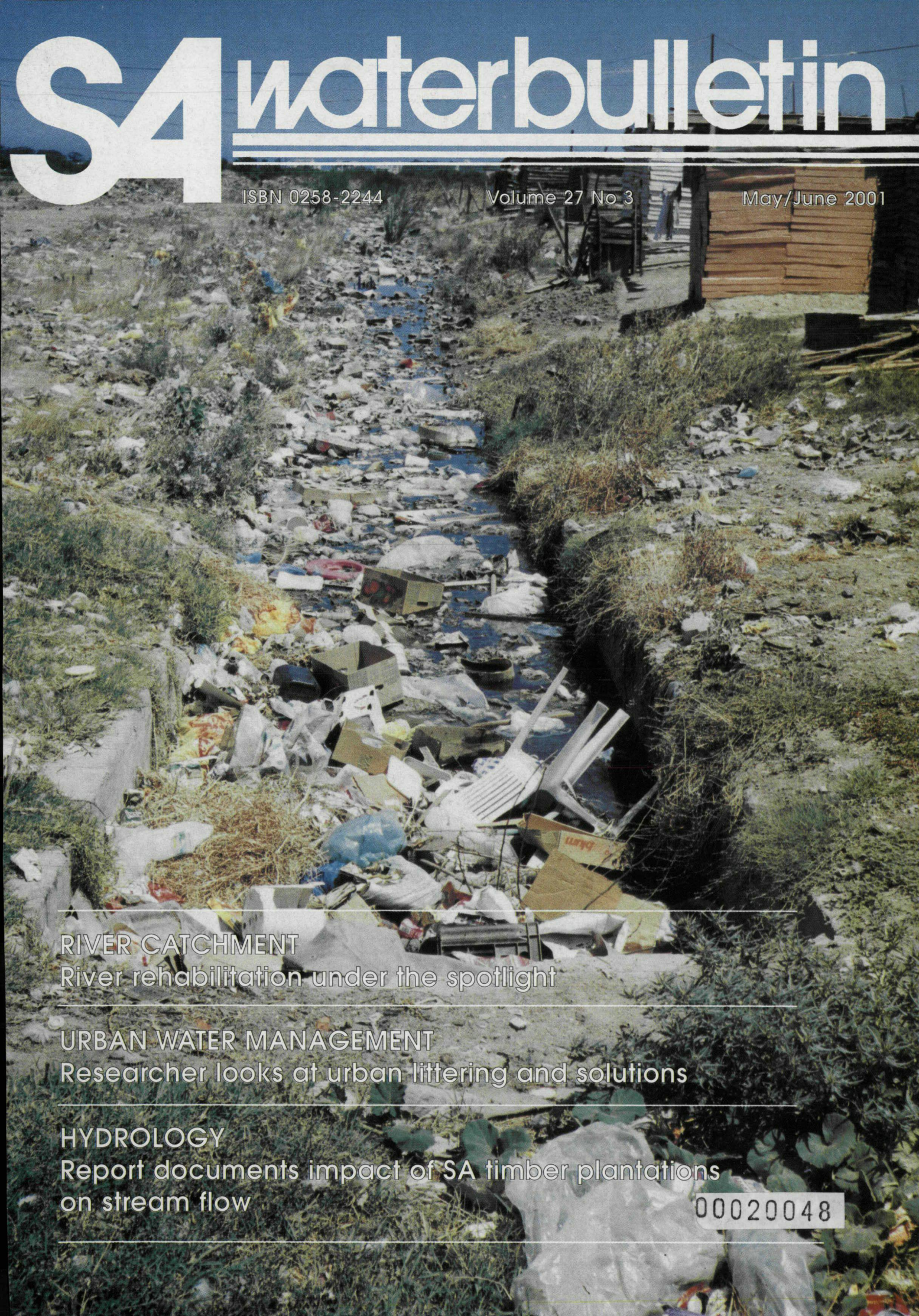


S4 waterbulletin



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RIVER CATCHMENT

River rehabilitation under the spotlight

URBAN WATER MANAGEMENT

Researcher looks at urban littering and solutions

HYDROLOGY

Report documents impact of SA timber plantations on stream flow

00020048

INTRODUCTORY COURSE in WATER MICROBIOLOGY

Division of Water,
Environment and Forestry Technology
CSIR • Pretoria

21 - 24 August 2001

Register before 30 July 2001

The Water Resources Management Programme, CSIR, is presenting a course for people in the water industry who need to know more about the basic techniques used in the microbiological analysis of water. The course is recommended for industries, municipalities, government departments, water boards and water bottlers.

The course will be limited to a maximum of 10 participants to ensure personal attention. They will be trained in the basic concepts of health related water microbiology. The theoretical (theory 25% and lectures 15%) and the practical (60%) aspects to be covered will include:

- Detection and enumeration of indicators of pollution (heterotrophic plate count, total and

faecal streptococci, coliphage and the confirmation of *E. coli*.

- Demonstration of the detection of other pathogens in water (viruses, parasites and *Legionella*).
- Interpretation and reporting of results.
- Lectures on water purification and water disinfection, the importance of the chemical composition of water and their related health implications, the geology and hydrology of ground water.
- Quality control and laboratory safety.

A certificate of attendance will be issued on completion of the course.

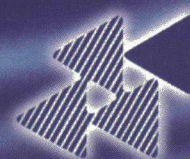
Should you be interested, please contact:

Pauline Coubrough

Tel: (012) 841 3952

Fax: (012) 841 2506

E-mail: pcoubrou@csir.co.za

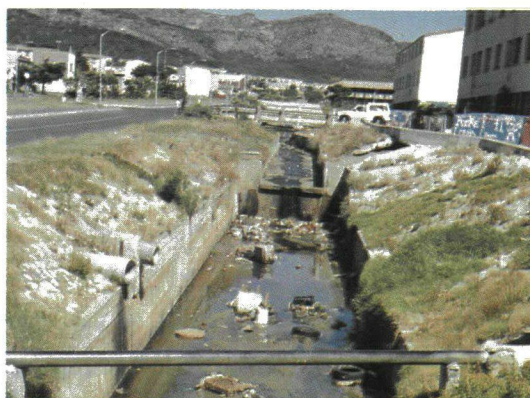


**Water,
Environment
and Forestry
Technology**

CSIR



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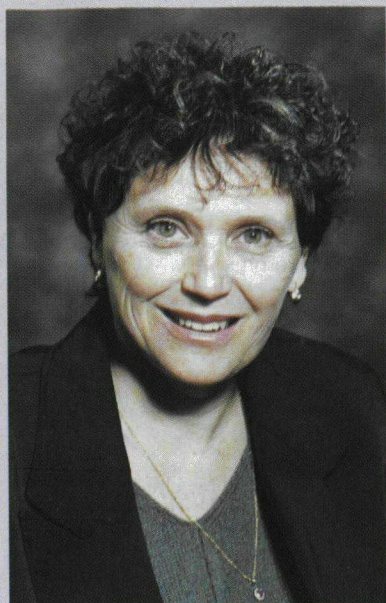
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Cover: Litter within the Cape Metropolitan Area. (Photo: Neil Armitage)

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New Executive Director appointed for WRC

Dr Rivka Kfir has been appointed as the new Executive Director of the Water Research Commission (WRC). She succeeds Dr Piet Odendaal, who retired at the end of August 2000. Dr Kfir, former Technology Manager at the CSIR, was the Executive Director: Knowledge Management and Strategy at the National Research Foundation (NRF) during the past year. She takes up her new position at the WRC on 1 July 2001.

Odendaal receives honours

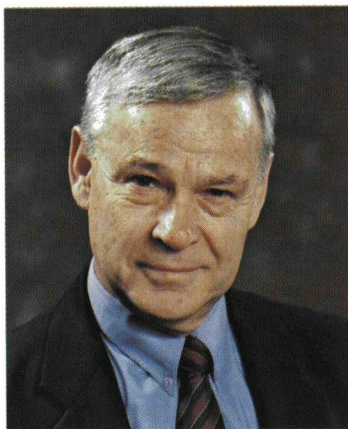
Dr Piet Odendaal, former Executive Director of the Water Research Commission (WRC), was recently honoured with a Doctorate in Engineering *honoris causa*, by the University of Natal. This honour was bestowed on him for "improving the living conditions of countless South Africans and for his international promotion of water research".

Odendaal is credited with promoting water research and collaboration as well as sustainable water management, in South Africa and internationally.

RESEARCH PARTNERSHIPS

He strongly believed in research partnerships amongst researchers and between institutions. Under his leadership the Water Research Commission developed and now follows a multi-disciplinary approach to research into all aspects of the water cycle in South Africa.

He was Chairman of the Institute of Water Pollution Control (Southern African Branch) in 1985, President of the Water Institute of Southern Africa



Dr Piet Odendaal

(WISA) in 1990, and awarded Honorary membership of WISA in 2000.

International highlights of his career were his election as Vice President of the International Association on Water Quality (IAWQ), 1995-1999, and then as President of IAWQ in 1999; the role he could play in engineering the merger between IAWQ and the International Water Services Association (IWSA) to establish the International Water

Association (IWA) in 2000; and becoming one of the two Co-Presidents of IWA upon its inception.

UNEXPECTED SURPRISE

Mr Odendaal told *SA Waterbulletin* that the honorary doctorate bestowed on him came as a totally unexpected surprise. He counted it a great honour, and indeed a privilege, as it pertained to something he really enjoyed doing. He said that he had been fortunate to be in a position where he could contribute towards promoting water research over a broad front. Furthermore, he also had opportunity, internationally, to facilitate collaboration and the exchange of information world-wide in pursuit of common goals.

"However, I also feel somewhat guilty for receiving this honour, as everything which I have attained in the water field was only possible with the support and collaboration of others," said he.

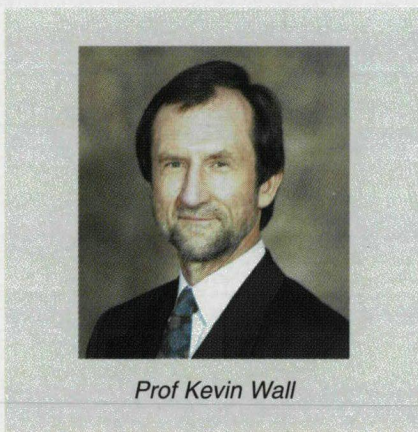
"A heartening aspect of this award is that it *de facto* enhances the profile of water research and management in SA."

SAICE President calls for sustained infrastructure development

The present President of the SA Institute of Civil Engineers (SAICE), Prof Kevin Wall, recently presented his SAICE presidential address as a public lecture at Wits, saying that sustained infrastructure development is an essential foundation for growth and development.

The focus of his address was on the civil engineers and local government which is "the sphere of government closest to the citizens". Wall pointed out that local government needs to be "developmental", saying that the Water Services Act, for example, strongly stresses the need for the development of competent local government to take responsibility for the provision of water and sanitation services.

In his address he outlined the importance of local government as the primary delivery agent for civil engineering services to the people of South Africa.



Prof Kevin Wall

He identified

- ☐ key issues of challenge and/or opportunity for local government and civil engineers with respect to services delivery, and
- ☐ key actions or programmes to be driven by SAICE in order to support civil

engineering service delivery by local government.

He said that the civil engineering professionals of South Africa could be proud of the infrastructure that they have built over the decades. However, civil engineers should aim to be relevant by seeking and actively promoting solutions that enable or enhance delivery of civil engineering services for the benefit of all South Africans. They should also be very concerned about issues such as inadequate maintenance, and the provision of unsustainable infrastructure.

Prof Wall is the manager of Urban Management and Infrastructure at Boutek, CSIR, and honorary professor at the University of the Witwatersrand (Wits). He has many years of experience in urban regional engineering and planning projects and had previously worked for the City of Cape Town, the Urban Foundation and Ninham Shand.

UP Environmental engineering presents successful short course



A short course on Environmental Management was presented by the Environmental Engineering Group of the Department of Chemical Engineering at the University of Pretoria during May 2001. The course aims were to provide participants with sufficient information to address general environmental management issues at the workplace, and to assist people in industry to maintain and expand their levels of expertise in environment-related subjects. The course leader, Mr Francois Friend, said that feedback from the 18 participants indicated that the objectives were well addressed. Three participants received certificates of attendance, while certificates of competence were

awarded to the fifteen participants who, in addition to attending the course, also successfully completed a brief assignment and test.

The three-day course included the following topics: environmental awareness, auditing, impact and risk assessments, integrated environmental management, environmental law in SA, responsible care in the industry, environmental economics, and public participation, amongst others.

According to Mr Friend, the course is ideally suited to personnel in an organisation wishing to obtain updated and relevant environmental education, irre-

spective of whether they are employed in general or functional management. It is designed to cater for managers, engineers, scientists and non-technical employees involved in environmental management and related processes. The short course is also presented in-house on request.

The next short course on Environmental Management will be presented from 18 to 20 September 2001, at the University of Pretoria. For more information please contact the course co-ordinator, Ms Tanya de Bruin, at Tel: (012) 362-5119 or 420-5015, Fax: (012) 362-5285, E-mail: tanya.ce@up.ac.za



One of the three study areas chosen for field sampling of water sources - the Hex River Valley.

Researchers investigate the occurrence of pesticides in rural water sources

In South Africa, data on pesticides in rural water sources are sparse, despite the fact that South Africa is a significant user of pesticides in agriculture. Available evidence suggest that the potential for environmental contamination is high. One study demonstrated significant residue levels of a range of locally used pesticides in farm dams in the Western Cape and a number of epidemiological studies have provided indirect evidence that environmental exposures, including water-related routes, may be important causes of pesticide-related morbidity in South Africa.

This is said in a report on water quality in the rural Western Cape released by the Water Research Commission. The University of Cape Town's Occupational and Environmental Health Research Unit in conjunction with the Departments

of Analytical Chemistry and Chemical Engineering at the Peninsula Technicon undertook the three-year investigation into the presence of pesticides in rural water sources in the Western Cape with the financial support of the Water Research Commission.

The researchers, L London, MA Dalvie, E Cairncross and A Solomons, say the study arose out of a concern for the lack of data on the presence of pesticides in rural water sources, and the important policy implications that pesticide pollution of water would have for rural development.

The project was undertaken in two phases, according to the report. Phase 1 was concerned with the identification of sites thought to be of concern from the perspective of potential contamination of

water sources, and the identification of appropriate sampling points within the study sites. Other aspects which received attention during this phase were: the choice of specific pesticides and metabolites for analysis; establishing reliable and accurate analytical methods for pesticide analyses, including the establishment of quality control and quality assurance protocols. Researchers also formalised protocols for field sample collection, pilot farm-base questionnaires and reviewed the literature, an activity that continued throughout the project.

Phase 2 involved the regular sampling of the selected sites, implementation of quality assurance protocols and ongoing liaison with stakeholder groups. Phase 3 consisted of the completion of farm-based user surveys, as well as the analysis and write up of the findings.

Three study areas were chosen for sampling - the Hex River Valley, the Grabouw/Vyeboom area and the Piketberg region. The basis for selecting these areas was that they represented a spread of farming activities in the region. They also presented a climatic and hydrological profile that was most compatible with the best likelihood of finding pesticides in ground water. The researchers say in that sense, the three sites were the "worse-case" scenarios, selected so as to maximise the possibility of detections, and were not representative of all agriculture in the region.

Analyses were conducted at the analytical chemistry laboratories at PENTECH for the main pesticides of concern, endosulfan and chlorpyrifos following standardised methods of extraction and analyses. Levels of quantification achieved in the laboratory (0.05 µg/l for chlorpyrifos and 0.1 µg/l for endosulfan isomers and endosulfan sulphate) were substantially lower than previously reported in the South African literature, and compatible with monitoring required for low level exposures of concern in other countries.

Parallel analyses, using similar methods were run at the State Forensic laboratories for 31 pesticides, including endosulfan and chlorpyrifos, as quality assurance and to detect substances for which the PENTECH laboratories were not adapted. Samples were also shared with the laboratories of the Agricultural Research Council as part of the quality assurance programme. The researchers say that overall, the quality assurance analyses suggested that for the two pesticides concerned, the PENTECH laboratories were achieving adequate quality assurance.

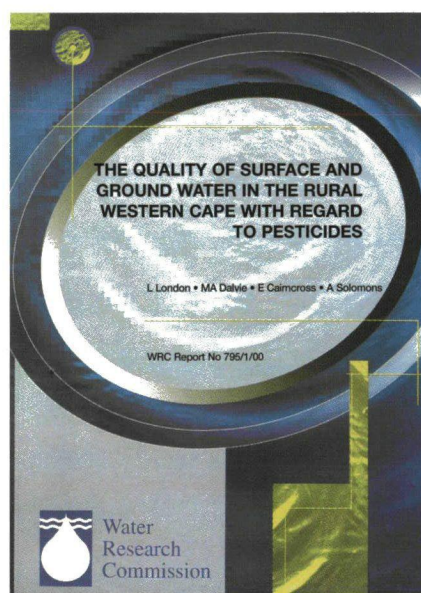
Field sampling was conducted on an approximately weekly basis with each study area being visited on a monthly basis. Sites were chosen in each area to cover a spectrum of ground and surface water of different description and utilised for different purposes, including a range of sources used for drinking. Standard field sampling methods were followed at all times.

