

THE WATER WHEEL

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Vaal River System Under Scrutiny



WDSA2008

WATER DISTRIBUTION SYSTEM ANALYSIS

17 - 20 AUGUST 2008
KRUGER NATIONAL PARK
SOUTH AFRICA

HOSTED BY THE UNIVERSITY OF JOHANNESBURG



WDSA2008

The 2008 WDSA Conference (WDSA2008) will be the 10th in the WDSA series and the first to be hosted outside of the USA. WDSA2008 will take place from 17 to 20 August 2008 in the Kruger National Park, South Africa, a world famed wildlife sanctuary and one of the world's greatest natural assets. WDSA2008 is hosted by the University of Johannesburg.

CONFERENCE TOPICS

Abstracts are solicited on virtually all topics of relevance to water distribution systems analysis. Applied, theoretical, and methodological studies are welcome. Topic categories include:

- System Operation and Control
- System Design
- Optimisation Algorithms for System Design
- Real-Time Forecasting, Operational Analysis, and Control Event Detection
- Decision Support for Sustainable Water Management
- Vulnerability/Consequence Assessment
- Security and Reliability of Water Systems
- Water Quality Sensing and Monitoring
- Case Studies and Field Applications
- Hydraulic Transient Analysis
- Leak Detection
- Infrastructure Asset Management
- Model Calibration Algorithms and Applications
- Network Demand Modeling
- Network Hydraulic Models and Algorithms
- Network Water Quality Models and Algorithms
- Stochastic Simulation and Analysis
- Systems Integration or Integration with GIS/SCADA/CIS
- Water Supply in Developing Countries
- History and Heritage of Water Supply

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Cover: Excessive and unlawful water use is placing strain on the Vaal River System, studies have revealed. (See page 14).

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

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More than one mechanism for water licensing

In the article on pages 30 to 31 of the March/April 2008 edition of the *Water Wheel* (The Business of Compulsory Licensing) Mr Peter van Niekerk argues strongly that using a market mechanism to effect the equitable allocation of water holds great advantages over a purely administrative system like the compulsory licensing process.

During these arguments one has to take into account Principle 7 of the Fundamental Principles and Objectives for a New Water Law for South Africa which states that "the objective of managing the nation's water resources is to achieve optimum, long-term, environmentally sustainable social and economic benefit for society from their use". Further the Constitution of the Republic states that there is a commitment from the nation to reform in order to bring equitable access to the water resources.

One cannot argue against Mr Van Niekerk's concerns on the complex nature of the compulsory licensing process to affect this. In the same vein, one can also not argue against his viewpoint of the simpler process of a market for entitlements and thereby effecting equitable allocation (but unfortunately over a longer period). One should ask the question whether we can afford such a longer period, and the answer is probably no.

The market mechanism is a slow approach to water reform (but a necessary one with great benefits) and is based on a willing-seller willing-buyer concept (in spite thereof that state authorisation is necessary to give effect to a transaction). For the mechanism to be effective, the State should actively



LETTERS TO THE EDITOR

intervene, and the interventions should not only be economical in nature. Mr Van Niekerk mentions some of these.

The problem is what to do with water uses that were undertaken legally when the National Water Act commenced (the so-called "existing lawful water uses"), which may be continued with subject to the conditions and obligations attached to that use until it is replaced with a licence, if these conditions and obligations do not meet the relevant objectives. As the Acts reads at the moment this could only be achieved by following the compulsory licensing procedure (as the market mechanism may take too long and only addresses the water uses involved in the trading).

The compulsory licensing process forms part of a bigger process to achieve water allocation objectives. It is a mechanism to transfer existing lawful water uses to licences, and while doing that water reform actions may (or should) also be taken. Thereafter, all the licences should be reviewed regularly to give effect to the relevant objectives.

It is submitted that not the one or the other mechanism should be considered to give effect to the Fundamental Principles and Objectives for a New Water Law and the Constitution, but both, either separately or jointly, including other mechanisms such as

- ◆ voluntary surrendering of an existing lawful water use for a licence (even for a lesser use), usually if there is a benefit for the user to do so;
- ◆ enforcing water conservation and water demand management principles;
- ◆ expropriating entitlements to use water;

- ◆ increasing water tariffs resulting in voluntary sale of entitlements;
- ◆ reviewing and amending or replacing the conditions of licences; and
- ◆ developing the water resources.

Each of these mechanisms has a specific role to play, depending on the circumstances, and the argument should not be which is the best but which of these together and in what sequence are the best in a specific case. In certain cases, for example where intensive water application practices are used for irrigation, objectives could probably only be achieved if all the water users concerned are holders of licences and not just existing lawful water users. Therefore all the existing lawful water uses should be transferred to licences, probably by implementing the compulsory licensing process. In spite thereof, objectives could still be achieved, for example through authorizing the use of water by new users resulting in that less water is available for the existing users (due to changes in the assurance of supply) so that they have to implement water conservation measures to ensure that their undertakings are not adversely affected.

The organisations involved should therefore apply their minds to decide which of the various mechanisms should be used in a specific case and how. Applying the minds should not be a once off decision but a process.

Lastly, most (if not all) of the mechanisms have their practical and administrative shortcomings, which should be rectified by the necessary amendments to the National Water Act. If not, water reform is going to remain a nightmare.

Hubert Thompson, Pretoria

WATER ON THE WEB

www.eol.org

This free Internet encyclopedia, the Encyclopedia of Life, is part of a US\$100-million, 10-year project aimed at listing all the creatures and plants on the planet. About 30 000 species have been listed to date. The project is led by the US Field Museum, Harvard University, Marine Biological Laboratory, Missouri Botanical Garden, Smithsonian

Institution and Biodiversity Heritage Library – a group that includes London's Natural History Museum, the New York Botanical Garden and the Royal Botanic Garden in Kew, England.

www.dewpoint.org.uk

The DEW Point Resource Centre generates and disseminates knowledge on behalf of the UK Department for International

Development (DFID) and their development partners in environment, water resources, water and sanitation and climate change. The website provides a range of free information databases for the wider development community. Topics include bioenergy, climate change, environment, hygiene, technology, water and sanitation and water resources.

FBW reaches 70% level



More than 72,5% of poor people receive a free basic water allocation of 6 kℓ per household a month, reports Minister of Water Affairs & Forestry Lindiwe Hendricks. She was responding to a question asked in

Parliament in March. “The 6 kℓ does not, however, provide sufficient water for water-borne sanitation. Several municipalities are providing an additional allocation free of charge or at a lower rate to cater for flush toilets to poor people,” she said.

With regard to Free Basic Sanitation, Hendricks told Parliament that a revised strategy would be submitted to Cabinet for approval by the second quarter of this year. “Once approved, Free Basic Sanitation must be rolled out gradually, taking into account municipal managerial capacity, financial viability, ability to operate and maintain systems, billing at affordable levels, acceptable payment levels and proper use of the Equitable Share.”

The minister further cautioned that not all municipalities were the same and all had different levels of capacity and financial resources. “They will have to approach Free Basic Sanitation in line with their implementation capacity,” she noted.

New manual for detection of phytoplankton

A condensed laboratory methods manual to monitor phytoplankton, including cyanobacteria, in South African water resources has been published by the Water Research Commission (WRC).

Reservoirs provide the bulk of South Africa’s raw, potable, irrigation and live-stock water. These reservoirs are variously impacted by eutrophication arising from their catchments. Associated with these conditions is the excessive development of phytoplankton, especially cyanobacteria.

The monitoring of phytoplankton, cyanobacteria and their related organic compounds is essential to the production of water safe for human and animal consumption. A need for a comprehensive methods manual for phytoplankton was identified during encounters with South African laboratories tasked with water quality monitoring.

Most of the smaller laboratories do not possess the capacity and/or expertise to develop methods essential for the effective monitoring of phytoplankton. To address this, a project was initiated in association with

the WRC that resulted in the publication of this methods manual. It is envisaged that this publication will aid to the much needed capacity building in the South African drinking water industry.

To order the report (Report No: TT 323/08) contact publications at Tel: (012) 330-0340 or E-mail: orders@wrc.org.za



Funds to save Vaal from pollution

The Gauteng Provincial Government has allocated R50-million towards investigations into wastewater spillages into the Vaal River.

During a visit to sections of the Vaal River in April, Local Government MEC Dorothy Mahlangu said some of the major causes of the spillages were big industries operating in the Vaal area who “dump waste such as animal skins and animal carcasses in stormwater pipelines.” Regular sewage spillages have also been experienced from failing municipal sewerage infrastructure.

According to the MEC communities also needed to be educated on how the sewerage system worked as some of the spillages were caused by people blocking wastewater pipelines with foreign objects. “We need to work with the police with regard to the offenders and the companies that contaminate the river. Most importantly, we need to discourage communities to contaminate the water,” she commented.

According to Johnny Thabane, Member of the Emfuleni Local Municipality Mayoral Committee, the Department of Water Affairs & Forestry (DWAF), the Department of Provincial and Local Government and the municipality have lobbied Treasury for funds to upgrade the municipality’s troublesome Rietspruit Wastewater Treatment Plant and Leeuwkuil Water Treatment Works. DWAF has already contributed R9,5-million towards the elimination of troublesome pumps and upgrading of the two treatment works.

National wetlands conference calls for papers

There has been a call for papers for the 2008 National Wetlands Indaba, to be held in Skukuza, Kruger National Park, on 28 to 31 October.

The Indaba is a cross-disciplinary gathering of practitioners involved with the conservation and sustainable use of South Africa’s wetland resources. These include scientists, decision-makers, researchers,

conservationists, and educators hailing from various organisations.

The theme for this year's Indaba is 'Healthy Wetlands – Healthy People', adopted from the theme for Wetlands Day 2008. In line with the theme there will be discussions on the benefits that can be derived from wetlands from both the direct, positive effects on human health on maintaining healthy wetlands – such as the provision of food, clean

water, medicinal plants etc. – and the direct negative effects of mismanaging wetlands that result in the impairment of communities' health and well-being.

Abstracts for papers, workshops and poster may be submitted no later than 31 July. Submissions can be made to André Beetge from Working for Wetlands; Tel: 084 240 2264; Fax: (013) 262-8140; E-mail: abeetge@mweb.co.za or beetge@sanbi.org

Research boost for alien busters

A long-term collaborative research agreement has been signed between Working for Water (WfW) and the Department of Science & Technology and National Research Foundation's Centre for Excellence for Invasion Biology (CIB), based at the University of Stellenbosch.

The agreement is designed to improve the government initiative's effectiveness of alien plant clearing operations in rural and urban freshwater catchment areas. The research to be done by the CIB will address

the integrated management of alien invasive species. It will incorporate training of post-graduate students, particularly at the doctoral level, and short courses on invasive species ecology and management for environmental managers in government agencies.

The management of alien invasive species is best done by integrating a range of tools to control or halt the spread of the species and developing strategies to prevent the introduction or establishment of new populations. The CIB-WfW research programme, and the students that form part of it, will support



At the signing of the collaborative agreement between the DST-NRF Centre of Excellence for Invasion Biology (CIB) and Working for Water (WfW) were (front) WfW Director Mandisa Mangqalaza; CIB Deputy Director: Science Strategy Prof Dave Richardson, (back) CIB Post-Doctoral Associate Dr John Wilson and CIB Deputy Director: Operations Sarah Davies.)

effectiveness of biological control (i.e. the use of natural enemies, often herbivorous insects, to control invasive species) using molecular techniques and to understand the impacts of biological invasions on freshwater and terrestrial ecosystems.

"Partnerships of this kind are exactly what are required to reduce the rates and impacts of biological invasions in South Africa, and the CIB looks forward to a close and fruitful working relationship with the WfW programme," commented CIB Director Prof Steven Chown.

these efforts by undertaking targeted applied research, for example, using genetic techniques to identify the source of South African invasive plant populations, and ecological techniques to compare the biodiversity impacts of different alien clearing methods.

The research programme will include in-depth research to improve the

WATER BY NUMBERS

- **R3,1-billion** – The money budgeted by the Gauteng Housing Department for the coming financial year for the eradication and formalisation of the remaining informal settlements in the province.
- **9** – The number of major water resource capital projects at the planning stage at present to be constructed in the next five to ten years at a cost of R12-billion, according to the Minister of Water Affairs & Forestry Lindiwe Hendricks.
- **1391** – The year toilet paper was first made for the Chinese emperor, according to WaterAid. The British Perforated Paper Company first produced toilet paper in Great Britain in 1880.
- **4%** – The proportion of Africa's total annual renewable water resources which have been developed for irrigation, water supply and hydropower use to date, according to the African Development Bank. About 340 million Africans lack access to safe drinking water.
- **98%** – The proportion of the Egyptian population who have access to piped water.
- **R1,4-million** – The amount for which the eThekweni Municipality is suing a Durban waste disposal company for allegedly dumping waste in a council pipeline, which caused pollution in the Umhlatuzana River.
- **US\$1,2-billion** – The value of a project by Mexico City authorities to refurbish the city's sewerage system. A total of 160 km of sewerage pipes will be renovated under the project.
- **160** – The number of water treatment plants operated by international food group Nestlé.
- **866** – The number of inspectors working for the so-called Green Scorpions across the country.
- **US\$500-billion** – The projected financial cost of a hurricane to US coastal cities by 2020. Despite the increasing hurricane threat, construction continues unabated along the country's Atlantic and Gulf coasts. Hurricane Katrina, which swamped New Orleans, was the costliest natural disaster in US history, with damages of US\$80-billion.

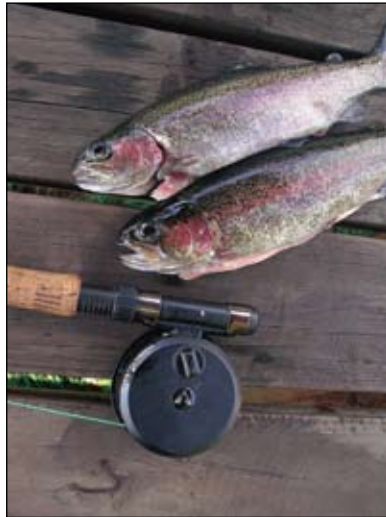
SA identified as alien fish hotspot

South Africa has been identified as a 'species-invasion hot-spot' in an international study into exotic freshwater fish species in natural environments.

The country is one of several areas identified around the world where non-native species make up more than a quarter of the freshwater fish species recorded. The recently published study was undertaken by an international research team comprising scientists from Canada, Belgium and France. The other hotspot areas are the Pacific coast of North America and Central America, Patagonia, southern and western Europe, Madagascar, central Asia, the south of Australia and New Zealand.

