THE WATER WHEEL
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Experts score bulk water a D

WATER RESEARCH COMMISSION

Water Institute of Southern Africa

MTD MEMBRANE TECHNOLOGY DIVISION

MEMBRANE TECHNOLOGY conference 2011

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Following the success of the first international conference, the WISA Membrane Technology Division is proud to announce that it will host a 2nd International WISA Membrane Technology Conference in KwaZulu-Natal. The organizing committee invites you to register and submit your abstracts.

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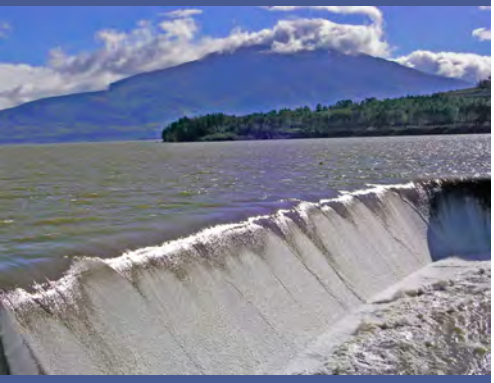

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***Cover**: SAICE's latest infrastructure report card shows a decline in water and sanitation systems despite government efforts. Cover illustration by Ralf Broemer. See page 12.*

Letters to the Editor

Empty for a reason

I refer to the article on Beervlei Dam in the January/February 2011 issue of *The Water Wheel* as well as the letter from CL Marechal (Pr Eng) on the same topic in the March/April 2011 edition.

Mention was made in the original article that the main purpose of the project was that of flood attenuation for the lower Gamtoos Valley. In order to achieve this objective the reservoir of the Beervlei Dam needs to be empty at the start of the flood in order to store as much of the flood water as possible. The Karoo sediments in the area contain a lot of salts and it has been found that lengthy storage of water results in high water salinity. The mode of operation is that any floodwater is used as quickly as possible by the downstream irrigators and the reservoir is thus kept empty for flood absorption purposes. A similar flood attenuation dam has been built upstream of the town of Ladysmith (KwaZulu-Natal) and this dam has a large uncontrolled outlet in its base to ensure emptying after a flood. You will see from this explanation that the Beervlei Dam has not been decommissioned as mentioned by Mr Marachel, but is alive and well in its empty state!

I have received many queries from members of the public as to why the Beervlei Dam is always empty. I have accordingly requested the Department of Water Affairs some eight years ago to erect a sign board with such an explanation at the viewpoint of the Beervlei Dam. Unfortunately this has not been done. I consider it most important that we as Water Resource Managers and Engineers interact with the public via various means and I would still like to see such a sign board when I drive past the dam en route to the coast.

Paul Roberts (Pr Eng), Secretary: SANCOLD

Environmental legislation correction

Thanks for a lovely magazine. However, I must point out what appears to be an error on p21 of the interesting article by Petro Kotzé ('Princessvlei – Tug of war over Cape Flats wetland continues' in *the Water Wheel* March/April 2011). In the blue coloured box on the right hand side of the page, it is mentioned that EIA is still governed by regulations promulgated in terms of the Environment Conservation Act of 1989. (By the way, it was incorrectly given in the article as Environmental, instead of Environment).

In fact, EIA regulations were promulgated and implemented in terms of NEMA in 2006, with revised regulations in 2010.

Luke Sandham, Associate Professor, School of Environmental Sciences & Development, North West University

Correction

In the article 'Women share secrets of career success in water' (*the Water Wheel* March/April 2011) the names of the authors, Lindiwe Ndlela and Nazreen Kola, were accidentally omitted. *The Water Wheel* regrets the error.

Dams not the be all and end all of water

The World Wildlife Fund (WWF) has called on South Africans to be more sensible in their use and management of land and water resources.

"The more we reduce the ecosystems' ability to deliver clean fresh water, the less water secure we will be and the greater the cost we will have to pay for our water," said Mark Botha, Head of WWF's conservation programmes.

In his message delivered during National Water Week in March, Botha said that many South Africans, especially those living in urban areas did not have a full understanding of where the water that flowed from their taps really came from, and the key role clean catchments played in providing it. "Cape Town has run out of water many times in the last century. Each time an expensive 'supply side' solution was found to buy us more time, but always at a cost. Now, with augmentation options rapidly diminishing, we are finding that the biggest cost of dams is the complacency that they leave us as ratepayers."

"At some point, we need to realise that we cannot only continue building more dams and other water infrastructure, but that it is imperative to invest in the natural resources that we already have. We need to concentrate more of our efforts on catchment security," noted Botha. According to him, catchment security is about the sound ecological management of our water generating infrastructure – not the dams, works and pipes that bring the liquid to our houses – but the catchment, wetlands and rivers that bring it to our dams and farms.

WWF recognises the need for man-made water infrastructure; however, it believes that without healthy freshwater ecosystems this infrastructure may be rendered useless. To illustrate, it appears that the much-touted desalination plants built in haste at great expense in the southern Cape in 2009/10 are hamstrung by ecological water constraints. Two of the four have already been shut down due to insufficient water availability.

At the same time, the mountain catchments in the Garden Route are being over-run by invasive plants, and clearing efforts are not even holding them at current infestations. If the costs of the desalination plants (estimated to be around R35-million) had been routed into securing ecological integrity of the catchments, the people of Plettenberg Bay may have not experienced water shortages last summer, WWF said in a statement.

Source: WWF

New roadsigns help toads hop to it

Ten new road signs have been erected in Cape Town to alert road users to the presence of Western Leopard Toads (*Amietophrynus pantherinus*) in certain areas of the city.

The signs were installed at crucial points within the distribution range of this endangered species.

The Western Leopard Toad is only known to occur in a very small area of the Western Cape, which includes the low-lying sections of the Cape Peninsula, the Cape Flats and the Agulhas Plains.

In Cape Town, almost all of the historic distribution range of the toad has been transformed due to urbanisation.

They now occur within residential areas where they have to survive an increasing number of threats such as herbicides, attacks by domestic pets, artificial barriers such as solid boundary walls and, of course, being killed by cars when crossing roads. The toads breed in remaining wetland areas within these residential areas and have to migrate to and from their breeding ponds every year between July and August. Road mortalities during these periods of active movement have added significantly to the threatened status of this charismatic amphibian.

In an effort to create awareness and encourage responsible use of road networks, the City of Cape Town has erected road signs warning users to slow down and be vigilant, especially when driving at night.

Source: City of Cape Town

International award for Durban metro

The eThekwini Water and Sanitation Unit emerged victorious following the announcement of the inaugural Water for Life Best Practices Awards during World Water Day earlier this year.

The municipality won the award in the category Best Participatory, Communication, Awareness Raising and Education Practices. The annual prize, organised by the United Nations, aims to highlight those organisations or individuals displaying outstanding merit and achieving particularly effective results in the field of water management or in raising awareness of water issues.

eThekwini won for its innovative approach to communication and awareness raising in poor areas and its contribution to addressing key challenges related to water and sanitation in a continuously growing urban area. According to the adjudicators, the success of the approach used to raise awareness can be seen in the results of the independent surveys that measure customer satisfaction; the reduction in non-revenue water levels; the increase in payment of accounts through the debt relief programme; and by the number of schools and teachers reached through the sustainable schools programme.

Among others, the city has managed to reduce incidence of diarrhoea by up to 31% in some of its poorest areas by providing toilets and education on better hygiene for children. In addition, cholera outbreaks have been prevented while the number of blockages in toilets and sewerage pipes has been reduced.

Water diary

IMPOUNDMENTS
JUNE 13-17
The 2nd IWA Symposium on Lake and Reservoir Management will take place in Granada, Spain with the theme 'Sustainable Approaches to Enhance Water Quality'. Enquiries: Prof Francisco Rueda; Email: fjrueda@ugr.es

AGRO INDUSTRIES
JUNE 22-24
The 8th IWA International Symposium on Water Management Problems in Agro-Industries will be held in Cesme, Turkey. The aim of the symposium is to provide a forum for discussion of the present problems and recent experiences and advancement in the management of waste in the agro-processing sector, such as textile, pulp and paper, leather, food, sugar, edible oil, beverage etc. Enquiries: Mrs Tugçe Katipoglu Yazan; Istanbul Technical University; Tel: +90 212 285-6586; Email: agro2011@itu.edu.tr; Visit: www.agro2011.itu.edu.tr/site/

WATER QUALITY
JUNE 28-30
The Third Municipal Water Quality Conference will take place at the Cape Town International Conference Centre. The conference is organised jointly by WISA and the Department of Water Affairs with the theme 'Reshaping the South African Municipal Water Quality Landscape'. Among others, the latest Blue and Green Drop reports will be launched. Enquiries: Dot Zandberg, Email: conference@wisa.org.za or Maryna Niemand, Email: niemandm@dwaf.gov.za

YOUNG WATER PROFESSIONALS
JULY 3-5
The Second Regional Conference of the WISA/IWA Young Water Professionals will take place at the CSIR International Conference Centre, in Pretoria. Enquiries: Cilla Taylor (Secretariat); Tel: (012) 667-3681; Email: confplan@iafrica.com

WATER HISTORY
JULY 5-7
The International Water History Association will be holding its 7th biennial conference in the Kruger National Park. Enquiries: Petra Lawson; Email: Petra.Lawson@nwu.ac.za

WATER LAW
JULY 3-7
The IUCN Academy of Environmental Law 2011 Colloquium will be held at the Mpekweni Beach Resort, in the Eastern Cape. The aim of this colloquium is to share understanding and expertise in the field of water and the law. Themes include governance and water management; land use planning; pollution and waste; ecosystems and the natural environment; coastal and marine issues; water rights and water scarcity, among others. Enquiries: Glaudin Kruger (Secretariat); Tel: +27 (0)83 316 2905; Email: kruger@kruger-associates.com or Visit: www.iucnael-watercolloquium-2011.com

IRRIGATION
AUGUST 2-5
The South African Irrigation Institute 2011 National Congress will be held at the Protea Hotel Kruger Gate, Mpumalanga with the theme 'Sustainable Irrigation for People, the Planet and Prosperity'. Enquiries: SABI, Tel: (021) 850 8220; Email: Riana@sabi.co.za

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Mapping human vulnerability to climate change

Canadian researchers are mapping human vulnerability to climate change using the same analytical tools as those used to study how various species of plants and animals migrate to climate change.

PhD student Jason Samson of McGill University's Department of Natural Resource Sciences, together with his colleagues combined climate change data with censuses covering close to 97% of the world's population in order to forecast potential changes in local populations for 2050. The team found that if populations continue to increase at the expected rates, those who are likely to be the most vulnerable to climate change are the people living in low-altitude, hot regions of the world, including South America, the Arabian Peninsula and much of Africa.

In these areas, a relatively small increase in temperature will have serious consequences on a region's ability to sustain a growing population. "It makes sense that the low latitude tropical regions should be more vulnerable because the people there are already experiencing extremely hot conditions which make agriculture challenging. An increase in temperature over the next few decades will only make their lives more difficult in a variety of ways," noted Samson.

This contrasts with Samson's predictions about the impact of climate change on human populations in high-latitude more temperate zones of the world, where the temperature change is expected to be greater. Because the spread of human populations along with their activities are already more constrained by the cooler conditions in these regions, the researchers expect that climate change will have less of an impact on people living in these areas.

The study also points to clear inequities in the causes and consequences of climate change: the countries that have contributed the least to climate change, based on their average per-capita carbon dioxide emissions, are nevertheless predicted to be the most vulnerable to its impacts. It is hoped that this data could be useful for decision makers around the world in the ongoing international negotiations around climate change.