Data collection commenced in the Hex River region in April 1998, and in the other areas over the next few months, and continued through to May 1999, so as to allow characterisation of a full year's cycle of farming activity. Concomitant with sampling, data were collect-

ed on spraying patterns in the region and on river flow, temperature, rainfall, water pH and turbidity.

RESULTS

The findings of the study demonstrated a significant spread of detections throughout all three regions for both chlorpyrifos and endosulfan. Concentrations were generally very low (between 0.05 and 1 µg/l), but there were exceptions with levels in excess of 10 µg/l. Chlorpyrifos was detected most frequently in Piketberg - 62 (66 per cent) out of 94 times sampled, compared to the Hex River Valley 96 (52 per cent) out of 184 times and Grabouw 51 (49 per cent) out of 104 times. Endosulfan was found most frequently in Grabouw 72 (69 per cent) out of 104 times compared to the Hex River Valley 85 (46 per cent) out of 184 times and Piketberg 37 (39 per cent) out of 94 times. Of importance is the observation that the problem is not confined to the Hex River Valley but ubiquitous in all three study areas chosen for investigation. Out of 382 samples there were 30 per cent detects above the European Union limit of 0.1 µg/l for chlorpyrifos and 37 per cent for endosulfan.



The researchers say temporal trends were compatible with the role of high irrigation wash-out of both endosulfan and chlorpyrifos in the regions, with seemingly significant ingress of pesticides brought through the Berg River into the Piketberg area. Other factors such as soil characteristics, shallow water tables and inten-

sive spraying probably explain the presence of these pesticides in water. Detections were also consonant with spraying patterns, but less so with rainfall.

The data were consistent in that sub-surface drains were commonly contaminated and that certain sites were clearly active "hot-spots" as a result of their siting and vulnerability to run-off. Contamination of surface water in dams also emerged as an issue, particularly in the Grabouw/Vyeboom area, often consistent with periods of local pesticide application, suggesting direct entry of pesticides from spray activity into dam waters. The researchers say these findings are consistent with previous research on farm dams in Grabouw.

Compared to international findings, the frequency of detections in this study are consistent with results from field studies of rivers in agricultural areas in Spain and California, but higher than results obtained from routine surveillance in Texas and California. The researchers say this discrepancy might arise because the likelihood of detections is lower with sporadic testing as occurs in routine surveillance.

"Moreover, the concentrations detected in this study for endosulfan and chlorpyrifos were consistent with international literature. Maximum levels found in this study, however, appeared substantially higher (about 80 to 90 orders of magnitude higher) than that found in two Californian studies which provided enough detailed data for comparisons."

The researchers say it should be borne in mind that this study sought out sites on purpose, where probabilities of pesticides reaching water were highest and is therefore not representative of the overall situation with regard to pesticide pollution by agricultural pesticides.

However, this study demonstrates that pesticides can and do reach water sources in rural farming areas of South Africa albeit in low concentrations, and does require attention.

Copies of the report entitled **The quality of surface and ground water in the rural Western Cape with regard to pesticides** (WRC report 795/1/00) are available free of charge (in South Africa) from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US\$ 20, via surface mail).

Setting water supply tariffs for industrial and commercial consumers



Research results indicate that industrial and commercial water consumers display a very high level of water consciousness.

Commerce and industry represent a major grouping of water consumers in most local authorities, consuming up to 50 per cent of the water supplied in larger municipalities. These enterprises also have significant impacts on the local economy, society and the environment. Yet surveys have revealed significant inconsistencies in the manner in which municipalities set tariffs for these consumers.

The Water Research Commission has already established a guideline on setting water tariffs, in the form of a module in the *Management guidelines for water service providers*. However, this module concentrates mainly on water tariffs for residential consumers.

Recognising this gap, the Development Bank of Southern Africa and Durban Metro Water and Waste took initiatives which led to the establishment of a new Water Research Commission project in 1998 to establish guidelines for water supply tariffs for industrial and commercial consumers.

The guidelines have been compiled and written by the Palmer Development Group and are aimed at water managers in water services authorities and water

services providers who are involved in setting retail water prices, that is, prices to the end-user. The Guide will assist them in setting water supply tariffs for non-residential consumers, taking equity, economic development and conservation objectives into consideration.

In many cases the existing tariffs may be quite different from the desired tariffs. Hence, it is important that the process of tariff reform is given adequate attention. In the Guide, the authors propose the following tariff reform process:

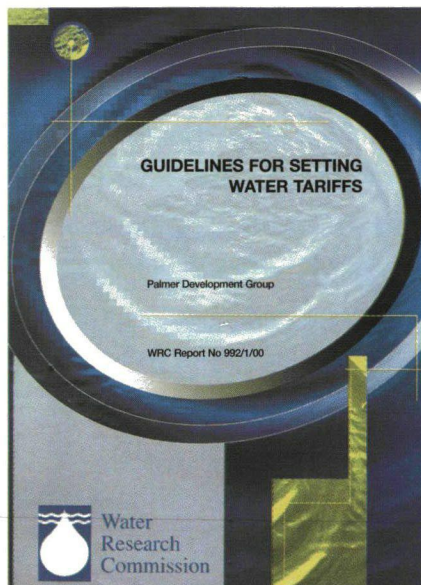
- ☐ *Understand the national context.* The roles of various institutions involved in water supply are described, together with the relevant national water pricing policies.
- ☐ *Understand the local context.* A broad

range of factors are outlined which tariff reformers may wish to consider to better understand their local context. These include the local institutional, historic, economic and water resources context, the consumer market, the costs of supply, revenues and current tariffs. Given the political nature of tariff-setting practitioners are strongly advised to undertake a stakeholder analysis.

- *Set pricing goals, establish principles and develop performance indicators.* Practitioners are advised to define pricing goals and to prioritise or weigh these as far as possible. A basic set of principles are proposed for good tariff practice. Various practical indicators are proposed in the Guidelines with which to measure organisational performance.

- *Make some preliminary choices.* The possible components of the water tariff are described, including development charges, connection charges, fixed fees and volumetric tariffs. Two approaches are described in the Guidelines for determining tariff levels: the revenue requirements approach and the marginal costs approach. The user is advised to consider the impact of future supply costs and to examine the scope for

cost reductions when determining revenue requirements. A set of guidelines are provided to assist with these choices, covering universal cases and specific conditions.



- *Define the tariff structure and set tariff levels.* Users are advised to establish a tariff policy framework on the basis of the selected goals, and to use this for further consultation.

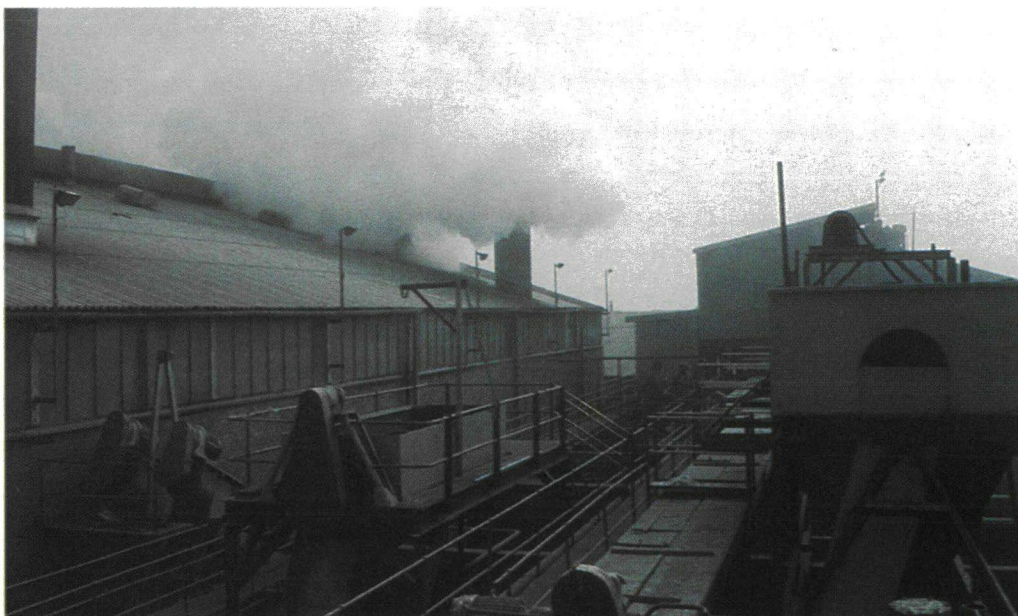
- *Undertake consultation and evaluation exercises.* The likely impacts of tariff reform should be evaluated before approval is sought. Depending on the outcome of the stakeholder analysis, and the extent of the proposed tariff reform, it may be necessary to consult stakeholders prior to seeking political approval. Long-term evaluation procedures should be set up to establish whether the tariff reforms are achieving the desired pricing goals.

- *Refine tariffs.* Users are advised to undertake incremental reforms to tariff structures and levels until they achieve desired goals and adhere to best practice principles.

A key conclusion of the research is that there is no practical system to implement inclining block water tariffs for non-residential consumers.

The report also describes some tariff refinements for special cases, such as the use of new development charges, seasonal pricing, drought pricing and commodity price-linked tariffs.

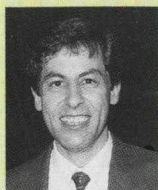
Finally, the report reviews a number of international and local case studies as a means of offering insights into the circumstances of other local authorities.



A good understanding of the economic activity in a water supply area is important. Water supply tariffs should promote the development of competitive businesses. Hence, business tariffs should not be loaded with excessive taxes or cross-subsidy requirements.

Copies of the report titled **Guidelines for setting water tariffs - with a focus on industrial, commercial and other non-residential consumers** (WRC Report 992/1/00) are available free of charge (in South Africa) from the Water Research Commission, PO Box 824, Pretoria 0001. Overseas price: US\$ 15, via surface mail.

The challenge of identifying waterborne pathogens leads to new technology



Dr Jacques Theron

Dr Jacques Theron of the Department of Microbiology and Plant Pathology at the University of Pretoria, was invited as an outstanding young researcher to present a paper at the 2000 Stander Memorial Lecture Evening. This article emanates from his paper entitled "Emerging waterborne infectious diseases: addressing the challenges" and gives the reader a perspective on the problems and a glimpse at an exciting new biotechnological development to identify some of the elusive pathogens.

Thanks to modern technology and public policy many of us can consume the water that is readily available to us without risk. However, because of various recent and widely reported incidents, many people are feeling concern about the quality and safety of our water. This is not surprising; some of these incidents have resulted in serious and widespread illness, even death. Estimates project that worldwide today approximately a 1000 people (800 children, 200 adults) die every hour due to microbial waterborne disease.

Problems associated with microbial pathogens in drinking water are expected to worsen in the future, for a number of reasons. Some of the major factors contributing to disease emergence, include:

□ Changes in human demographics and behaviour:

Those that are most at risk to the effects of microbial contaminants include the very young, the elderly, pregnant woman, and immunocompromised individuals (i.e. people with a weak immune system including AIDS patients, cancer patients undergoing chemotherapy and organ transplant patients). For example, by the year 2010, people over the age of 65 will constitute the most rapidly multiplying sector of the population. The number of immunocompromised individuals is also expected to increase. This is partly due to the greater frequency of organ and tissue transplants, as well as new forms of can-

cer treatment involving the use of immunosuppressive drugs. What this means, in effect, is more people at risk of serious illness, and even death, from waterborne pathogens.

In many parts of the world, economic conditions are encouraging the mass movement of workers from rural areas to cities. Rural urbanisation allows infections arising in isolated rural areas, which may once have remained obscure and localised, to reach larger populations. Once in a city, the newly introduced infection would have the opportunity to spread locally among the population, and could also spread further along highways and by aeroplane. Furthermore, urban population growth in many parts of the world has resulted in a deterioration of some basic sanitation practices such as waste-water disposal, as well as insufficient supplies of clean water. Emergence of slum areas and shanty towns and the ensuing sanitation problems have also resulted in conditions under which disease-causing agents may grow and thrive.

□ Microbial adaptation:

Microbes, like all other things, are constantly evolving - with effective changes in virulence and toxin production. Selection for antibiotic-resistant bacteria and drug-resistant protozoa has become frequent, driven by the wide and sometimes inappropriate use of antimicrobial drugs in a variety of applications. Pathogens

can also acquire new antibiotic resistance genes from other, often non-pathogenic, species in the environment. Such adaptation often results in "new", more deadly strains against which humans have limited resistance.

□ Breakdown of Public Health measures and deficiencies in Public Health infrastructure:

Classical public health measures have long served to minimise dissemination and human exposure to many pathogens spread by traditional routes such as water. The pathogens often live, albeit in reduced numbers, either in hosts or in the environment, or even in small pockets of infection, and are therefore able to take advantage of an opportunity to re-emerge if there are breakdowns in preventative measures. Cholera, for example, has been raging in South America and Africa. The rapid spread of cholera in South America may have been abetted by reductions in chlorine levels used to treat water supplies. Also, the widely publicised U.S. outbreak of waterborne *Cryptosporidium* infection in Milwaukee, Wisconsin, in 1993, with over 400 000 estimated cases, was in part due to a non-functioning water filtration plant.

SOURCES OF MICROBIAL CONTAMINATION

Microorganisms, also called microbes,

are present everywhere in our environment, in soil, air, food and water. Our exposure to them causes harmless microbial flora to establish in our bodies, however some microbes are pathogens and can cause diseases. These diseases are considered waterborne if the pathogens are transmitted by water, to infect humans or animals that ingest the contaminated water. Diseases transmitted by water are primarily those found in the intestinal discharges of humans or animals.

Human excreta contains billions of microbes. These microbes not only survive, but also multiply in water. The microbes constitute a wide range of different organisms, including pathogenic microbes, which even healthy people excrete. People who have a disease or who are carriers of a disease-producing microorganism are more obvious sources of waterborne infections. Estimates indicate that about 5 per cent of those who have contracted an enteric or intestinal disease remain life-long carriers, even after having recovered from the disease.

At first it may seem puzzling that these intestinal microbial contaminants can infect a drinking water source. However, through natural flow or by accident, various types of water can interconnect and flow together. For example, storm water runoff from residential, rural and urban areas can carry waste material from domestic pets and wildlife, to collect in surface waters and even enter groundwater. Through an accident or equipment failure, sewage (which is a rich source of microbial contamination) may come into contact with drinking water. Furthermore, defective on-site wastewater disposal or septic systems in rural and other residential areas can contribute large numbers of coliforms and other bacteria to both surface water and groundwater.

Microbial contaminants occur widely and are not limited to areas inhabited by humans. Wildlife and cattle can contribute contaminants to water in isolated areas. Cattle graze many back country areas and drink from streams that flow through to other areas or into other water sources, carrying with it microbial contaminants that could be transmitted to humans.

PATHOGENS OF CONCERN

Much success has been achieved in

controlling the more common forms of waterborne diseases. Progress has been due to the adoption of public health measures, as well as the implementation of important water treatment techniques, such as filtration, disinfection and sewage treatment. However, established disinfection and filtration techniques do not always remove all microbial contaminants from drinking water - the effectiveness of water treatment may vary depending upon the nature of the waterborne microbial contaminant.

Bacteria are the least troublesome and are generally removed by current water treatment processes.

Viruses present a greater challenge. They are generally harder than bacteria, although they too can be controlled, but with increased amounts of disinfectant. Viruses, linked to waterborne disease, have protein protective coats and are considered to be about 100 times more resistant to disinfectant than are bacteria.

Protozoan parasites, unlike bacteria and viruses, are resistant to commonly used treatment procedures. During their life cycles, some species persist in an environmentally resistant cyst stage. They are considered to be about 10 000 to 50 000 times more resistant to disinfectant than are bacteria. Even water treatment by filtration may not do the job, since some of these parasites are small enough to pass through filtration systems.

Pathogens of particular concern in water include:

- ☐ bacteria - species of concern include *Salmonella*, *Shigella*, *Escherichia coli*, *Vibrio*, *Klebsiella*, *Campylobacter*, *Legionella*, *Pseudomonas*
- ☐ viruses - groups of concern include enteroviruses, hepatitis A, rotavirus
- ☐ protozoa - species of concern include *Entamoeba*, *Giardia*, *Cryptosporidium*, *Cyclospora*.

TESTING OR MONITORING FOR BACTERIAL PATHOGENS

A number of problems beset water quality experts in their efforts to determine the presence of microbial pathogens in drinking water. The method for each group of microbes, whether protozoa, viruses or bacteria, must cope with a different set of conditions or characteris-

tics, which complicate the task of identifying particular microbes.

A long-established method for monitoring the microbial quality of drinking water is based on the presence of coliform bacteria. Although not likely to be pathogenic themselves, coliform bacteria serve as an indicator - their presence in a water sample indicate that drinking water may be contaminated with human wastes. If the coliform bacteria count is high, further testing is done for fecal coliforms. Standardized and relatively easy and inexpensive to use, tests for coliform bacteria are more readily administered than tests determining the presence of individual pathogens. However, a major failing of the test is its unreliability in indicating the presence of several other important pathogens, including *Legionella*, most pathogenic viruses, *Cryptosporidium* and *Giardia*. Furthermore, indicators can only be measured at discrete times and cannot be monitored continuously. Sporadic microbial contamination can thus escape periodic monitoring of indicator organism concentrations. This is particularly important when highly infective pathogens (i.e. pathogens that cause infections in low doses) are present in the water supplies.