The study demonstrated that human activity is the main driving factor behind the establishment of exotic fish species populations in river ecosystems. Data was examined on the presence of around 10 000 freshwater fish in 1 055 river basins covering both 80% immersed lands and 80% of globally recorded freshwater fish species.

The team also sought to determine the extent of the relative influence of the particular characteristics of each ecosystem and human activities on the diversity of the non-native fish species. Three hypotheses were



tested: namely the biotic resistance, biotic acceptance and human activity.

The first suggests that a higher diversity of freshwater fish in the host ecosystem acts as a barrier to the establishment of non-native fish species populations. The second postulates conversely that, for a given ecosystem, non-native species diversity follows that of native species because favourable conditions for the latter are also suitable for the newly-arrived species. As for the third, it takes account of the different indicators

at river-basin scale (gross domestic product, percentage of land urbanised, population density), that can yield determination of the relation between anthropic pressure and non-native species diversity.

The three hypotheses' relative weight was measured using statistical methods. For the whole set of river basins investigated, the environmental conditions of fluvial ecosystems were found to have practically no influence on the exotic species diversity. On the contrary, it is the human factors, and especially the intensity of economic activities, which determine the number of non-native species present in a river basin.

These results thus suggest that the economic development foreseen in the developing countries should be accompanied by a rise in the number of non-native freshwater fish species. Given that biological invasions are considered as one of the main causes of biodiversity loss, such a scenario would probably be detrimental to the aquatic biodiversity conservation of these regions.

Interestingly, the study indicates that exceptional river basins, such as the Amazon Basin in South America and that of the Congo in central Africa, are still hardly affected by species introduction.

WATER DIARY

GROUNDWATER JUNE 25-28

An International Conference on Groundwater and Climate in Africa will be held in Kampala, Uganda. The conference, co-organised by the University College London, Directorate of Water Development (Uganda) and UNESCO-IHP seeks to bring together water and climate scientists, government departments, the private sector and the donor community to share knowledge and expertise and thereby improve present understanding of the impact of climate variability and change on groundwater resources in Africa. *Enquiries: Richard Taylor; E-mail: r.taylor@geog.ucl.ac.uk; or E-mail: info@gwclim.org; Visit: www.gwclim.org*

YOUNG PROFESSIONALS JULY 16-18

The Fourth IWA Young Water Professionals Conference will take place in Berkeley, Cal-

ifornia, in the US. The conference will focus on all aspects of the water cycle, water and wastewater technology, engineering and management. *E-mail: 2008ywpc@iwahq.org.uk Visit: http://www.iwa-ywpc.org/templates/ld_templates/layout_654239.aspx?ObjectID=654242*

DISTRIBUTION AUGUST 17-20

The 10th International Conference on Water Distribution System Analysis will be held in the Kruger National Park (Skukuza). The conference will be hosted by the University of Johannesburg. *Enquiries: Carla de Jager; E-mail: wdsa2008@uj.ac.za; Visit: www.uj.ac.za/wdsa2008*

RIVERS AUGUST 29-SEPTEMBER 7

The 2008 River Festival will take place in Brisbane, Australia. *E-mail: [*val.com.au or Visit: \[www.riverfestival.com.au\]\(http://www.riverfestival.com.au\)*](mailto:info@riverfesti-</i></p>
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WATER SEPTEMBER 7-12

The IWA World Water Congress & Exhibition will be held in Vienna, Austria. The conference aims to bring together water professionals to advance their common goal of sustainable water management. *Enquiries: E-mail: 2008vienna@iwahq.org.uk; Visit: www.iwa2008vienna.org*

SANITATION SEPTEMBER 24-26

The International Network for the development of Sustainable Approaches for Large Scale Sanitation in Africa (NETSSAF) will be hosting an international conference on Sustainable Sanitation in Africa in Ougadougou, Burkina Faso. *Visit: www.netssaf.net/170.0.html*



Scientists discover 'rain-making' bacteria

A US Montana State University (MSU) professor and his colleagues have found evidence suggesting that airborne bacteria are globally distributed in the atmosphere and may play a large role in the cycle of precipitation.

The research of David Sands, MSU professor of plant species and plant pathology, along with his colleagues Christine Foreman, an MSU professor of land resource and environmental sciences, Brent Christner from Louisiana State University and Cindy Morris, was published in Volume 319 no 5867 of the international journal *Science*, published on 29 February.

The researchers' study show that most active ice nuclei are actually biological in origin. Nuclei are the seeds around which ice is formed. Snow and most rain begin with the formation of ice in clouds. Dust and soot can also serve as ice nuclei. However, biological ice nuclei are different from dust and soot

nuclei because only these biological nuclei can cause freezing at warmer temperatures. The bacteria were found all over the world, including the US, Australia, South Africa, Morocco, France and Russia. The team's research also show that most ice-nucleating bacteria as associated with plants and some are capable of causing disease.

While the implications of a relationship between rain and bacteria could be enormous, they are yet to be proven, said Prof Sands. For example, a reduced amount of bacteria on crops could affect the climate. Because of the bio-precipitation cycle, over-grazing in a dry year could actually decrease rainfall, which could then make the next year even drier.

To access the *Science* article, go to www.sciencemag.org

Unlocking the secrets of *E. coli*

Using new genetic techniques, scientists are unlocking the secrets of how *E. coli* bacteria contaminate food and make people sick.

Michigan State University, in the US, has developed a new technique to test the DNA of *E. coli* bacteria by examining very small genetic changes called single nucleotide polymorphisms or SNPs. Using SNPs, scientists analysed 96 markers, making genetic analysis of pathogenic bacteria possible at a rate never before accomplished.

"It used to take three months to score one gene individually," explained Prof Thomas Whittam of the National Food Safety and Toxicology Centre at MSU. "Now, we are working on a new, more rapid system that can do thousands of genes per day."

UN calls for improved climate observations

The United Nations weather agency, the World Meteorological Organisation (WMO), has called for improvements to climate observation technologies to help people and economies adapt to climate change, climate variability and extreme weather.

The call was made on World Meteorological Day, celebrated on 25 March. The theme for this year was 'Observing our Planet for a Better Future', highlighting the necessity of monitoring meteorological and hydrological phenomena to aid countries in their quest to achieve sustainable economic development. Natural disasters are increasingly impacting developing countries, the WMO pointed out, with nine out of ten of them being linked to hydrometeorological hazards – a phenomenon that has collectively caused 1,2 million deaths and US\$900-million in damages between 1980 and 2000. WMO Secretary-General Dr Michel Jarraud urged developed nations to help poorer countries through the transfer of technology and providing access to satellite information. He also appealed for the "building of human capacity", or training the next generation to operate sophisticated equipment.

'Virtual water' innovator wins international prize

Prof John Anthony Allan from King's College London and the School of Oriental and African Studies has been named the 2008 Stockholm Water Prize Laureate. Prof Allan pioneered the development of key concepts in the understanding and communication of water issues, and how they are linked to agriculture, climate change, economics and politics.

The professor introduced the 'virtual water' concept in 1993, which measures how water is embedded in the production and trade of food and consumer products. For example, behind a cup of coffee lies 140 ℓ of water used to grow, produce, package and ship the beans. That is roughly the same amount of water used by an average person daily in England for drinking and household needs.

Virtual water has major impacts on global trade policy and research, espe-

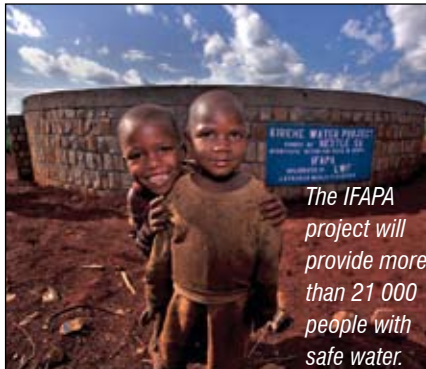
cially in water-scarce regions, and has redefined discourse in water policy and management. By explaining how and why nations such as the US, Argentina and Brazil 'export' billions of litres of water each year, while Japan, Italy and Egypt 'import' billions, the virtual water concept has opened the door to more productive water use.

National, regional and global water and food security, for example, can be enhanced when water intensive commodities are traded from places where they are economically viable to produce to places where they are not. While studying water scarcity in the Middle East, Prof Allan developed the theory of using virtual water, via food, as an alternative water 'source' to reduce pressure on the scarcely available domestic water resources there and in other water-short regions.

PPP brings hope to Rwandan communities

A community water project inaugurated in Kirehe, Rwanda, offers a new model of cooperation between religious communities and public and private sectors in pursuit of human development.

"This is a historic milestone for inter-faith cooperation and public private partnerships (PPPs) in Africa," remarked Rev Dr Ishmael Noko, General Secretary of the Lutheran World Federation (LWF) and president of the Inter-Faith Action for Peace in Africa (IFAPA) at the project's inauguration in March. The project will bring safe water to up to 21 600 people in the sector of Gatore in Kirehe district. International corporate



giant Nestlé S.A provided financial and technical support for the project, which is

implemented through the LWF Department for World Service programme in Rwanda.

The provision of piped water services in Gatore supplements existing water infrastructure and contributes to ensuring access to water and sanitation facilities in the region. This is expected to have a significant impact on health, hygiene and economic output in Kirehe. Under the oversight of the Inter-Religious Council of Rwanda, the IFAPA Water Project is managed by a local water users committee. Women are reported to play a key role in ensuring community ownership and good management of the project.

Saudi Arabia boosts nanotech research

Saudi Arabia is to launch several new centres to boost nanotechnology research in the region.

The Saudi Arabian national research and development organisation and international research organisation IBM Research

announced an agreement earlier this year to establish the Nanotechnology Centre of Excellence at the King Abdulaziz City for Science and Technology in the capital, Riyadh, reports SciDev.Net.

The centre will collaborate with IBM

Research to identify and develop promising opportunities in nanotechnology. It will create research materials for solar energy and nanomembranes for the desalination of seawater. Researchers will also investigate new methods for recycling plastic materials.

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Water treatment in a box

VWS Envig offers a range of water treatment package plant technology products. Package plant technology is characterised by its compactness, cost-effectiveness and mobility and is suitable for use in remote locations.

According to Wayne Taljaard, General Manager: Engineered Systems, package plants are a viable alternative to traditional full-scale water treatment plants. "The range of package plants encompasses all the conventional treatment processes, including clarification, sand filtration, reverse osmosis, and ion exchange. Several package plant models also contain innovative treatment elements tailored for particular applications. The main advantage of using this technology, however, relates to its modularity and ease of operation."



The company designs and assembles the plants according to customer specifications. The plants are skid mounted and occasionally installed in containers. They are then shipped to the customer ready for operation.

These plants are extremely cost-effective and, because they are preassembled, installation costs on-site are kept to a minimum.

They are designed for minimal operator intervention and make use of robust equipment that is able to withstand adverse conditions in remote areas," said Taljaard.

VWS Envig's package plants have been installed on mines throughout Africa, in remote towns, air force bases and industrial plants. One such an installation took place in Zambia for Lumwana Mining Company. With the construction of a new copper mine underway, a potable water treatment plant was required to serve the campsite occupied by the mine's employees. The plant, which has a capacity of 350 m³/day, has been operational since 2006. A similar plant to accommodate the growth taking place at the mining site was delivered late last year.

Uitenhage wastewater plant upgrade completed

Specialist consulting engineering and project management group SSI has successfully commissioned a R21,5-million extension to the Kelvin Jones Wastewater Treatment Works outside Uitenhage, in the Eastern Cape.

Originally built in 1986, the existing plant reached full capacity in 2000 and the Nelson Mandela Bay Municipality subsequently approved its extension through a new 10 M²/day module. This brings the total capacity up to 24 M²/day, which is sufficient to manage the municipality's wastewater treatment requirements in the Uitenhage area for the foreseeable future. At the same time, the existing plant was modified to harness a stepped aeration process to provide flexible operating alternatives for phosphate and nitrogen removal.



Project manager Marius van Aardt explains: "Shortly before this contract was awarded, the Department of Water Affairs & Forestry promulgated new effluent standards for the Swartkops River catchment to improve water quality. The new regulations limited phosphorus concentration

to 1 mg/ℓ and nitrogen to 15 mg/ℓ in the final effluent. These new standards required a redesign of the treatment process, effectively converting a conventional activated sludge treatment system into a stepped aeration process capable of removing phosphates and nitrogen."

Challenging aspects of the contract included the poor state of the soil, the high groundwater table in the area, as well as the fact that the alterations had to be made to the plant while it remained in operation for 24 hours a day. The civils contractor on the project was URSA Concrete cc, the main mechanical and electrical contractor was Lektratek Water Technology and the electrical subcontractor was Service Electrical.

WATER DIARY (continued)

DESALINATION OCTOBER 20-22

A conference titled 'Membranes in Drinking Water Production and Wastewater Treatment' will be held in Toulouse, France.

Visit www.mdiw2008.com

GROUNDWATER OCTOBER 14-17

A symposium on Coupling Sustainable Sanitation and Groundwater Protection will take place in Hannover, Germany. The symposium will focus on applicable solu-

tions for the protection of groundwater against anthropogenic domestic effluents in the context of developing countries.

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symposium2008@bgr.de

New from the WRC



Report No: TT 313/07 (Vol 1) and TT 314/07 (Vol 2)

On-Farm Application of In-field Rainwater Harvesting Techniques on Small Plots in the Central Region of South Africa (JJ Botha; JJ Anderson; DC Groenewald; N Mdibe; MN Baiphethi; NN Nhlabatsi and TB Zere)

Research has shown that rural communities can benefit greatly from the use of in-field rainwater harvesting (IRWH). This technique has the potential to reduce total runoff and evaporation considerably, resulting in increased yields due to increased plant-available water. The WRC has contributed to IRWH research for a number of years. In this project the technique was implemented in a number of rural communities around the towns of Thaba Nchu and Botshabelo over two years. The project was aimed at exchanging the technology as effectively as possible and to assist and support the farmers and extension officers with the application of the IRWH technique. The research output comprises two parts: The main report is captured in Volume 1 while Volume 2 is an extension manual to aid in the teaching of the IRWH technique.

Report No: 1368/1/07

Water Conservation through Energy Conservation (D Fraser; K Ndwandwe; P Basnal; A Isafiade; NS Nyathi; T Majozi; CJ Brouckaert and BM Brouckaert)

Industries with thermal processes (as opposed to electrical processes and excluding electrical power generation) are a significant sub-class of the industrial

water-use sector. Energy which is consumed in excess has to be dissipated. This is frequently through the use of wet cooling towers, where the excess energy is used to evaporate water. This results in a two-fold problem for the environment: firstly, the evaporated water is lost from the national water cycle and, secondly, the salts contained in the cooling water

remain behind for discharge or

disposal as cooling tower blow-down. The overall aim of this project was to promote water and energy savings in the South African process industry through more efficient use of both process water and cooling and heating utilities. This was to be achieved by creating awareness of potential water and energy savings in the process industry and through the development and promotion of tools incorporating water and thermal pinch and mathematical modelling for the optimisation of water and heat exchanger networks.

