

# S4 waterbulletin

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## **WATER LAW**

**Water allocation under South African law analysed**

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## **IRRIGATION**

**Irrigation demand estimated from satellite imagery**

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## **WATER AND HEALTH**

**WRC publishes atlas of water-related diseases**

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# ONE-DAY SEMINARS

## ONE-DAY SEMINARS

on

# Legionella in Industry

to be held

FEBRUARY 1998

### WHERE:

- Johannesburg - 16 February 1998  
Pietermaritzburg - 18 February 1998  
Cape Town - 20 February 1998

### TOPICS:

Topics to be addressed in the seminars will be:

- Ecology of Legionella
- Different environments where Legionella are found
- Methods for the detection of Legionella
- Evaluation of Australian and British standard detection methods
- Risk assessment, standards and legislation
- Control of Legionella in cooling water systems

### SPEAKER:

Mike Iddon from Britain will be the guest speaker at the seminars. He will share from his expertise of almost forty years' experience as a practising water treatment chemist and consultant on the prevention and control of Legionella.

### COSTS:

- Members - R270  
Non-members - R300  
Students - R250

***The one-day seminars will be hosted by the Legionella Action Group.***

### For further information please contact:

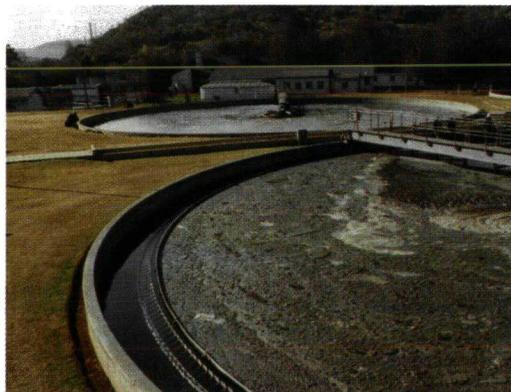
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Fred Goede (Sastec)  
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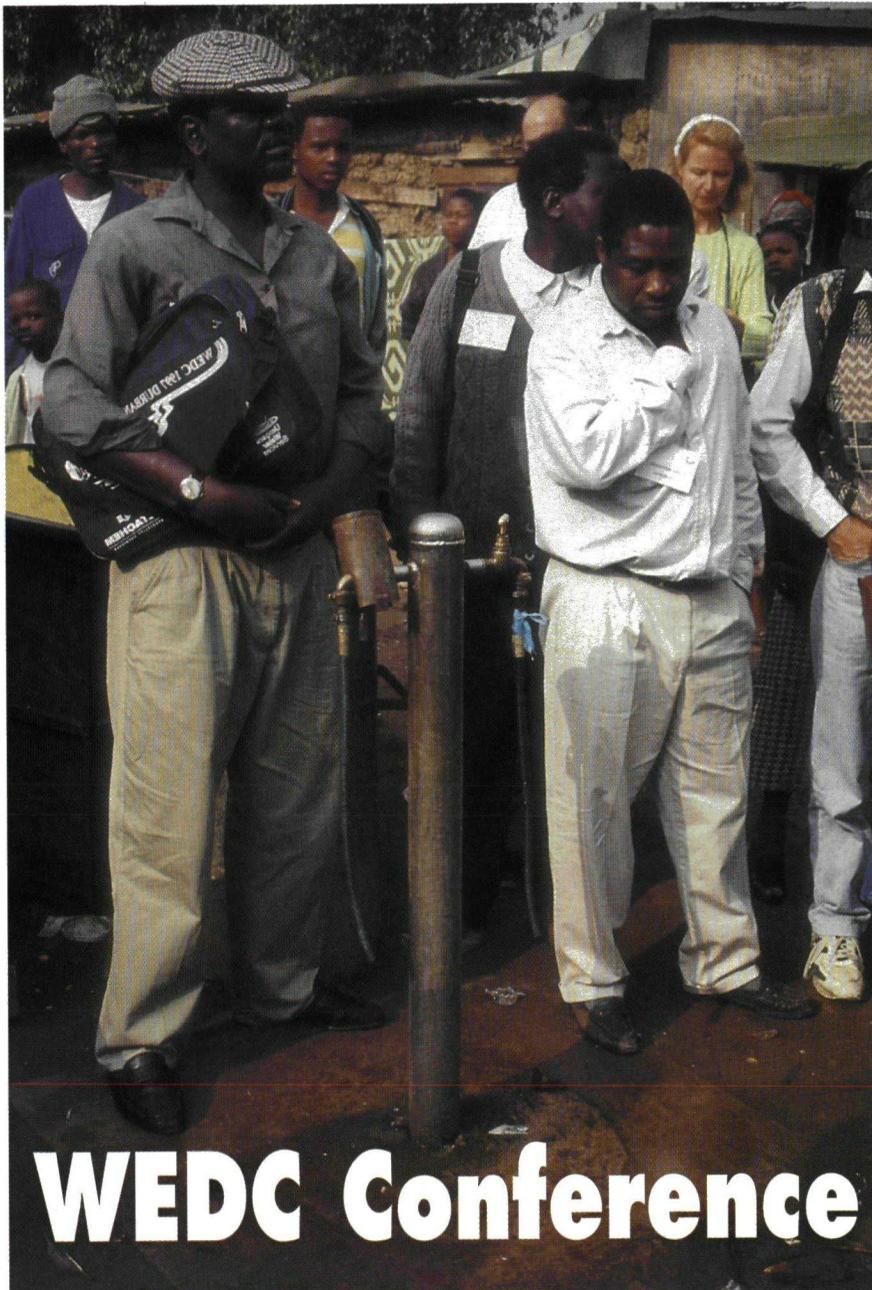
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Cover: A Kruger National Park river - low flow. (Photo: Courtesy of the National Parks Board)