Testing for bacteria is also done by growing bacteria in a growth medium. This involves adding a water sample to nutrient media and then incubating. Bacteria that are present will utilize the nutrients and grow into an increasingly turbid solution. This method is generally adequate for most kinds of bacteria because they multiply very rapidly, sometimes a generation can grow within 20 minutes, with visible results occurring between 24 and 72 hours. Identification of specific microorganisms from these cultures may involve further biochemical, physiological and serological tests.

Several problems, however, are encountered with culturing methods, including the presence of viable but non-culturable cells, loss of viability of bacteria after collection, difficulties in isolation from biocontaminated samples and the time required for culture and confirmation, which can be several days. The occurrence of viable but nonculturable pathogens pose a significant health threat. These bacteria exhibit low levels of metabolic activity but fail to produce colonies on most traditional culture

media. Pathogens in this state have, however, demonstrated the ability to return to an active potentially disease-causing stage. Furthermore, appropriate collection, rapid transport to the laboratory and rapid plating of the samples are important for the isolation of pathogens. Such conditions, however, are often difficult to attain in developing countries.

MOLECULAR-BASED DIAGNOSTIC TECHNIQUES

The prevention, control and treatment of waterborne infectious diseases is generally facilitated by the early and accurate identification of the pathogenic organism. Many diagnostic procedures

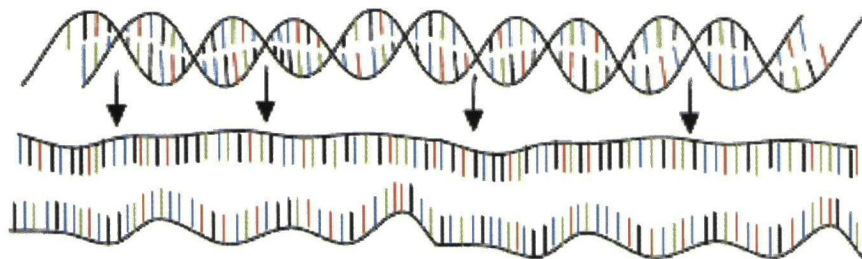
require the growth in culture of the pathogenic organism and subsequently the analysis of a wide spectrum of physiological and metabolic properties that facilitate its identification. Although such tests may be specific, they are expensive and time-consuming. In some cases, it may be difficult or even impossible to cultivate the pathogen. Recent

PCR : Polymerase Chain Reaction

30 - 40 cycles of 3 steps :

Step 1 : denaturation

94 °C



Step 2 : annealing

54 °C



Step 3 : extension

72 °C

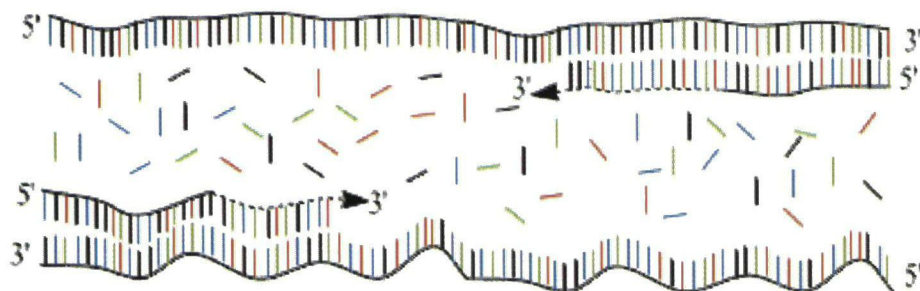


Diagram of the Polymerase Chain Reaction (PCR). The PCR is primarily a method for amplifying a defined (target) DNA sequence. The target sequence is defined by two sequence specific oligonucleotide primers that flank the target sequence and which anneal to the complementary strands of the target sequence. The PCR consists of repetitive cycles of DNA denaturation, annealing of the oligonucleotide primers to the target DNA and extension of the primers across the target sequence by using a heat-stable DNA polymerase in the presence of free deoxynucleotides (dNTPs). By repeating this three-stage process, an exponential increase in the amount of target DNA results.

scientific advances hold promise that waterborne pathogens can be more quickly and accurately detected.

DNA

As a result of developments in molecular biology, organisms can now be detected and identified by analysing DNA from water samples with polymerase chain reaction (PCR) techniques or nucleic acid hybridisation. Although hybridisation is useful in research because it provides excellent sensitivity, these methods are generally time-consuming and labour-intensive and are therefore considered impractical for routine laboratory use.

In contrast, PCR is an enzymatic method for amplifying exponentially a specific pre-selected fragment of DNA. Since the DNA of different organisms is different, genes can be identified which are therefore unique for a specific organism. This enables the detection and identification, with a very high-probability, of specific disease-causing bacteria, viruses and/or protozoa. The sensitivity of PCR is such that theoretically, only a single intact nucleic acid template (one organism) is needed to amplify the target sequence sufficiently for further analysis. The amplification is achieved with a thermostable DNA polymerase enzyme, two synthetic oligonucleotide primers, and the four standard building-

blocks of all genes (deoxyribonucleoside triphosphates) that are incorporated into DNA. Each PCR amplification is subdivided into three steps which are repeated in cycles: (a) the melting (strand separation) of the duplex sample DNA; (b) the annealing of the two primers to opposite DNA strands; and (c) the extension of the primers by polymerase-mediated nucleotide additions to produce two copies of the original DNA sequence. The standard PCR reaction is run through about 30 cycles in a couple of hours which results in the amplification of the original DNA by over 9 billion-fold.

CONCLUSION

Part of the reason why microbial contaminants are receiving such belated attention is that their effects are difficult to determine. For example, just to ascertain how many people have become sick from microbial contaminants in drinking water is a formidable challenge. For most people the symptoms are not particularly worrisome, therefore many cases go unreported. A recent United Nation's report, however, portrays a grim picture of water quality conditions in some developing countries. The report states that about 80 per cent of all diseases and more than one-third of deaths in developing countries are the result of people consuming contaminated water. Not only are the diseases debilitating, but about one-tenth of each

person's productive time is sacrificed to water-related diseases. Some recent evidence indicates that the effects of microbial contaminants may not be limited only to short-term gastrointestinal diseases. These findings show that waterborne contaminants also may be linked to certain long-term chronic conditions, such as diabetes and heart disease, while links with miscarriages also are suspected.

In order to evaluate the public health threat posed by waterborne microorganisms, rapid and accurate methods for the detection of these organisms within large populations of other bacteria are therefore essential. Conventional microbiological methods for identifying these microbes involve culturing along with biochemical and serological assays which often take several days to complete. To avoid these problems, different methods based on molecular biology techniques have been developed, with those based on DNA amplification (PCR) being the most rapid and sensitive. Thus, a combination of increased surveillance, improved detection methods, and testing requirements should result in a marked improvement in the ability to detect, investigate, and control waterborne pathogens. Taken together, these approaches promise to provide information necessary to assess risks, control disease, and ultimately improve public health in the years to come.

SABI National Congress Irrigation: Appropriate Technology

13 September 2001 • Warmbaths

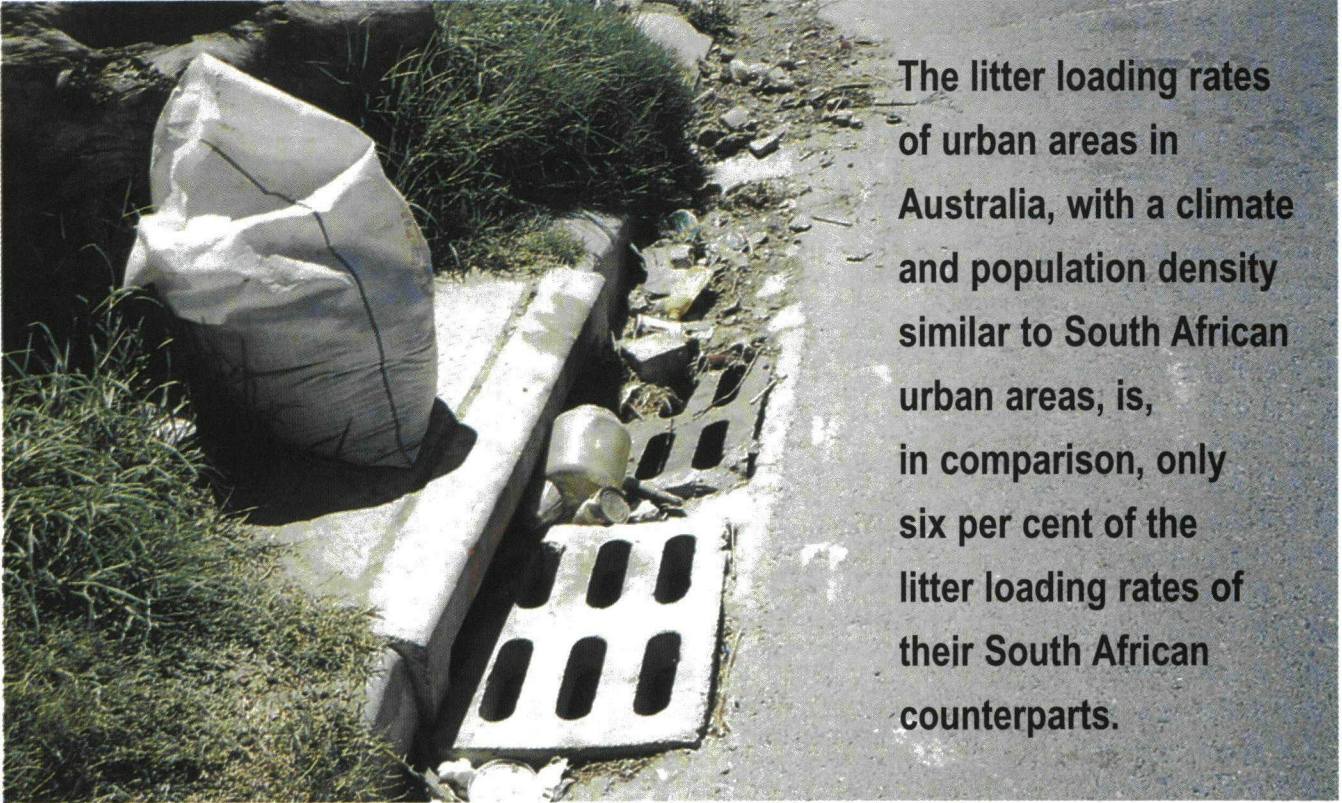
The congress will be held at the Aventura Warmbaths, 170 km north of Johannesburg. The focus of the congress will be appropriate irrigation technology for South Africa. New practices and innovations in irriga-

tion scheduling, chemigation, system maintenance, design guidelines, water management, communication and training for emerging as well as commercial farming will be covered.

Information about the costs, the programme, and available accommodation is available upon request from the congress organiser. Please register early, as space and accommodation is limited. Registration closes on 30 July 2001.

Enquiries and registration:
Riana Lombard (Congress organiser)
Tel/Fax: (021) 855-5412
E-mail: riana@sabi.co.za

REGISTER NOW !



The litter loading rates of urban areas in Australia, with a climate and population density similar to South African urban areas, is, in comparison, only six per cent of the litter loading rates of their South African counterparts.

Reducing litter in South Africa's urban drainage systems

South Africa generates in excess of 40 million tonnes of solid waste each year - mostly of domestic origin. More than 780 000 tonnes of this waste is washed into the drainage system where it lies entangled amongst the vegetation along the banks of streams, rivers and lakes, is strewn along the beaches, or is buried in the sediment deposits under the water surfaces.

It currently costs between R2 000 and R10 000 per tonne to remove litter from the drainage systems. In other words, to remove all the litter from the waterways without seeking to reduce the quantities

involved, would cost South Africa at least R2 billion per year at current costs. This is clearly unfeasible. Urban litter quantities have to be reduced.

Many sections of the public are also increasingly desperate that a solution be found to the litter problem of the environment. Although many suggestions have been made, there is very little scientifically verified data from anywhere in the world to show that the proposed methods will have any efficiency in South Africa. There is therefore a decided need for finding ways to reduce litter loadings along with better catchment management.

In view of the present urban litter problems, the Water Research Commission (WRC) of South Africa and the Cape Metropolitan Council (CMC) have jointly funded a four-year investigation into the reduction of urban litter in drainage systems. The WRC report expected to emanate from this investigation will deal with the reduction of urban litter in drainage systems as an important component of sustainable integrated catchment management.

It should be of particular value for Local Authorities and environmental managers throughout South Africa, as well as civil and environmental consultants engaged in municipal and waste management work.

AIMS

The project aims firstly to improve the knowledge of the source, type and amount of urban litter coming from dif-

ferent types of urban catchments, which, in turn is linked to land use and the level of environmental awareness. This will help in the design of appropriate structures to remove the litter, and also provide baseline data. Secondly the project is to provide scientific data on the efficacy of various catchment management techniques in the reduction of urban litter reaching the drainage systems. Such knowledge would enable local authorities to develop sustainable litter management plans (LMPs) that will drastically reduce the urban litter pollution in streams and also realise considerable cost savings.

The quantity of litter deposited in the catchment depends on many different factors. These include: the type of development, the density of development, the income level of the community, the type of industries located in the catchment, the effectiveness of refuse removal, the level of environmental con-

cern, and the extent of preventative legislation. In consequence a number of pilot catchments representing a diversity of land-uses have been selected for a detailed litter audit.

PROJECT CATCHMENTS

The catchments are located in: Cape Town Central Business District (CBD), Fresnaye, Imizamo Yethu, Ocean View, Welgemoed, Summer Greens and Montagu Gardens. The audit will seek to determine the amount and type of litter being deposited in the catchments both now and after the imposition of various litter management strategies. This will determine the effectiveness of different approaches to catchment litter management which will in turn feed into the development of more effective catchment litter plans.

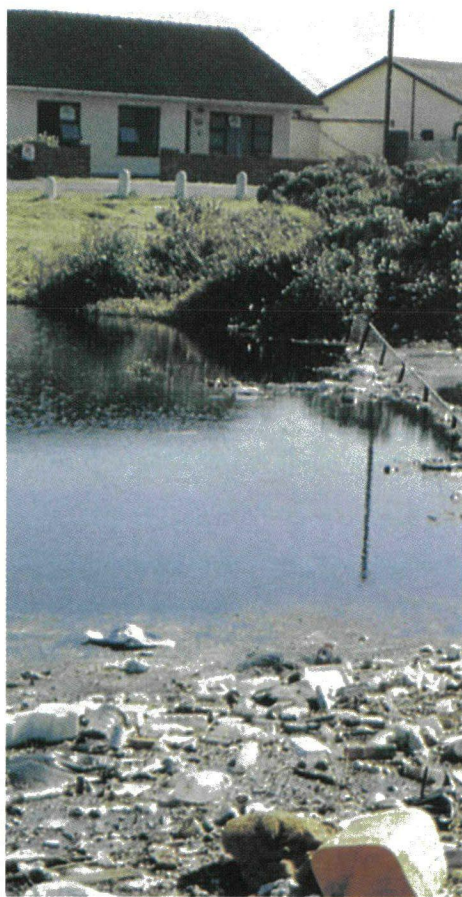
PATTERNS

After six months of data collection, the following patterns are emerging:

- ☐ An effective street cleaning programme dramatically reduces the amount of litter finding its way into the drains,
- ☐ Relatively little litter finds its way into the drainage system from residential areas with a formal refuse collection service compared to those without,
- ☐ Plastic packaging appears to contribute much more to the litter problem than polyethylene shopping bags,
- ☐ The stormwater system often doubles up as a sanitary sewer as households without access to proper toilet facilities dump their night soil into the catchpits.

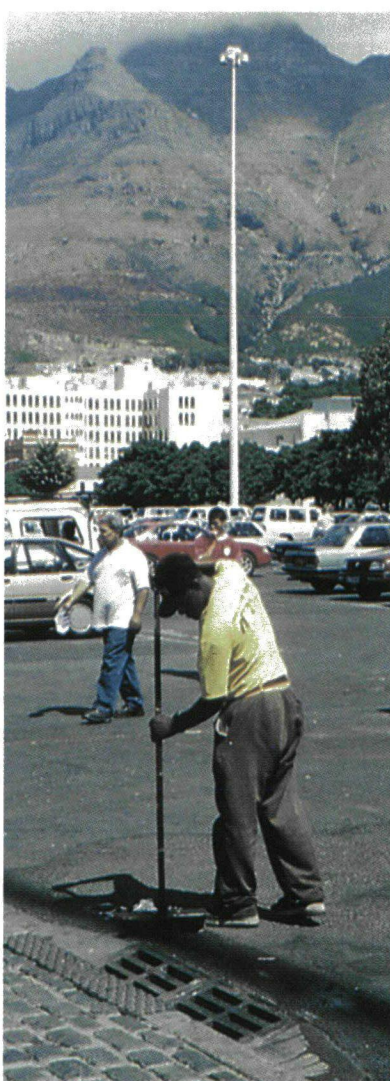
The research is being carried out by the Civil Engineering Department at the University of Cape Town in conjunction with the Catchment Management Department of the CMC and four of the Metropolitan Local Councils (Blaauwberg, Cape Town, South Peninsula and Tygerberg).