Report No: KV 205/08

Hydrological Information Requirements and Methods to Support the Determination of Environmental Water Requirements in Ephemeral River Systems (DS Hughes)

This consultancy project was designed to provide hydrological data analysis support for a large WRC project undertaken by the University of the Free State on the environmental water requirements (EWR) in non-perennial systems. The first component was to identify the hydrological issues that are considered of ecological importance within EWR determinations for non-perennial river systems. The second component was to establish appropriate hydrological models, calibrate or calculate their parameters and critically assess the initial results. The models were tested on the Seekoei River, a tributary of the Orange River.

Report No: 1687/1/08

The Determination of Annual Phosphorus Loading Limits for South African Dams (William R Harding)

Managing dams such that levels of eutrophication do not exceed thresholds above which problems are encountered should be a primary focus of South African water resource management. The fundamental point of departure in any eutrophication assessment is to be able to determine the relationship between the level of nutrient loading, in particular phosphorus, and the in-lake condition. A number of simple relationships exist for predicting in-lake phosphorus conditions based on hydro-morphological data and catchment land use. Such models, supporting screening level assessments, have not been tested for their relevance in South Africa, i.e. across a range of impoundment types. Given the importance of having such workable models available it was therefore important that their local relevance be determined. This project has, for the first time, undertaken a preliminary testing of a suite of models across a set of 30 dams.

Report No: 1603/1/08

On-line Real-time Enzymatic Biosensor System for the Rapid Detection of Faecal Contamination of Water Intended for Drinking Purposes (B Pletschke; C Togo and J Limson)

Inadequate sanitation frequently results in the channelling of untreated sewage and faecal material into marine and freshwater catchment areas and riverine systems. Current tests to detect pathogens (or rather indicator microorganisms i.e. total faecal coliforms, *E. coli* etc.) are in place to detect and quantify the presence of faecal contamination, but these require laborious and time-consuming processes. In this project the use of a sequential flow injection analysis system with a spectrophotometric detector or in combination with an electrochemical detector was tested to determine whether this was the cheapest and most rapid method to detect faecal contamination in water resources.

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International Year of Sanitation



CT sewage pumps protected when lights go out

The City of Cape Town has installed special safeguards against load shedding to reduce the risk of sewage spills resulting from non-functioning sewage pumps.

"During 2006, the Koeberg power failures affected almost all of the City's 390 sewage pump stations, resulting in overflows. This has been reduced significantly by the introduction of telemetry systems and upgrading maintenance schedules," reported Director of Water Services Siphos Mosai.

According to Mosai, most pump stations are equipped with a duty pump and a standby pump. When one of the pumps malfunctions, it is removed and sent away for repairs. The standby pump then takes over. It is when a pump is being repaired and there is only one pump at the pump station when the risk for overflows is high.

"The City has now implemented contingency plans for future load shedding and the wet winter season. These include the installation of back-up generators for strategic

sewage treatment plants, as well as cooperation with the City's Electrical Department to plan power cuts in such a way that sewage flows can be managed and spillage into the environment reduced," noted Mosai.

In addition, Cape Town has upgraded its telemetry system which links the 26 municipal pump stations across the entire city to the Schaapkraal control centre via its base station at the Steenbras Water Treatment Plant. The system alerts the control centre as soon as it detects a pumpset failure. This enables the centre to mobilise response teams quickly.

"Experience has shown that power cuts for two hours or less do not cause overflow problems. However, longer blackouts can cause problems, as retention facilities at the stations have a limited capacity," explained Mosai. "During sustained power cuts, residents are advised to use water sparingly, and to flush toilets only when necessary to reduce the City's volume of wastewater."

New booklet to help girls

In celebration of the International Year of Sanitation a guidance booklet on menstrual hygiene management has been launched in New Delhi, India.

While menstrual hygiene is an important sanitation issue it has long been in the closet. An aspect that every girl and woman deals with in their lives, the taboos surrounding this issue in society prevents girls and women from articulating their needs. Subsequently

the problems of poor menstrual hygiene management have been ignored or misunderstood.

Unicef developed the guidance booklet on menstrual hygiene management to serve as a reference and support girls and women in providing basic factual information about menstruation, its hygienic management, and to clarify some myths and taboos surrounding the topic.

Kenyan inmates pioneer sanitation project

At the Shimo la Tewa prison in the Kenyan city of Mombasa, inmates are pioneering a sanitation project that is working with nature to neutralise human waste.

The initiative which involves the development of a wetland to purify sewage, is expected to cost a fraction of the price of high-tech treatments in addition to many environmental, economic and social benefits. The sewage collection and wetland purification system, as well as labour and construction costs and including upgrading of sanitary facilities inside the prison amount to some US\$110 000 or US\$25 per person served.

Apart from wastewater management, the project is also to assess using the wetland-filtered water for irrigation and fish farming, giving prisoners a new source of protein with excess to be sold to local markets. Part of the wastewater will also be used for the production of biogas. The biogas can be used as a fuel for cooking, heating and lighting, thereby cutting electricity bills and saving the prison service.

The project is being financed by the government of Norway and the Global Environment Facility with support from a range of partners, including Kenya's Coast Development Authority and National Environment Management Authority supported by the University of Dar es Salaam in Tanzania and the University of Wageningen, the Free University of Amsterdam and the non-governmental organisation Aqua-4-All in the Netherlands.

Source: UNEP

'First-of-its-kind' MoU signed

The US' Millennium Challenge Corporation (MCC) and the UK Department for International Development (DFID) have signed a first-of-its-kind Memorandum of Understanding (MoU) to increase coordination between the two organisations and make their poverty

reduction efforts more effective.

Focusing initially on Africa, the MoU identifies practical areas for cooperation on the ground in countries in which both the US and UK are engaging in poverty reduction, including Ghana, Malawi, Mozambique and Tanzania. The agreement builds on existing cooperation to identify new areas where collaboration between the two organisations can better help partner countries and improve development practice, such as data and statistics sharing, coordinated approaches to issues such as environmental protection, infrastructure projects, transparency in large-scale procurements, rigorous evaluation of aid effectiveness, and future staff exchanges, among others.

It is reported that the MoU provides a solid framework for in-country cooperation to take place between MCC and DFID in a number of sectors, including education, water and sanitation, and governance.

Collaborative efforts needed to tackle sanitation challenge

There is an urgent need to address the issue of sanitation in a sustainable manner involving all stakeholders, especially local governments, communities and investors, maintains UNESCO Director-General Koichiro Matsuura.

"Significant advances have been made in the development of low-cost technologies for sanitation, overcoming the technology barrier which was regarded, in the past, as a main cause of slow progress in ensuring sanitation for all. Mainstreaming sanitation at the national level and prioritising sanitation in national policies and strategies is a starting point to accelerate progress," he said. "Strengthened international partnerships will help leverage investment and provide new technological options."

Matsuura reaffirmed UNESCO's commitment to promote science and knowledge to tackle water-related sanitation problems. Among others, the organisation supports research and capacity building in the fields related to sanitation through postgraduate research and training programmes at UNESCO-IHE Institute for Water Education.

Japan donates US\$4-m for girl-friendly schools

The government of Japan has announced a grant of more than US\$4-million, via UNICEF, to support free primary education and to promote primary healthcare in the Democratic Republic of Congo.

This funding, from the government of Japan's Grant Aid scheme for community empowerment, will give some 6 650 pupils access to primary education and will ensure that Congolese students benefit from child-friendly and girl-friendly schools that possess essential school equipment, school supplies, safe water and latrines.

The grant will also fund the opening of seven new community daycare centres that are expected to service some 500 children aged between three and five, along with eight health centres to provide care to Congolese women and children.

Limpopo communities to get improved sanitation

The Mopani District Municipality in Limpopo is to spend R103-million on upgrading water and sanitation services this year, with projects already underway in all five local municipalities in the district.

"We are committed to providing all communities in the district with clean water and decent sanitation by 2010," said municipal spokesperson Tumelo Malaka. He reported that the projects are being implemented with assistance from the Development Bank of Southern Africa, DWAF and the Department of Provincial and Local Government.

The projects include the construction of a new sewerage system in Modjadjiskloof and the installation of bulk water pipelines in Mamaila village in the Greater Letaba Municipality.

Between 2000 and 2007, the district has spent R371-million on water infrastructure, resulting in more than 60% of the estimated million residents having access to a potable water supply. "We will continue to prioritise water provision," said Mokgobi.

Source: *BuaNews*


Political will biggest barrier to improving sanitation



A lack of political will remains the greatest obstacle to efforts to drastically reduce the number of people without access to basic sanitation and clean, running water, according to United Nations Secretary-General Ban Ki-moon.

Speaking on World Water Day, celebrated on 22 March, he called on the international community to take firmer and faster steps to tackle the problem. "If we take up the challenge, the positive impact will reverberate far beyond better access to clean water. Every dollar invested in water and sanitation yields an estimated seven dollars worth of productive activity. And that comes on top of the immeasurable gains in cutting poverty, improving health and raising living standards."

The Secretary-General described it as unconscionable that a child dies on average every 20 seconds because of sub-standard sanitation conditions – a situation endured by an estimated 2.6 billion people worldwide, or more than a third of the global population, that are preventable. "Poor sanitation combines with a lack of safe drinking water and inadequate hygiene to contribute to the terrible global death toll. Those who survive face diminished chances of living a healthy and productive existence. Children, especially girls, are forced to stay out of school, while hygiene-related diseases keep adults from engaging in productive work."

Ban said that achieving the Millennium Development Goal of halving the proportion of people without access to basic sanitation by 2015 was far from being achieved. Population growth, widespread poverty and insufficient investment are among the key obstacles, but the Secretary-General noted that the "biggest culprit" is the lack of political will. 

START SAVING OR START PAYING, River Studies Warn



Extensive urbanisation, economic development and industrialisation coupled with water wastage and illegal water use are placing increased pressure on the Vaal River System, recent studies have revealed. Unless users start saving water immediately a new bulk water transfer scheme would have to be implemented as a matter of urgency.

Lani van Vuuren reports.

The Vaal River System is focused around three water management areas (WMAs), namely the Upper Vaal, Middle Vaal and Lower Vaal. It also includes various water resource systems that are linked to the Vaal River WMAs through inter-basin transfers, such as the Thukela-Vaal Water Transfer Scheme and the Lesotho Highlands Water Project.

Running through the economic heart-land of the country, this system has long been known as the 'workhorse' of South Africa's water resources, serving major economic activities, such as mining and power generation, agriculture as well as a population of around 12 million people. Due to extensive development in the Vaal River System as well as the Crocodile (West) WMA, which is supplied with water from the Upper Vaal, the local surface water resources in all three of the Vaal WMAs have been fully exploited more than three decades ago.

In 2004, the Department of Water Affairs & Forestry (DWA) initiated the development of a strategy for the Vaal River System that will define management measures to meet the growing water requirements of the industrial and urban sectors served by the system. DWA project leader Seef Rademeyer explains that the series of studies includes the development of a large bulk water supply reconciliation strategy; a water

conservation and water demand management (WC/WDM) potential assessment; and the development of an Integrated Water Quality Management Plan (IWQMP).

Several consulting firms are involved in this integrated and complex process, including WRP, SRK, Golder Associates, DMM Development Consultants, PDNA and Diversity and Transformation Solutions. Zitholele Consulting is driving the stakeholder consultation process.

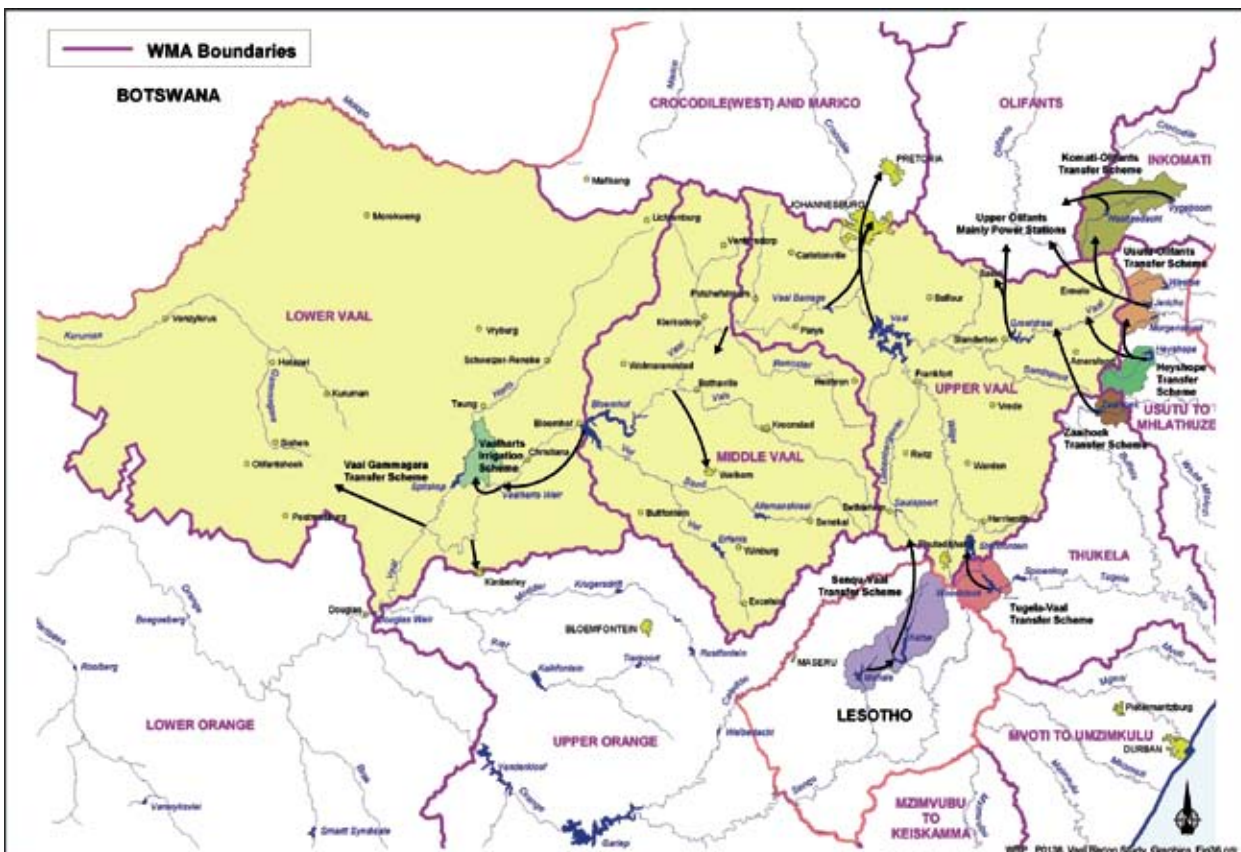
NEGATIVE WATER BALANCE

One of the most important revelations of the studies has been the high level of unlawful water use taking place in the Vaal River System, mainly for irrigation. The studies show that irrigation water use in the Vaal River System has increased by more than 100% between 1998 and 2005 for the area upstream of the Vaal Dam alone. Estimated irrigation water use for 2005 in the three WMAs

was 1 060 million m³/a. Up to 240 million m³/a of irrigation water use in the Upper Vaal WMA is estimated to be unlawful.