US environmental scientist named 2011 Stockholm Water Prize Laureate

Stephen Carpenter, Professor of Zoology and Limnology at the University of Wisconsin-Madison, in the US, will receive the 2011 Stockholm Water Prize.

Prof Carpenter's groundbreaking research has shown how lake ecosystems are affected by the surrounding landscape and by human activities. His findings have formed the basis for concrete solutions on how to manage lakes.

Prof Carpenter is recognised as one of the world's most influential environmental scientists in the field of ecology. By combining theoretical models and large-scale lake experiments he has reframed our understanding of freshwater environments and how lake ecosystems are impacted by humans and the surrounding landscape.

The Stockholm Water Prize Nominating Committee emphasises the importance of Prof Carpenter's contributions in helping us understand how we affect lakes through nutrient loading, fishing, and introduction of exotic species. "Prof Carpenter has shown outstanding leadership in setting the ecological research agenda, integrating it into a socio-ecological context, and in providing guidance for the management of aquatic resources," noted the Committee.

HM King Carl XVI Gustaf of Sweden will present the prize during the World Water Week in Stockholm later this year.

New commission confronts threats to food security from climate change

Recent droughts and floods have contributed to increases in food prices. These are pushing millions more people into poverty and hunger, and are contributing to political instability and civil unrest.

Climate change is predicted to increase these threats to food security and stability. Responding to this, the world's largest agriculture research consortium, CGIAR, has announced the creation of a new Commission on Sustainable Agriculture and Climate Change.

Chaired by Prof Sir John Beddington of the UK, the Commission will in the next few months seek to build international consensus on a clear set of policy actions to help global agriculture adapt to climate change, achieve food security and reduce poverty and greenhouse gas emissions. The Commission brings together senior natural and social scientists working in agriculture, climate, food and nutrition, economics and natural resources from Australia, Brazil, Bangladesh, China, Ethiopia, Kenya, India, Mexico, South Africa, the UK, the US and Vietnam.

Findings of existing research will be synthesised to clearly articulate scientific findings on the potential impact of climate change on food security globally and regionally. The Commission will then produce a set of specific policy actions for dealing with these challenges.

Water footprint measuring advances

A major step towards standardisation of water footprint measurement has been achieved with the issuing of a global assessment manual by the Water Footprint Network.

The assessment, issued by the 139-member network and scientists of the University of Twente in the Netherlands, complements the recently completed Global Water Footprint Standard in giving consistency to measures of water use and impact. "The Global Water Footprint Standard comes at a time when companies in all sectors are awakening to the risk that water scarcity poses to their bottom lines and reputations," reports Jim Leape, DG of WWF International, a leading member of the Water Footprint Network. "This work helps companies understand their dependency and impact on water resources, and offers guidance on response strategies that conserve water for industry, communities and nature."

By measuring the amount of freshwater used in goods and services consumed or in production, the water footprint concept is helping companies to reduce water use where it is most wasteful. Individuals can use the water footprint to understand how much water they are using through the food they eat, the clothes they wear and the consumer goods they buy. Changing to less water-intensive products and choosing to buy foods from water-rich areas or catchments that are sustainably managed will move them toward a sustainable water footprint.

To download the manual or order a hard copy, visit: www.waterfootprint.org/?page=files/WaterFootprintAssessmentManual

Source: WWF

Overberg celebrates opening of new UF plant

Farmers in the Overberg are now assured of water of the highest quality following the official inauguration of the new ultrafiltration plant near Swellendam.

The 800 000 ℓ/day UF facility, designed and constructed by local firm Ikusasa Water, was erected at Overberg Water's Rûensveld Oos water purification plant. This plant treats highly coloured Cape brown water from the Theewaterskloof Dam for use by farmers and other rural users.

Overberg Water Chairman Joe Emeran, pictured with Ikusasa Water Chairman Andrew Theunissen, praised the staff of Overberg Water for their commitment to good governance. He said that it was only through public-private partnerships that South Africa can move forward and provide citizens with better services as it was within the private sector that funds were available for innovation research and development.

It is exactly with such a partnership that the UF facility came to be, noted Theunissen. Overberg Water and Ikusasa Water worked closely together for almost two years to optimise the treatment process. Extensive piloting work ensured that the final configuration selected would be the correct one. The facility is based on the most advanced local and international technology.

The UF plant was designed to operate in parallel and independently from the existing conventional treatment plant. Raw water is pumped directly from the river and divided between the UF plant and the conventional plant. The treated water from both plants is then blended into a single clear water reservoir. Backwash water from both plants is recycled to the feed of the conventional plant. The advantages achieved with this configuration were an 800 kℓ/day increase in total water production, improved water quality, reduction in water losses and a reduction in alum use.

Ikusasa Water is the first South African manufacturer of UF capillary membranes, which it produces at its Somerset West facility under licence from the Water Research Commission and Stellenbosch University. The company also currently has a Memorandum of Understanding in place with the university to further advance the technology.

Overberg Water CEO Dries Potgieter expressed his satisfaction with the plant. "While most of the water supplied by our utility goes towards agricultural use this does not mean we can allow it to be of inferior quality. In fact, many of our clients supply overseas markets and have to comply with extremely stringent quality regulations. The quality of water used can have a huge impact on such contracts. About 20% of the water goes towards domestic use."

The new UF treatment plant is highly automated, and can supply high-quality water regardless of the feed water quality. It is capable of removing particulate matter, colour, bacteria (such as cholera), viruses and parasitic microorganisms.

Apart from its smaller footprint the new UF facility at Rûensveld Oos also offers other advantages over conventional plants. It uses about a tenth of the coagulants as conventional plants to treat the high colour, high turbidity source water, thus offering lower running costs.

Company says saving water can boost mine production

Recent testing on a South African platinum mine has shown that saving water through paste and thickened tailings technologies is not only good for the environment but can allow higher throughput and boost profitability.

Using a pilot plant at Anglo Platinum's Mogalakwena South concentrator facility in Limpopo province, engineers and scientists at SRK Consulting, together with engineering consultants Paterson & Cooke have developed a simple model for estimating overall water consumption on the mine – and how to improve it. The tests showed that substantial water savings can be made by increasing the concentration of solids in the thickeners, especially when material density reaches 65% to 70% (conventionally, material reporting to tailings storage facilities will register densities of around 55%).

"For solid concentrations between 65% and 75% there is a rapid decrease in the release of free water," said SRK's principal geotechnical engineer, Johan Boshoff. "This results in a dramatic improvement in water consumption as pool size at the tailings facility – and hence evaporation and seepage losses – are reduced." One of the main constraints to raising throughput in mining plants is the lack of enough potable water, noted Boshoff. "The water saved by implementing thickened tailings technology can allow plants to improve their throughput, and this is a key factor in determining the profitability of a mine".

There are other important benefits to be derived from recovering more water at the plant, rather than from tailings, for example, better structural stability of the tailings makes it safer and easier to access. This in turn allows rehabilitation of tailings dams to begin earlier – speeding up compliance with environmental rehabilitation requirements. It reduces the danger of mine water seeping into groundwater resources, which has become a growing concern in South Africa's mining industry.

The technology related to water extraction in mineral processing plants is well-advanced in many countries where water is a highly valued resource and environmental regulations are very stringent. There is little doubt that SA is headed in this direction, said Boshoff. "Despite our concern about the lack of water in this country, the price is still too low to make users address the problem more assertively."

Chrome smelter cleans up its act

The Tubatse Ferrochrome smelter is reducing its environmental footprint and helping to preserve water in Steelpoort River through its new wastewater treatment plant.

The plant, developed by Veolia Water Solutions & Technologies and KV3 Civil Engineers, treats all water outflow on the smelter site, including industrial stormwater, contaminated groundwater, treated sewage water and industrial effluent containing a high concentration of dissolved salts.

According to Frank Rosslee, Engineering Manager at Tubatse Ferrochrome, the true value of this plant lies in the fact that by treating the contaminated groundwater and other wastewater sources, a large volume of water is re-used, without releasing anything harmful into the surrounding environment. "The added environmental gain from the project is that the volume of water that the smelter needs to extract from the Steelpoort River is reduced," he notes.

The added advantage to the smelter is that its process water quality has improved considerably, which assists in enhancing the life expectancy of all its major process equipment. "Most components in the smelting process have to be water cooled and harsh water can cause damage due to corrosion, embrittlement, stress corrosion cracking, chemical deposition, fouling, organic growth and other negative effects of dry and saline process water," Rosslee explains.

The plant has the capacity to treat 5 000 m^3/day of water. According to Veolia Water Solutions & Technologies MD Gunter Rencken, the basic processes that the wastewater and groundwater are subjected to include adding ferrous chloride, removing silt and oil residue, clarification, ultrafiltration, reverse osmosis and a combination of thermal and solar evaporation.

Water on the web

www.fao.org/nr/water/infores_multimedia.html
The FAO has a wonderful number of photographic galleries and short animations on the link between food production and water. The latter should be of specific interest to those wanting to get to improve their knowledge of the water sector.

@vaal_dam
People can now follow the latest available information on the Vaal Dam on Facebook and Twitter.
The Vaal is the first South African dam to have its own social media pages. This is an initiative of the Department of Water Affairs and CSIR.

www.un.org/millenniumgoals/
There is less than five years left before the deadline of the Millennium Development Goals. This site offers information on countries' progress on the various goals around the world.

www.unwater.org/worldwaterday/index.html
The World Water Day site offers feedback of all the World Water Day events held across the world, including South Africa.

Space scientist takes award

Space scientist Andiswa Mlisa, a Director of Cape Town earth sciences consultancy Umvoto Africa, is the winner of the small business sector award, and runner-up overall, in this year's Technology for Women in Business (TWIB) awards.

TWIB is an initiative aimed at enhancing the accessibility of science and technology to women in business, particularly in small, medium and macro enterprises (SMMEs). It is a national programme run under the auspices of the Department of Trade and Industry.

New from the WRC

Report No: KV 257/10

Impact study of the estuarine research and related activities funded by the WRC (C Breen; L Downsborough; D Roux & J Crafford)

The purpose of this investigation was to assess how WRC funding and involvement in estuarine knowledge generation impacted the social environment, the economic environment and the health and welfare of the people of South Africa. It is intended that the outcome of this study will assist the WRC in planning its future involvement and research agenda regarding estuaries. Among others, the study found that the WRC has found strategic direction and has been the principal funder for estuaries research for at least 15 years. In addition, estuaries research supported by funding from the WRC has had a significant and positive effect nationally and locally on the management of estuaries.

Report No: TT 429/10

Water-related microbial disease guidelines Volume 3: How great is the problem? (health impact assessment)

This guidelines document presents the third in a five-volume series aimed at addressing the question of how best South Africans can protect themselves from water-related microbial disease. It provides a framework of principles and guidelines for the assessment of health impacts, of water development projects such as water supply, sanitation and hygiene education, irrigation and dam construction.

Report No: KV 249/10

Development of a low cost LED-photodiode based spectrophotometer for continuous on-line monitoring using optical flow cells (C Garcin; F Nicolls; B Randall; M Fraser; M Griffiths and S Harrison)

This report describes the development of an LED-photodetector device for continuous on-line monitoring using optical flow cells as a low cost alternative to conventional spectrophotometry. Conventional spectrophotometers generally use tungsten or deuterium incandescent light sources, and have diffraction gratings, mirrors, filters and various other components that make up complex and expensive instruments. The development of light emitting diodes that emit at specific wavelengths in a narrow bandwith offer several advantages for replacing the conventional technology: LEDs are robust, inexpensive, longer lasting, smaller, and stabilise within milliseconds.