A full report of this research will be published upon completion of the project. However, if you would like more information, please contact Mr Neil Armitage at the Department of Civil Engineering, University of Cape Town. Tel: (021) 650-2589 • Fax: (021) 689-7471 • Email: armitage@eng.uct.ac.za



Above: Litter trapped along a streambank in the Cape Metropolitan Area.

Right: An effective street cleaning programme dramatically reduces the amount of litter washed into the drainage system.



Quantifying water use in SA timber plantations

Forestry in South Africa is estimated to have a consumptive water use equivalent to 7.5 per cent of the country's available water resources. Since 1972 the expansion of the forest industry has been regulated on the basis of its estimated water resource effects.

The provisions of the of the new National Water Act could make forestry liable to pay for water use as a streamflow reduction activity. This has placed increased attention on the quantification of the water use of timber plantations and the accuracy with which such use can be estimated. For this reason, it is important that full use is made of the information contained in South Africa's long-running catchment afforestation experiments.

According to a report released by the Water Research Commission the South African afforested catchment experiments were initiated over sixty years ago with a long term vision of multiple replication of sites and species over many decades. The report, written by DF Scott, FW Prinsloo, G Moses, M Mehlomakulu and ADA Simmers from the CSIR Division of Water, Environment and Forestry Technology at Stellenbosch, says the

historical nature of the data collected in the afforested catchment experiments, the length of record and the range of sites involved make the experiments unique and invaluable.

"Although most of the experimental data have already been analysed to some extent or another, there was a need to consolidate the experimental data, to re-work the data in a uniform and consistent way and to generalise the results, particularly with respect to new information needs."

Researchers can now review this large body of data and assess the composite picture which has emerged to date with respect to the influence of forestry on streamflow.

Researchers can now review this large body of data and assess the composite picture which has emerged to date with respect to the influence of forestry on streamflow.

WRC STUDY

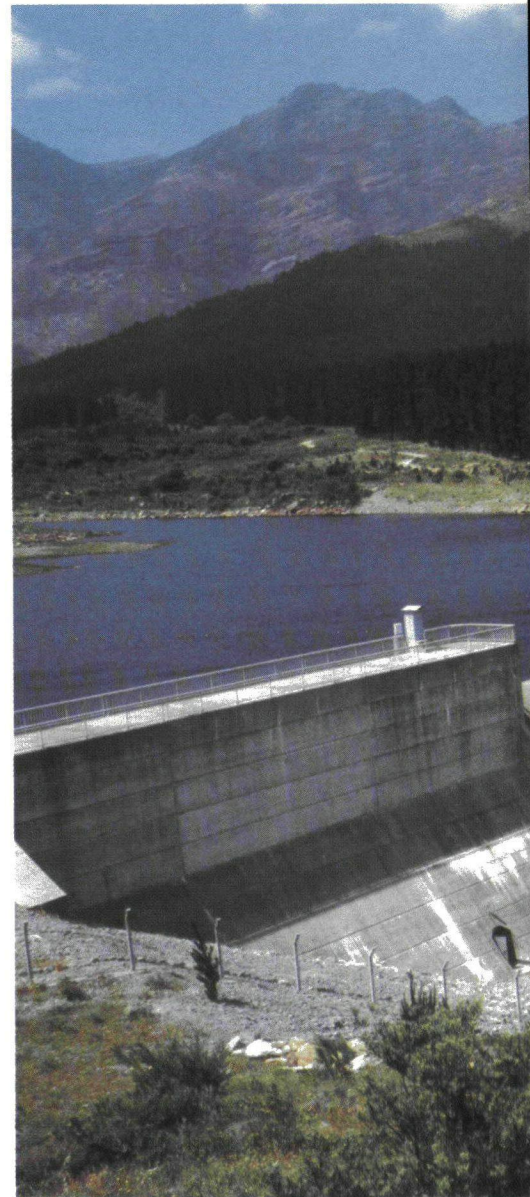
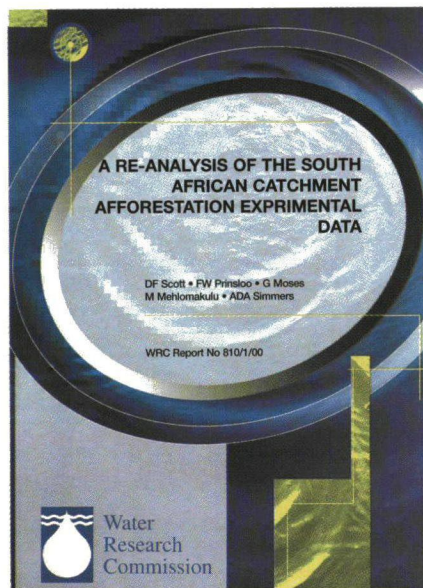
A Water Research Commission funded study looked at a series

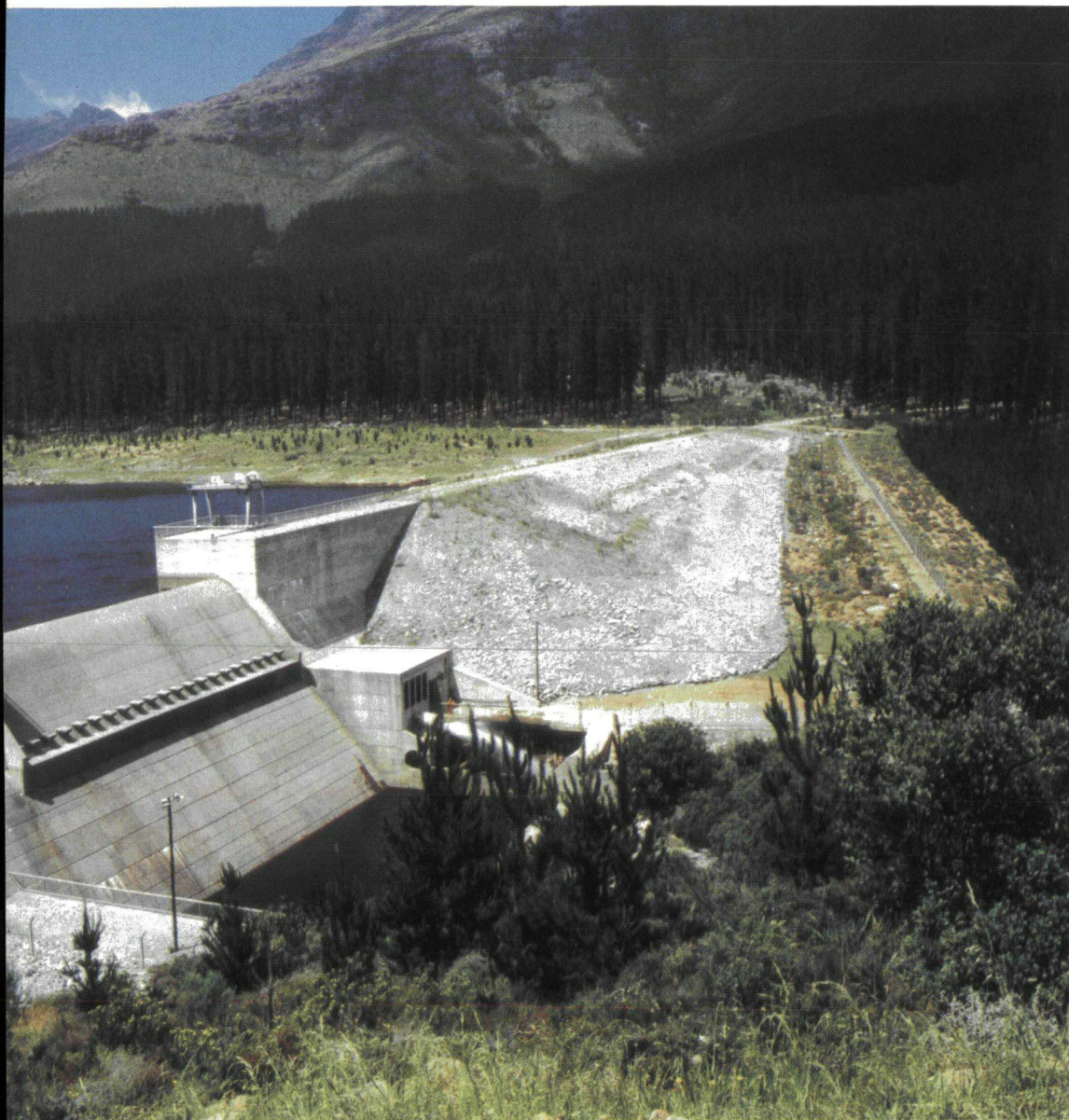
of paired catchments comparisons. This method involves the long-term monitoring of streamflow from pairs of catchments before and after a major vegetation change in one of them. The treatment effect is primarily measured against a baseline provided by the relationship between the two catchments before treatment. The method is applicable to both afforestation and clear-

felling treatments. The statistical test for treatment effect is by means of the dummy variable technique of regression analysis.

Weekly streamflow volumes were used as the computational unit, which provides some smoothing when comparing different catchments, but at the same time provides for robust statistics because of the large sample numbers. The effects on both total flows and low flows were analysed separately - low flows being defined as those weeks when flow was below the 75th percentile exceedance level in the control catchment.

Seventeen experiments were analysed





“We salute the vision and persistence of the early South African forest hydrologists, CL Wicht, UW Nänni and others, who planned and established these (the afforested catchment) experiments, and the many technicians and researchers who maintained the equipment and collected the data over the years with care and dedication.”

One of the research sites - Jonkershoek near Stellenbosch in the Western Cape.

altogether, from data generated in thirteen treated catchments, and comprising twelve planting experiments and five clearfelling experiments - twelve of which experiments were with pines and five with eucalypts.

RESULTS

The report says for each successfully analysed experiment, the estimated effects on total and low flows are standardised to a ten per cent level of planting or clearing and plotted against time in two figures. The seasonal effects are illustrated by plotting the mean flow reductions or increases for each month of the year, generated over many years while the plantations were mature.

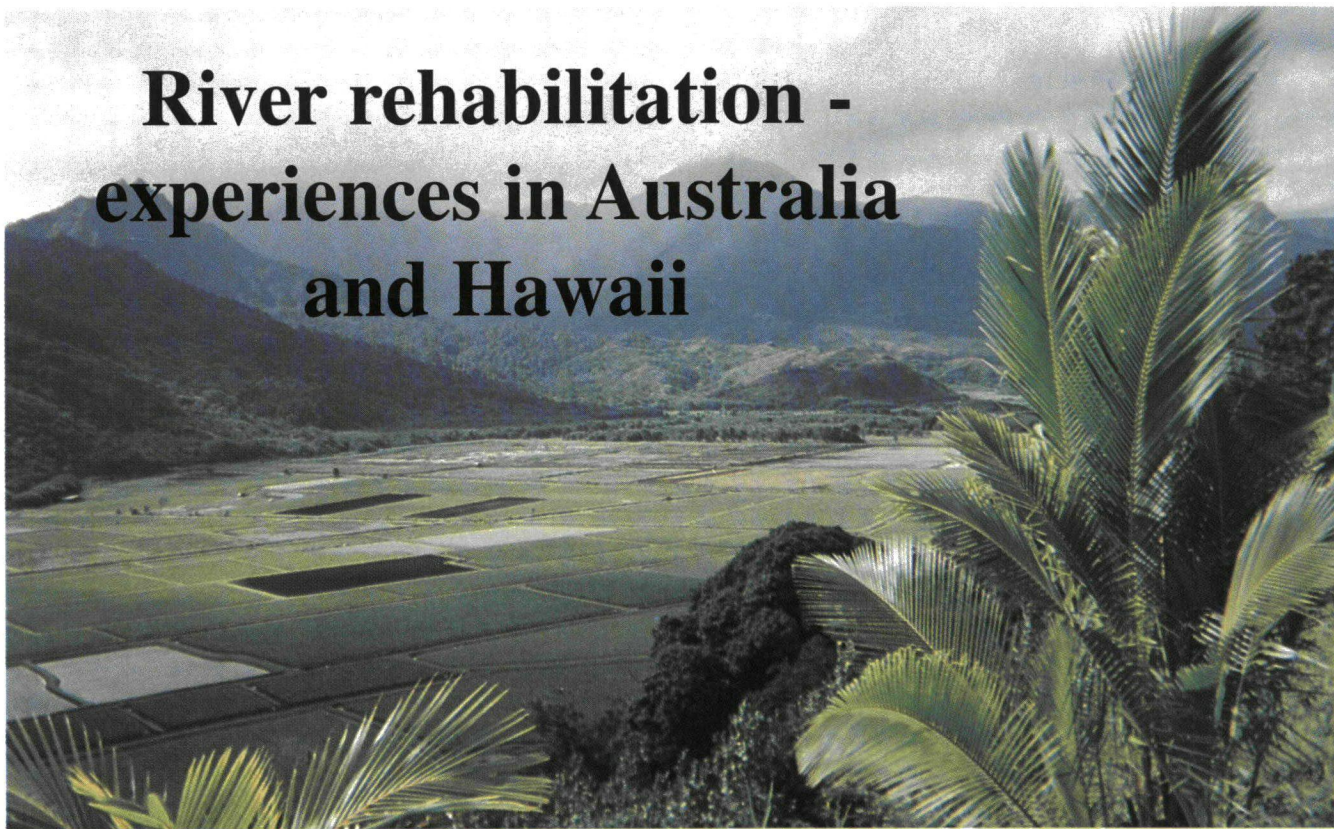
The initiation of flow reductions (onset of significant reductions after planting) varies widely depending on the stature of the competing native vegetation and the rate at which catchments are dominated by the plantation crop. The pine plantations in tall fynbos in the Western Cape and in high altitude grasslands in the Drakensberg usually took several years to have a clear impact on streamflow (up to six years). However, some pine crops had an early effect on streamflows (within 3 years). Eucalypts have an earlier impact on streamflows, within two to three years.

Once water reductions are significant they generally become larger quite quickly, reaching peak or near peak

reductions fairly early in the rotation. Peak reductions under pine are reached around 15 years of age and at least five years earlier under eucalypts. At one of the drier sites flows ceased completely in the fourth year after planting, which was also a dry hydrological year.

Copies of the report entitled **A re-analysis of the South African catchment afforestation experimental data** (WRC report 810/1/00) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price of the report: US\$ 25, via surface mail).

River rehabilitation - experiences in Australia and Hawaii



The Hanalei river in Hawaii: an Ahupua'a system closely restored to its original state.

An enthusiastic Dr Mandy Uys of Laughing Waters Aquatic Research Consultancy left South Africa in 1999 to learn how rivers elsewhere in the world were being restored. She says that her post-doctoral research travels led her to link up and work with practitioners and scientists in the field of river rehabilitation in California, Vancouver, Honolulu and Melbourne. The Water Research Commission funded several months of her

studies in Australia, where she worked with Dr Ian Rutherford of the Cooperative Research Centre for Catchment Hydrology (Melbourne University), developing principles for Australian urban river rehabilitation. Her full report to the WRC about Australian River Rehabilitation will be published and made available in due course. In this article, however, Dr Uys gives a brief overview of what she has seen and learnt.

Historic approaches to "river improvement" were developed chiefly with human needs and safety in mind (e.g. dams, canals, diversions). However, contemporary management approaches are increasingly influenced by environmental priorities and catchment-scale planning. Rehabilitation practitioners aim to improve the river as much for its own intrinsic worth, values and sustainability, as for human use. The perception of the river in its

catchment - and its place in our culture, is changing worldwide.

The change is reflected in the new South African water law, which names the river as a "resource" rather than a "user" of water. This guarantees the river a "right" to environmental flows which will maintain ecological function, channel, bed and floodplain form, function and connectivity; and a measure of its natural flow characteristics. In the

law, the quantity of water required to maintain these functions is termed the Ecological Reserve. Economic water use subsidises both ecological water use and South Africa's international obligations on shared water resources. The country is a world leader in this regard.

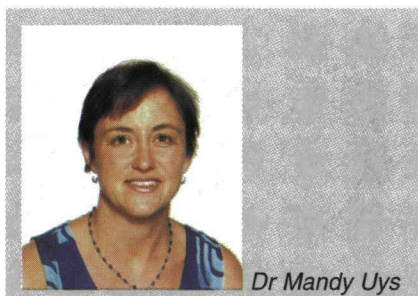
REHABILITATION

River rehabilitation, be it a practise, sci-

ence, art, or all three, fits within the broad definition of river management, which in turn is a part of integrated catchment management (ICM). There is an array of terms associated with the field: "restoration", "rehabilitation", "river enhancement", "beautification", "regeneration" and others. These are differently defined around the world. I will use the Australian definitions here. "Restoration" is the practise of returning a river to its "natural", "original", "previous" or "pre-impact" state. These endpoints are in themselves vague and difficult to define with confidence. In Australia, "pre-impact" is usually considered to be the condition of the river prior to European settlement. Because it is seldom possible to restore to this state, for logistical, economic or political reasons, the more pragmatic option of "rehabilitating" a river is an accepted approach and goal. The aim of rehabilitation is to improve and reinstate process, form and function to one or many of the physical, chemical, structural, biotic and abiotic components of the river, without the goal of returning the river to its pre-impact state. Where original state can be determined, however, it may serve as a guiding image in planning. The term "remediation" applies to actions taken on a river section which has been altered or degraded to the extent where returning to a pre-impact condition is either unattainable or no longer appropriate. The ecosystem itself has shifted to a new state. The goal is to address the damage in the short-term, and to improve and reinstate some degree of physical diversity, ecological function and environmental value to the river section.

