is the second highest user of water inside most homes. The average bath holds 150 to 200 litres when filled to the overflow level. Where practical, more than one person in the family should use the same water, for example, young children can bath together. Also, you should preferably not fill the bath to a depth of greater than 100 mm.

It is a good idea to take a shower instead of a bath.

www.sxc.hu

Of course, you can always have a quick shower instead. A short shower is more water and energy efficient and the hot water lasts longer if many people want to shower. By turning off the shower taps while you soap up, you will save even more water.

The bathroom is not the only place where water should be conserved in the home. You can also save a lot of water in the kitchen and laundry. Use a bowl instead of leaving the tap on when washing up, and keep cool water in the fridge rather than running the tap to get a cold drink. Using dishwashers or washing machines that are only half full not only wastes water, but electricity as well. You can also save water and power by only boiling the amount of water you need in the kettle.

Using the dishwasher only when full saves both water and electricity.

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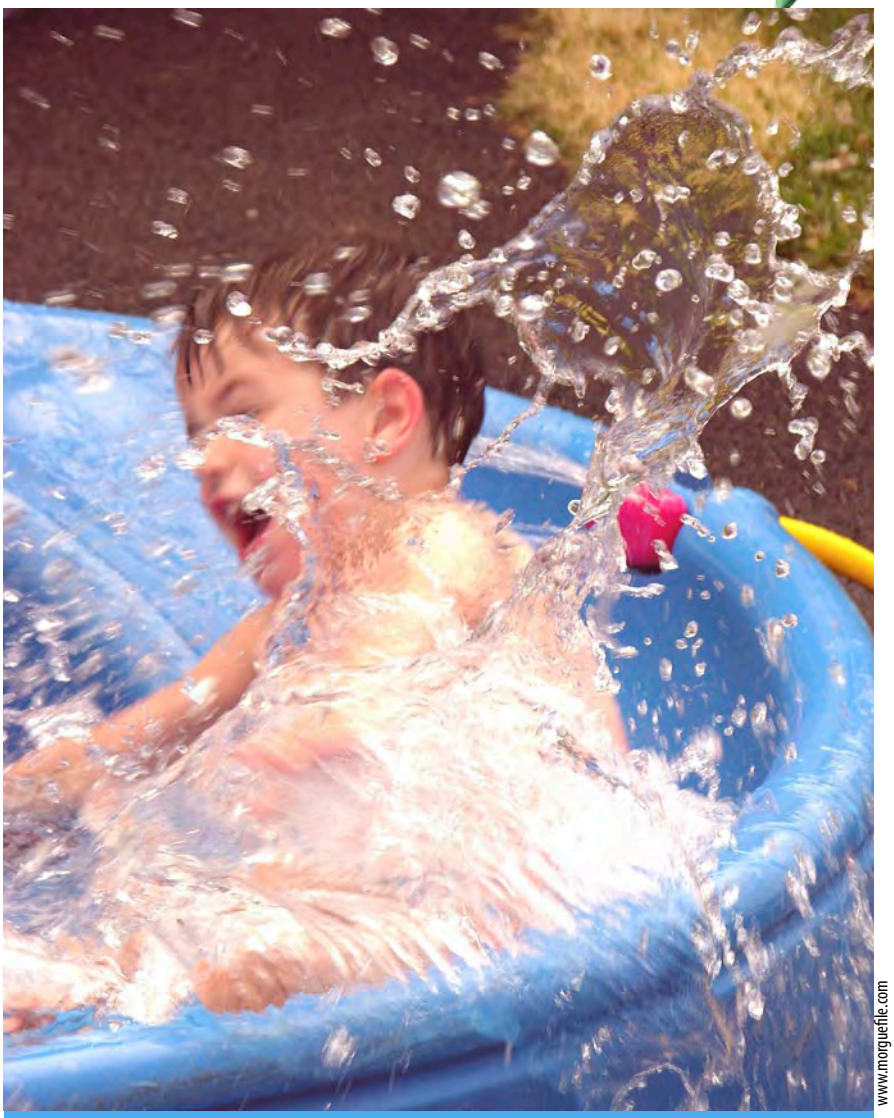
SAVING WATER IN THE GARDEN

If you have been blessed with a lovely garden you have to water it. But there are lots of ways to save water outside the house too. Speak to your local nursery about planting plants naturally found in the area that are drought tolerant and water thrifty. In spring and summer avoid watering in the middle of the day when evaporation rates at high. By watering less frequently, but rather deeply and thoroughly, you will also conserve water. Ideally, gardens should be watered once a week for half an hour rather than every day for ten minutes.