It is believed that some farms located along the Ash-Liebenbergsvlei, which receives the water flowing from the Lesotho Highlands Water Project, could be taking much more than their registered share of run-of-river water. "This has been a shocking discovery, and probably the main reason why the Vaal River System is currently in deficit," reports Rademeyer. "This is water that has already been paid for by urban users in the WMA that is not reaching them."

The negative water balance has largely been obscured by the good rainy season South Africa is experiencing at present. However, this could all change if the country were to enter a drought year. "Therefore, curbing this unlawful water use is non-negotiable if we want to avert a potential water crisis in the system," notes Rademeyer.



The Vaal River management areas.



Dirnie van Rensburg

Water leaks have been found to be a serious challenge in several municipalities in the Vaal River System.

ADDITIONAL WATER TRANSFER SCHEMES

The demand for water in the Vaal River System, especially in the Upper Vaal WMA is set to grow in the immediate future as the area experiences further economic development and population growth. The urban sector represents the largest portion of the system's water use. In Gauteng, especially, substantial increases in water use have occurred historically as a result of the increasing urban population and expanding economic activities.

Additional water transfer options are already being investigated. Two schemes are currently being considered, namely a further phase of the Lesotho Highlands Water Project or further water resource development in the Thukela River System. The two proposed dams for further development of the Thukela are one on the Bushman's River (Mielietuin Dam) and the other on the main stem of the Thukela River (Jana Dam). This could provide a nominal transferable yield of 15 m³/s.

In turn South Africa and Lesotho issued a joint feasibility study into the Lesotho Highlands Further Phases in 2005. The proposed Polihali Dam has been sited as

the most preferred option. Both projects are at advanced stages of assessment and either could support growing water requirements in the Vaal River System area, reports Rademeyer.

CURBING WATER WASTAGE

The problem is that both these augmentation options will take more than ten years to implement. With the

Vaal River System already in deficit a decision will have to be taken immediately unless other solutions can be found.

In looking for these solutions the WC/WDM component of the studies focused on the potential of water savings in the main urban areas of Johannesburg, Tshwane, Ekurhuleni, Emfuleni, Rustenburg, Mogale City, Matjabeng, Govan Mbeki and Randfontein.

Some of the municipalities are already implementing successful WC/WDM measures, In general, however, there is a lack of accurate and reliable water balance information which influences the effective implementation and measurement of the various WC/WDM interventions. In fact, says Rademeyer, getting reliable, usable information from the local municipalities in general, especially in lieu of the shortage of technical skills present, has been one of the challenges of the project.

The lack of technical expertise further contributes to inadequate preventative maintenance while insufficient political support to promote consumer billing and cost recovery needs are also evident. Irresponsible water



WRP

The Sebokeng Pressure Management project is one of the successful water demand management projects implemented in the Vaal River System.

use practices have been found in all of the municipal areas, such as garden watering during very hot periods and not tending to leaking taps and toilets. High levels of leakages and wastages occur in some municipalities which have to be managed more effectively.

The coordination of WC/WDM efforts by government departments has been found to be essential. For instance, DWAF's advocacy programme about the disadvantages of hosepipe irrigation must be coordinated with the Department of Agriculture's efforts where hosepipes are provided to consumers as motivation to develop vegetable gardens.

If no WC/WDM measures are implemented, it is projected that Rand Water's supply, the bulk water supplier to most of the urban centres studied, will increase from the present 1 300 million m³/a to almost 1 800 million m³/a in 2030. "The good news is that the impact of even small savings through water conservation and water demand management could result in a substantial postponement of the date an additional bulk water transfer scheme would be required," says Rade-meyer. "A mere 15% water saving would be sufficient to delay the decision to proceed with an infrastructural option to 2012."

GROWING INDUSTRIAL DEMAND

Given the present growth projections for the Vaal River System, even with WC/WDM additional bulk water resources would eventually be required. The Vaal River System supports three of the most important industries in the country, namely electric power generator Eskom, petrochemical company Sasol and Mittal Steel. All of these industries are large water consumers.

At present, Eskom operates 12 coal-fired power stations which receive a substantial volume of water from the Vaal River System. Some of these stations were decommissioned decades ago, but are now being reinstated to increase supply in response to the growing demand

CHARACTERISTICS OF VAAL RIVER WATER MANAGEMENT AREAS (WMAs)



SA Tourism

Upper Vaal WMA

Land use in the Upper Vaal is characterised by the sprawling urban and industrial areas in the northern and western parts of the WMA. This WMA is considered economically important, contributing nearly 20% of the GDP of South Africa. There is also extensive coal and gold mining activities in this part of the system. These activities are generating substantial return flow volumes in the form of treated effluent from the urban areas and mine dewatering that are discharged into the river system. These discharges are having significant impacts on the water quality in the main stem of the Vaal River throughout all three the WMAs. The potential for future economic growth in this WMA remains strong. Growth will largely be attracted to the already strong urban and industrial areas in the Johannesburg-Vereeniging-Vanderbijlpark complex.

Middle Vaal WMA

The Middle Vaal WMA is rural in nature, with land use characterised by extensive dry land agriculture. Irrigation is practiced downstream of dams along the main tributaries as well as at locations along the Vaal River. The largest urban areas are Klerksdorp, Welkom and Kroonstad. The economy of the Middle Vaal WMA contributes about 4% of GDP of South Africa, with the most dominant economic activity being the mining sector, generating more than 45% of the GDP in the area. Few of the gold mines in the area have a secure future beyond 2010, although the reserve base could support mining up to the year 2030. As in the Upper Vaal WMA, mine dewatering and the subsequent discharge into the river system impacts on the water quality.

Lower Vaal WMA

The land use in the Lower Vaal WMA is primarily livestock farming, with some dry land cultivation in the northeast. Intensive irrigation is practiced at Vaalharts as well as locations along the Vaal River. Diamond-bearing intrusions near Kimberley (the most important urban area) and alluvial diamonds are found near Bloemhof. Iron ore and other minerals are found in the south-eastern parts of the WMA.

Source: DWAF



Lani van Vuuren

The Sterkfontein Dam, part of the Thukela Water Transfer Scheme.



Lani van Vuuren

The Vaal Dam is one of the main water infrastructure features on the Vaal River.

for electricity to fuel the South African economy.

In addition, there are plans to develop three new power stations, envisaged to receive water from the Vaal River System. This means water requirements from Eskom is due to increase from about 313 million m³/a in 2006 to 397 million m³/a in 2030.

Sasol has two plants receiving water from the Vaal River System. The Sasol Secunda Complex's main source of water is Grootdraai Dam, which will be supported

through the Vaal River Eastern Sub-system Augmentation Project (VRESAP) once it becomes operational later this year. This project involves the construction of a 120 km, 1,9 m-diameter pipeline from the Vaal Dam to the Knoppiesfontein diversion structure and from there into the Bosjesspruit and Trichardsfontein dams near Secunda, Mpumalanga.

In turn, the petroleum giant's Sasolburg complex is supplied from the Vaal Dam. Sasol's total water requirement is expected to increase from 118 million m³/a to 166 million m³/a by 2030.

Only Mittal Steel, which also receives its water from Vaal Dam, has not indicated an increase in water use in its projections. In fact, the company plans to decrease its present water use from 17 million m³/a to 16 million m³/a by 2010, from where onwards it is expected to remain constant.


WATER QUALITY

The water quality study was aimed at developing management measures to maintain and even improve the water quality in the Vaal River System for the planning period up to 2025. The study's water quality status assessment confirmed the major issues of salinity and eutrophication in the Vaal River System.

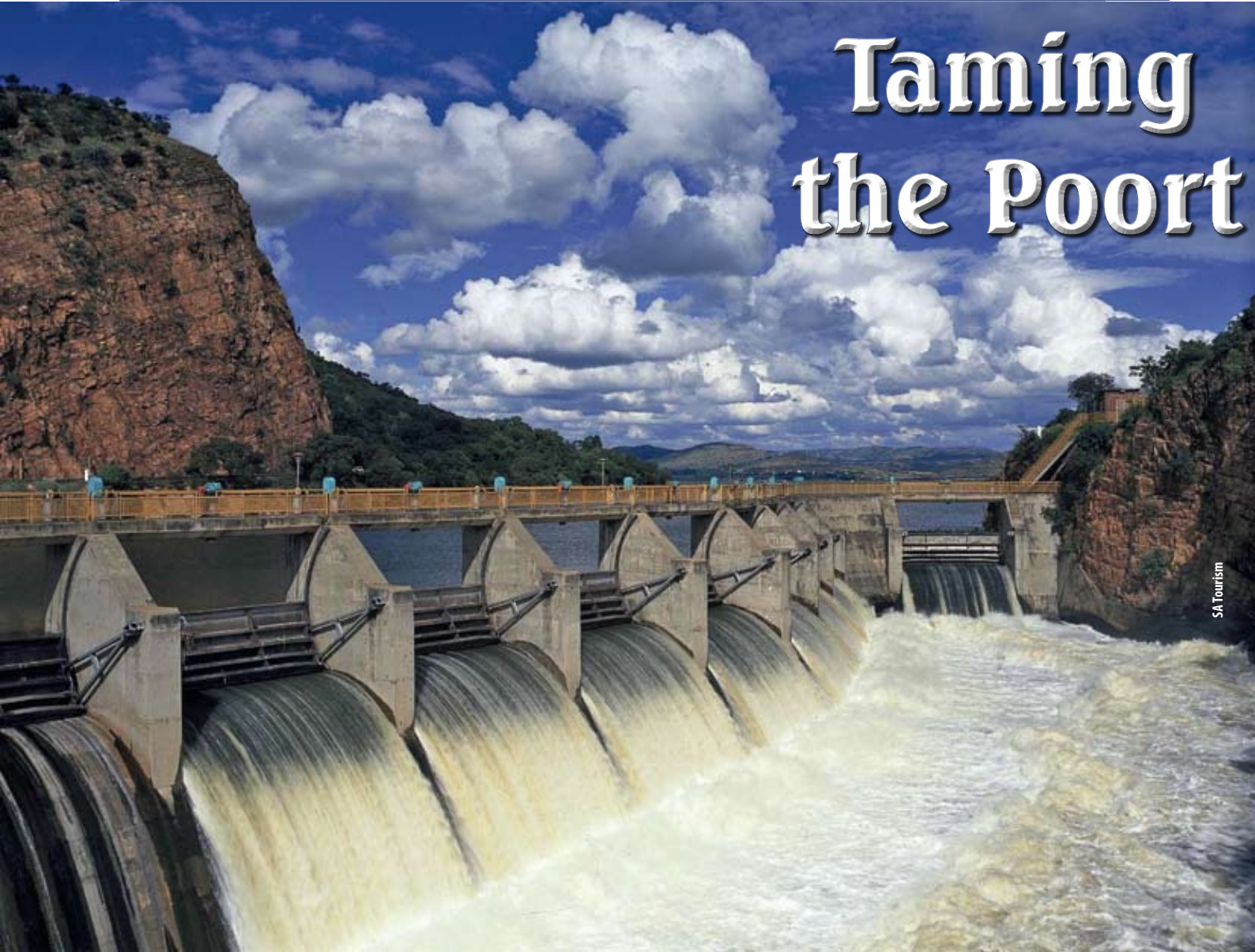
Dissolved salts from urban effluents, mines and industries in the catchment continue to increase the salt concentration of the Vaal River. The specific catchments contributing to the deteriorating water quality of the system include Waterval, Suikerbosrand, Rietspruit, Klip River, Mooi River, Koekemoerspruit, Schoonspruit, Vierfontein and the Harts River catchment.

The upper part of the catchment's water is of fairly good quality. The areas of concern, however, include the Vaal Barrage, Middle Vaal River, and Lower Vaal River downstream of the Harts River confluence, where total dissolved salt (TDS) levels are high. Of further worry is the impact of high TDS concentrations on downstream water users below the Vaal Barrage and those abstracting water from the barrage.

In addition, a high risk of eutrophic conditions in the Vaal River reach from the Vaal Barrage to Bloemhof Dam has been found. This is mostly due to sewage spills and sewage effluent discharges into the Vaal River and its tributaries. Initial indications are the situation could be improved by releases from the Vaal Dam. However, present assessments point to the need for the removal of nutrients from the system through improved final effluent quality.

In the end it is up to all the water users of the Vaal River System to ensure they can continue to benefit from South Africa's hardest working river. 

Taming the Poort



SA Tourism

Hartbeespoort Dam, situated on the border between North West and Gauteng, is one of the oldest and most interesting dams constructed in South Africa. Lani van Vuuren reports.

It was Boer General Hendrik J Schoeman who first saw the potential for a dam on the Crocodile River, 30 km west of Pretoria, in the 1890s. In 1898, he completed the construction of a dam on his farm Hartbeespoort, and named it Sophia Dam, after his wife.

The dam was of concrete, and was about nine metres high. This dam did not impound any water, but was used for the leading out of water and the irrigation of adjacent land. Unfortunately, the dam was washed away in a flood on 9 January 1909.