Early approaches to "restoration" (as it was known) were motivated chiefly by management issues related to dwindling and degraded commercial fisheries (salmon and trout), healthy resource supply, and recreational issues. Northern hemisphere countries such as Britain, Denmark, Germany, North America and Canada led initiatives from as early as the 1960s. While the issues they were dealing with were largely different from those faced by Southern Hemisphere countries like Australia and South Africa, their lessons can inform us meaningfully if considered in context.

The promulgation of far-thinking and enabling legislation can advance a field rapidly. This was the case in the US, where compliance with the Clean Water



Dr Mandy Uys

Act and the Endangered Species Protection Act has caused accelerated development of the "restoration" field dramatically. Successful lawsuits against industrial polluters are not uncommon, and often the proceeds fund portions of restoration projects. The larger US "flagship" projects, which have high public and media profile, also attract luxurious corporate funding. Costs can be high: the estimated cost of rehabilitating the Kissimmee River in Florida was US\$14 billion in 1998. However, bureaucracy prevails, and I gathered from practitioners that even projects at this level were obstructed by heavy-handed administration at local and national levels.

HAWAII

The Hawaiian model for rehabilitation has valuable lessons for South Africa. It is not confined to the "river" but to the restoration of culture, land and water, leading to the renewal of the traditional link between humans and their environment. The Hawaiians view the land and water as family ("ohana"). The restoration movement is largely driven by a native Hawaiian organisation, the Ahupua'a Action Alliance (AAA) whose exhaustive efforts over eight years have resulted in significant partnerships with American agencies (e.g. US Environmental Protection Agency, US Army Corps) and organisations. The AAA's aim is to reinstate the traditional Hawaiian form of land and societal management, the "Ahupua'a". This model has survived unchanged on the islands for almost 2000 years.

AHUPUA'A

Following Polynesian settlement ca. 4 AD, each island was divided into a number of wedge shaped units or Ahupua'a, each comprising one or more watersheds. The remnants of these are still visible today. Each Ahupua'a belonged

to a chief and his clan and was run by a strict hierarchy of lesser chiefs, headmen and "kahunas" who were specialists in one or other discipline (canoe and home building etc). There was no land ownership, and the clan members had freedom of movement from the mountain source, forests, lowlands and sea at any time of the year. The clan was entirely self-reliant in their Ahupua'a, taking sufficient from the land for food and to fashion shelter, canoes, clothing and tools. Strict controls were kept on all forms of harvesting, and all produce and products were shared. The lowland areas of the watershed were used as terraces for the growing of "taro" which was (and still is) the staple carbohydrate for Hawaiians. Water flowing off the steep volcanic slopes onto the lowlands was diverted from the river channel through narrow, hand-dug irrigation canals, flowed over the taro terraces, into irrigation canals and into the river. At the entrance to the ocean, curved coral walls were built into the sea. The areas these enclosed were known as "fishponds". Juvenile fish could enter through the coral wall into the fishpond where they sheltered for growth. Adult fish of a certain size were unable to return to sea through the wall, and remained in the ponds as a backup food supply should the fishing fail.

In the late 1800s, the chiefdom of Hawaii was overthrown by Kamehameha II, a lesser Hawaiian chief, and transformed into a kingdom. This and the subsequent illegal American annexation of the islands resulted in major modifications to the rivers of the Ahupua'a, largely to serve the needs of commercial agriculture and rapid urbanisation. Diversion of water from the windward to the leeward side of the islands had serious consequences for the islands and islanders. The AAA attribute the collapse of the Ahupua'a system and the subsequent demise of native Hawaiian society to the decoupling of the land-river-estuary-sea ecosystems which resulted from these new land management practises.

MODERN APPROACH

The modern Ahupua'a movement strives to reconstruct the society by reconnecting the people to their landscape, and relinking the ecosystems within catchments. Though the contemporary model is based on the traditional Ahupua'a unit, it is purposely influenced by contemporary design, science, tech-

nology and logistical constraints. The AAA refer to this balancing of modern and traditional as "walking between two worlds". The youth are considered key members of projects. At a workshop I attended, one teacher commented that the more technology involved in the project (eg. computers and global positioning systems (GPS)), the more enthusiastic and effective her young assistants would be, and the greater the chance of buy-in and voluntary training from US agencies and other organisations.

A number of Ahupua'a units are being or have already been successfully reinstated in Hawaii (see photograph). The EPA in Hawaii has adopted the Ahupua'a "from source to coral reef" as their watershed management unit. While the model may seem a touch romantic, impractical and untransferable to most parts of South Africa, the principles on which it is based could benefit us strongly in this country, particularly from a cultural perspective.

AUSTRALIA

In Australia, stream management is now often referred to as stream rehabilitation. The field has developed rapidly over the past decade spurred on by dramatic reforms in water management in the early 1990s. These included the corporatisation of water supply and the development of water markets. Major public issues on iconic Australian Rivers (eg. Snowy and Murray Darling), such as salinity, channel widening, and long-term flow reductions mobilised media and public interest in the early 1990s, thereby shifting the field of river rehabilitation to a focal point in Australian consciousness.

Although many initiatives have been driven at state-level, federal agencies have been progressive in funding research and development to advance the field. In addition, in the mid-1990s, the Cooperative Research Centres (CRCs) were launched. These are alliances between industry, agency and research institutions. Industries fund, guide, and collaborate with a large portion of the research undertaken by these centres. Research results, in turn, are used to inform management decisions. The system appears to be highly effective and integrative. The CRCs for Catchment Hydrology and for Freshwater Ecology in Australia are tasked with many of the larger rehabilitation research programs.



A weir on the Maribyrnong river, in Australia. A rock ramp fishway (on the right) was recently created to overcome the weir.

More recently, standardised, regionally-appropriate approaches and techniques for rehabilitation have been developed, based on local and international experience. In 1998, a document entitled "Research and Development Needs for River Restoration in Australia" was produced by a multidisciplinary team. The two volume "Australian Manual of Stream Rehabilitation" produced in 2000, represented one of the outcomes of this report, and a significant step for the field. Another key report was the "Riparian Land Management Technical Guidelines" produced in 1999. These foundational documents were produced by CRCs in collaboration with the federal agency Land and Water Resources Research Development Corporation (LWRRDC). In 1999 the highly successful Second Australian Stream Management Conference was entitled "The challenge of rehabilitating Australia's streams".

At present, some of the key issues receiving attention in Australia river rehabilitation research are: the planning, prioritisation, goal setting, evaluation and scientific research procedures for stream rehabilitation projects; the means of identifying and prioritizing degrading factors; the scale of projects and how to plan for catchment-level activities; the urban / rural divide in rehabilitation, and the development of enabling legislation.

SOUTH AFRICA

South Africa is well positioned to adopt, adapt or modify many of the guidelines provided by the international experience

in river rehabilitation. This could align us strategically with current global trends in the field, and help us to avoid making the expensive mistakes which others have learnt from! Many of the foundational elements of rehabilitation science and practise (eg. environmental flow setting procedures, integrated catchment management and resource classification) are already in place in this country, and will both contribute to and benefit from integration with a rehabilitation initiative.

CONCLUSION

The Hawaiians are correct when they say "rehabilitate the society and the details will follow". The attitudes, values and socio-economic status of a society is the source of their effect on the environment, and the extent to which it is degraded. The damaged environment is simply the symptom. If efforts are directed towards solving problems at the level of the symptom only ("reactive management"), then no amount of work, money or community input will achieve the aim of reinstating ecosystem value, function and sustainability. Outcomes may be effective in the short-term, but are unlikely to satisfy expectations of long-term change, and will not justify the resources spent. It is vital that we understand that reinstating functionality and value to a catchment and to its community is not a quick fix. It is like regrowing an indigenous forest: it will take decades to see results.

Dr Mandy Uys can be contacted on e-mail: mandyuys@yahoo.com or cell no. 083-650-9518.

Shallow sewers provide viable intermediate sanitation

Shallow sewer systems provide a viable intermediate sanitation alternative between on-plot VIPs and full waterborne sewerage, according to a report published by the Water Research Commission (WRC) in Pretoria. The report, compiled by Guy Pegram and Ian Palmer of the Palmer Development Group, provides an appraisal of the applicability of these systems in South Africa.

The project was funded by the WRC as a contribution towards achieving strategic sanitation in South Africa, in the belief that shallow sewers could provide a low-cost intermediate technology sanitation solution, which is particularly applicable in

dense low to medium income urban and peri-urban settlements.

Detailed recommendations about the institutional and financial arrangements required for shallow sewer implementation are provided in the report, together with an indication of the technical and social consultation issues that should be addressed.

Copies of the report entitled **The applicability of shallow sewer systems in South Africa** (WRC report TT 113/99) are available free of charge in South Africa from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US\$ 15 - via surface mail).

The provision of adequate sanitation has a major impact on health and quality of life and is thus a priority for South Africa. However, the level at which sanitation services are provided continues to be one of the most contentious issues for urban service provision, with politicians and civic organisations pushing for full waterborne sewerage, whereas local government treasurers see the high costs of these systems as being unaffordable.

There are a number of intermediate sanitation technologies between on-plot disposal and conventional waterborne sewerage that may be considered for urban communities.

This report evaluates the applicability of one such option for South African conditions, namely shallow sewerage. Although the appraisal addresses the technological components of these systems, the main focus is on the management arrangements required for suc-

cessful implementation and operation of these systems. This is because internationally, the experience is that the institutional, financial and community participation components of these systems have the greatest impact on their sustainable operation.

SHALLOW SEWER SYSTEMS

Shallow sewer systems were developed by South American engineers in the early 1980s, in an attempt to provide an affordable sanitation alternative for dense, possibly unplanned, urban settlements. This is achieved by the following adaptations of conventional sewerage, which reduce the capital and operating costs of the systems.

Firstly, shallow sewerage, like simplified sewerage, is based on a relaxation of the typical technical specifications of conventional sewerage to reduce construction costs. This includes the use of smaller diameter pipes, flatter sewer

gradients and replacing manholes with simple access points.

Secondly, block sewers are located within the residents' plots or under sidewalks, in order to reduce the length of piping and enable sewers to be laid at shallower depths because of the reduced loading. These block sewers connect to conventional trunk street sewers.

Thirdly, responsibility for maintenance of the block sewers may be delegated to the residents, thereby reducing the operating costs incurred by the service provider.

Satisfactory functioning of shallow sewer systems has been achieved under a wide range of conditions in Brazil, Ghana, Pakistan and Greece. It is particularly appropriate for upgrading of informal peri-urban settlements and for areas with intermediate levels of water consumption (30 to 50 l/capita/day), but has also been applied in greenfield

developments with higher levels of water supply. Nevertheless, successful implementation of shallow sewerage requires high rates of connection and extensive community mobilisation and support.

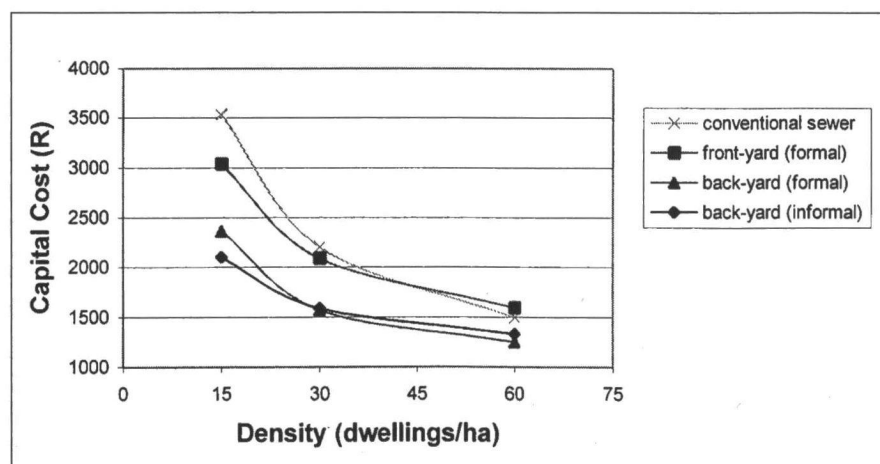
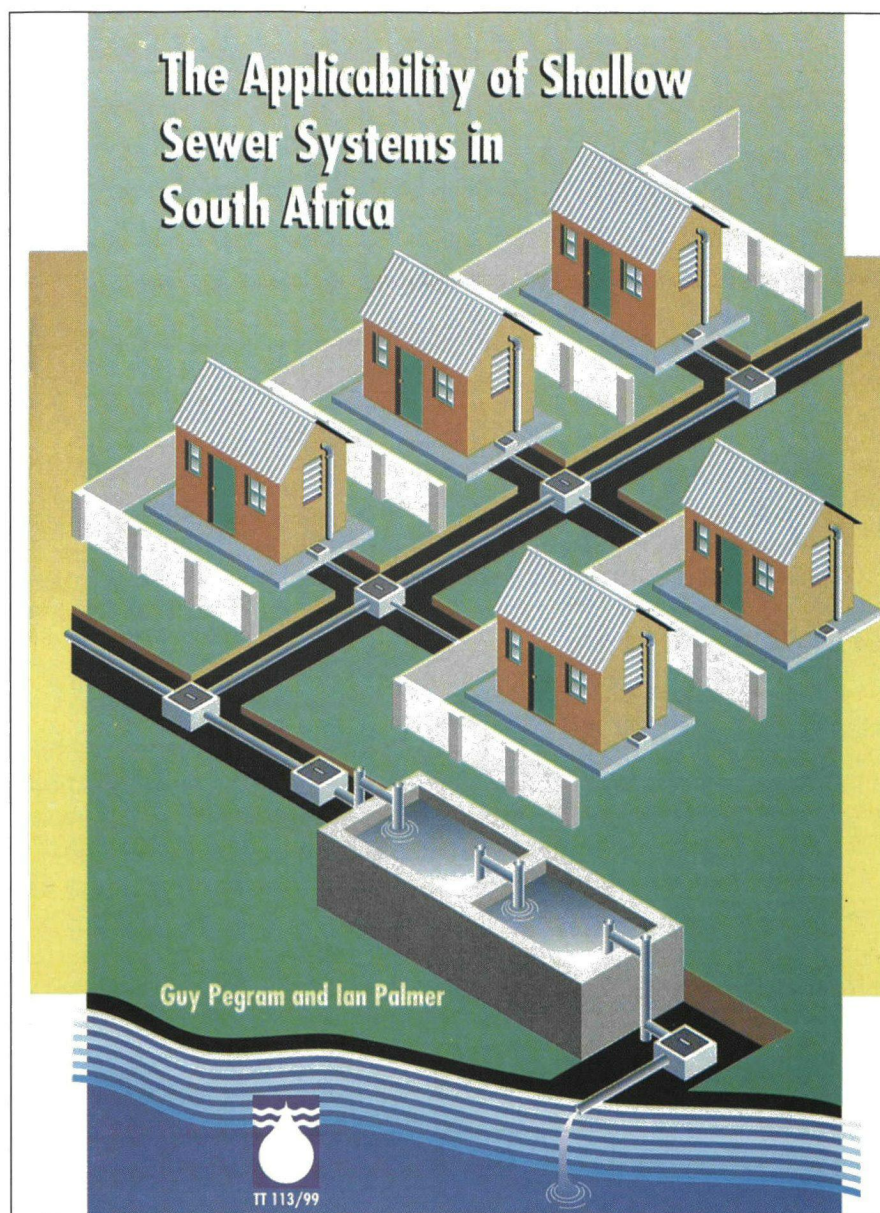
COSTS OF SHALLOW SEWER SYSTEMS

Shallow sewer systems were designed and costs were estimated for typical South African formal housing and informal peri-urban settlements, at different densities and for varying slope and geotechnical conditions. The figure presents the capital cost comparison for internal infrastructure between backyard shallow sewers, front-yard shallow sewers and a conventional sewer system at different densities, estimated using typical 1998 South African construction costs.

In the formal settlement, backyard shallow sewerage ranges from 65 per cent to 85 per cent of the capital cost of conventional sewerage. The cost savings are greater for settlements with adverse geotechnical conditions, such as rock that needs to be excavated. Where residents contribute labour for the construction of the sewer systems, the capital costs may be reduced to between 50 and 70 per cent of the cost of conventional sewerage. On the other hand, the total capital cost of internal and connector infrastructure for shallow sewerage is about twice that of VIPs.

Table 1 presents the average capital and operating costs of different sanitation alternatives, assuming that all maintenance is performed by the service provider. This indicates that the life cycle cost of shallow sewerage is about two and a half times that of VIPs, but only two thirds of conventional sewerage. However, if the residents are responsible for operation and maintenance of the block sewers, and contribute labour for construction, the annualised cost drops to almost half of conventional sewerage (that is, R26 per household per month). These cost estimates are consistent with the international experience and support the assertion that shallow sewers provide an intermediate sanitation alternative between VIPs and full waterborne sewerage.