Report No: 1690/1/09

Sensing as a tool for resource assessment towards the determination of the legal compliance of surface and groundwater use (LA Gibson; Z Münch; J Engelbrecht; N Petersen; and J Conrad)

The overall objective of this project was to determine the usefulness and applicability of using remote sensing technologies as a tool for resource assessment towards the determination of the legal compliance of surface and groundwater use. This project focuses on the creation of new knowledge and being at the innovative edge of the topic. The study found that in the context of illegal water use, using remote sensing as a tool to quantify water storage may be appropriate in identifying water bodies and generating a fair estimate of volumes stored. The application of the water balance equation to the G10K catchment did not determine the level of legal compliance of water users to legislation. However, new methodologies, unused in South Africa, were applied to the study area with many challenges encountered. There is much hope that, as remote sensing technology develops and remotely sensed data becomes available at a higher spatial and temporal resolution, the full potential of these models will be able to be fully tested and if proven accurate, could possibly be used operationally in the future.

Report No: 1681/1/10

Modelling the influence of vegetation, soil moisture and aerosols on early summer Southern African climate (M Tadross; I Oliveira; M Mdoka; F Tummon; G Maure; N MacKellar; N Brown; O Crespo; S Hachigota & B Hewitson)

Little is currently known regarding global and regional controls of the early part of the rainfall season. An enhanced understanding of the controls of early-season rainfall characteristics are required to enable the design of new forecasting methodologies, which in turn may offer practical benefits to water managers and underserved members of the South African population, e.g. subsistence farmers. New forecasting methodologies will require knowledge of which antecedent conditions are important and be able to use this information to predict early-season rainfall, given likely non-linear interactions. This project focused on the links between early season (September-January) rainfall and local antecedent conditions of vegetation, soil moisture and atmospheric aerosols.

Report No: 1562/1/10

Methodological approach to assessing eco-hydrological responses to climate change in South Africa (RE Schulze; BC Hewitson; KR Barichievy; M Tadross; RP Kunz & MJC Horan)

The purpose of this project was to investigate effects of climate change on second order impacts, viz. ecological flow indicators and water temperature parameters, with particular focus on scientific techniques and methods. This was achieved by downscaling climate output from the ECHAMS/MPI-OM General Circulation Model (GCM) and then using the results as input data into the daily time-step ACRU hydrological model in order to simulate the impacts of climate change, as projected by this particular GCM, on the selected eco-hydrological indicators at a fine spatial scale.

Report No: 1753/1/10

Land-water linkages: Agent-based modelling of land use and its impact on water resources (YE Woyessal WE Welderufael & JDM Kinyua)

Over the last few decades, numerous researchers have improved measurements of land-use change, the understanding of the causes of land-use change, and predictive models of land-use change, by a representation of much more complex, and sometimes intricate, processes of land use. In central South Africa, agriculture, mainly commercial farming, is the economic backbone of the community in the region. Small-scale farmers are currently being introduced to improved agricultural practices through improved surface water (rainwater) management. The hydrological balance of any river basin is directly and indirectly influenced by the spatial and temporal distribution of land-use and land-cover changes. The general aim of this project was to contribute to the understanding of the dynamics of human-environment interactions and decision-making processes for the sustainable use of land and water in the Modder River. More specifically, the project looked at the driving forces in land-use change; the influences of the spatial and temporal distribution of land-use and land-cover changes on the hydrological balance of the river basin; and analysing and modelling both the physical environment and the human dimension of the processes of land use change and its impact on water resources.

Report No: TT 432/1/10

'Going with the franchising flow' – An exploration of partnerships for the operation and maintenance of water services infrastructure (K Wall & O Ive)

The rapid rate of construction and commissioning of new water services infrastructure is severely challenging the public sector institutions in South Africa responsible for operating and managing this infrastructure. Innovative approaches are required. There is an alternative institutional model that is suited more for the ongoing operation and maintenance

of water services systems than for investment in new infrastructure and, importantly, that is friendly to small business and local economic development. This alternative is the franchising partnership. A WRC scoping study completed in 2005 found that franchising partnerships could alleviate and address many challenges in the management of water services. At the same time, franchising would support the development of local microenterprises and broad-based black economic empowerment, all within the public sector delivery environment. The objective of a second study commissioned by the WRC, and now completed, was to identify the scope for franchising partnerships for the operation and maintenance of selected water services infrastructure, to establish the viability of franchising partnerships, and to make a case for outsourcing to franchises to be considered by water services institutions.This report forms part of a series of seven reports. The other reports are not available in hard copy, but can be downloaded directly from the WRC website.

Report No: 1747/1/10

Multidisciplinary analysis of hydroclimatic variability at catchment scale (M Rouault; N Fauchereau; B Pohl; P Penven; Y Richard; CJR Reason; CGS Pegram; N Phillippon, G Siedler & A Murgia)

The MAHYVA project, Multidisciplinary Analysis of Hydroclimatic Variability at the Catchment Scale, was a project that involved climatologists, meteorologists, oceanographers and hydrologists from southern Africa and Europe. The goal was to document, understand and build capacity in analysing the impact of climate variability on rainfall, streamflow and vegetation at the catchment scale. Because of the important role of the ocean on southern African rainfall, oceanography was an important component of the project.

While more information was needed on how the main modes of variability interact with South African climate, there was also a strong need to improve our knowledge on how large-scale climate variations impact on smaller hydrological scales. Consequently, the MAHYVA project aimed at building variability to hydrological parameters at the catchment scale, which included refining both the spatial and temporal scales of investigations.

Report No: KV 259/10

Evaluating the potential contribution of episodic toxicity data to environmental water quality management in South Africa (AK Gordon; SK Mantel & WJ Muller)

The approach of this project was to undertake a desktop literature review with the aim of addressing questions around the quality and quantity of episodic toxicity data available in the aquatic environmental water quality literature; the philosophical and practical constraints limiting their inclusion in environment water quality management procedures and guidelines in South Africa; and to investigate how these data could be incorporated into the current development of a risk-based approach to deriving water quality guidelines for aquatic ecosystems, and the continued refinement of the Direct Estimation of Ecological Effect Potential (DEEEP), a direct toxicity assessment method developed by the Department of Water Affairs.

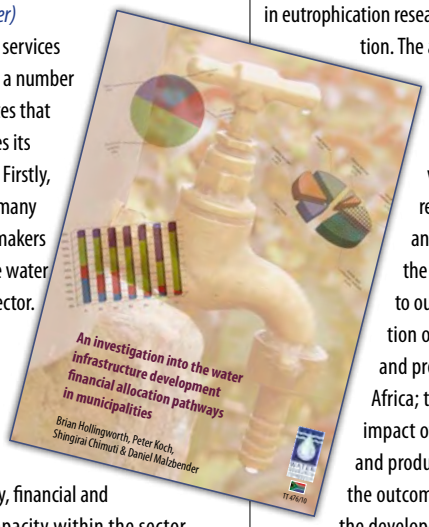
Report No: KV 250/10

Development of an immobilised fixed film system for sulphide oxidation in passive mine-water treatment (PD Rose; J Gilfillan; N Rein & D Render)

The work reported in this study was undertaken to evaluate, at the pre-feasibility level, the proposition, based on observations by researchers at the Rhodes University Environmental Biotechnology Research Unit (EBRU) over several years, that the immobilised sulphide oxidising fixed film system may be considered for the treatment of sulphide containing wastewaters. The passive treatment application was targeted in these studies where sulphide removal presents a severe technological bottleneck in the development of these treatment systems. A consultancy project was undertaken to consolidate and confirm work undertaken at EBRU on sulphide oxidising fixed film systems and to investigate the intellectual property position on which further investment in the process may be considered.

Report No: TT 476/10

An investigation into the water infrastructure development financial allocation pathways in municipalities (B Hollingworth; P Koch; S Chimuti & D Malzbender)



The water services sector has a number of attributes that determines its financing. Firstly, there are many decision-makers within the water services sector. Secondly, there are many sources of finance, and thirdly, financial and human capacity within the sector varies considerably. Because of the many institutions involved in all the processes, a complete picture of financing in the sector has not emerged. In order to analyse finances in the water services sector, this research project, following a well-known concept from business management, has postulated a 'value chain'. This envisages the adding of value through a number of sequential functions (or phases), as the technical and institutional arrangements change to match the challenges of each function. This also allows the examination of each function to determine the contribution of the institutions that lead it to overall efficiency and effectiveness. What is important in the context of regulated markets and prices is that 'value' a, 'cost' and 'price' are not equivalent. The purpose of this analysis is, on one level, to guide policy formulation in the water services and municipal sectors and on another level, to assist all decision-makers to be better informed in making financial decisions concerning matters such as financial grant allocations, tariffing, capital expenditure, operations and maintenance expenditure.

Report No: TT 461/10

Eutrophication research impact assessment (Frost & Sullivan)

The WRC has been extensively involved in eutrophication research since its inception. The aim of this project was to map the full extent of domestic water quality research funded and published by the WRC since 1984; to outline the application of the research and products in South Africa; to determine the impact of the research and products; and to relate the outcomes/impacts of the developed products to a common measure such as 'Rand value of research product impact'. The study showed that, overall, WRC research on eutrophication has made positive steps towards improving all aspects of South African society. Consistent research, supported by the targeted application by industry of the results and more efforts to increase public awareness, will do a great deal towards eradicating the problem of eutrophication and ensuring a safer, more sustainable future for people, animals and ecosystems alike.

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Maintenance, skills still impede infrastructure services

Lani van Vuuren

While South Africa's national infrastructure managed a 'satisfactory' C- in the latest assessment by the South African Institution of Civil Engineering (SAICE), the country's water and sanitation structures have been shown to be increasingly at risk. Report by Lani van Vuuren.

The *SAICE Infrastructure Report Card for South Africa 2011* is the second released by the institution, the first being published five years ago. The report focuses on the present condition of engineering assets in ten different sectors, from water and sanitation to ports, rail, healthcare and schools. "This report has been three years and many hundreds of hours in the making," noted report convenor Sam Amod.

The assessment shows that, in general, there has been marginal improvement in the country's infrastructure, fuelled mainly by the heavy investment in national assets such as ports, rail, airports and national roads. However, this does not mean that there has been a blanket improvement, state the authors. "On the contrary, the quality and reliability of basic infrastructure serving the majority of our citizens is poor and, in many places, is getting worse. Urgent attention is required to stabilise and improve these."

WHERE HAVE ALL OUR ENGINEERS GONE?

The prevailing skills shortages in the engineering sector again emerged as a theme this year. South Africa remains grossly under-served by technical expertise – the ratio of population to engineer in the country is about 3 200 to 1 (20 times less than other upcoming countries such as China and India). Furthermore the vast majority of engineers remain older white males.

The challenge remains most acute in local government circles (a previous SAICE survey had found that out of 283 municipalities, 83 had not a single technical employee on staff). Those municipalities who did employ engineers and/or technicians reported large numbers of vacancies, often owing to budget constraints. Thus the inadequate capacity of these service providers to fulfil their responsibilities remain a recurring theme.

"From evidence it is clear that much of local government is indeed in distress, and that this state of affairs has become deeply rooted within our system of governance. In assessing the reality of poor municipal performance, cognisance needs to be taken of the unresolved problems identified in previous assessments (despite recognition from national government and legislation that is often in line with best practice) and the intergovernmental impact of this failure, both institutionally and for communities."

"Much of local government is indeed in distress, and this state of affairs has become deeply rooted within our system of governance."