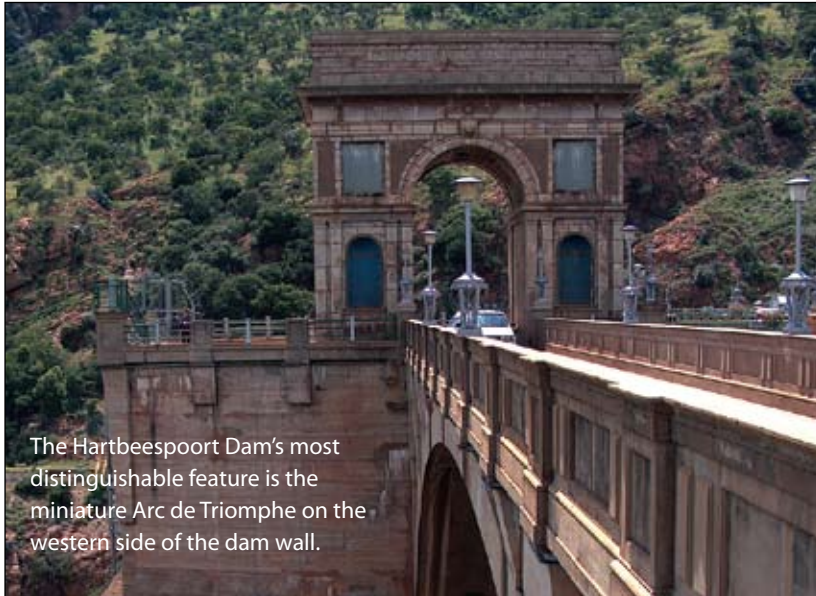
ONE MAN'S DREAM

At the opening ceremony of the dam on 28 May 1898, Genl Schoeman made a pledge to President Paul Kruger to build a dam using government funds. The purpose of such a project would be to irrigate a few plots of land on which poor whites could be settled.

On 1 April 1899, Genl Schoeman wrote a letter in which he stated that he was willing to sell a portion of his farm for the above-mentioned project. President Kruger reportedly welcomed this idea.

The outbreak of the Anglo-Boer War in October 1899 put a hold on the implementation of the project, however.

When the war ended in 1902, the total reconstruction of South Africa got underway. It was in this same year that the viability of the site for the construction of the dam was investigated. Interestingly, original investigations into the potential of constructing the Hartbeespoort Dam were conducted with the view to providing urban water to Pretoria and Johannesburg, and not for irrigation for settlement purposes.



Lani van Vuuren

The Hartbeespoort Dam's most distinguishable feature is the miniature Arc de Triomphe on the western side of the dam wall.

POLITICS INTERVENE

The then Transvaal Irrigation Department investigated the site, and proposed a 43 m-high gravity dam. The establishment of the Union of South Africa in 1910 postponed any further work on the scheme, until 1914. The Hartbeespoort Bill Act was rather suddenly passed in 1914, allowing work on the project to continue. The estimated cost at the time was £605 000.

A possible reason for the sudden flare-up of interest in the Hartbeespoort Dam is the political occurrences of 1913 and 1914, including the miners' strike and uprisings on the Witwatersrand. It is said that the government could have passed the project to appease the white electorate.

On 16 June 1914, the House of Assembly voted for the scheme. Start of construction of the dam and irrigation canals was planned for the end of 1915. However, South Africa's involvement in World War One meant that the project was sidelined once again.

The implementation of the scheme did not go as planned. A number of obstacles were in the way of implementation. Firstly, the Department of Irrigation was not prepared for the rising

costs of the project due to the difficult terrain through which the canals were constructed. Some of the rock formations on which the dam wall itself was constructed had to be excavated deeper than was thought previously.

There were also some gaps in the legislation, which led to litigation regarding the expropriation of land. Lastly, the war led to a decrease in State funds for the construction of the scheme as funding for a number of government departments was slashed to pay for the war effort.

As a result, work on the dam only started in 1916. Two years later progress was hampered when floods destroyed much of the work. In 1918, government passed the Hartbeespoort Irrigation Scheme (Acquisition of Land Act) which authorised the expropriation of land required for the construction of the dam. Pressure to complete the project mounted and, as a result, special provision was made in the 1921/22 budget for the scheme. At that stage, the dam was one of the largest schemes implemented in the Transvaal.

The dam design was adapted from a gravity structure to a varying radius arch structure 59 m high. This allowed for much less cement to be used. In addition, the foundation could be completed in one dry season.

Work on the river diversion was started in March 1921 and completed in May of that year. The first foundation concrete was placed on 29 July, and by September 1922 the wall was two metres above the riverbed. By April 1923 the wall was completed, and only the finishing of the parapets and crest road remained. During the construction phase the dam impounded the floods of 1922/23. The whole scheme, including the canals, was completed in 1925.

The dam was filled on 11 March 1925, and a maximum flood of 2 700 cusecs passed down the spillway on 26 March of that year. After completion, 97 farmers and 65 lessees made use of the water from the Hartbeespoort Dam.

The west end of the dam wall sports an unusual feature, an arch built as a replica of the Arc de Triomphe. There are two inscriptions on the arch. The inscription on the eastern side reads *Dedi in deserto aquas, flumina in invio* which means 'I give waters in the wilderness and rivers in the desert (Isaiah 43:20). The inscription on the western side reads *Sine aqua arida ac misera agri cultura* which means 'Without water it is arid and miserable in agriculture'.

WHITE AND BLACK LABOUR

One of the main aims of the Hartbeespoort Irrigation Scheme was to provide employment to soldiers demobilised after World War One as well as poor whites. However, it is reported that the attitude of these groups towards hard labour resulted in a request for permission to use blacks, which was granted in 1919.

At the peak of construction, some 1 835 men were employed at the dam, and 3 500 on the scheme as a whole. The more experienced workers were used at the dam itself, while others were used on the canals. The workers were accommodated on-site in houses, semi-detached houses and housing blocks with four living quarters. The site also


had an office block, store, blacksmith, and a small hydropower station.

In 1928, the Brits magisterial district was proclaimed. This was as a direct consequence of the increased activity in the Hartbeespoort area, and rapid development that took place under the scheme.

RAISING THE DAM WALL

In 1964, the Department of Water Affairs proposed that the dam be raised to increase its capacity and to make a larger volume of water available for irrigation purposes. The raising of the dam was done by means of ten 2,74 m radial crest sluices on the spillway raising the full supply level by 2,4 m. The dam has a crest length of 140 m and a capacity of more than 200 million m³. Today, the dam still irrigates almost 14 000 ha of land.

The dam has unfortunately become famous not for its aesthetics or water storage ability. Rather it is cited as one of the worst examples of eutrophication, resulting from high levels of phosphates and nitrates washing into the dam.

This had had a negative affect on the water quality, the fish life, use of the dam and the environment. Last year, the Department of Water Affairs & Forestry initiated a remediation programme called Harties Metsi a Me (meaning 'Harties, my water', which is working towards improving the situation at the dam. Rand Water is the implementing agent for the programme. 



Hartbeespoort Dam during construction of the wall.

Civil Engineering Magazine



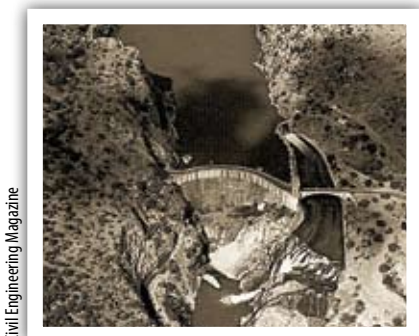
Cable way at Hartbeespoort Dam during the construction of the foundations, 1922.

Civil Engineering Magazine



Completed Hartbeespoort Dam.

National Library of SA



Civil Engineering Magazine

Completed Hartbeespoort Dam as seen from the air.

Sources:

Hydropolitical History of South Africa's International River Basins (WRC Report No: 1220/1/04)

Fifty Years of Consulting Engineering in South Africa published by SAACE

'The Construction of Hartbeespoort Dam'; *Civil Engineering*, June 2004, Vol 12 No 6
www.dwaf.gov.za



Lani van Vuuren

Minister of Water Affairs & Forestry Lindiwe Hendricks and Eskom CE Jacob Maroga at the signing of the Memorandum of Understanding between the two parties at Kwa-Thema.

Water & Energy Join Hands to Avert Future Crisis

Lessons learnt from the present electricity crisis should be applied to ensure similar deficiencies are not experienced in the water sector, said Minister of Water Affairs & Forestry Lindiwe Hendricks. She was speaking at the signing of a Memorandum of Understanding (MoU) between the Department of Water Affairs & Forestry (DWAF) and Eskom at Kwa-Thema, in Gauteng, in March. Lani van Vuuren attended the event.

The MoU is aimed at facilitating broader cooperation on issues relating to efficient water use at Eskom's power generation plants. "While the country is not experiencing a water crisis at present, there is no denying that South Africa is water scarce, and we cannot afford to rest on our laurels and think that because we have good infrastructure and recently had good rainfall that there is a guarantee of long-term water security. We cannot afford to waste water, we cannot allow people to take more than their allocation, and we cannot allow people to use water unlawfully," Hendricks said.

"Our colleagues at Eskom will only be too aware that the timely implementation of effective and comprehensive energy demand management would have dramatically lessened the

current electricity crisis. That experience teaches us in the water sector of the need to ensure that our water conservation and water demand management programmes are high up on the agenda and are comprehensively implemented," the minister continued. "Dams are extremely expensive to build and by implementing water conservation measures not only do we contribute to environmental sustainability, but also help to delay the date by when

"Both DWAF and Eskom recognise that there is still significant room for improvement in water efficiencies, which will be further explored within the scope of this MoU."

we need to start constructing the next water scheme."

According to the minister municipalities play a key role in initiating and driving local water conservation programmes and, along with provincial governments, needed to work towards creating a more water efficient South Africa. "Measures to be implemented include public education campaigns, water pricing (tiered water or block tariffs to penalise excessive use), and subsidies," Hendricks said.

The latest MoU signed by DWAF and Eskom seeks to establish a strategic partnership between the two parties in best water management practices and water performance improvement within power generation in South Africa. This will create a platform for sharing information and guiding regulatory initiatives and exploring synergistic opportunities

Lani van Vuuren



Chair of the Portfolio Committee on Water & Forestry, Connie September, said water and energy were “twins” and “one cannot conserve the one without conserving the other.”

between Eskom’s energy efficiency and demand side management programme and DWAF’s water conservation and water demand management programme, among others.

“Both DWAF and Eskom recognise that there is still significant room for improvement in water efficiencies, which will be further explored within the scope of this MoU,” Hendricks explained. “We are looking forward to working with Eskom to develop innovative solutions and improve current levels of water use efficiency in their power plants.”

Water is critical to the power generation process. Eskom is one of the country’s largest consumers of fresh water, accounting for some 2% of South Africa’s total water consumption annually. The company’s power generation plants use about 325 Mℓ/year of water.

“It is therefore critical for Eskom and DWAF to enter into a strategic partnership to encourage the sustainable use and availability of water and energy sources into the future,” noted Eskom CE Jacob Maroga. “Eskom acknowledges the scarcity of water in South Africa, and actively supports the initiatives of the department in areas of water conservation, water demand management and water quality.”

He reported that the company was active in the field of electricity conservation.

This has implications for water conservation. (In fact, for every kilowatt hour of electricity that is saved, about 1,32 ℓ of water is also saved on average.) “Eskom has pioneered dry-cooling technology as its main cooling method to reduce its water consumption, and this technology has been adapted for the company’s new power stations inland.” A conventional wet-cooled power station consumes about 50 Mℓ/year of water as opposed to a dry-cooled power station which consumes about 3 Mℓ/year of water.

Examples of dry-cooled power stations include Matimba near Lephalale, in Limpopo, and Kendal, near Witbank, in Mpumalanga. Medupi power station, under construction near Lephalale at present, will also be dry-cooled. In addition, the power generation firm is working towards making its de-mothballed power stations Komati, Grootvlei and Camden more water efficient.

“Eskom is also committed to ensure that its water usage adheres to laws and regulations governing water allocations and quality objectives,” noted Maroga. “As far as our new build projects are concerned, we have been working closely with DWAF to ensure that our water requirements are met. We are therefore confident that water will be delivered to meet the commissioning dates of the various power station units.”

Chair of the Portfolio Committee on Water and Forestry, Connie September, who also attended the MOU signing, expressed her delight at the signing of the MOU. “Water and electricity are twins. The Portfolio Committee hopes that this agreement will bring long-term solutions and that the minister will be able to report positive actions to us soon.” 

**WATER IN POWER PLANTS:
WET COOLING VS. DRY COOLING**

A conventional wet-cooled power station uses a re-circulating system in which cooling takes place via evaporation in an open cooling tower. About 75% of the total quantity of water supplied to such a power station evaporates through these open cooling towers. In contrast, dry cooling technology does not rely on open evaporative cooling for the functioning of the main systems. As a result, overall power station use is about 15 times lower than a conventional wet-cooled power station.

Source: www.eskom.co.za

Matimba power station near Lephalale, in Limpopo, is the largest direct dry-cooled station in the world, with a capacity in excess of 4 000 MW.



Improved Irrigation Planning a Mouse Click Away



Lani van Vuuren

The latest version of the celebrated SAPWAT program to be launched later this year promises to be a powerful and user-friendly irrigation water planning tool, writes developer Pieter van Heerden.

With some 60% of South Africa's water use being in the agricultural sector it is important that water supply planners, irrigation scheme managers, system designers and irrigation farmers have access to reliable methods for estimating the irrigation requirements of crops. In the early years, guidance was provided by the so-called 'Green Book' titled *Estimated Irrigation Requirements of Crops in South Africa*, published in 1985. This publication became the accepted methodology for determining irrigation quotas.

HISTORY OF SAPWAT

In 1992, the Food and Agriculture Organisation (FAO) of the United Nations published CROPWAT, a computer program to help agro-meteorologists, agronomists and irrigation engineers to carry out standard calculations for evapotranspiration and crop water use studies and, more specifically, the design and management of irrigation schemes. The program proved very simple to use, even by first-time computer users with little or no training.

"SAPWAT 3 weather database is 50-year daily weather data for more than 2 000 quaternary drainage regions for South Africa."

CROPWAT became the internationally accepted irrigation planning methodology and still maintains that position. However, it never came into general use in South Africa. A report on the expert consultation on procedures for revision of FAO guidelines for prediction of crop water requirements indicated that there was a need to develop crop factors based on calculating evaporation and transpiration separately to cater for non-standard crop growth situations and irrigation practices. This was particularly important in South Africa and other countries where emerging farmers with limited resources required specialised support.

The Water Research Commission financed a project by MBB Consulting Engineers to develop a procedure to succeed the Green Book. In consultation with Martin Smith of the FAO it was decided to start with CROPWAT and to concentrate on separating evaporating and transpiration as well as on upgrading procedures to cater for 'modern' irrigation methods such as micro, drop, centre, pivot and short furrow irrigation while maintaining CROPWAT's simplicity and user-friendliness.

Naturally this had to be in context of South African crops, soils and practices utilising extended databases and relevant research data. SAPWAT – a computer program for establishing irrigation requirements and scheduling strategies in South Africa was finally released in 1999, and by and large achieved the envisaged objectives. The program has gained general acceptance in South Africa.