Financial analysis of the implementation of shallow sewerage with capital grant financing and delegated management



The capital cost per household for different sanitation alternatives and densities. (Legend box next to graph provides key to sanitation alternatives.)

	Capital (R)		Operating (R/month)			Total Annualised (R/month)
	Internal	B& C ¹	Internal	B& C	Admin	
VIP	1250	-	2.00	1.00	-	13
Shallow sewer systems						
- back-yard	1500	1000	7.00	3.00	4.00	31
- front-yard	2000	1000	8.50	3.00	4.00	36
Conventional sewerage	2100	1500	8.00	5.00	8.00	45

Table 1: Typical capital and operating costs for different sanitation alternatives (Rands).

of block sewers in a typical large metropolitan local authority indicated that the required sanitation tariff per household would be about R18 per month. This could be collected as part of the water tariff, or through rent or rates. This would increase to about R21 per month where the local authority took responsibility for all operation and maintenance.

APPLICABILITY IN SA

Based on the financial analysis and an evaluation of the institutional and funding environment, the study indicated that shallow sewerage provides a viable intermediate sanitation alternative between on-plot VIPs and full waterborne sewerage. An evaluation of

the different types of South African settlements in which shallow sewer systems may be applied, indicated that shallow sewers are most likely to be appropriate for:

- Upgrading of low-income informal settlements, where there is access to capital grant financing and community willingness to take responsibility for construction and operation of the block sewers.
- Upgrading of low to middle income formal or informal settlements with on-plot sanitation, where the community is committed to shallow sewers, has raised funds for materials and will take responsibility for construction

and operation of shallow sewers.

- Upgrading of middle income settlements with on-plot sanitation, where cost recovery for services is high and the community is willing to pay the local authority for the full capital and operating cost of the sewerage system - this represents a technical rather than a management solution.

GREENFIELD DEVELOPMENTS

Although shallow sewer systems seems to be most appropriate for upgrading the above settlements with rudimentary on-plot sanitation, they may be applied in the following greenfield situations:

- Greenfield developments for an identified low-income community, with access to capital grant financing and a willingness to take responsibility for construction and operation of the block sewers.
- Greenfield developments for a middle income community, where full cost recovery for all services is expected and the local authority takes responsibility for all sewer maintenance.

Tenth South African National Hydrology Symposium

www.ccwr.ac.za/sanciahs2001/

"Southern African Hydrology: Past, Present and Future"

26 – 28 September 2001

University of Natal, Pietermaritzburg

The 10th South African National Hydrology Symposium is an event to celebrate. The aim is to highlight the role of hydrologists, water resources engineers, aquatic scientists and catchment managers in the past, present and future development, management and study of the southern African region's water resources.

THEMES

- Hydrology and integrated water resources management
- Hydrology, land-use and ecosystems
- Incorporating social and environmental concerns on decision making
- Prediction and coping with change: hydrological data and modeling
- Education in Hydrology

COSTS AND ACCOMMODATION

Early registration fee (before 31 July 2001) is R500.00, please note that the late registration fee will be R600.00. A special rate is available for full time students until 31 July 2001. Please note: Delegates must please make their own accommodation arrangements. (See symposium web site for a list of hotels and B&B.)

INFORMATION AND REGISTRATION ENQUIRIES

- Ms N Mabasa, Computing Centre for Water Research, University of Natal, Pietermaritzburg, Scottsville 3209. Tel: (033) 260-5178, Fax: (033) 260-6288, E-mail: mabasa@aqu.ccwr.ac.za
- Dr G Jewitt at Tel: (033) 260-5818, Fax: (033) 260-5490, E-mail: jewittg@nu.ac.za



DAY SEMINARS on Whole Effluent Toxicity Testing

13 September 2001 - Vanderbijlpark

21 November 2001 - Pretoria

The day seminars are specifically aimed at addressing the commercial and practical applications of Whole Effluent Toxicity (WET) testing.

Legislation with regard to protection of the environment is progressively becoming more stringent. Current effluent discharge permits and new licenses are all requiring biological impact evaluations, which includes

WET testing. Therefore many companies, industries, local councils and other water-using institutions either need or want to determine the impacts of their effluent on the receiving environment, particularly for future license negotiations. The person responsible to implement, manage and report on the ecological impact often has little or no ecologi-

cal training, and is faced with more questions than answers - questions and issues such as: What is WET testing all about? What toxicity tests need to be done? What methods and instruments are available? What do the test results mean? What are the costs involved? Who can advise on the development of a toxicity -monitoring programme? etc .

TOPICS

The seminars will cover the following:

WET tests

- Introduction to available WET tests (cost, time, simplicity, reliability, etc.)
- New methods, method development and associated problems
- Continuous biological and toxicological monitoring
- Training

Case studies

- Practical examples of WET testing (methods, problems, processing and analyses of results)
- Implementation, integration and IT management of WET test results for control and process management purposes
- WET testing at point of manufacture
- The responsibilities and policies of industries, product

suppliers and contractors

- The impact of WET testing on industries

Remediation

- The effect of wetlands on toxicity reduction

Integration

- The link between biological, chemical and toxicological monitoring
- Cost effectiveness of WET testing versus chemical testing
- The integration of WET testing into a current monitoring program

Legal aspects

- The Department of Water Affairs' view on WET testing, compliance limits and licenses
- Policing of toxicity compliance in accordance with limits agreed to for discharge licenses
- Point source dilution versus reduction of pollutants

COSTS AND VENUES

Registration costs will be R200 per person. Please enquire about venue details.

SPEAKERS

Do you have a contribution or presentation? Interested speakers are invited to submit abstracts of presentations without delay.

ENQUIRIES AND REGISTRATION

Please direct all enquiries and registration to:

Dr Pieter van Eeden
Tel. 083-304-0314

or

Mrs Anna Loots
Tel. (012) 667-3801

Overview of the WRC web site

<http://www.wrc.org.za>



The Internet web site of the Water Research Commission (WRC) was first launched on 1 April 1997. Since then, the contents and coverage of the web site has grown substantially, providing a comprehensive overview of the water research environment and related activities in South Africa. Here is a quick glance at what is currently available on the WRC web site:

WRC NEWS

The latest announcements and other news items reporting on WRC-related activities

INTERNATIONAL

Water-related announcements and news items from all over the world, which will be of interest to the local water community.

FOR THE RESEARCHER

- Updated Strategic Plans for the individual WRC research areas
- Guidebook for Project Leaders
- Background information on the annual evaluation procedure of project proposals used to finally select research projects suitable for funding by the WRC

FOR THE END USER

- List of all research report titles
- Announcements of the latest reports published by the WRC
- An electronic order for ordering research reports
- The 2000 WRC Annual Report
- Full text versions of the WRC publications:
 - WATER SA. A guide for authors planning to submit papers for publication in WATER SA is also available.
 - SA Waterbulletin

ACCESS TO WRC DATABASES

- Waterlit bibliographic database. More

than 330 000 references to local and international publications on all water-related topics. Free access available to South African residents.

- SA Water Research Database (SAWaR). This database contains information regarding water and water-related research being conducted within South Africa. Research projects funded by the Water Research Commission as well as other prominent organisations and agencies are included.
- Water Resources and Sanitation Bibliography (WRS). The information contained in this bibliography covers the period 1900-1993. References are to publications resulting from research undertaken by South/Southern African authors. Special reference is given to the KwaZulu-Natal Region.

INTEREST GROUPS

The WRC hosts (or provides links to) a number of water-related interest groups:

- SAES: School of Applied Environmental Sciences Project (University of Natal) to develop guidelines for the disposal of water-treatment sludges to land and to monitor the environmental effects on soil, crops and waters.
- EMILY: The Electronic Membrane Information Library
- KZNWRN: KwaZulu-Natal Research Network
- SmallSys: An international interest and action group on small water treatment systems
- CERM: Consortium for Estuarine Research and Management
- interWater: Contains information on water and sanitation in developing countries and is maintained by a group of partner institutions in the water sector under the auspices of the Water Supply and Sanitation Collaborative Council.
- JASWIC: Joint Acceptance Scheme for Water Installation Components - contains information about various water and sanitation components accepted for use by the major South African local authorities. Its list of

components is now searchable.

- River Health Programme
- Aquatox Forum

WRC SOFTWARE

Software, developed though WRC funding, are available for downloading from the web site:

- ALGEPACK: Problems and solutions regarding algal-related problems in the environment and in water purification plants
- CMMVID: Cross flow membrane module and potable water plant design
- DESDAF: Design and analysis tool for packed saturators used in dissolved air flotation.
- RSDO/RSPO: Reservoir system design/pumping optimisation
- RWSSM: Regional water supply services model
- SANFLOW: South African Night Flow Analysis Model
- SLADS: Sludge Land Application Decision Support software
- STASOFT: Stasoft model version 4 - a tool which can be used for designing, modelling and controlling water treatment processes that involve carbonate chemistry
- WSSM/SSW: Water supply services model / Sanitation services model

EVENTS

Details about local and international water-related events, together with contact and web addresses (if available), as well as information about water-related courses presented in all parts of the world.

ABOUT THE WRC

- WRC Board member names and contact details
- Names and contact details of WRC Research Managers
- WRC Mission Statement
- Physical address and contact details as well as a map and directions to reach the offices of the WRC

New reports published by the Water Research Commission

The following reports are available free of charge (in South Africa) from the Water Research Commission in Pretoria. To order a copy, please contact the librarian, WRC, PO Box 824, Pretoria 0001. Tel: (012) 330-0340. Fax: (012) 331-2565. E-mail: orders@wrc.org.za

Report 577/2/00 - Decision support for the conservation and management of estuaries.

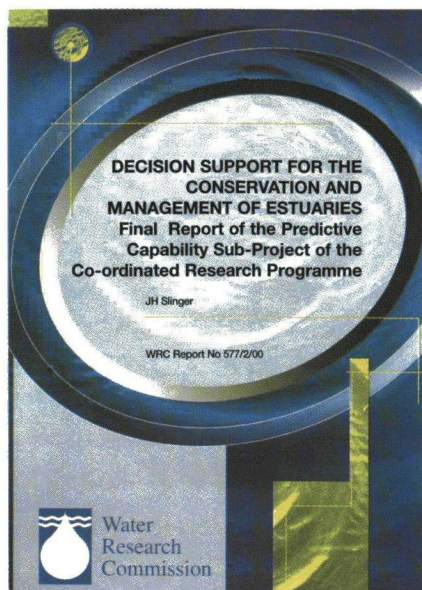
Report to the Water Research Commission by the Consortium for Estuarine Research and Management.

Author: JH Slinger

Overseas price: US\$ 15 (via surface mail)

Estuarine systems are favoured sites for development, recreation and conservation.


Over the years, knowledge of the structure and functioning (including freshwater requirements) of estuarine systems has been developed, however,



this information lacks integration. The separate studies of hydrodynamics,

sediment flushing, water quality, biota and the requirements of society are not structured around common statements of the problem and do not address the linkages between the various processes.

The major aim of this research project was to produce decision support systems for the integrated management and conservation of estuaries, based on sound scientific and socio-economic principles.

In the report the present status of several models and modelling techniques capable of predicting the physical, chemical or biological responses of South African estuaries to freshwater inflows are described. A system for linking these models, which was developed to provide a holistic predictive tool for estuarine management, is also presented. 

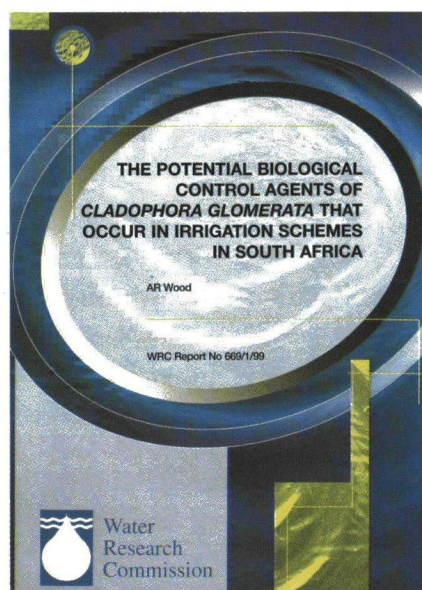
Report 669/1/99 - The potential biological control agents of *Cladophora glomerata* that occur in irrigation schemes in South Africa.

Report to the Water Research Commission by the Plant Protection Research Institute, Private Bag X5017, Stellenbosch.

Author: AR Wood

Overseas price: US\$ 15 (via surface mail)


It is estimated that over 25 per cent of water released into South Africa's irrigation schemes is lost during peak demand periods due to blockages caused by aquatic weeds. The weed of greatest concern is the green alga *Cladophora glomerata*, the so-called



"draadalg". At present this alga is controlled by mechanical removal from gratings and other structures as well as the combined use of copper-sulphate and sulphuric acid.

The aim of this Water Research Commission sponsored project was to determine what pathogenic organisms occur in *Cladophora glomerata* and whether any of these should be further investigated as biological control agents for this problematic alga.

Biological control of weeds is the use of living organisms to control unwanted plants. A number of biological control programmes directed at various aquatic weeds have been successful worldwide, however, few have investigated the use of pathogens against an alga.

The report says twenty three isolates (mainly chytrids and *Pythium* species) were tested in initial pathogenicity tests, most proving to be able to penetrate slightly damaged cells of *C. glomerata* within an 24 hour period, confirming their pathogenic status. However, after 48 hours, the longest period of observation, no adjoining healthy cells had been penetrated. 

Report 779/1/00 - The use of chloramination and sodium silicate to inhibit corrosion in mild steel pipes.

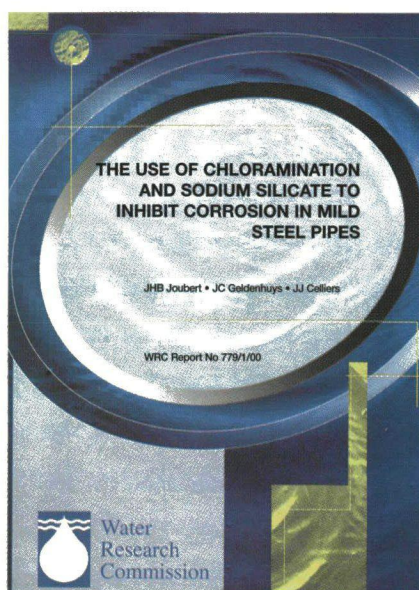
Report to the Water Research Commission by Scientific Services at the Rand Water Company.

Authors: JHB Joubert, JC Geldenhuys and JJ Celliers

Overseas price: US\$ 15 (via surface mail)

Corrosion in long pipelines and in reticulation systems can be managed by controlling the calcium carbonate precipitation potential of the purified water through adjustment of the pH and alkalinity levels. However, this method is not consistently successful as the adjustment of the desired parameters is not always practically possible due to shortcomings in plant design or a lack of technical knowledge.

There is evidence that monochloramine and sodium silicates can effectively be administered to inhibit corro-




sion, although it is seldom utilised for that purpose in the production and distribution of potable water.

The use of monochloramine could serve a two-fold purpose. It is primarily used to preserve microbiological quality of water in a distribution system and as a bacteriostat to prevent biofouling. Secondly, it could be used as a corrosion inhibitor.

The advantage of chloramination is that trihalomethanes, in addition to those formed during the primary disinfection with breakpoint chlorination, are not formed, nor are total organic halogens or mutagenicity levels increased.

The aim of the research was to determine the extent by which corrosion in steel pipes can be inhibited or reduced by the use of monochloramine or sodium silicates and whether these two chemicals can be used in combination with any type of coagulant.

According to the report two distinct experiments were undertaken, namely a trial based on weight loss of mild steel coupons exposed to water treated in nine different ways and a second trial with mild steel electrodes exposed to water treated in the same way in which the corrosion rates were measured with electro-chemical techniques.

In the weight-loss experiments, lower corrosion rates were measured with the addition of monochloramine, even when it was dosed in combination with sodium silicate. Lower corrosion rates were measured with incremental higher dosages. 

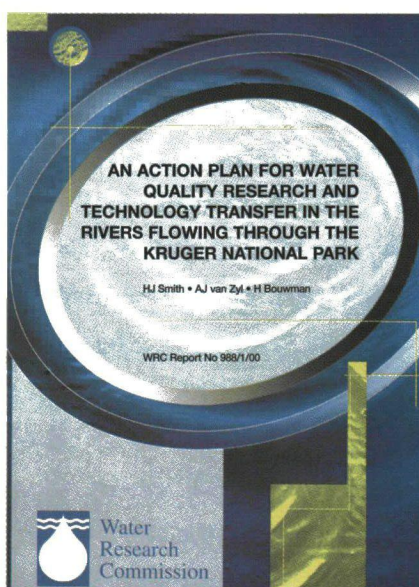
Report 988/1/00 - An action plan for water quality research and technology transfer in the rivers flowing through the Kruger National Park.

Report to the Water Research Commission by the Institute for Soil, Climate and Water and the Plant Protection Research Institute of the Agricultural Research Council.