Added to the lack of engineers is the lack of maintenance of existing infrastructure. To address remaining historical imbalances and keep up with the demands of socio-economic growth government is still focused on the rollout of new infrastructure rather than maintaining that which is already in existence. "Infrastructure, once created, is unrelenting in its demand for maintenance and this demand will increase the longer it is ignored.. South Africa is a developing country and government has recognised the importance of infrastructure in increasing equality and meeting social and economic needs, but this recognition is compromised by neglect of maintenance which results in infrastructural failure and recapitalisation requirements," the document points out.

SAICE's assessors, led by a team from CSIR, found a dearth of data pertaining to infrastructure. Reliable, consistent data is a prerequisite for the urgently required shift towards routine maintenance. Data permits planning, prioritisation of targets and adequate budgeting for maintenance and extension.

Overall, the allocation of maintenance funding was found to be wholly insufficient, especially in circumstances where it was expected to also cater for a maintenance regime that had led to neglect. This inadequacy is accordingly compounded by poor management, which results in the meagre funds going unspent.

WATER

Bulk water infrastructure was scored a **D-**, slightly down from the 2006 assessment. Of specific concern is the deteriorating state of the country's bulk water infrastructure, much of which is reaching the end of its life and will soon require upgrade or replacement. The Department of Water Affairs (DWA) is responsible for 250 schemes with a replacement value of R139-billion. The average age of this infrastructure is 39 years.

SAICE has found insufficient maintenance and capital renewal, compounded by the serious capacity and funding problems within the department. According to the report it has been estimated that reinvestment of R1,4-billion a year is required to maintain present bulk water infrastructure. "The problem [of lack of maintenance] is compounded by fading institutional memory as individuals retire or are lost to the private sector. Still, despite long lead-in times for new projects and the above problems, DWA has been proactive in planning new supply schemes, which is a positive step."

"However, since 2006 a disturbing mismatch between water demand and bulk infrastructure development has come to light, with the result that users in the highly strategic Vaal and Umgeni systems are exposed to unacceptable risk of water restrictions for the next decade," the report points out. This mismatch, it says, was precipitated by comprehensive failure to meet water demand management targets. However, it also points to a failure on the part of authorities to react to this serious problem in time.

"The long delay in identifying large-scale water theft by farmers along the Liebenbergsvlei River and further delays caused by failure to monitor abstractions is also symptomatic of the severe shortage of capacity within the Department of Water Affairs." Studies initiated around the Vaal River system as far back as 2004 discovered that up to 240 million m^3 of irrigation water

Left (p 12): *A typical metropolitan sewage treatment plant.*

Right*: Around R1,4-billion a year is required to maintain South Africa's bulk water infrastructure.*

Below: *A worker prepares to clean a VIP toilet in the eThekwini municipal area. With few exceptions maintenance of infrastructure remains a challenge in South Africa.*

Lani van Vuuren

Lani van Vuuren

Lani van Vuuren

There remain big anomalies in the state of wastewater infrastructure between large metropolitan centres and rural areas.

use in the Upper Vaal was unlawful, and that this was probably the main reason for the water management area's negative water balance.

The report points to a general culture of complacency which has developed in South Africa regarding water resources and use. The country needs to do much more in terms of instituting appropriate water conservation technology and a water conservation culture. Another serious problem is the uncontrolled, high levels of pollution, especially in dams.

With regards to municipal water supply, extreme variations in the condition and performance of infrastructure in the water sector were found. For example, water supply quality was found to be very good in metropolitan areas, but frequently unacceptable in rural areas. On the up side, 2,2 million South Africans have been provided with basic services. SAICE also praised DWA for introducing the Blue Drop/ Green Drop certification systems, which it described as 'a very positive development' and 'a key initiative in monitoring water quality locally'. "Releasing the reports to the public have set a good example to the leaders of other infrastructure sectors," the authors said.

SANITATION

Major urban areas were scored an unchanged **C-** for sanitation infrastructure, with the report pointing to serious problems with the management of many wastewater treatment works. There is also a lack of wastewater monitoring (not meeting effluent standards or even measuring effluent quality) in many plants. However, the greatest challenges remain in rural areas, and sanitation infrastructure here scored a very unsatisfactory **E** grade.

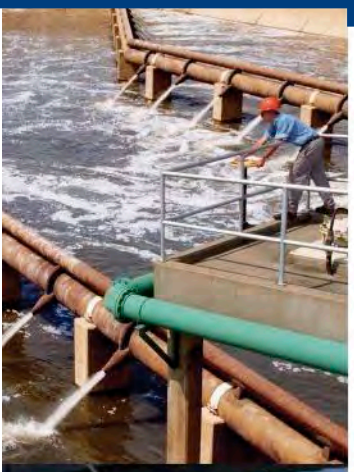
While an additional 3,3 million people have gained access to basic sanitation facilities since the 2006 report card was published users are often not receiving the full benefit because of high failure rates. The report points to the fact that most sanitation facilities are not compliant with appropriate technical design standards resulting in them being built in a manner susceptible to quick failure and extreme maintenance difficulties. Secondly, there is a consistent lack of communication with users on why and how to use these facilities, compounding maintenance problems.

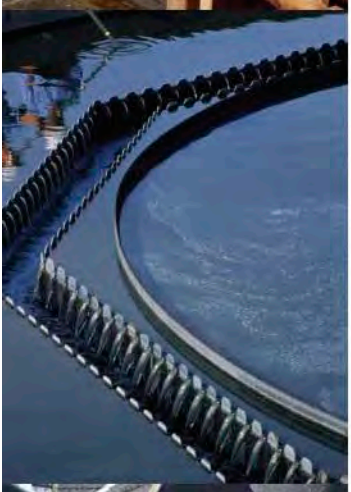
"One example of these problems is the fact that many sanitation facilities lack hand-washing facilities and do not impress the importance of hand washing to users. This simple, avoidable problem threatens all hygienic improvements and restrictions of disease achieved through proper sanitation."

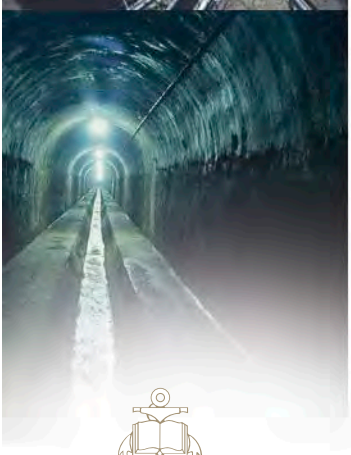
"From our evaluation, skill constraints notwithstanding, bold leadership and effective management are irreplaceable ingredients for successful and sustainable infrastructure provision," noted Amod. "More of this leadership must be directed to changing the behaviour of the public if our resources – and infrastructure – are to be sustainable."

While this report outlined government's infrastructure-related deficiencies, all South African citizens were responsible for sustainability, Amod concluded.

To access the *SAICE Infrastructure Report Card for South Africa 2011*, visit: http://www.saice.org.za/pdf/IRC2011-landscape-1-final-lr.pdf ❑







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New water institute aims to spearhead 'BLUE REVOLUTION'

Lani van Vuuren

UF membranes, pictured here, are among the focus areas of the SU Water Institute.

The new Water Institute at Stellenbosch University (SU) is ready to lead South Africa's 'blue revolution' through the advancement of technology and innovation. This was the main message at the official launch of the institute during National Water Week in March.

The institute brings together a host of established water research groups across various disciplines and departments. The researchers now united under the banner of water include, among others, microbiologists, polymer scientists, soil scientists, geologists, invasion biologists, engineers, zoologists, food scientists, biochemists, agricultural economists and even a philosopher.

"At SU we have, over the years, built up excellent capability within the field of water research in various departments and faculties," notes Prof Eugene Cloete, Dean of the SU Faculty of Science and Chair of the Advisory Board to the Water Institute. "By uniting our researchers in such a way I believe we have created a national asset that actively contributes towards solving South Africa's and the continent's water-related challenges."

According to Prof Cloete, there is a clear need to develop innovative new technologies and materials to address the issues faced by the water sector, such as the improved supply of potable water. "Although new approaches are continually being examined, these need to be durable, cost-effective, and more efficient than current options for the removal of contaminants from water. Innovation holds the key to the mitigations of all of these problems – ranging from unsophisticated technologies like rooftop rainwater harvesting and nanotechnology."

"Innovation holds the key...from unsophisticated technologies like rooftop rainwater harvesting to nanotechnology."

Current research undertaken at the water institute in collaboration with government and industry focuses on the themes of health, agriculture and food, a sustainable environment, nanotechnology and filtration, effluent treatment as well as social aspects around water. One of the early successes of the institute has been the development of the now famous nano-filtration 'teabag', which achieved world-wide status last year. SU has since signed a licensing agreement with the company Aquacure to produce, manufacture and market

Justin Alberts/SU

Prof Russel Botman, Vice Chancellor of SU, Minister of Science & Technology Naledi Pandor and Chair of the SU Water Institute Advisory Committee Prof Eugene Cloete at the launch of the institute earlier this year.

the filters. Special equipment is also being imported to undertaken the electrospinning of the filters at commercial scale.

The Water Research Commission (WRC) is a significant contributor to many of the research undertaken at the SU Water Institute. This includes studies into membrane technology led by Prof Ed Jacobs at the Department of Chemistry and Polymer Science. Present research aims to increase the water recovery ratio of ultrafiltration membranes to beyond the accepted 95% level. According to Prof Jacobs, key to the success of this research is the development of a floating media filtration process used both to condition feedwater for the UF process and to separate solids for discharge. Preliminary investigations are also underway to develop equipment and protocol to harvest kinetic energy from flowing water and to convert it to potential energy to drive a membrane filtration process.

The WRC is also contributing to research around endocrine disrupting contaminants (EDCs) at SU. The Department of Botany and Zoology under leadership of Prof Hannes van Wyk is currently developing several additional biomarkers for the screening of potential endocrine activity in our waters. Meanwhile the Department of Biochemistry, led by Prof Pieter Swart, is doing valuable work aimed at reducing the risk of EDCs through early detection. "Our approach is to fill the information gaps in developing and validating the testing and screening of substances with possible EDC effects in purified drinking water."