You can also save water by improving your soil. Feeding your soil with compost and mulch will help to retain plenty of water. The healthier the soil, the greater the penetration and retention of water. Another way of improving the volume of water plants soak up is by digging basins around the bases of trees and shrubs. Collecting rainwater for watering from the roof is another great way of saving water. Remember that this water should not be used for drinking or cooking as it has not been purified.

ON-LINE SOURCES:

- http://tlc.howstuffworks.com/home/5-ways-to-conserve-water-at-home.htm
- http://www.waterwise.co.za/site/home.html



www.morguefile.com

We all love water, which is why we all have a responsibility to conserve it.

WHERE WATER GOES IN THE HOME

Place	Non-water saving family	Water saving family
Bath	2 baths at a depth of 150 mm = **180 litres**	1 bath at a depth of 100 mm = **60 litres**
Shower	2 showers at 7,5 ℓ/min, for 5 minutes each = **75 litres**	3 showers at 6 ℓ/min, for 4 minutes each (close taps while soaping) = **70 litres**
Wash basin	Water used freely = **30 litres**	Water used carefully = **20 litres**
Toilet	16 uses at 12 ℓ per flush = **190 litres**	Volume of flush reduced and short flushes used when necessary = **51 litres**
Clothes washing machine	5 uses per week = **90 litres**	5 uses per week = **90 litres**
Hand washing	Clothing, floors, windows and other = **20 litres**	Water used sparingly = **15 litres**
Dish washing	Sink filled with water each time = **40 litres**	Water used sparingly = **20 litres**
Cooking and drinking	**15 litres**	**15 litres**
Total water used	**640 litres**	**341 litres**

Source: A guide to water saving in South Africa by Steve Camp

Africa's first sanitation technology demo centre opens

Sanitation remains one of the most important elements of service delivery as the pre-local government elections' open toilet saga demonstrated. Local municipalities can potentially be dazed by the myriad of technologies on offer, and it can become difficult to choose the right solution for the application. Africa's first sanitation technology demonstration centre, which officially opened its (toilet) doors in May, is expected to go a long way in helping in this regard. The open-air, permanent display centre, situated at CSIR's Pretoria headquarters, displays full-scale examples of more than 30 sanitation products and technology – from full waterborne systems and dry sanitation to urine diversion toilets. All the toilets at the centre adhere to the basic sanitation policy requirements – namely safety, reliability and privacy. The centre was funded by the CSIR and the Water Research Commission. WRC CEO Dr Rivka Kfir was the keynote speaker at the official opening on 27 May. "While a picture says a thousand words, seeing is believing, and this centre, where one can actually interact with the systems on display is of considerable value. The lack of proper sanitation still leads to the unnecessary death of millions of children each year, and it is hoped that this centre will make a difference in the provision of appropriate sanitation to all."

Sanitation technology demonstration centre 'champions' Louiza Duncker of the CSIR and Jay Bhagwan of the WRC view some of the displays on site.

CEO of the WRC, Dr Rivka Kfir, was the keynote speaker at the official opening of the centre.

Hans Ittmann, Executive Director of CSIR Built Environment says a few words before officially opening the centre.

Visitors take a stroll through the sanitation technologies on display.

Technology suppliers were on hand to explain some of the features of their products on display.

The unusual 'ribbon' cut to officially open the centre.

The dry sanitation technology display.

This colourful display shows that toilets can be beautiful as well as functional.

THE WATER WHEEL

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