Authors: HJ Smith, AJ van Zyl and H Bouwman

Overseas price: US\$ 20 (via surface mail)


The Kruger National Park River Research Programme has identified a need to improve the understanding of water quality issues in the catchments of perennial rivers of the Kruger Park as well as a need to transfer the exist-



ing knowledge on water quality to catchment stakeholders.

This report documents the results of a survey of perceived water quality information and research needs which was

conducted via questionnaires and completed during interviews with a selected group of representatives from all levels of stakeholders. According to the report the greatest need was found to be the implementation of validated and catchment-relevant prediction tools. A great deal of research was also judged to be needed to refine water quality criteria for river reaches, to determine the impacts on water quality, to manage the quality of water and to find effective ways to transfer and communicate water quality issues to all the different stakeholders.

The report proposes a multi-level (hierarchical) stakeholder approach to sustainable natural resource management. This approach, the authors say, holds promise to serve as a platform from which to launch new research, decision support products and initiatives. It could also serve as a framework for integration, communication and participation, and consequently technology transfer 

Report 740/1/00 - Effect of water quality on irrigation farming along the lower Vaal River: the influence on soils and crops.

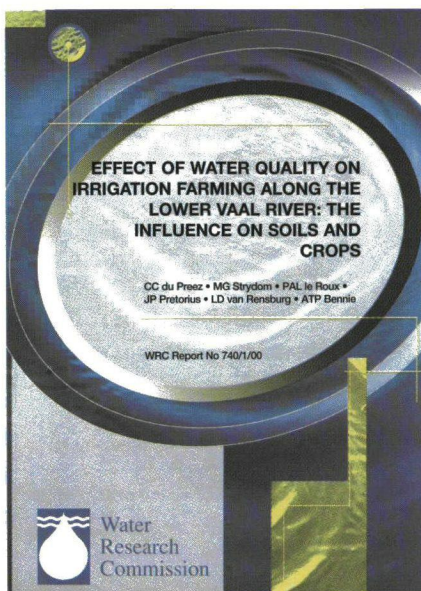
Report to the Water Research Commission by the Departments of Soil Science and Agronomy at the University of the Orange Free State.

Authors: CC du Preez, MG Strydom, PAL le Roux, JP Pretorius, LD van Rensburg and ATP Bennie
Overseas price: US\$ 25 (via surface mail)

In the lower Vaal River where water is mainly used for irrigation, the salt content of the water is often so high, according to periodic reports by irrigators, that it leads to soil salinisation and plant and crop damages.

In this study the researchers tried to ascertain the observed change in Vaal River water quality during the past number of years and investigated how water quality is expected to change under realistic future scenarios. They also assessed and evaluated the effects that these changes are likely to have on irrigated soils and crops. The


researchers conducted an extensive survey of typical salt profiles that have developed in various soil types under irrigation and investigated the usefulness of available salinity models for soil-crop-systems.



According to the report a plant's ability to tolerate salinity is a function of many factors. Some of the factors are soil fertility, the physical condition of the soil, salt distribution in the profile, irrigation methods and climate. Climate probably influences the response of plants to

salinity as much as, if not more than, any other factor. Most crops can tolerate greater salt stress if the weather is cool and humid than if it is hot and dry.

To avoid salt accumulation to an excessive level, the salts should be removed in amounts about equal to those applied. To dissolve and remove salts adequate water must be applied to allow percolation through the entire root zone - leaching. The amount of leaching is referred to as the leaching fraction and is defined as the fraction of water entering the soil that passes beyond the root zone.

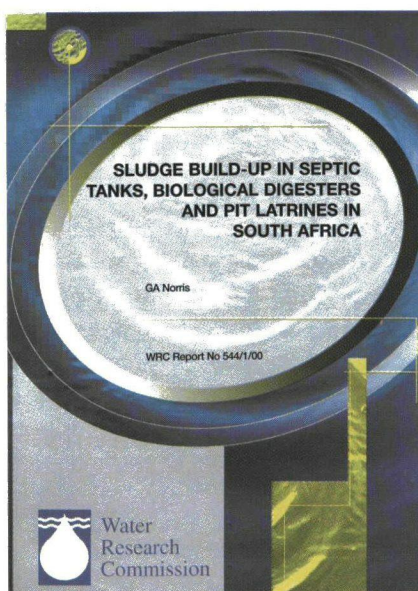
The report says it is difficult to compare crops, as far as salt tolerance is concerned, since yields of different crops are not expressed in comparable units. Currently, the most important crops planted in the study area are wheat (moderate tolerant), lucerne (moderate sensitive), maize (moderate sensitive), groundnuts (moderate sensitive) and cotton (tolerant). A rather good yield can still be obtained by using a higher leaching fraction, change from low to high frequency irrigation or change from a rather sensitive to a more tolerant crop. The tolerance data for different crops included in the report serve only as a guideline. Absolute tolerances vary, depending on climate, soil conditions and production practices amongst others. 

Report 544/1/00 - Sludge build-up in septic tanks, biological digesters and pit latrines in South Africa.

Report to the Water Research Commission by CSIR Building and Construction Technology.


Author: GA Norris
Overseas price: US \$10 (via surface mail)

Sludge build-up rate is an important design criterion in sizing on-site sanitation systems such as septic tanks, pit latrines and "Loflo systems etc. Research has indicated that the design criteria currently used in South Africa are generally in appropriate because



the criteria are largely based on experience in other countries.

The aim of this particular project was to establish the sludge build-up rates in various on-site sanitation systems under South African conditions. The most common factors generally considered to influence the rate of sludge build-up were number of uses, diet, anal cleansing materials used, soil conditions, seasonal effects (temperature, moisture etc.), retention time, influent characteristics and toilet cleaning materials.

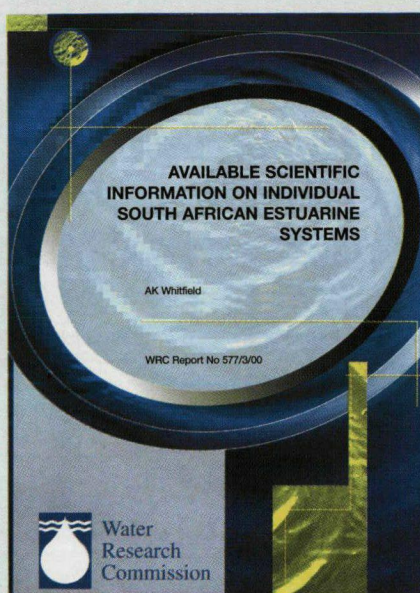
The sludge build-up rate in VIP latrines, septic tanks and two kinds of "Loflo" digesters at various sites were measured. Soil investigations and socio-economic surveys were conducted, and user perceptions were also noted and reported. Despite various problems sufficient information was obtained for the purpose of establishing acceptable design guidelines. 

Report 577/3/00 - Available scientific information on individual South African estuarine systems.

Report to the Water Research Commission by the JLB Smith Institute of Ichthyology, Private Bag X1015, Grahamstown 6140.

Author: AK Whitfield
Overseas price: US\$ 20 (via surface mail)

This is the third report in the 577-series dealing with South African estuarine systems. The first report 577/1/95 also titled Available scientific information on individual South African estuarine systems was published in 1995 and has been widely used over the past few years. An internet version of the report is available on the CERM (Consortium for Estuarine Research and Management) web page - www.ru.ac/cerm/datab.html - where it provides




researchers, planners and managers with an easily accessible source of scientific information on the various South African estuaries.

The current report is an updated hard copy of the 1995 publication. In addition

to providing valuable data sources for individual systems, the latest version of this document also highlights those estuaries for which limited information is available. A section dealing with references having wider relevance to estuaries of a particular region, or even to the subcontinent as a whole, has also been included.

For the purposes of the report, South African estuarine systems have been divided into three major biogeographic regions, namely, subtropical - from the Kosi Estuary in KwaZulu-Natal to the Mbashe Estuary in the Eastern Cape, warm temperate - from the Mendu Estuary in the Eastern Cape to the Silwermyl Estuary in False Bay, and cool temperate - from the Krom Estuary on the Cape Peninsula to the Orange River mouth on the Northern Cape coast.

Information availability on each estuarine system is categorised as nil, poor, moderate, good or excellent, based on the scope and depth of available scientific publications and reports. 

Practical course

Aquatic toxicity testing

18-21 September 2001 • CSIR, Pretoria

The course, presented by the Water Programme of the CSIR, is aimed at persons active in the water industry, e.g. water resource managers (DWA, Catchment Management Agencies), water users (water boards, local authorities, industries), researchers (tertiary institutions, private laboratories) and consultants.

- ☐ The course will be limited to a maximum of 12 participants to ensure personal attention
- ☐ Participants will receive certificates of attendance
- ☐ Further assistance will be available to participants after the course

Lectures:

- Introduction to toxicity testing
- Water and effluent testing
- Culturing and maintenance of test organisms
- Sample concentration procedures and equipment use
- Data processing
- Accreditation/Good laboratory practice (GLP)

Hands-on training:

- Three standard aquatic toxicity tests (fish and water flea lethality tests; and the algal growth inhibition test)
- Rapid urease enzyme and bacterial growth inhibition tests

Practical demonstrations in:

- The Ames *Salmonella* mutagenicity
- A frog embryo teratogenicity test

Contact person: Annette Venter • Tel: (012) 841-2830 • Fax: (012) 841 2506 • E-mail: aventer@csir.co.za



WORKSHOP INVITATION



The Water Research Commission
and
Environmentek, CSIR
invite you to attend a workshop to discuss:

Guidelines for *Legionella* levels in water and human health risk assessment

19 September 2001
CSIR, Pretoria

A set of guidelines is required for the effective control of *Legionella* levels and to manage the potential health risk effectively. Such guidelines are intended to be a "code of practice" for use by power stations, water treatment companies, hotels, shopping centers as well as the building and maintenance managers of community building complexes. The "code of practice" will also provide guidelines for the prevention and control of *Legionella* at hospitals, AIDS centers, old-age homes and frail care centers. Your participation and input, as an industrial partner, in the workshop discussions will be of vital importance, and necessary to get consensus and create a user-friendly document.

PROGRAMME

9.00 - 10.30	Introduction The <i>Legionella</i> bacterium Guidelines for sampling procedures Guidelines for methods of detection
10.30 - 11.00	Tea
11.00 - 13.00	Guidelines for prevention and control Guidelines for monitoring and maintenance Guidelines procedures during outbreaks Risk management
13.00 - 14.00	Lunch

Venue: Loerie Seminar Room, Building 33, CSIR

Date: 19 September 2001

Time: 9.00 - 14.00

Please register early, before 5 September 2001, only a limited number of persons can be accommodated.

Registration and enquiries:

Pauline Coubrough
Tel: 012 841 3952
Fax: 012 841 2506
e-mail: pcoubrou@csir.co.za

Further Information:

Annatjie Oelofse
Research manager:
Health-related water issues
Tel: (012) 330-0340

WHO report presents solutions for water problems

"Simple, inexpensive measures, both individual and collective, are available that will provide clean water for millions and millions of people in developing countries - now, not in 10 or 20 years," said Dr Gro Harlem Brundtland, Director-General of the World Health Organisation (WHO) at the release of a report on water and sanitation.

The WHO report, entitled "Water for Health – Taking Charge", strongly urges several basic measures, including purifying water (by chlorination and sodis) and improving hygiene, as immediate means of improving people's water supply in developing countries.

CHLORINATION

"We looked at how chlorinated water could be provided to poor households through a simple, low-cost treatment and secure storage method," says Mark Sobsey, Professor of Environmental Microbiology at the University of North Carolina in Chapel Hill. "One of our findings is that improving water quality alone does work, and we can do this without improving sanitation."

"What we know now is that even in conditions of very poor sanitation and hygiene, where people are collecting whatever water is available to use for their household water supply, if the water is chlorinated, the water is improved microbiologically, and you can find statistically significant decreases in diarrhoeal disease."

A good example of successful chlorination is to be found in the Maldives where a national control programme used it in wells and in oral rehydration salts against diarrhoea.

RAINWATER

Rainwater was also collected for drinking water in the Maldives. Twenty years after the programme started, all of the Maldives islands have their own community rainwater collection tanks, and deaths from diarrhoea are virtually unknown, says Prof Sobsey.

SODIS

"Another easy, small-scale, cost-effective, immediate technique for providing safe water, individually or collectively, is a little-known but highly effective solar thermal technique. It is called SODIS and promoted by the Swiss Federal Institute for Environmental Science and Technology near Zurich."

"SODIS, or solar water disinfection, is a nearly cost-free system because sunlight costs nothing, and the only other ele-

ments are throw-away plastic soft-drink bottles and a black surface," explains Martin Wegelin, a researcher at the Swiss Institute for Environmental Science and Technology.

Transparent bottles are filled with water and placed horizontally on a flat surface for about five hours. The illness-causing microorganisms (pathogens) in the polluted water succumb to the killing effect of the ultraviolet light in solar radiation. The process is enhanced when the solar water disinfection is combined with a "solar thermal water treatment" which makes use of the fact that the colour black absorbs light. This is accomplished by painting the bottom half of the bottle black or placing it on a black plastic sheet or black-painted corrugated iron..

Field studies in Bolivia, Burkina Faso, China, Colombia, Indonesia, Thailand and Togo have shown that this process works.

HYGIENE

Studies of diarrhoea show that the simple act of washing one's hands with soap and water reduces incidence of the disease by 35%. Valerie Curtis of the London School of Hygiene and Tropical Medicine says "our research shows that washing with hand soap would sharply reduce deaths from diarrhoeal disease. All it requires is soap and motivation. We used a positive motivation approach in a three-year project in Burkina Faso in the city of Bobo-Dioulasso - by the end their use of soap had tripled".

PREVENTION BETTER THAN CURE

Prevention of water-related diseases is important, says the WHO report. During the past fifty years there has been a strong emphasis on medical interventions, including drug use. This emphasis tended to reduce the attention and priority given to safe water supply and adequate sanitation into the back seat. However, with the present understanding of the limitations of a strictly medical approach, the importance of good hygiene, safe water and sanitation has now again come to the fore.

For more information or to order the report please contact Jamie Bartram, the WHO coordinator at the Water, Health and Sanitation Unit, WHO, Geneva. Telephone (+41 22) 791 3537 or e-mail: bartramj@who.int

SA WATERKALENDER

The Water Research Commission is placing this calendar in order to assist with the co-ordinating of water events in South Africa.

You are invited to send information about conferences, symposia or workshops to the SA Waterbulletin.

Address:
The Editor,
SA Waterbulletin,
P.O. Box 824,
0001 Pretoria
Tel (012) 330-0340
Fax (012) 331-2565

Legend:

- ☐ An SA Water Event arranged for these dates.
- ☐ 2nd SA Water Event scheduled for these dates.
- ☒ 3rd SA Water Event scheduled for these dates.

See conferences and symposia pages for events.

2001

JANUARY	FEBRUARY	MARCH	APRIL
S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
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Die Waternavorsingskommissie plaas hierdie kalender om te help met die koördinerings van watergebeurtenisse in Suid-Afrika.

Alle belanghebbendes word uitgenooi om inligting aan SA Waterbulletin te stuur.

Adres:
Die Redakteur
Posbus 824
0001 Pretoria
Tel: (012) 330-0340
Fax: (012) 331-2565

Gids:

- ☐ Een SA Watergeleentheid vir hierdie dae.
- ☐ 'n Tweede SA Watergeleentheid vir dié datums.
- ☒ 'n Derde SA Watergeleentheid vir dié datums.

Sien Konferensies- en Simposiumbladsy vir aangeduide geleenthede.

2002

JANUARY	FEBRUARY	MARCH	APRIL
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SOUTHERN
AFRICA

2001

AFRIWATER EXHIBITION

AUGUST 15 - 17

The international African water, waste & environmental exhibition will be held at Gallagher Estate, Midrand.

Enquiries: Craig Newman, TML Reed Exhibitions. Tel: (011) 886-3734. Fax: (011) 789-6497. E-mail: craign@tmlreed.co.za

AFRIWATER SEMINARS

AUGUST 15 - 17

The Water Institute of Southern Africa will organise a series of half-day seminars on pertinent topics at the Gallagher Estate in Midrand.

Enquiries: Roelien Bakker, WISA. Tel: (011) 805 6368. Fax: (011) 315 1258. E-mail address: conference@wisa.co.za

SANITATION

AUGUST 20 - 24

The 27th WEDC conference with the theme "People and systems for water, sanitation and health" will be held in Lusaka, Zambia.

Enquiries: Professor John Pickford, WEDC, Loughborough University LE11 3TU, England. Fax: (44) 01509 211027. E-mail: j.a.pickford@lboro.ac.uk

WATER AFRICA

SEPTEMBER 3 - 5

The Water Africa 2001 conference and exhibition dealing with water supply and pollution control will be held at the Nile Conference Centre in Kampala, Uganda. Enquiries: Africa Trade Promotion, Postnet Suite 102, Private Bag X782, Bedfordview 2008. Tel: (011) 918-5580/918-0744. Fax: (011) 918-5607/918-5580. E-mail: globaltr@iafrica.com

ENVIRONMENT

SEPTEMBER 10 - 14

The next ISO 14001 Environmental Auditor training course will be held at the Eskom Conference Centre in Midrand, Johannesburg.