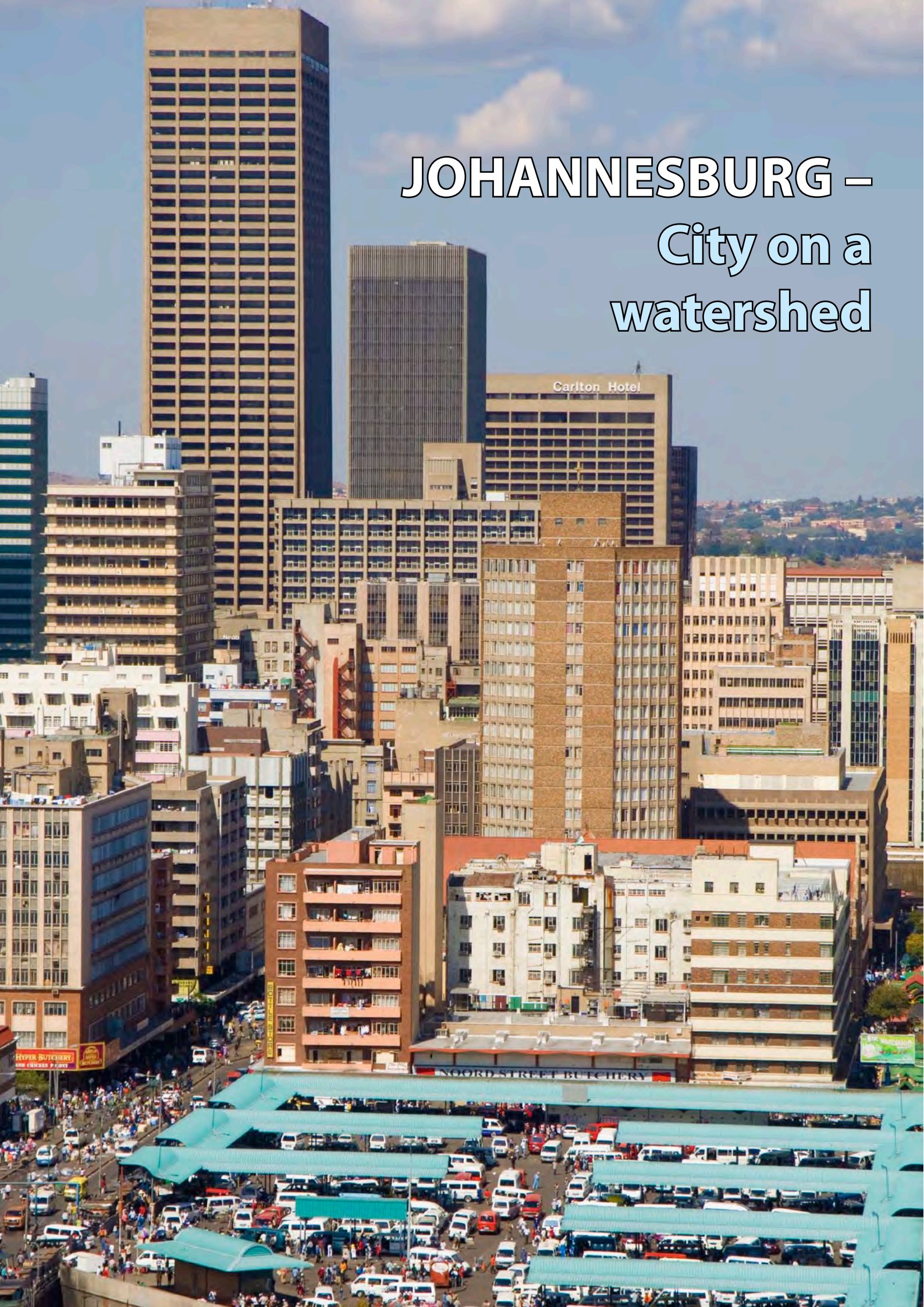
In the end it is all about making a difference where it matters. "We hope to see the Water Institute continue its groundbreaking work and truly put science and our expertise at the service of human need, to overcome some of the biggest water-related challenges facing our country, our continent and the globe," concluded Prof Russel Botman, SU Vice Chancellor. ❑

SOUTH AFRICA'S WATER CHALLENGES, ACCORDING TO SCIENTISTS AT THE SU WATER INSTITUTE RELATE TO:

- **The monetary value attached to water:** "We need more focus on issues about the efficient allocation of water, because water is such a scarce resource and of enormous economic importance, especially to the agricultural sector," notes Prof Theo Kleynhans of the SU Department of Agricultural Economics in the Faculty of AgriSciences. "Water must remain an important policy and business issue."
- **Low-cost housing, health and sanitation:** "It is admirable to want to provide housing for all South Africans, but if we do not also ensure the adequate upkeep of provided facilities such as toilets and taps, the sanitation problems associated with low-cost housing will continue to pose a health risk to humans and the environment," notes Dr Jo Barnes of the Division of Community Health in the SU Faculty of Health Sciences. She believes more serious thought must go into the design of low-cost housing to ensure better sanitation conditions.
- **The contamination of irrigation water and fresh food produce:** According to Dr Gunnar Sigge of the SU Department of Food Science in the Faculty of AgriSciences, South Africa's failing sanitation levels, combined with its below par water treatment services might be to blame for the potential contamination of rivers, irrigation water and raw food products with waterborne disease-causing pathogens. "There is a real risk that people who eat unwashed raw food could contract diarrhoea or other waterborne diseases when contaminated water is ingested or used to irrigate these crops."
- **The use of membrane technology to solve water shortages:** Faced with water shortages local authorities are increasingly turning to membrane technologies to help solve their water provision problems. "On the South Coast alone, seawater desalination plants are already running in Knysna, Sedgefield, Mossel Bay and Boesmans River," notes Prof André Burger of the SU Department of Process Engineering in the Faculty of Engineering. "Our challenge is to make it increasingly effective and cost-effective." Prof Burger also foresees that seawater desalination together with effluent recycling will become an integral part of water provision in the water-scarce Western Cape within five years.
- **The impact of invasive species on water quality and provision:** "Now more than ever we need research being done [on the impact of invasive species] to find its way into policy and into practical guidelines that can help individual landowners and other custodians of land to effectively manage our resources," notes Prof Dave Richardson, Deputy Director: Science Strategy of the DST-NRF Centre of Excellence for Invasion Biology based at SU. "In South Africa as the case worldwide, riparian zones are heavily invaded by alien plants that generally are massive consumers of water. In many areas, this destabilises stream banks and substantially reduces water quality and quantity due to the increased biomass." Alien fish species such as trout and bass, as well as water weeds such as hyacinth also impact local biodiversity.
- **The occurrence of EDCs in our water:** A whole host of endocrine disrupting contaminants (EDCs) are being released into our environment every day. The chemicals in these products have the ability to mimic or antagonise the functioning of the steroid hormones in our bodies. EDCs can disrupt the normal functioning of the endocrine system in humans, fish and reptiles. Research has shown that EDCs have had an impact on infertility levels in some communities, the occurrence of certain types of cancers as well as hormone-related bodily changes such as hermaphroditism. "It isn't possible to simply routinely test and detect EDCs, as they have no visible characteristics like smell or taste and they usually occur at extremely low concentrations," notes Prof Pieter Swart, chair of the SU Department of Biochemistry in the Faculty of Science. Therefore specialised analytical methods are required. "Thanks to solid support from, for instance, the WRC, South African researchers have been able to make valuable contributions to the field."

Drs Michéle de Kwaadsteniet and Marelize Botes with Prof Eugene Cloete all of SU at the seminar which preceded the launch of the Water Institute.

Lani van Vuuren



JOHANNESBURG – City on a watershed

Johannesburg's location is both its gift and its curse – close to the gold, but far from water. Article by Petro Kotzé.

Johannesburg's location is both its gift and its curse. On the one hand, the gold-bearing reef that is the reason for its existence has shaped it into the economic heartland of the country. On the other hand, it is one of the few cities in the world not located close to one of the most important resources necessary to sustain its growth: water.

Indeed, where other major cities in the world have developed close to rivers, seas or other water sources, the Witwatersrand metropolitan area has been described as one of the largest concentrations of people so far away from one. The nearest river of any significance, the Vaal, is about 70 km away.

Since gold was discovered on the Rand in 1886, the once dusty mining town has grown into a metropolis that houses a quarter of South Africa's population and is responsible for about 10% of the continent's economic activity. As the city has grown in size, however, so has its thirst for water, with formidable consequences for its bulk water supplier – Rand Water, established in 1903. Today, the bulk of the water supply is pumped from the Lesotho Highlands, through a system of interconnected water sources, pumps, valves, pump stations, purification plants, pipelines of various diameters and reservoirs.

This growth has put increasing pressure on both the quantity and quality of water available while, according to Rand Water, the increasing volume of people in need of water and sanitation services is a mounting concern. Looming mining applications in the catchment of the Vaal Dam and the possible effects of climate change add further force behind future water supply problems. This puts the City of Gold in a precarious position, not only located on a physical watershed, but according to some, also a metaphorical one – changing from a water-secure to a possibly water insecure city.

SMALL BEGINNINGS

Johannesburg is situated on a divide between the Vaal River catchment (the Vaal itself being a tributary of the Orange River) and the Limpopo River catchment. On one side, water runs down the Vaal and the Orange towards the Atlantic, while on the other side water drains towards the Indian Ocean via the Limpopo River system.

The city straddles this major watershed, known as the Witwatersrand, and the discovery of gold in the conglomerates (sedimentary rock consisting of peddles and sand grains cemented together) underlying the area during the 1880s was the catalyst for its development. The area was named after the pristine springs and small streams that occurred along a ridge some 380 m above the surrounding country, in the southern parts of Gauteng, striking westward in the North West province. It refers to an area stretching between Springs in the east and the Krugersdorp/Randfontein area in the west, a distance of about 90 km. Shortly after gold was discovered, a conglomerate of camps and shanties sprang up to house the thousands of people seeking their fortune.

Originally, water was drawn from the Fordsburgspruit, as well as from a spring at the eastern end of Commissioner Street, near the present day End Street, called Natalspruit. Another water point was a spring at the site of the present Johannesburg general hospital in Parktown. With the expansion of mining activities, industrial development, pollution and population growth, the demand for potable water grew. Soon, the rivulets and boreholes were inadequate sources of supply. Eventually, the need arose to bring water from the Vaal River.

The Vaal River scheme (1914-1924) was to be developed in phases. The first phase would involve the construction of the Vaal Barrage, a purification and pumping works at Vereeniging (1924), a pipeline to Zwartkoppjes Pumping Station, and pipelines to Village Main Reef and elsewhere in the distribution system. The Barrage, deriving water from the Vaal River and the four tributaries, would be capable of yielding 91 Mℓ/day. The Vaal Dam was completed in 1938 (with a yield of 354 Mℓ/day) followed by the Zuikerbosch pump station in 1949.

The first inter-basin transfer from a river basin outside the normal

The Vaal Dam, constructed in the 1930s, remains the centre of Rand Water's supply infrastructure.

Lani van Vuuren

Chris Kirchhoff-mediaclubsouthafrica.com

Courtesy Rand Water

Today Rand Water supplies water through about 3 056 km of pipeline into 58 reservoirs.

catchment of the Vaal system was announced in 1970. The plan was to supplement water using the Thukela River in KwaZulu-Natal by pumping water over the Drakensberg into the Vaal River catchment and other inter-catchment transfers (the Thukela-Vaal Augmentation Scheme).

Currently, the bulk of Rand Water's water supply comes from the Lesotho Highlands. The scheme was designed to deliver some 2,2 x10^9 of water annually to South Africa, and the first water flowed into the Vaal Dam via the Ash River outfall on 8 January 1998.

INTRICATE SYSTEM

From small beginnings in 1905, satisfying an annual daily consumption of water of about 11 Mℓ/day, Rand Water today operates a massive water supply system. Of course, the water utility's operations have expanded way beyond Johannesburg – as far as Rustenburg in the west and Groblersdal in the east.

Water is abstracted from the Vaal Dam and treated at the Vereeniging and Zuikerbosch Purification and Primary pump stations. It is then pumped at a head of about 180 to 360 m to the main booster pump station, Zwartkopjes and its three satellite booster pump stations, Palmiet, Eikenhof and Mapleton.

Each booster pump station then elevates the water a further 180 m to 360 m to reservoirs in and around Johannesburg. From these areas the water flows under gravity and is re-pumped at distribution stations to the extreme boundaries of the supply area.

The water is supplied through about 3 056 km of pipeline into 58 reservoirs (two-thirds of the value of this infrastructure, estimated to be worth R30-billion, lies underground in pipelines). Water is then delivered in bulk from the reservoirs to Rand Water's customers.

In the early days, mining activities gulped up most of the water. This has evolved over the decades, in tune with the changing face of Gauteng, and it is believed that about 70% of the water is now supplied to urban domestic consumers. Thus, demand growth is now closely linked to population growth rates, with economic growth playing a secondary role.