SAPWAT is not a crop growth model. It is a planning and management tool relying heavily on an extensive South African climate and crop database. It is general in applicability in that the same procedure is used for vegetable and field crops, annual and perennial crops and pasture and tree crops.

It is possible to simulate wide-bed planting, inter-cropping and different

irrigation methods. In addition, the effect of soil water management options, such as deficit irrigation, can be evaluated.

It extended the applications provided by CROPWAT and facilitates so-called 'designing for management'. It creates a 'computer game' atmosphere that promotes consultation and interaction between farmers and advisors.

“A crop budgeting routine was added to assess the influence of various cropping systems on irrigation water requirements and on gross income, expenses and gross margin.”

UPDATING THE PROGRAM


Pieter van Heerden, the developer of SAPWAT 3, became frustrated when applying SAPWAT to a wide range of conditions because exporting results was a chore, and in many cases involved utilising external spreadsheets. To solve this problem he developed, under the auspices of the International Water Management Institute, the PLANWAT program in dBase that made it possible to manipulate and process SAPWAT-generated output applicable all the way from a single vegetable bed to a 10 000 ha water user association.

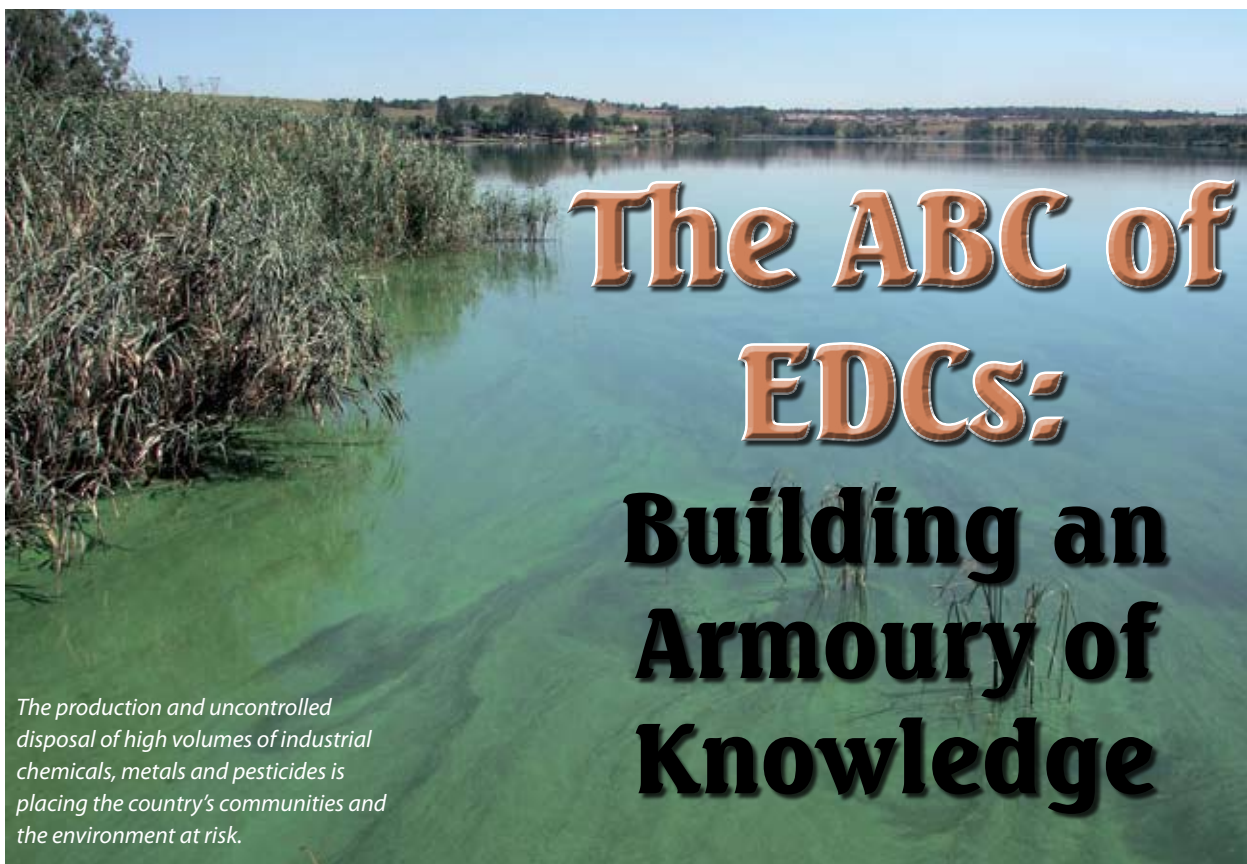
He also added the methodology required to estimate the volume of runoff that could be harvested from a household plot in the rural areas during the rainy season as well as the storage volume of water required to see the garden through the dry season. In addition, a crop budgeting routine was added to assess the influence of various cropping systems on irrigation water requirements and on gross income, expenses and gross margin.

SAPWAT 3 integrates an upgraded version of PLANWAT with the latest SAPWAT crop irrigation requirement engine. One of the shortcomings of CROPWAT and SAPWAT was that calculations were based on long-term average climatic data. Included in the SAPWAT 3 weather database is 50-year daily weather data for more than 2 000 quaternary drainage regions for South Africa as produced by the University of KwaZulu-Natal. The user can estimate year-on-year irrigation requirements for any sub-period of the 50-year data set and can compare different periods with each other to investigate the effect of wet and dry years.

All data tables, except the climate table, are open for adding or editing data by the user so that data can be adapted to local situations. The climate data is based on the internationally accepted Köppen climate system and SAPWAT 3 uses weather station data to place a weather station and its associated region in a climate zone. In addition, crop data is adapted for different climate zones.

The new program also provides for:

- ◆ Storage of data on different hierarchical levels to simplify irrigation water planning, use and analysis of use on different levels;
- ◆ Comparison of the effect of different irrigation strategies on evaporation loss;
- ◆ Comparison of the effect of different irrigation strategies on irrigation water requirement;
- ◆ Comparison of year-on-year variation in irrigation requirement due to year-on-year variation in climate;
- ◆ The influence of irrigation systems and their efficiencies on irrigation water requirements;
- ◆ The influence of soils and their characteristics on irrigation water requirements; and
- ◆ The effect of various cropping systems on irrigation water requirement and on gross income, expenses and gross margin. 



Lani van Vuuren

The production and uncontrolled disposal of high volumes of industrial chemicals, metals and pesticides is placing the country's communities and the environment at risk.

In part two of the series on endocrine disrupting chemicals (EDCs) Lani van Vuuren looks at the South African EDC Research Programme and the need for building an armoury of knowledge to contain and manage these potentially harmful substances.

EDCs can enter the water environment by direct discharge into water, the use of pharmaceuticals and chemicals in household and in agriculture and industry, accidental spills and releases of compounds and indirectly through diffuse sources, such as storm-water runoff. In turn, natural hormones, including estrogens, can be released into the environment via sewage effluent and from sources such as animal feedlots.

Concerns over the potentially harmful effects of EDCs on humans and wildlife have been rising worldwide over the last two decades. In an attempt to answer some of these concerns the South African EDC Research Programme was initiated under the leadership of the Water Research Commission (WRC) in 1999. The main objective of this programme is to investigate the occur-

rence, magnitude and affect of EDCs in water systems and to determine to what extent the population and the environment are at risk by being exposed to these chemicals.

Prior to the start of the programme few of the exposure routes of potential EDCs, and hardly any of the suspected health effects had been investigated. Also, the capacity to study these chemicals was virtually non-existent.

The first WRC-funded study on EDCs was published in 2000 and was an evaluation of these substances found in South Africa. The next two projects, undertaken by Prof JH van Wyk from the Department of Zoology at the University of Stellenbosch, were on the development of bioassays using egg-laying species such as freshwater fish, frogs and turtles.

Around this time the WRC became involved in the Organisation for Economic Cooperation and Development (OECD). At that time most developed countries were starting to initiate extensive EDC research and monitoring programmes, and passing laws to mandate environmental protection agencies to start evaluating and developing screening programmes for these chemicals.

The first Global Water Research Coalition (GWRC) workshop on EDCs was hosted by the WRC in 2002. Workshop participants included representatives from research organisations in the US, Australia, France, Germany, The Netherlands, and the UK. The resultant workshop report, *State of the Science Report on Endocrine Disrupting Chemicals in Water Systems*, included knowledge gaps and research needs for the GWRC, a priority

list of EDCs, occurrence of EDCs in water systems and an overview of sources and biological testing methods for EDCs.

"The study of EDCs requires a multidisciplinary approach," explains WRC Research Manager Annatjie Moolman. "As a result, a strategy research plan has been developed. The early years of the programme focused much on capacity building, both of selected laboratories to undertake the research as well as honing the skills of a network of researchers and scientists in the field. The latter has been done under the guidance and leadership of EDC Programme Manager Ansie Burger."

BUILDING CAPACITY

Assistance was provided to the following universities and research organisations: University of Pretoria (UP), University of Stellenbosch, University of Fort Hare, University of Venda, Medunsa, Tshwane University of Technology, the Agriculture Research Council, CSIR, South African Bureau of Standards and Ampath, a pathology laboratory.

Various research institutions were encouraged to build human resource capacity by training students of especially previously disadvantaged backgrounds. "The aim was to create centres of excellence where EDC research was already being undertaken," says Moolman.

Scientists generally use two types of tests to evaluate whether water contain EDCs. First, researchers can directly measure the concentrations of individual compounds in a sample using analytical methods (the results of these tests, however, will not directly show whether exposure to that material will disrupt the endocrine system).

Second, scientists test a sample to determine whether exposure to that sample could affect a subject's endocrine system. Laboratory technicians perform this type of test, called a bio-assay, either *in vitro* or *in vivo*. *In vitro* test methods use cell cultures to determine, for example, whether

a sample contains compounds that can bind with a hormone receptor. In turn, *in vivo* tests expose a population of animals, such as fish, to water so that technicians can observe the biological response.

After compiling a list of priority compounds in collaboration with stakeholders such as the Department of Water Affairs & Forestry and the GWRC, specific methods for activity testing and chemical analyses were evaluated. Methods for activity testing were validated and verified and selected on grounds of sensitivity, selectivity, repeatability and robustness. "These tests were mainly biochemical and not easy to conduct and would only represent one receptor mode of action, for example, estrogenic activity. This means that assay would not given any indication of the effect on the thyroid, immune or nervous systems, for example," notes Moolman.

The WRC took the initiative to use and evaluate different methods during a limited surveillance survey involving four

test sites in Gauteng, KwaZulu-Natal, and North West. The sites were selected based on the suspicion of the presence of EDCs. EDC activity was detected at all the sites and the presence of EDCs was confirmed by chemical analysis.

PILOT STUDY

The initial study was followed up by a pilot study conducted in an urban nature reserve in Gauteng. This study, led by Prof Riana Bornman of UP's Department of Urology, represented a first attempt at using local endemic vertebrate species in and around a study site as bio-indicators in investigations into environmental estrogenic activity. At that stage, this was one of the most comprehensive EDC studies to be undertaken in the world. Both bio-assays and chemical residue analyses were used to determine whether sufficiently high levels of EDCs exist in the general environment to exert adverse health affects on aquatic and/or animals and humans.

The findings of a study into the effect of endocrine disrupting chemicals (EDCs) on eland in an urban nature reserve were the first indication of mammalian wildlife being affected by environmental pollution of EDCs in South Africa.



SA Tourism

The small reserve receives effluent from sewage treatment plants, industries and informal settlements in the catchment area, making it an ideal site to study the presence of EDCs and the possible effects on the environment and species living there. Previous and ongoing studies in this area also provided valuable background information on the study site.

Water and sediment samples were collected from the two dams in the reserve, a channel and wetland every two months over a period of two years. Analytical chemistry and bio-assays were then performed to test for estrogenicity. Roots from aquatic plants in the area were also examined. Sharptooth catfish, African clawed frogs, freshwater snails, eland and striped mice were evaluated as possible biomarker species for EDC exposure.

The study concluded that wildlife in the area is already affected. Wildlife exposure seems to manifest in feminisation of fish and amphibian species, and on conditions such as intersex (forming of eggs in the testes). Other findings include high chemical residue levels in water, sediment and tissue of the animals studied, skewed sex ratios, reduced biodiversity, and gonadal malformations of fish, snails, mice and eland, among others.

"It is highly unlikely if at all possible that such a diversity of effects in a range of animals could be coincidental," noted Prof Bornman at a workshop to present the findings to stakeholders in 2007. These findings were also the first indication of mammalian wildlife being affected by environmental pollution of EDCs in South Africa. Another world first was the health risk assessment undertaken at the reserve to determine the potential risk to the human population.

GLOBAL RECOGNITION

The WRC-led pilot study has been recognised abroad for its innovative approach to researching EDCs. At a workshop of the Water Environment Research Foundation (WERF) held in San Francisco, in the US, last year, participants agreed that

it makes more sense to integrate occurrence, fate and transport, the analytical methods (including chemical target analyses and bio-assays), and health effects (environmental and human) in water-related projects. They maintained that this approach would give a better understanding of the impact of different chemical groups and would stimulate information development for communication, but also the development of new technologies for water treatment.

The WRC has further funded a pilot investigation to assess the present of estrogenic activity during the various processing steps of drinking water treatment. The study, which was recently published, investigated three drinking water plants in Gauteng. Source water and water from selected treatment processes were tested. A battery of *in vivo* and *in vitro* biological and biochemical techniques were applied, while chemical analyses were used to establish EDC residues in water.

The bio-assays showed estrogenic activity in source and treated drinking water, while chemical analysis also indicated the occasional presence of EDCs in water samples. Water treatment processes removed some of the EDCs, with final water (after chlorination) showing most reduction in EDCs.


These results are similar to findings of studies globally. An important factor in the efficiency of water treatment plants to reduce or remove estrogenicity is the source water quality.

THE WAY FORWARD

Despite the progress made through the EDCs Research Programme to date, many uncertainties remain, especially regarding the potential health risk of EDCs to the human population. Scientists working on the programme say they have hardly discovered the tip of the iceberg, and much more work needs to be undertaken. "Most of the EDC research we are funding at present is still aimed at refining scientific measures to improve the quality and accuracy of the research,

to enable us to prove beyond a doubt the potential risk and effects of exposure to EDCs," notes Moolman.

More research is also required to uncover the different exposure routes to EDCs. Moolman reports that South African researchers are also involved in projects funded by the National Research Foundation and the Medical Research Council looking beyond water sources to other potential exposure routes, such as food.