Enquiries: Crystal Clear - Tel: (011) 882-3368. E-mail address: info@crystalclear.co.za

TOXICOLOGY

SEPTEMBER 13

The 4th one day seminar and workshop on "The practical

applications of Whole Effluent Toxicity (WET) testing" will be held at Emfuleni Conference Centre, Vanderbijlpark.

Enquiries: Dr. Pieter van Eeden at 016-889-3795, or e-mail: pieter.vaneeden@freemail.absa.co.za

ENVIRONMENTAL
MANAGEMENT

SEPTEMBER 18 - 20

A short course on environmental management will be held at the Post-Graduate Centre of the University of Pretoria.

Enquiries: Ms Tanya de Bruin. Tel: (012) 362-5118/9. Fax: (012) 362-5285. E-mail address: tanya.ce@up.ac.za

MINE WATER

SEPTEMBER 25 - 28

A conference on environmentally responsible mining in Southern Africa will be held at the Misty Hills Country Hotel, Muldersdrift, near Johannesburg.

Enquiries: Me Ammie Wissing, Conference Planners, PO Box 36782, Menlo Park, Pretoria 0102. Tel: (012) 348-4493. Fax: (012) 348-1563. E-mail address: wissing@iafrica.com

TOXICOLOGY

NOVEMBER 21

The 5th one day seminar and workshop on "The practical applications of Whole Effluent Toxicity (WET) testing" will be held at a venue in Pretoria.

Enquiries: Dr. Pieter van Eeden at 016-889-3795, or e-mail: pieter.vaneeden@freemail.absa.co.za

WATER MANAGEMENT

NOVEMBER 25 - 29

The International Management Training Network (ITN) conference with the theme "Learning opportunities for water management in Africa" will be held in Midrand, Johannesburg.

Enquiries: Roelien-M Bakker, ITN Conference Centre, PO Box 6011, Halfway House 1685. Tel: (011) 805-6368. Fax: (011) 315-1258. Cell: 082-342-8561. E-mail: conference@wisa.co.za

2002

RIVER SYSTEMS

MARCH 3 - 8

The 4th international ecohydraulics symposium with the theme "Environmental flows for river systems" will be held in Cape Town.

Enquiries: Conference Secretariat, Southern Waters Ecological Research and Consulting (Pty) Ltd. PO Box 13280. Mowbray 7705. Fax: (021) 6503887. E-mail address: conference2002@southernwaters.co.za. Website address: <http://www.southernwaters.co.za>

HYDROLOGY

MARCH 18 - 22

UNESCO's 4th international conference on Flow Regimes from International Experimental and Network Data (FRIEND) with the theme "Bridging the gap between research and practice" will be held in Cape Town.

Enquiries: Juanita McLean, Institute for Water Research, Rhodes University, PO Box 94, Grahamstown 6140. Tel: (046) 622-4014. Fax: (046) 622-9427. E-mail: Juanita@iwr.ru.ac.za

DESERTIFICATION

APRIL 8 - 10

An international symposium on alternative ways to combat desertification - Connecting community action with science and common sense - will be held in Cape Town.

Enquiries: Mary Seely, Desert Research Foundation of Namibia, PO Box 20232, Windhoek, Namibia. Tel: +264 61 229855. Fax: +264 61 230172. E-mail: mseely@drfn.org.na

WISA

MAY 19 - 23

The Water Institute of Southern Africa (WISA) will hold its next biennial meeting at the ICC conference centre in Durban. Call for papers.

Enquiries: Roelien-M Bakker, WISA. Tel: (011) 805-6368. Fax: (011) 315-1258. E-mail address: conference@wisa.co.za

OVERSEAS

2001

FOG COLLECTION

JULY 15 - 20

The second international conference on fog and fog collection will be held in St John's, Newfoundland, Canada. The conference will focus on the physics, chemistry, meteorology, forecasting and remote sensing of fog; fog deposition and the interaction of fog with vegetation;

dew research, fog collection projects in developing countries and the negative effects of fog on commercial offshore activities.

Enquiries: Dr Robert Schemenauer (Conference Chair), PO Box 81541, 1057 Steeles Avenue West, Toronto, Ontario M2R 2X1, Canada. Fax (1 416) 739 4211. E-mail address: robert.schemenauer@ec.gc.ca

CYANOBACTERIA

JULY 16 - 20

The 5th international conference on toxic cyanobacteria will be held in Noosa, Qld, Australia.

Enquiries: E-mail: ictcv@bne.clw.csiro.au OR website: <http://lurac.la.trobie.edu.au/botbml/cyanotox.html>

WEDC

The 27th Water, Engineering and Development Centre (WEDC) conference with the theme "People and systems for water, sanitation and health" will be held in Lusaka, Zambia.

Enquiries: WEDC, Institute of Development Engineering, Loughborough University, Leicestershire LE11 3TU UK. Tel: +44 (0) 1509 222885. Fax: +44 (0) 1509 211079. E-mail: WEDC@lboro.ac.uk Web: <http://www.lboro.ac.uk/wedc>

ALGAL WORKSHOP

JULY 23 - 25

The 3rd Australian algal workshop will be held at Coopers Plains in Brisbane, Qld, Australia.

Enquiries: E-mail: Glenn.McGregor@dnr.qld.gov.au

BIOGEOCHEMISTRY

JULY 30 - AUGUST 3

The 6th international conference on the biogeochemistry of trace elements will take place in Guelph, Ontario, Canada.

Enquiries: ICOBTE, c/o Dr Les Evans, Conference Chair, Department of Land Resource Science, University of Guelph, Ontario, Canada N1G2W1. E-mail: icobte@lrs.uoguelph.ca

AQUACULTURE

AUGUST 5 - 7

The European Aquaculture Society (EAS) will hold a symposium with the theme "aquaculture in Europe" in Trondheim, Norway.

Enquiries: Please see <http://www.easeonline.org>

WATER IN HISTORY

AUGUST 10 - 12

A symposium on the role of water in history and development will be held in Bergen, Norway.

Enquiries: Alv Terje Fotland, Centre for Development Studies, University of Bergen, Stromgaten 54, N-5007 Bergen Norway. Fax: +47 5558 9892. E-mail: Alv.Fotland@sfu.uib.no

STOCKHOLM WATER SYMPOSIUM

AUGUST 13 - 16

"Water security for the 21st century - building bridges" will be the theme of the 2001 Stockholm Water Symposium to be held in Sweden.

Enquiries: Symposium Secretariat, Sveavägen 59, SE-113 59 Stockholm, Sweden. Tel: +46 8 522 139 75. Fax: +46 8 522 139 61. E-mail: sympos@siwi.org. Web: www.siwi.org

EVAPOTRANSPIRATION

AUGUST 13 - 25

A short course on the determination of evapotranspiration from satellite data and applications in water management will be held in Enschede, the Netherlands.

Enquiries: Mrs R Hummel, ITC, PO Box 6, 7500 AA Enschede, the Netherlands. Tel: +31 53 487 43 05. Fax: +31 53 487 43 36. E-mail: wres@itc.nl

ITC COURSES

SEPTEMBER

The International Institute for Aerospace Survey and Earth Science (ITC) in the Netherlands will present the following courses: Environmental systems analysis and management for water resources; Watershed management, conservation and river basin planning; Groundwater resources evaluation and management as well as short courses in Applied hydrogeology and Groundwater modelling.

Enquiries: AM van Lieshout. Tel: +31 534 874 306. Fax: +31 534 874 336. E-mail: lieshout@itc.nl

ANAEROBIC DIGESTION

SEPTEMBER 3 - 5

A conference on anaerobic digestion titled AD2001 will be held in Antwerp, Belgium.

Enquiries: Lood FM van Velsen, NVA, PO Box 70, 2280 AB Rijswijk, the Netherlands. Tel: +31 24 3284282. Fax: +31 24 3604737. E-mail address: sf@haskoning.nl

ICHTHYOLOGY

SEPTEMBER 3 - 7

The 10th European conference on ichthyology will be held in Prague, Czech Republic.

Enquiries: Website address: <http://www.eci-x.iapg.cas.cz>

MEMBRANE TECHNOLOGY

SEPTEMBER 9 - 13

A conference on membrane technology for wastewater reclamation and reuse will be held in Tel-Aviv, Israel.

Enquiries: Gideon Oron, Ben-Gurion University of the Negev, Blaustein Institute for Desert Research and Environmental Water Resources, Kiryat Sde-Boker 84990, Israel. Tel: +972 7 659 6901. Fax: +972 7659 6909. E-mail: mmbnrnt1@bgumail.bgu.ac.il

ACTIVATED SLUDGE

SEPTEMBER 10 - 12

The 5th Kollekolle seminar on activated sludge modelling with the theme "Modelling and the microbiology of activated sludge processes" will be held in Kollekolle, Denmark.

Enquiries: Ms Mia Clausen, Miacon c/o Department of Environmental Science and Engineering, Building 115, Technical University of Denmark, DK-2800, Lyngby, Denmark. E-mail: mc@imt.dtu.dk Tel: +45 4525 1613. Fax: +45 4593 2850.

GROUNDWATER

SEPTEMBER 10 - 14

An IAH congress on new approaches to characterising groundwater flow will be held in Munich, Germany.

Enquiries: Web page address: <http://www.hydrogeologie.uni-muenchen.de/munich2001/index.html>

RAINWATER

SEPTEMBER 10 - 14

Rainwater 2001 - conference and fair will take place in Mannheim, Germany.

Enquiries: Hans Hartung, FAKT, Kanalstrasse 23, D-97990 Weikersheim, Germany. Fax: +49 7934 990031. E-mail: ircsa@rainwaterconference.org

POLLUTION

SEPTEMBER 17 - 19

The conference Water Pollution 2001 will be held in Rhodes, Greece

Enquiries: Gabriella Cossutta, Conference Secretariat, Wessex Institute of Technology, Wessex, UK. Tel: +44 (0) 23 80293223. Fax: +44 (0) 23 8029 2853. E-

mail: gcossutta@wessex.ac.uk
Web: <http://www.wessex.ac.uk>

WATER RESOURCES

SEPTEMBER 24 - 26

The first international conference on water resources management will be held in Halkidiki, Greece.

Enquiries: Website address: <http://www.wessex.ac.uk/conferences/2001/wrm01/>

WASTE MANAGEMENT

OCTOBER 1 - 5

The 8th international waste management and landfill symposium will be held in S. Margherita di Pula, Cagliari, Italy.

Enquiries: EuroWaste srl, via Altinate, 96 - 35121 Padova. Tel: +39 049 663860. Fax: +39 049 663960. E-mail: eurowaste@tin.it or Web: www.unipd.it/sardinia symposium

GROUNDWATER

OCTOBER 4 - 5

An international conference on "Applying policies and decision-making tools to land-use planning" will be held in Birmingham, UK.

Enquiries: Lamorna Zambellas or Mary Goldsworthy. Tel: +44 (0) 121 711 5885. Fax: +44 (0) 121 711 5925 or e-mail: ngwcl@environment-agency.gov.uk

WEFTEC 2001

OCTOBER 13 - 17

The 74th annual conference and exhibition of the American Water Environment Federation will be held in Atlanta, USA.

Enquiries: E-mail: confinfo@wef.org Fax: +1 703 684 2475. Website address: <http://www.wef.org/docs/conference.html>

WORLD WATER

OCTOBER 15 - 19

The 2nd world water congress hosted by the International Water Association (IWA) will be held in Berlin, Germany.

Enquiries: Cornelia Wolff von der Sahl. Tel: +49(0)30/3038-2085. Fax: +49(0)30/3038-2079. E-mail: wolffvondersahl@mess-berlin.de Web-page: <http://www.iwa-berlin.de>

LAKE MANAGEMENT

NOVEMBER 11 - 16

The 9th international conference on the conservation and management of lakes (Biwako 2001) will be held in Otsu City in the Shiga Prefecture, Japan.

Enquiries: Conference Secretariat, c/o Shiga Prefectural Government, 4-1-1 Kyomachi, Otsu, Shiga 520-8577, Japan.

Tel: +81-77-528-3466. Fax: +81-77-528-4849. E-mail: lake2001@pref.shiga.jp Website: <http://www.pref.shiga.jp/lake2001/>

AGRO 2001

NOVEMBER 16 - 18

The 5th international symposium on waste management problems in agro-industries will be held under the auspices of the International Water Association (IWA), in Shiga, Japan.

Enquiries: Agro 2001, Kyoto University, 1-2 Yumihama, Otsu, Shiga 520-0811 Japan. Fax: +81-77-524-9869. E-mail: agro2001@biwa.eqc.kyoto-u.ac.jp

2002

UAWS

FEBRUARY 18 - 21

The 11th congress of the Union of African Water Suppliers (UAWS) will be held in Libreville, Gabon, with the theme "Water and the environment, strategic factors in poverty alleviation"

Enquiries: Administrative Secretary of UAWS, 01 Bp 1843 Abidjan 01, Côte d'Ivoire. E-mail: susher@sodeci.ci. Tel: (225) 2124-1443. Fax: (225) 2124-2629.

GROUNDWATER

MAY 12 - 17

An international groundwater conference with the theme - Balancing the groundwater budget - will be held by the International Association of Hydrogeologists (Australian Chapter) in Darwin, Australia.

Enquiries: Des Yin Foo IAH (NT), PO Box 95, Palmerston, NT 0831, Australia. Fax: (61) 8 8999 3666. E-mail: des.yinfoo@nt.gov.au

AWWA

JUNE 16 - 20

The American Waterworks Association's annual conference and exhibition will be held in New Orleans, USA.

Enquiries: David Rossiter, AWWA, USA. E-mail: rossiter@awwa.org Tel: +303 347 6209. Web: <http://www.awwa.org/tande/awwaconf.htm>

ENVIRONMENTAL FLOWS FOR RIVER SYSTEMS

International Working Conference on Assessment and Implementation
incorporating the

FOURTH INTERNATIONAL ECOHYDRAULICS SYMPOSIUM



3 – 8 MARCH 2002
CAPE TOWN, SOUTH AFRICA

This international working conference will focus on methods, procedures and policies for promoting sustainable use of water resources through proactive use of environmental flows. All parts of the river system will be addressed: the river channel and banks; associated wetlands, floodplains, lakes and estuaries; and linked groundwater and near-coast oceanic environments. A warm invitation is extended to river scientists, water engineers, water managers, policy makers, social scientists working on subsistence use of aquatic systems, and anyone interested in the sustainable use of river systems, to attend the conference and the related activities.

CONFERENCE OUTLINE

- Four plenary sessions
- Four days of parallel sessions
- One day of specialist workshops
- Pre-conference Training Courses
 - Flow assessment methods
 - Update on IFIM
 - Geohydrology
- Hydraulics & hydrology for ecologists
- Ecotoxicology
- Freshwater flows for estuaries
- Eutrophication
- Mid-week excursions
- Post-conference tours

KEYNOTE AND INVITED SPEAKERS

Minister Ronnie Kasrils, Minister of Water Affairs and Forestry, SA
Prof. Brian Moss, University of Liverpool, UK
Prof. Thayer Scudder, California Institute of Technology, USA
Prof. Klaus Jorde, University of Idaho, USA
Dr Catherine Sabaton, Electricité de France, France
Mr John Briscoe, World Bank, USA

Mr Bill Rowlston, Water Affairs and Forestry, SA
Prof. Jack Stanford, Flathead Lake Biological Station, USA
Prof. Angela Arthington, Griffith University, Australia.
Prof. Kevin Rogers, University of the Witwatersrand, SA
Prof. Geoff Petts, University of Birmingham, UK
Dr Cate Brown, Southern Waters, SA

The two prestigious journals – Regulated Rivers: Research and Management and Journal of Hydraulic Research – will each devote an issue to papers presented at the Conference.

DEADLINES

Abstracts 31 July 2001
Late registration 30 November 2001

CONFERENCE SECRETARIAT

Southern Waters Ecological Research and Consulting (Pty) Ltd.
P.O. Box 13280, Mowbray 7705, South Africa
Telephone: ++27-21-6854166 • Fax: ++27-21-6854630 or ++27-21-6503887
E-mail: conference2002@southernwaters.co.za
web site: <http://www.southernwaters.co.za>

ALL ENQUIRIES AND REGISTRATION:

Please refer to the Conference web site, or contact the Conference Secretariat.

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15 – 17 August 2001

Gallagher Estate Midrand Gauteng

Sending your staff to Afriwater 2001 exposes them to the local and global water, waste and environmental industry at full flood. No other trade exhibition of its kind attracts greater public and private sector participation. Nowhere else will your people gain more valuable insights about the issues and solutions that are shaping this industry.

Studies by the Center for Exhibition Industry Research in the USA show that staff who attend focused trade exhibitions (like Afriwater), increase their awareness of better business practices, make better business contacts and are more in touch with crucial market trends.

For complimentary visitor tickets, contact Maureen Madingoane today at Reed Exhibitions SA on tel: +2711 886 3734; fax: +2711 781 1270; or e-mail: maureenm@reedexpo.co.za.

NOTE: As this is a trade exhibition, persons under the age of 18 will not be admitted.

Organised by



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www.reedexpo.co.za