According to information supplied by Karl Lubout, water quality specialist at Rand Water, even though Rand Water's current catchment area largely comprises rural agricultural area the towns in the catchment are growing rapidly. However, proper infrastructure is lagging behind and the volume of people in need of proper water and sanitation services exceeds the service delivery capacity. "The lack of proper sanitation services in our catchment area, especially, is of great concern to us," says Lubout.

With regards to the impact of acid mine drainage, Lubout indicates that it does not currently have an influence of Rand Water's service delivery. Of more concern is the current number of mining applications around the Vaal Dam area. "If these applications are approved it will certainly have a negative impact on the quality of our raw water."

Population and economic growth rates are not the only factors influencing the future of Rand Water's

water supply, broader scale global influences, such as global warming, are also at play.

CLIMATE CHANGE

With regards to the effects of climate change, in general, the overall burden on the country will be disaster management costs, says Francois van Wyk, water quality expert at Rand Water. As an example, he cites the floods in Mozambique in 2000 which reduced that country's annual growth rate from 8% to only 2%. "Should such incidents occur more frequently, poorer countries will suffer massive social problems. The ultimate consequence of climate change is a substantial additional burden to the country's economy, with obvious restraints on Rand Water's financial position."

The predicted increase in extreme weather events, as well as possible prolonged periods of high (maximum) demand as a result of higher temperatures, are some of the pertinent issues with regards to climate change which Rand Water will have to pay attention to. Current inter-basin transfers may become areas of political conflict, elaborates Van Wyk. "If a severe water shortage occurs in the area, Lesotho may not want to release water to South Africa, or they may want to enforce substantially increased tariffs."

Furthermore, Rand Water will have to address and optimise overall energy efficiency. Due to erratic rainfall patterns, security of supply will also be at risk. "This may imply that storage capacity needs to be increased to store more water if and when it rains, while dams and reservoirs may be empty for prolonged periods of time," causing inefficient use at high cost.

Higher temperatures will not only increase evaporation from dams (and so increase water loss), it may also lead to the occurrence of algae during periods of the year not previously experienced, resulting in increased water purification cost.

An added burden as a result of climate change could be that the Rand Water supply area can become more conducive to the transmission of waterborne diseases. "Combined with the free migration of people from northern countries, this could become a major problem," says Van Wyk. In addition to additional storage, flood attenuation measures will need to be implemented, which will also be unused during dry periods, while the possibility of severe floods could cause major damage to infrastructure.

According to Van Wyk, pressures on supply from Vaal Dam could lead to the Department of Water Affairs insisting that Rand Water use a higher proportion of water from the Vaal Barrage, where water is of an inferior quality. This will mean that water treatment plants will have to be adapted to be able to treat this water adequately.

This situation could eventually result in the Clarens pipeline becoming a reality, as no losses of water due to unlawful use (as is currently occurring) or evaporation can be afforded. The Clarens to Johannesburg pipeline would involve constructing a pipeline to gravity feed the water from the transfer tunnel outlet near Clarens northwards to Gauteng. It would include the construction of a storage dam and a new water treatment works located on relatively high ground in Gauteng.

Prof Anthony Turton, water resource management scientist, believes that Johannesburg has reached a watershed moment, and that a limited water supply would, in turn, also limit economic development. "We have reached the end of our available water supply and have arrived at a new future: that of water recycling." Prof Turton believes that the answer lies in giving scientists and researchers the freedom to explore possible solutions. ❑

Chris Kirchhoff-mediaclubsouthafrica.com

Since gold was discovered in 1886, the once dusty mining town of Johannesburg has grown into an African powerhouse.

THE UNWANTED CITY

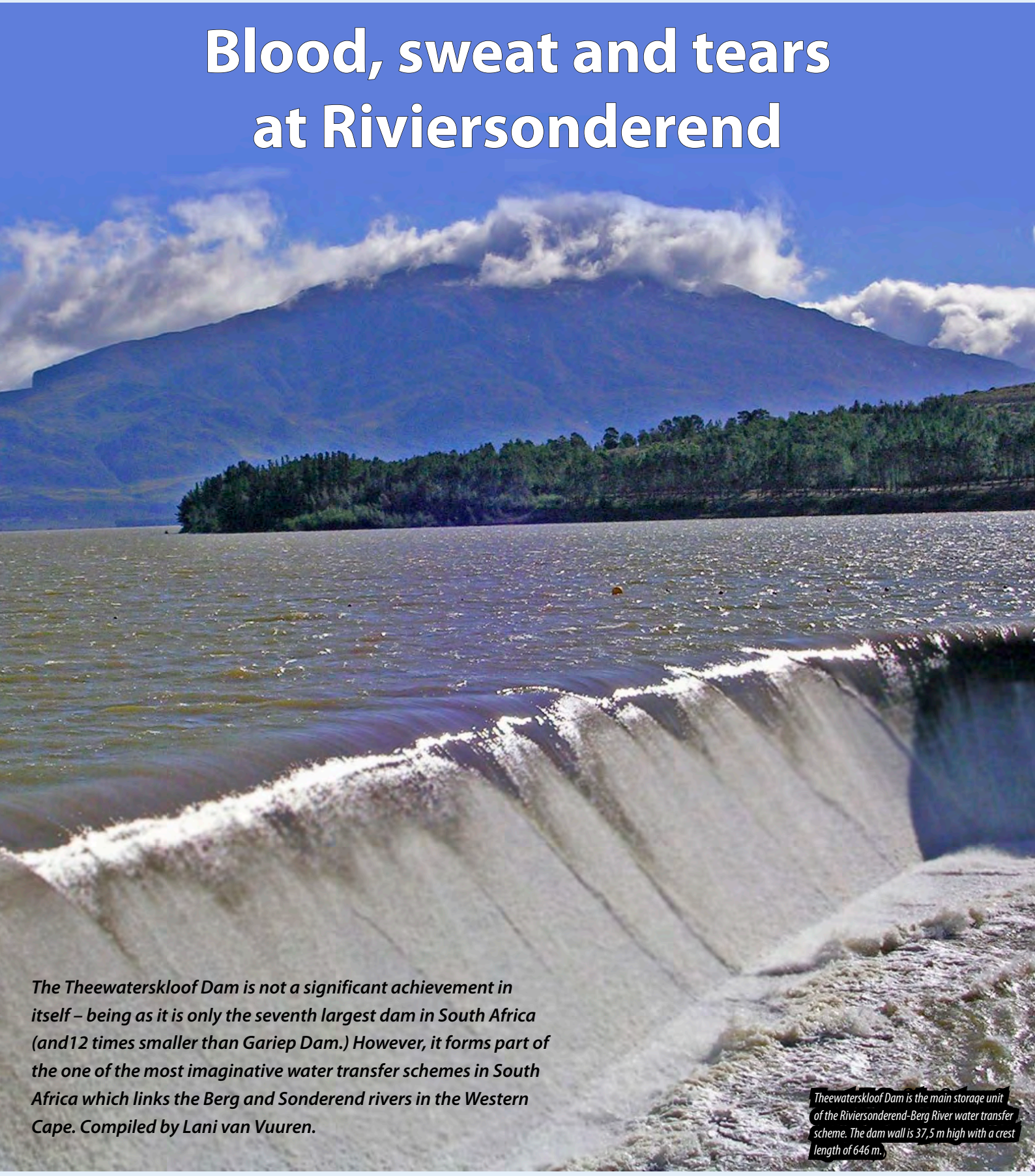
The first piece of Johannesburg was a triangular piece of *uitvalgrond* called Randjeslaagte between the farms of Braamfontein, Doornfontein and Turffontein. *Uitvalgrond* refers to 'left-over' property between the borders of claimed farms. These automatically belonged to the state as none of the farmers laid claim to it (often because it was unsuitable for agriculture due to a lack of water). That tiny area, just big enough for a village, was to become the biggest city in South Africa within three decades.

Traces of Randjeslaagte can still be found around Johannesburg. The northern point is just off the corner of Boundary Road, Parktown, and Louis Botha Avenue, close to Clarendon Circle. A triangular monument marks the spot.

The south-eastern corner is at the intersection of Market and End Streets. The latter is so named because it marks the eastern boundary of Randjeslaagte. The eastern side of the triangle runs up the hill along Catherine Avenue (adjacent to Nugget Street) and through Hillbrow, meeting the top at the corner of Banket Street.

The south-western corner is at the intersection of Commissioner and Diagonal Streets. Just off that corner is the start of West Street (so named because it marks the west side of the triangle). West Street curves inwards and aims straight at Hillbrow's Clarendon Place, which marks the apex of the pyramid.

Blood, sweat and tears at Riviersonderend



The Theewaterskloof Dam is not a significant achievement in itself – being as it is only the seventh largest dam in South Africa (and12 times smaller than Gariep Dam.) However, it forms part of the one of the most imaginative water transfer schemes in South Africa which links the Berg and Sonderend rivers in the Western Cape. Compiled by Lani van Vuuren.

Theewaterskloof Dam is the main storage unit of the Riviersonderend-Berg River water transfer scheme. The dam wall is 37,5 m high with a crest length of 646 m.

The storage potential of the Riviersonderend was realised as far ago as the 1800s, but it was the Irrigation Department who started the first serious investigations into the possibility of a scheme here in 1929. This mountainous region has one of the highest rainfalls in South Africa (as much as 5 000 mm/year).

A provisional dam design had actually been completed by 1952, and by 1964 the focus has zoomed in on the Theewaterskloof as the best storage site available. When the Greater Cape Town again started experiencing water shortages following the construction of the Wemmershoek Dam, it was decided to go ahead with the Riviersonderend-Berg River scheme. The scheme would not only supplement water supply to Cape Town, but would also be used to provide irrigation water during the dry months to farmers in the Boland. The project was described as 'one of the most impressive civil engineering projects of the 1980s'.

The scheme essentially involved linking the two water-rich catchments of the Riviersonderend and the Berg River to discharge surplus winter runoff into one central storage dam. When the need for water arises, it is delivered by gravity through a series of tunnels to where it is needed.

The interesting feature of the scheme lies in the fact that the flow can be reversed so that water from the Berg River can in the first place be stored in the Riviersonderend Valley and then be conveyed back in the dry summer to provide irrigation water in the supply of the valley from where it originated.

The project was constructed in two phases. The first phase comprised the construction of the Theewaterskloof Dam (the central storage unit for the scheme), the Franschhoek tunnel and associated works, while the second comprised the Jonkershoek Tunnel system, including several shafts and balancing dams on the Eerste River at Kleinplaas and the Berg River at Assegaaibos. The White Paper for the provision of the first phase was laid before Parliament in 1968 and construction started in 1970. The project was planned, designed and constructed by DWA.

Theewaterskloof is a conventional earthfill dam. The structure, which was completed in 1979, is 37,5 m high above the lowest foundation, and has a crest length of 646 million m³. The dam has a gross storage capacity of 482-million m³. When full the dam water covers an area of 5 100 ha. A conduit through the embankment is divided into two chambers housing the low-level and normal outlets respectively. The low level outlet, which has a maximum capacity of 180 m³/s is controlled by a slab gate at the upstream end of the culvert and the discharge energy is dissipated by means of a flip bucket.

In turn, the normal outlet pipes in the upper chamber are controlled from an inlet tower with draw-offs at different levels in the reservoir. The spillway, which is capable of handling a probable maximum flood of 394 m³/s, is of the side-channel type and the chute ends in a stilling basin.

A subsidiary embankment inside the Theewaterskloof basin contains the Charmaine inlet and outlet. The embankment is a composite structure – a concrete spillway flanked by a 6 m-high earthfill of crest length 136 m – designed to create a sediment retention basin which allows the intakes to draw of clear water into the Franschhoek Tunnel.