In lieu of this uncertainty, policy-makers are advised to take a precautionary approach when dealing with the issue of potential EDCs. Scientific research into the potential affects of EDCs will continue for many years into the future, notes Moolman. "Meanwhile the growing body of evidence suggests that there are chemicals present in the environment that are potentially harmful to not only present generations of humans and wildlife, but also perhaps future generations. We need stricter legislative control over these substances and we need to start looking for safer alternatives to avert risks of serious or irreversible harm to humans and the environment." 

FURTHER READING

- The Use of Sentinel Species to Determine the EDC Activity in an Urban Natural Reserve (**WRC Report No: 1505/1/07**)
- An Investigation of the Estrogenic Activity in Water from Selected Water Treatment Processes (**WRC Report No: 1532/1/08**)
- The Development and Validation of Bioassays to Detect Estrogenic and Anti-androgenic Activity Using Selected Wildlife Species (**WRC Report No: 926 & 1253/1/05**)
- Health Risk Assessment Protocol for Endocrine Disrupting Chemicals (**WRC Report No: KV 206/08**).

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Courtesy of CSIR

A household food garden in Madombidza, Limpopo, with a ventilated improved pit toilet in the background. Communities which had little or no exposure to ecological sanitation were found to have less knowledge of the fertiliser value of human excreta.

Recycling Human Waste Still Taboo in SA

Despite the increased supply of urine diversion (UD) toilets as basic sanitation facilities in peri-urban and rural areas in South Africa, the use of human excreta especially for food production is not gaining ground. This is one of the main findings of a new report published by the Water Research Commission (WRC). Lani van Vuuren reports.

The report, *Social/Cultural Acceptability of Using Human Excreta (Faeces and Urine) for Food Production in Rural Settlements in South Africa*, follows years of research by the CSIR's Built Environment Unit (BEU). The study was aimed at determining the acceptability of using human excreta as fertiliser for food production in rural settlements.

The UD toilet, also known as a dry toilet, is a form of ecological sanitation (ecosan). Ecosan is not so much a technology than a sanitation philosophy. It can be viewed as a three-step process: containment, sanitation and recycling

of human excreta. The ecosan approach to sanitation promotes a cycle or 'closed loop' system. Human excreta is treated as a resource and processed (usually dried and/or composted) until it is completely free of disease organisms. The nutrients contained in the excreta are then recycled by using them as fertiliser in agriculture.

The UD toilet basically operates as follows: waste is deposited in the chamber and dry absorbent material, such as wood, ash, straw or vegetable matter is added after each use to control moisture, control odours and flies, and facilitate biological breakdown

(i.e. composting). Urine is separated from the faeces through a specially adapted pedestal. While the urine may be collected and used as fertiliser, in South Africa it is usually diverted to a soakaway. About 4% of households in the country make use of dry toilets.

The desiccated faeces make a good soil conditioner, while urine is an excellent source of fertiliser, being rich in nitrogen, phosphorus and potassium. Despite these benefits, and the need to improve food production, especially in the rural areas, the handling of human excreta is still a very foreign idea in South Africa.

HUMAN EXCRETA REUSE – AN OLD PRACTICE

The recovery and use of human excreta for food production is not a new practice. The best known example of the collection and use of human excreta is that of China. It is reported that the Chinese were aware of the benefits of using excreta in crop production before 500 BC enabling them to sustain more people at a higher density than any other system of agriculture. The value of night soil as a fertiliser was clearly recognised with well developed systems in place to enable the collection of excreta from cities and its transportation to fields. Farmers even owned outhouses where they invited visitors to leave behind their 'valuable' excreta.

Early Europe, Greek and Roman societies collected human excreta and used it as fertiliser. The Romans also realised the cleaning power of urine and used it to wash clothing. Collecting it actually became a good business. So-called 'fullers', who worked in laundries, would install amphorae in streets and alleyways as public urinals passing regularly to collect the urine, and transporting it back to the laundry for washing.

The Japanese too practiced a disciplined use of excreta in agriculture, applying at rate of up to 4 t/ha on fields. Statistics from the Japanese Bureau of Agriculture for 1908 state that almost 24 million tons of excreta had been used on around 13,5 million hectares of arable land. Like the Romans, the Japanese provided public toilets with the express aim of collecting excreta for use.

In Mexico and Peru, both the great Aztec and Inca cultures collected human excreta for agricultural use. In Peru, the Incas had a high regard for excreta as a fertiliser, and would store it, dried and pulverised, to be used when planting maize.

MISCONCEPTIONS

The WRC study, which took the form of a qualitative survey, was undertaken in settlements in four provinces, namely the Northern Cape, Eastern Cape, Limpopo and KwaZulu-Natal. Both households who had UD toilets and those who had other forms of sanitation, such as ventilated improved pit toilets, were included in the study.

The research showed that most of the users accepted the UD toilet as a toilet only (mainly because they did not have a choice or the money to buy a flush toilet), and their expectations were still to eventually have flush toilets.

While people were generally aware of the fertiliser value of human excreta and did not ascribe any cultural beliefs, values or taboos to human faeces or urine, it was generally considered totally unacceptable for people to handle human faeces, especially concerning food production. "Food and human faeces are not supposed to be even mentioned in the same breath," Louiza Duncker of the BEU told delegates at the Second Dry Toilet Conference in Finland in 2006.

She said that, in many cases, users were not aware of the correct transmission routes of excreta-related diseases, for example, many households focused on keeping the floors clean in the UD toilet as a prevention method for disease instead of keeping the pedestal clean and washing their hands. Some believed that a person could be infected by



Courtesy of CSIR

Interviewees in Augrabies, in the Northern Cape

handling human faeces and even by inhaling the smell of it. A number of chest infections, such as influenza and colds, were said to have been caused by the smell of human faeces. Other respondents believed they were at risk of contracting HIV/AIDS if they handled human faeces.

"Food and human faeces are not supposed to be even mentioned in the same breath."

"In South Africa the perceptions and beliefs of the users represent a major stumbling block to the use of the products from dry toilets," said Duncker. "The general norm of not touching human excreta is also strengthened by programmes and interventions such as the WASH campaign and other hygiene awareness programmes." The messages from these campaigns are in direct opposition to the purpose and objective of the closed loop strategy of ecosan.



Courtesy of CSIR

A hand-washing facility outside a urine diversion toilet in Mthatha, in the Eastern Cape.

THE IMPORTANCE OF TRAINING

The only area where significant numbers of households could be found who reuse human excreta was Mthatha, in the Eastern Cape. Here, 88% of respondents said they used human faeces in their vegetable gardens and maize fields. These households have been using UD toilets for eight years and have accepted the technology completely.

In Mthatha area the communities were involved in the implementation of the projects and received extensive training on the operation and maintenance of the UD toilets. Follow-up and support after implementation of the projects and retraining were conducted to ensure the sustainability of the toilets. This is said to have had a major impact on the view and perception of the respondents.

In other areas which had UD toilets, the contents of the vaults were mostly burnt or buried. No cases were found where the urine was collected, and all of the UD toilets had soakaway pits. Those that did not have UD toilets were generally unwilling to use excreta in their gardens, citing it as being 'unhygienic', 'smelly', 'unacceptable' and 'repulsive'.

The quality of construction of the UD toilets also had a major impact on perceptions. In Augrabies, in the Northern Cape, many of the UD toilets had been constructed by 'fly-by-night' contractors using inferior materials, which had a major impact on the sustainability of the systems. Because the UD toilets had been constructed badly the contents of the vaults were wet and smelly making the task of emptying the vaults unpleasant and unhygienic.

A WOMEN'S ISSUE

In general the female respondents had a higher level of knowledge regarding the fertiliser value of human excreta and the medicinal value of human urine. Nearly

Mthatha, in the Eastern Cape, was the only area where a significant number of respondents could be found who use human excreta in their gardens.



Courtesy of CSIR

50% of women interviewed were aware of the fertiliser value of human excreta compared to 25% of men. The traditional gender role in the communities were still observed, with sanitation regarded mostly as a 'women's issue'.

“Respondents believed they were at risk of contracting HIV/AIDS if they handled human faeces.”


Many users felt it was unhealthy to eat vegetables grown in dry human faeces, especially leafy vegetables that are in contact with the soil. Vegetables such as tomatoes and anything that could be picked off of the plant itself and does not touch the soil are perceived relatively clean and edible, but not lettuce, spinach, cabbage or any vegetable that grows underground (such as potatoes, beetroot, onions and carrots).

LEADING BY EXAMPLE

The respondents were asked what they thought might work to change the minds of people towards using human excreta as fertiliser and soil conditioner in their gardens. Those respondents who were already using UD toilets thought that demonstration gardens, leading by example (i.e. councillors and people with high standing seen using human excreta) and educational workshops would be the best way to inform people

and change their attitudes towards using human excreta for food production.

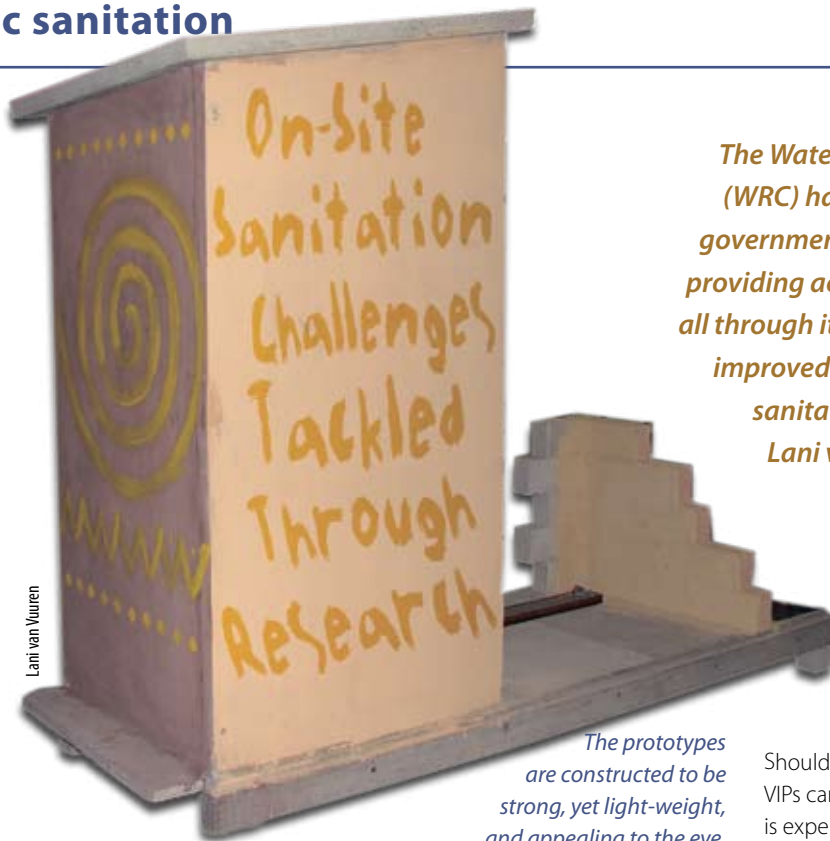
“The use of products from dry toilets will not happen automatically in South Africa,” noted Duncker. “Constant intervention and awareness raising will be needed to address the general norm of not handling faeces. A strategy needs to be developed to facilitate attitude change and a mind shift with the users.”

To order the WRC report (**Report No: TT 310/07**) contact Publications at Tel: (012) 330-0340 or E-mail: orders@wrc.org.za 

HISTORIC USE OF HUMAN EXCRETA IN SOUTH AFRICA

While human excreta is generally perceived in South Africa as 'dirty' and unusable, studies by CSIR revealed a number of ways in which human waste was used in earlier times. Wet faeces was used to heal wounds. It was also applied to snakebites to remove the poison.

Women who used cow dung to plaster the floors of their huts used to apply babies' first urine of the day to wash their hands prior to working with the cow dung. This practice was believed to 'cast a spell' on one's hands to avoid it being handicapped. Urine was also used for medicinal purposes, for example, to treat eye infections.



Lani van Vuuren

The prototypes are constructed to be strong, yet light-weight, and appealing to the eye.

The Water Research Commission (WRC) has put its weight behind government's commitment towards providing access to safe sanitation for all through its support for research into improved and sustainable on-site sanitation superstructures. Lani van Vuuren reports.

The latest statistics reveal that at least 6,5% of South Africa's population of 48 million people make use of on-site sanitation systems such as ventilated improved pit (VIP) toilets. Municipalities, who are now responsible for providing basic services, are increasingly rolling out these on-site sanitation systems, especially in rural areas. It is expected that in meeting the national sanitation target of 2010, it is expected that more than three million VIPs will be built.

It is reported that on-site dry sanitation technologies are able to provide long-term, safe and dignified sanitation to users. While VIPs are considered an appropriate basic sanitation technology choice, their lifespan is decidedly short term, with pits filling up after only a few years of use. This means that either the pit needs to be emptied or a new pit has to be dug. Compounding this situation is the fact that VIP superstructure construction as proposed by guidelines offer no easy access to the pit other than through the pedestal.

"Many VIP latrines have been built with permanent superstructures. Pits are filling up much faster than their design life," explains WRC Director: Water Use &

Waste Management Jay Bhagwan. "Then, there is conflicting advice on what should be put into pits to keep them operating well. Unfortunately, a variety of undesirable non-degradable objects are usually found in full pits which may complicate pit emptying exercises."

"Pit emptying is not only extremely hazardous because of the harmful contents, it is also expensive."

Bhagwan explains that there is a tendency to use pits for the disposal of household waste, much of which is non-biodegradable. In addition, despite education and awareness programmes which strongly advise against this, many users are in the habit of dosing their pits with disinfectants to reduce odours and poisons such as sheep dip to reduce fly breeding.

"At the rate of current supply, this means that millions of pits will either be full or filling up in the next few years. Pit emptying is not cheap and easy. Research undertaken by municipalities such as eThekweni reveals that emptying one VIP could cost as much as R1 150," notes Bhagwan.

Should desludging prove difficult, new VIPs can be constructed. However, this is expensive and contributes to the sanitation backlog. The alternative is to construct a new pit and move the superstructure. The implications of these developments are profound, and will have a huge impact on the sustainability of the technology and sanitation in general. In many cases, moving the superstructure is not possible, due to the nature of the materials being used to construct the VIP (i.e. a conventional brick and mortar superstructure can weigh 1,5 tons). Critical skills shortages also make it difficult for communities to construct their own toilets, with sustainability often hampered by the use of sub-standard products and shoddy workmanship.