The Franschhoek Tunnel is a reinforced concrete tunnel runing from the Charmaine outlet through the Theewaterskloof basin. The 4,3 m-diameter tunnel penetrates the Franschhoek Mountains for a distance of 7,9 km and breaks through at Assegaaibos in the Berg River Valley.

ENGINEERING FEATURES OF THE THEEWATERSKLOOF DAM

- **Type:** Earthfill
- **Height above lowest foundation:** 37,5 m
- **Gross storage capacity:** 482 million m³
- **Crest length:** 646 m
- **Type of spillway:** Side-channel
- **Spillway capacity:** 390 m³/s
- **Area at full supply level:** 5 100 ha

The Charmaine wall structure under construction in December 1976. The wall, which houses the Charmaine intake and outlet is situated inside the basin of the Theewaterskloof Dam.

Frans Druyts

Trisa Hugo

Frans Druyts

The Banhoek shaft under construction in 1979. The shaft is 162 m deep and 1,8 m in diameter.

Of the total length, 4,1 km was constructed as a reinforced concrete tunnel in an open cut, which was then later covered and the topsoil – which had previously been carefully removed and stored – replaced. This open cut required some 1,4 million m^3 of excavation. The tunnel has a maximum delivery capacity of 33,5 m^3/s. The remainder of the tunnel went through solid rock, 193 000 m^3 of which had to be removed.

At the end of the Franschhoek Tunnel, the Berg River is negotiated by means of a 33,5 m-diameter reinforced concrete siphon with supplementary intakes from the Assegaaibos Dam and outlets into the Berg River. Another tunnel, the Dasbos Tunnel, branches away from the main tunnel close to the 67 m-deep Wolwekloof shaft. This tunnel has a carrying capacity of 10,4 m^3/s.

The first phase of the project was completed in 1980.

Constructed in the second phase which took off in 1974, the Jonkershoek Tunnel system includes a total of 23 km of tunnels, and two diversion weirs connected with the main tunnels by shafts. In total, some 481 00 m^3 of excavation was required, while 236 000 m^3 of concrete was used.

Water spills of the Kleinplaas Dam concrete gravity spillway in 1982. The dam has a storage capacity of 377 000 m^3.

Frans Druyts

FACTS AND FIGURES

- Theewaterskloof Dam is the seventh-largest dam in South Africa, but 12 times smaller than Gariep Dam, the country's largest dam.
- If all the holes drilled for blasting on the Riviersonderend-Berg River project were to be joined into one continuous hole, it would reach over a distance of roughly 2 300 km.
- The 470 000 m^3 of concrete cast on the project was only 40% as much as that used to build the Vanderkloof Dam.
- Measured in 50 kg pockets, 3,4 million pockets of cement went into the various constructions on the project.
- If all the soil and rock excavated were to be placed on an area the size of a rugby field, the dump would be 12 storeys high.
- One and a half million kilograms of dynamite was used for blasting on the project.

Source: DWA

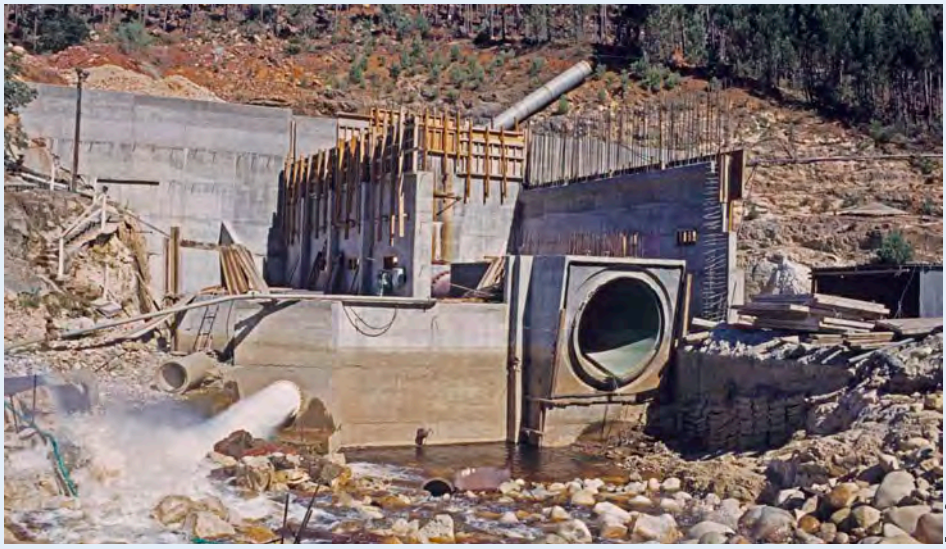
The main Jonkershoek tunnel cuts through the Groot Drakenstein and Jonkershoek mountains for 13 km to surface at the Kleinplaas Dam on the headwaters of the Eerste River in the Jonkershoek Valley. The Jonkershoek section contains two shafts connecting the tunnel to concrete diversion weirs, one the 67 m-deep and 4 m-diameter Wolwekloof shaft, which links the tunnel with a weir in the Wolwekloof River, and the other a 162 m-deep and 1,8 m-diameter shaft which links up the Banhoek diversion weir. Close to the Wolwekloof shaft, the Dasbos tunnel branches off from the main tunnel.

Between the Berg River and Wolwekloof the Jonkershoek Tunnel has an internal diameter of 4,3 m and a capacity of 33,5 m^3/s, but after Wolwekloof it narrows to a diameter of 3,5 m and a capacity of 15 m^3/s. The Kleinplaas balancing and diversion dam is fed by the

Jonkershoek River as well as by the tunnel system, and diverts water into the Stellenboschberg Tunnel as well as supplementing the flow in the Eerste River. A 200 m-long inverted siphon of 3,5 m diameter connects the Jonkershoek Tunnel system to the Franschhoek Tunnel.

The Jonkershoek tunnel was the largest tunnel project ever undertaken by the DWA up to that time without the help of outside contractors and the second largest in South Africa. The tunnelling side of the project presented immense challenges to the department's engineers and it demanded great ingenuity, patience and resolve to solve the problems encountered.

Ground conditions were found to be exceptionally bad in some places, with geological formations varying tremendously from hard to soft, sandy conditions. Any route through the mountains was going to be challenging and so the designers opted for the shortest. They ran into several serious fault planes, which severely hampered progress. Tunnelling was made even more difficult in some places by the fact that, in order to allow water from the various catchment areas to flow by gravity, it was necessary to tunnel below the water table.



Frans Druyts

The Berg River siphon under construction in 1981.

The soft formations encountered were very often outside the experience of even South African mining experts, and so experiments were conducted as work continued. Many a time tunnelling parties were forced back as sand and mud flooded into the working areas through faults. At one point during work on the Franschhoek Tunnel, operations broke through from granite into a plane of granite/sandstone.

The roof collapsed and tons of mud and water poured into the tunnel. It took 22 months to pass through this 50 m-wide fault, as it was necessary to undertake extensive diamond core drilling to determine the extent of the bad ground. When compared with the 45 m per week which the Berg River Tunnel team achieved, a concept of the extent of the problem can be formed.

In the process department engineers also had to develop new techniques to allow these faults to be crossed. Grouting failed hopelessly. After several months of high pressure grouting, using some 25 000 pockets of cement, the tunnel face, which had been closed by a 9 m concrete plug, was opened up to reveal that the grouting had been ineffective. Chemical grouting was also tried unsuccessfully.

Environmental conservation played an important part in the planning and execution of the project. Landscape architects were appointed for the whole project and disturbed areas were restored as naturally as possible. The open section of the Stellenbosch Tunnel from the Kleinplaas Dam is given as a fine example of the care with which environmental restoration was applied.

Here the surface soil was carefully removed and kept aside so that, after the concrete works were covered, it could be placed on top again. Attention was also paid to the combating of potential driftsand problems in the Theewaterskloof Dam basin area. Where possible stone quarries were sited in dam basins or in less conspicuous places.

In 1981, this project received an achievement award from the South African Institution of Civil Engineering. The project was officially concluded in 1982 apart from the Assegaaibos Dam, which was only completed a few years later. ❑

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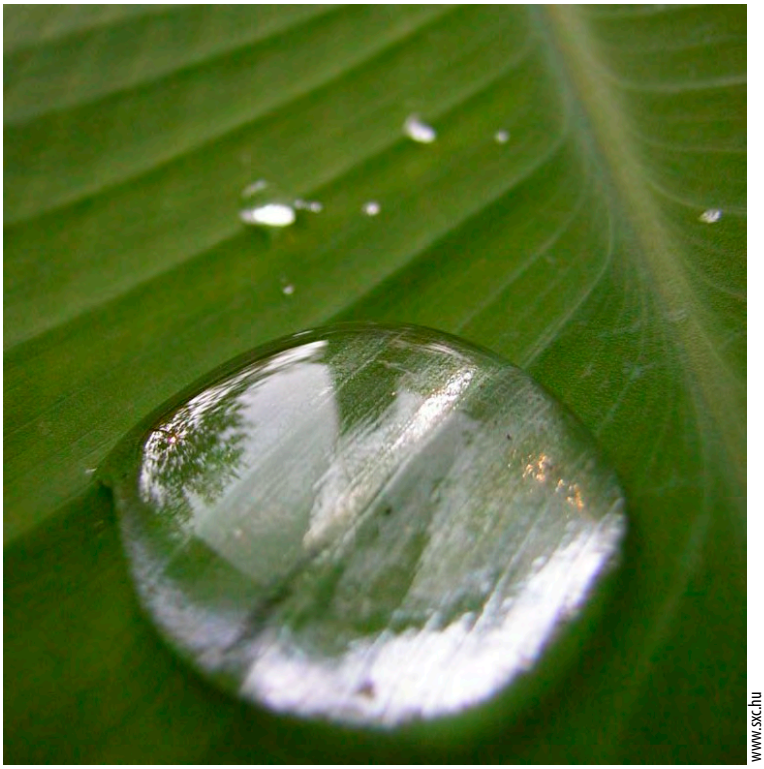
Thanks to Frans Druyts and Trisa Hugo for photographs.

Predictive uncertainty in water resource assessments



www.sxc.hu

A freshly concluded WRC project hopes to take the question mark out of water resource decision-making. Article by Prof Denis Hughes.

The statement that 'there are three kinds of lies: lies, damned lies and statistics' has been attributed to the 19th century British Prime Minister, Benjamin Disraeli (1804-1881) to convey suspicion about the use of statistical models to support arguments in the face of little data. There is little doubt that examples of the unscrupulous use of predictive models (whether statistical or other types of models) can be found throughout the history of science, however, we have also come to rely on models to organise and manage or lives.

Nowhere is this truer than with the sciences that involve natural environmental systems (including hydrology) which are complex and difficult to measure. While most hydrologists and water resource engineers would get (justifiably?) upset if their outputs were considered little better than clever statistics (and therefore no better than lies according to Disraeli), they would all be willing to admit that the outputs of their models contain uncertainties.

Uncertainty is a common feature in all walks of life – health is uncertain, wealth is uncertain, politics are uncertain, the weather is uncertain. Sometimes the uncertainty is explicitly stated, as with weather forecasts that suggest 'a 30% chance of rain', while in other situations the uncertainty has become big business (how many people regularly bet on horse races?).

Unfortunately, while there has been a long history of practical use of hydrology and water resources estimation models in South Africa, the issues associated with uncertainty have been largely neglected. In a very readable scientific journal article, Pappenberger and Beven (2006) provide some very insightful observations about why uncertainty has been neglected as well as some good justifications for why it should not be neglected in the future.