VARIETY OF SYSTEMS

In response to these challenges, the WRC is supporting research by the University of Pretoria (UP) in the development of alternative materials for the construction of superstructures for on-site sanitation systems. The aim is to create a light-weight superstructure which can either be moved by the household or disassembled easily and the material reused to build another structure, explains Elsabe Kearsley, Associate Professor at UP's School of Civil and Biosystems Engineering, who is leading the research. The superstructure

will be applicable to either VIPs or urine-diversion (UD) systems.

Community buy-in and acceptance is a crucial aspect of the project. "The technology of a latrine is just one aspect of design. If it is intended that the latrine be widely accepted and desired by people, then it must be liked," explains Kearsley.

Therefore the choice of material becomes very important. The project team found that there are various systems available in South Africa for the construction of the superstructure of toilets. These systems can be divided into two main groups, mainly the light-weight systems that can be moved (for example, pre-cast plastic and/or fibreglass) and systems that cannot be moved, but the material may be reusable in the construction of a new superstructure (for example, Archloo, compressed stabilised earth blocks). It has been found that the only way of improving the systems already in existence would be to reduce the volume of material used by the toilet superstructure.

The systems with the largest community involvement are those where the bricks and slabs are manufactured by the

community. Unfortunately, these systems are also prone to failure as a result of traditional lack of quality control. The systems that seem to work best are the pre-manufactured systems that are just assembled on site.

ALTERNATIVE MATERIALS

The UP project team has set out to create an alternative superstructure meeting the following criteria:

- ❑ The superstructure should be usable for different types of sanitation systems (including VIP and UD toilets);
- ❑ The slab should be manufactured to allow access to the pit other than through the pedestal;
- ❑ The superstructure has to be moveable;
- ❑ The superstructure must be adjustable to allow changes in layout (i.e. to accommodate a disabled person or a patient that requires assistance);
- ❑ The local community must benefit financially from the construction process;
- ❑ The superstructure has to be durable and aesthetically acceptable; and
- ❑ The risk of failure of critical components has to be limited.

Two types of systems are being investigated at present: a system that can be dismantled, and another system which uses foam concrete blocks that can be reused if the structure is moved. The volume of material used is being reduced by using very high-strength concrete in the panels and entrapping large volumes of air (more than 50% of the volume) into the blocks.

Tests are being conducted on all the full-scale structures to ensure that they can withstand the forces that they will be subjected to during a typical lifespan without undue distortion or distress. These forces include wind loads, impact loads, loads from people or sharp-edged objects colliding with walls, door slamming and localised loads caused by various fittings.

FIRST PROTOTYPES

While the project team is only one year into the three-year project, the first prototypes have already been manufactured. The first toilet was completed using high-strength concrete panels



UP concrete technologist Derek Mostert demonstrates the ease of casting foam bricks.





Lari van Vuuren

One year into a three-year project the UP project team has come up with a number of VIP prototypes using alternative materials, such as light-weight foam bricks.

varying in thickness between 16 mm and 20 mm. The superstructure weighs only 450 kg.

“The technology of a latrine is just one aspect of design. If it is intended that the latrine be widely accepted and desired by people, then it must be liked.”


The panels can be manufactured in a factory and transported to site where local labour can be used to construct the units. Alternatively rural communities can be provided with bags of blended material that can be mixed with a small mixer and cast into moulds without vibration. “By training rural builders and setting them up with basic equipment and moulds, it should be possible for rural communities to make their own pre-cast panels. These builders could operate in a type of franchise system where they do not have to pay for the materials and equipment upfront.”

A second superstructure prototype has been constructed using lightweight foam concrete blocks. The blocks are 140 mm high, 90 mm thick and 300 mm long. They are stacked dry thus requiring no skills normally associated with constructing masonry walls. Because of the reduced weight the blocks are easily handled by, for example, female builders, and the size of the blocks can

be adjusted to suit the application. This version weighs only 300 kg, still much lighter than its brick-and-mortar cousin.

To ensure that the walls are not blown over in storms, the blocks are manufactured with holes in the core, through which a steel bar is placed to tie the roof to the floor slab. After the blocks have been placed, a polypropylene net or carpet backing can be placed over the surface to strengthen it further. “If this system is used for a moveable superstructure, the net can be pulled off the surface, the bricks can be re-used and a new layer of net and sprayed concrete can be applied within a day,” says Kearsley.

A modular floor slab has also been designed to allow for easier access to the pit. The floor panels can be adjusted to suit individual requirements for emptying of the pit as well as variations in superstructure layout.

More prototypes are being constructed to further improve the design and materials. In all of the cases the price of material is equivalent to the price of a conventional superstructure. It is hoped to eventually launch a pilot scheme in which one of various new superstructures can be evaluated and community input received. 



Kathy Eales

Government is increasingly rolling out VIP toilets in an effort to reach its sanitation targets.

Water Law Publication A First for SA

The new water law compendium, published by the Water Research Commission (WRC) is proving a valuable legal resource in the implementation of the National Water Act (NWA).

Lani van Vuuren reports.

The publication, *Water Law of South Africa 1912 – 1998*, captures nearly 400 water court cases handled by the legal system from 1912 to 1998. The work is authored by water law expert Adv Maritza Uys and took almost four years to complete.

'Water law' is concerned with persons' rights to water and concomitant duties of others. Water courts were established by colonial legislation, consolidated in the Irrigation Act of 1912, and abolished by the NWA in 1998. All cases dealing with the then current general Water Acts (Irrigation Act of 1912 and Water Act of 1956) and common water law are included in the publication.

Interestingly, the first case captured in the compendium is dated 21 February 1912. It involved the case of Koffyfontein Estates Ltd (a diamond-mining company) vs Havenga (a farmer) over rights to water in the Riet River. Also included is the text of the 1912 and 1956 Water Acts and regulatory publications until 31 September 1998 when the NWA came into effect.

According to WRC Director: Water Resource Management Eiman Karar, the compendium is meant to fill the need for a legal source for use during the implementation of the NWA, and especially for purposes of determining existing lawful water uses, as defined in the Act. "During the investigation of this research, it was realised that, although certain import water court judgements had been published before 1970, these publications did not provide adequate data for purposes of utilisation for the various phases and

processes of implementation of the Act, and that a more complete source was necessary, containing all water cases."

She explains that the reason is that the justification for codification has changed: before the Act, judgements were used firstly by the affected parties to the cases to vest rights and, secondly, to report cases of special importance for purposes of use by the judiciary in the interpretation of the water law. "Under the 1998 Act, however, a complete record of all water cases is required, to determine existing lawful water uses for purposes of the establishment of water use entitlements under the new Act, and also to understand the water law of the previous dispensation, to facilitate continuity of water use and water resource development and management."

The majority of water court cases were decided before 1956, when water users relied heavily on the courts to establish and declare their water rights, mainly because the water law was a statutory system and not an administrative one. After the Act of 1956, the Minister of Water Affairs increased the assumption of control over water sources by the declaration of government water control areas. In these areas, water rights were administratively allocated, which had a huge affect on the role of the water court to determine water rights.


The Department of Water Affairs & Forestry is in the process of finalising the registration process under section 34 of the NWA as well as the verification process. To verify existing lawful water uses, DWAF and its

support practitioners will rely heavily on established rights, and will need legal sources to prove the existence thereof.

After verification, the even more onerous task of compulsory licensing will follow, which will once again rely heavily on historical water rights. "A well-recorded case register and publication of judgements will form one of the most important sources of both these processes to make the era of equitable distribution of water entitlements in the quest for redress not only in the water but also in the land allocations in South Africa," notes Karar.

Minister of Water Affairs & Forestry Lindiwe Hendricks has welcomed the compendium. "This is a valuable contribution from the WRC as being an outstanding knowledge dissemination initiative for the benefit of all users. Equity and redress are cornerstones in the NWA which signals an end to any discrimination in allocations of water. To be able to rectify misgivings of the past, we need to be fully aware of the history and learn from it. This publication seeks to create a historical perspective of water laws in South Africa, and will be a vital resource for future planning scenarios."

Karar comments: "It is expected that water allocation practitioners as well as the water tribunal especially will find this addition a valuable one which fully justifies the investment made."

* To order the report and accompanying CD (**Report No: KV 203/08**), contact Publications at Tel: (012) 330-0340 or E-mail: orders@wrc.org.za 

Stop Killing our Rivers and Streams

Our rivers and streams are the lifeblood of our country. Without them we have no water to drink, no water for our factories and power plants, no water to grow our food, and no water for our environment.

Yet we are slowly killing our rivers by polluting them. What is water pollution? Water pollution is any substance introduced into a river, stream, lake or ocean that harms the natural resources found in those environments (such as plants and animals).

Lakes and rivers can naturally clean up a certain amount of pollution by dispersing it harmlessly. For example, if you were to pour a cup of black ink into a river, the ink would quickly disappear into the river's much larger volume of clean water. The ink would still be there in the river, but in such a low concentration that you would not be able to see it.

At such low levels, the chemicals in the ink does probably not present any real problem.

However, if you poured many litres of ink into a river every few seconds through a pipe, the river would quickly turn black. The chemicals in the ink could very quickly have an effect on the quality of the water. This, in turn, could affect the health of all the plants, animals and humans whose lives depend on the river.

This means that water pollution is all about quantities: how much of a polluting substance is released and how big



Abandoned and closed mines produce a large quantity of polluting chemicals. Many dangerous metals, including iron, aluminium, lead, mercury, chromium and cadmium come out of old mine workings and pollute water resources.

a volume of water it is released into. A small quantity of a toxic chemical may have little impact if it is spilled into the ocean from a ship. But the same amount of the same chemical can have a much bigger impact pumped into a lake or river, where there is less clean water to disperse it.

There are two different ways in which pollution can occur. If pollution comes from a single location, such as a

discharge pipe attached to a factory, it is known as **point-source pollution**.

Unfortunately, a great deal of water pollution happens not from one single source but from many different scattered sources. This is called **non-point-source pollution**.

When point-source pollution enters the environment, the place most affected is usually the area immediately around the source. This is less likely to happen with nonpoint-source pollution which, by definition, enters the environment from many different places at once.

WHERE DOES POLLUTION COME FROM?

It must be remembered that water is part of a deeply interconnected system. This means what we pour on the ground ends up in our water, and what we spew into the sky ends up in our water.

By depleting and polluting rivers, lakes and wetlands, we are destroying ecosystems

that play an essential role in filtering and assuring freshwater resources.

Water pollution has many different causes and this is one of the reasons why it is such a difficult problem to solve. Disposing of sewage is a major problem. Human waste landing up in river systems due to communities lacking toilet facilities, leaking faulty sewerage pipelines and overflowing sewerage treatment works can lead to

DID YOU KNOW?

- ◆ According to Guinness World Records, the worst **river pollution** in the world occurred in November 1986 when fire-fighters tackling a blaze at the Sandoz chemical works in Basel, Switzerland, flushed 30 tons of agricultural chemicals into the Rhine River, western Europe's most important waterway, killing about 500 000 fish.
- ◆ Every year, **200 to 500 million tons** of heavy metals, solvents, toxic sludge and other wastes accumulate in water resources from industry.
- ◆ More than 80% of the world's **hazardous waste** is produced in the US and other industrial countries.
- ◆ About two million tons of waste is dumped every day into rivers, lakes and streams. One litre of wastewater pollutes **eight litres** of freshwater.

water-related illnesses such as cholera and diarrhoea.

Wastewater for industries and mines is another source of pollution. Factories and mines are point sources of water pollution, but quite a lot of water is polluted by ordinary people from nonpoint sources. Virtually everyone pours chemicals of one sort or another down their drains and toilets. Even detergents used in washing machines and dishwashers eventually end up in our rivers. So do the pesticides we use in our gardens.



Harmful substances spilled into rivers can build up in the environment and aquatic life, for example, fish.

A lot of toxic pollution also enters wastewater from highway runoff and city sidewalks. Highways and typically covered with a cocktail of toxic chemicals – everything from spilled fuel and brake fluids to bits of worn tyres and exhaust emissions. When it rains, these chemicals wash into drains and rivers.

WHY DOES POLLUTION MATTER?

Some people believe pollution is an inescapable result of human activity: they argue that if we want to have cities, mines, factories and cars some degree of pollution is almost certain to result. Fortunately, not everyone agrees with this view. One reason people have woken up to the problem of pollution is that it brings costs of its own that undermine any economic benefits that come about by polluting. It affects our health, destroys our environments, and makes the water so much more expensive to treat for drinking purposes.

We need to make a choice: either we live with smelly rivers, and poisoned fish that we cannot eat, or we do our part to keep the environment clean so the plants, animals and people who depend on it remain healthy.



South Africa is a water-scarce country, thus it is extremely important that we safeguard all the water resources we have against pollution.



Kathy Estes

Solid and human wastes polluting our river systems can cause serious health hazards and outbreaks of diseases such as cholera and diarrhoea.



When it rains, chemicals and other polluting substances from city roads and sidewalks wash into drains and rivers.

STOP RIVER POLLUTION – HOW YOU CAN HELP

- ◆ Do not litter.
- ◆ Reduce your use of pesticides and fertilisers and look for safer alternatives to control weeds and bugs.
- ◆ Take part in local river clean-up campaigns.
- ◆ Always throw unwanted fishing line in a trash can, not in the water.
- ◆ Do not use toilets and stormwater drains to dispose of trash of any kind.
- ◆ Notify your parents or the authorities if you see someone dumping trash in a river or stream.

WRC Team Leads Visit to Peatland

In April the Water Research Commission (WRC) led a visit of international experts to the Mfabeni Mire, situated next to St Lucia, where it is funding valuable envi-

ronmental research. The mire is one of the oldest active peatlands in the world, reaching depths of 10,8 m. The area is known for its erratic rainfall and, during drier periods

Mfabeni contributes to Lake St Lucia's fresh water input. The team of international experts converged on the site to learn more about the wetland's workings.



Yvonne Gounden

Wetlands ecologist Prof Fred Ellery from Rhodes University, conservation ecologist Prof Ab Grootjans from the University of Groningen, the Netherlands, and hydrologist Prof Bruce Kelbe of the University of Zululand take measurements at the Mfabeni Mire.



Yvonne Gounden

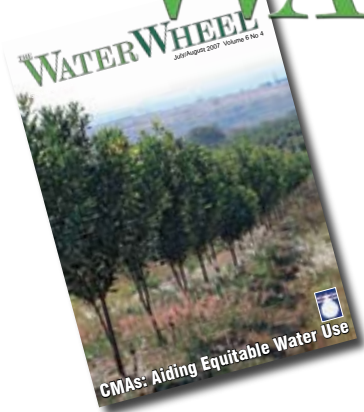
Piet-Louis Grundling, whose research in the area is being funded by the WRC, takes measurements at the site.



Yvonne Gounden

Television media interviewed international wetland experts at the Mfabeni site.

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