Uncertainty in the results that are generated by hydrology and water resources assessment models are derived from several sources. Firstly, the models themselves are imperfect representations of the real world and even complex models contain spatial and temporal generalisations. Secondly, the 'parameters' that are used to establish a model for a specific drainage basin or catchment are either based on the model user's knowledge and understanding of that area, or on a comparison (using model 'calibration' methods) with some limited observations of stream flow, reservoir water levels or borehole water levels. The latter may all be subject to measurement or interpretation errors. Thirdly, the models are typically driven by observed records of climate inputs (precipitation, temperature, evaporation etc) which may contain errors and may not adequately reflect the real climate inputs because of the limited number of observation stations.

This source of uncertainty is very relevant to mountainous areas where there are large spatial variations in real rainfall and typically few rain gauges. It is also unfortunate that the density of our climate and

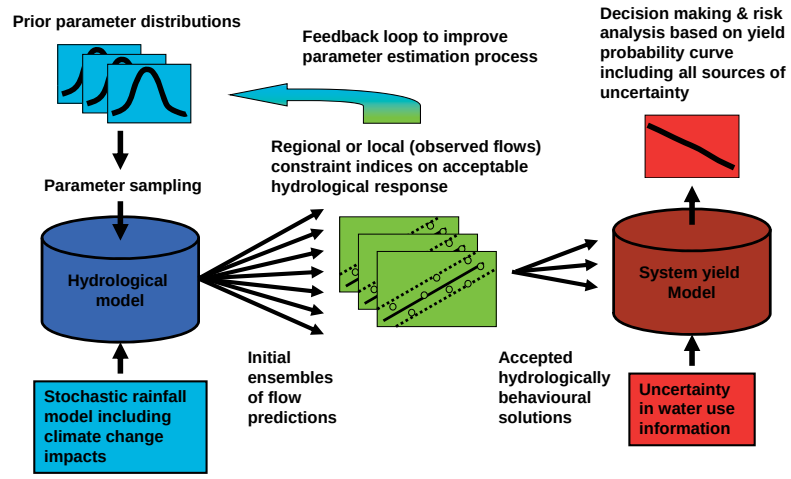
hydrological observation networks have been shrinking in recent years and therefore the uncertainty in climate inputs to models will be greater in the future unless this trend is reversed.

Even where we have good data records there is uncertainty about whether these can be considered to represent the most extreme conditions that we can expect, even in the near future and even under static climate conditions (i.e. without the possible impacts of global warming). A final source of uncertainty lies in our imperfect knowledge of how much of the natural water resource is already being utilised. There are some situations where some or all of this information is available and can be considered accurate (low uncertainty), but there are many other situations where the degree of uncertainty is very high and yet we cannot wait to make decisions until all of other uncertainties have been reduced (if ever).

In recognition of the importance of these issues, the Water Research Commission funded a three-year project on incorporating uncertainty in water resources simulation and assessment tools in South Africa. The work was undertaken by the Institute for Water Research at Rhodes University, the School of Bioresources Engineering and Environmental Hydrology at the University of KwaZulu-Natal and IWR Water Resources. The project was designed to identify the main sources of uncertainty, establish a framework and associated modelling tools for uncertainty assessments, suggest ways of reducing uncertainty and investigate the links between uncertainty and decision-making risk in water resources planning and management.

The project was also expected to make some recommendations with regard to the future incorporation of uncertainty analyses in the standard water resources assessment methods used in practice within South Africa. The project was supported by funding from the National Research Foundation under the Key International Science Cooperation (KISC) programme which enabled Dr Thorsten Wagener from Pennsylvania State University to participate and attend the project workshops.

A framework for including uncertainty and risk analysis in water resources assessments.



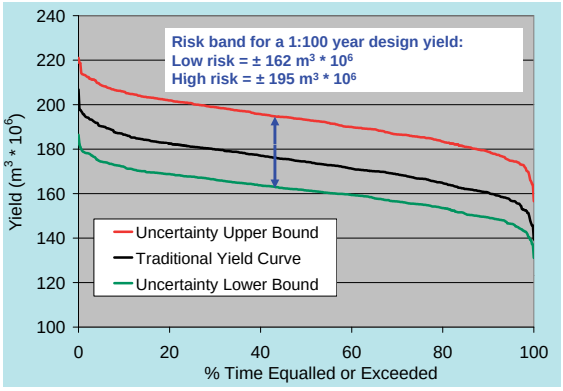
One of the outcomes of the project, which has just been concluded, include new parameter estimation routines for the widely used Pitman rainfall-runoff model that include uncertainty and the generation of ensembles rather than a single sequence of stream flows. The project highlighted the need for improved understanding of the interactions between surface and groundwater and how these processes are integrated with models.

The combined use has been recommended of regional and local (based on observed stream flow data) indices of hydrological catchment response that can be used to constrain the ensemble outputs for further use in water resources assessments to those that can be considered hydrologically 'behavioural' (i.e. realistic). This approach allows for a better integration of the methods used for hydrological simulation across gauged and ungauged catchments. The use of a stochastic rainfall model to integrate climate and model parameter uncertainty was also assessed and compared with the more traditional use of stream flow stochastic generation within a water resources yield model.

The main conclusion of the project is that incorporating uncertainty in practical water resources assessments is necessary and can be achieved without any drastic changes being required to current methodologies. The potential advantages are improved objectivity in hydrological modelling, the identification of interventions that could reduce uncertainty (such as improved monitoring) and more realistic assessments of risk during the process of water resources decision-making.

There remain some questions about how to implement the proposed methods in practice, including the necessary changes to existing software tools, training in the concepts of uncertainty and the interpretation of uncertain predictions from a risk perspective. However, these issues will be addressed in the next phase of the project together with some more research orientated questions that remain unresolved. ❑

An example of yield analysis under uncertainty and an illustration of the links between uncertainty and decision-making risk.



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Today, one out of every two people lives in a town or city. This year's World Water Day, celebrated on 22 March, focused on the challenges of providing water and sanitation to urban residents.

Across the world, urbanisation (meaning the growth of towns and cities) has been associated with improved human development, rising incomes and better living standards. People move to cities for all sorts of reasons: they might get better housing or better jobs, or may have access to the kind of infrastructure and education that is not available in rural areas. However, with growing cities also comes growing problems.

As far as water and sanitation is concerned the greater concentration of people can make it easier to provide services, however, more people also means more pollution. Cities require large volumes of freshwater and, in turn, have a huge impact on freshwater sources.

In Africa, nearly 40% of people live in towns and cities. African cities are growing faster than any other in the world. The largest city, Cairo, in Egypt, is already home to around 11 million people. Lagos, in Nigeria, is the second largest, followed by Kinshasha (Democratic Republic of Congo) and Luanda (Angola). Interestingly though, most of the growth is taking place in the continent's smaller cities (those with less than half a million residents). By 2050, half of the continent's population will be urban dwellers.

HELPFUL WEBSITES

- World Water Day http://www.worldwaterday.org/
- State of African Cities (http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=3034)
- UNEP South Africa water profile (http://www.unep.org/dewa/Portals/67/pdf/South_Africa.pdf)
- Department of Water Affairs' My Water page (http://www.dwa.gov.za/dir_ws/DWQR/default.asp?PageID=7&PageHeading=My%20Water)
- Wikipedia's page on urbanisation (http://en.wikipedia.org/wiki/Urbanisation)

Millions of people in Africa live in informal areas or slums.

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More than 11 million people call Cairo home, making it the largest city in Africa.

The problem is that many of these people end up in informal areas or slums, where conditions are generally poor, and people receive little or no basic services. In addition, informal housing (i.e shacks) are vulnerable to disasters such as floods or fires. Lack of water also causes the outbreak of diseases such as diarrhoea or cholera. It is estimated that up to 60% of Africa's urban population is not connected to the public water system. This means they either get their water from unprotected sources (like rivers) or buy their water at extremely expensive rates from private water vendors.

Photothèque Société des Eaux de Marseille

Often poor city dwellers are forced to buy water from private vendors which can be up to 100% more expensive than public water piped to richer residents.

Much has already been done to improve the situation. Between 1998 and 2008, more than a billion urban citizens gained access to improved drinking water while around 800 million gained access to basic sanitation. Unfortunately, the world's population is growing too quickly, undermining the progress of rendering services. In Africa alone, it is estimated that half a billion people will be added to the urban population within the next 25 years.

There are thus many challenges in cities. In the words of Dr Joan Clos, Executive Director of UN-HABITAT: "As cities expand, we must improve our urban planning and management in order to provide universal access to water and basic services while ensuring our cities become more resilient to the increase effects of climate change."

In South Africa, water and sanitation in towns and cities is the responsibility of local or regional municipalities. Countrywide, around 88% of South Africa's population now have access to at least basic water services. Just over 70% of people have access to basic sanitation (like a VIP toilet).

Around nine out of ten people in the metros have access to at least basic levels of water. Services in the large metropolitan services are generally better than those in smaller towns, although the Department of Water Affairs' Blue and Green Drop systems for water and wastewater treatment services is helping to put things right, and there are towns that perform well despite their smaller size and limited human and financial capacity.

Infrastructure backlogs remain a challenge (with additional pressure being put on existing services through population growth and migration from people from rural areas to towns). At the same time, upgrading and maintenance of new and old infrastructure needs to be undertaken, which require further significant investments. ❑

WATER FOR CITIES: FACTS AND FIGURES

- Every second, the urban population grows by two people.
- Around 3,3 billion people live in cities – 828 million of them in slum areas (i.e. informal settlements).
- By 2030 every second person in Africa will live in a city. By 2050, the number of people living in cities is expected to reach 6,4 billion.
- One out of four city residents worldwide live without access to basic sanitation facilities.
- Close to a third of people living in urban areas in the developing world do not have piped water at home.
- Poor urban people often have to buy water from private vendors – usually at escalated costs.
- In Africa, 40% of people live in urban areas (close to 400 million people). This figure is growing by 3,4% a year, making Africa the fastest urbanising continent in the world.

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Today, more than 3 billion people around the world live in cities.

World Water Day comes to Cape Town

This year the United Nations World Water Day was celebrated in Cape Town in March. Dignitaries from all over the world, including HRH Prince Willem Alexander of the Netherlands and Joan Clos, Executive Director of UN-Habitat, attended festivities at the southern tip of Africa. It was not all fun and games, though. Some serious discussions were held around this year's theme 'Water for Cities: Responding to the Urban Challenge'. More than a billion people are living in Africa's cities – mostly in informal areas – and the continent is urbanising faster than anywhere else in the world. This places huge demands on water supply, with many urban residents having to use unsafe sources.

Bruce Sutherland/Dutch Royal House

Prince Willem Alexander of the Netherlands addresses the media.

Prince Willem Alexander of the Netherlands and South African Minister of Water & Environmental Affairs Edna Molewa address some tough questions.

Lani van Vuuren

Lani van Vuuren

UN Messenger of Truth, Rolf Stahlhofen, performing 'Water is Life', a song specially written for the day.

Bruce Sutherland/Dutch Royal House

Prince Willem Alexander of the Netherlands with Cape Town Mayor Dan Plato and Deputy Minister of Water & Environmental Affairs Rejoice Mabudafhasi during World Water Day celebrations.

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3rd-5th July, 2011

CSIR ICC, Pretoria, South Africa

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A conference for postgraduate students and young professionals (under the age of 35, **or** of any age who are still studying or who gained their qualifications less than five years ago) working in the water and wastewater sector in Africa.

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- Water Use and Waste Management
- Water Utilisation in Agriculture
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