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## WEDC Conference

### an opportunity to share and learn

The 23rd International WEDC Conference recently held in Durban was well attended by delegates from 34 countries, a notably large number of delegates were from Africa, while Asian countries were also well represented. The theme of the conference was Water and sanitation for all: partnerships and innovations.

The Water Engineering and Development Centre (WEDC) at the

Loughborough University (UK) organised the conference in South Africa in collaboration with Umgeni Water, the Department of Water Affairs and Forestry, Durban Metro Water and Waste, WISA, SAICE, the Department of Health, Mvula Trust and the University of Natal.

Professor John Pickford from WEDC and Conference Co-organiser explained: "WEDC undertakes post-grad-

uate training and education, research and consultancy for the planning, provision and maintenance of physical infrastructure for development. Water and sanitation has been a continuous theme over the past 25 years. A WEDC conference is an opportunity for practitioners, planners and researchers to share their experiences and learn from each other".

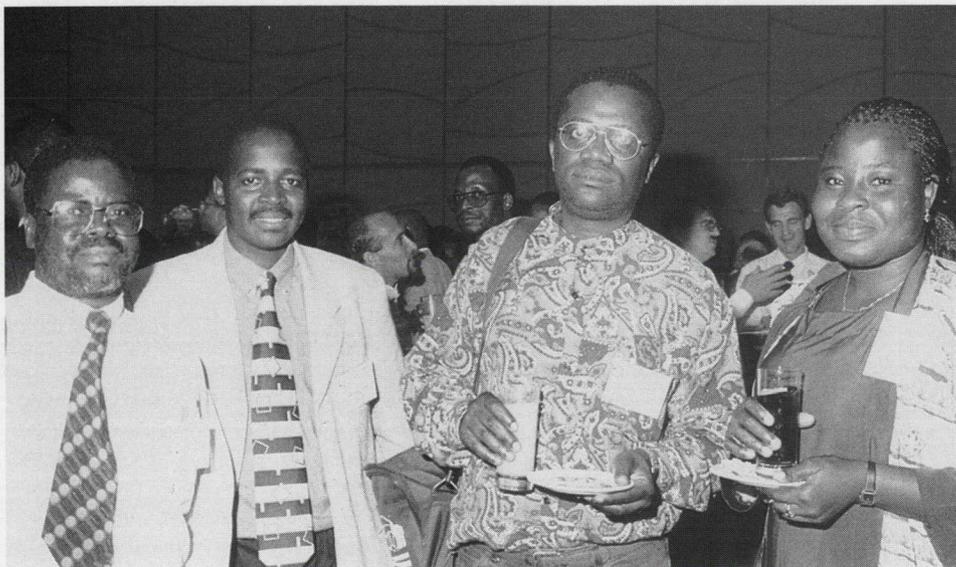
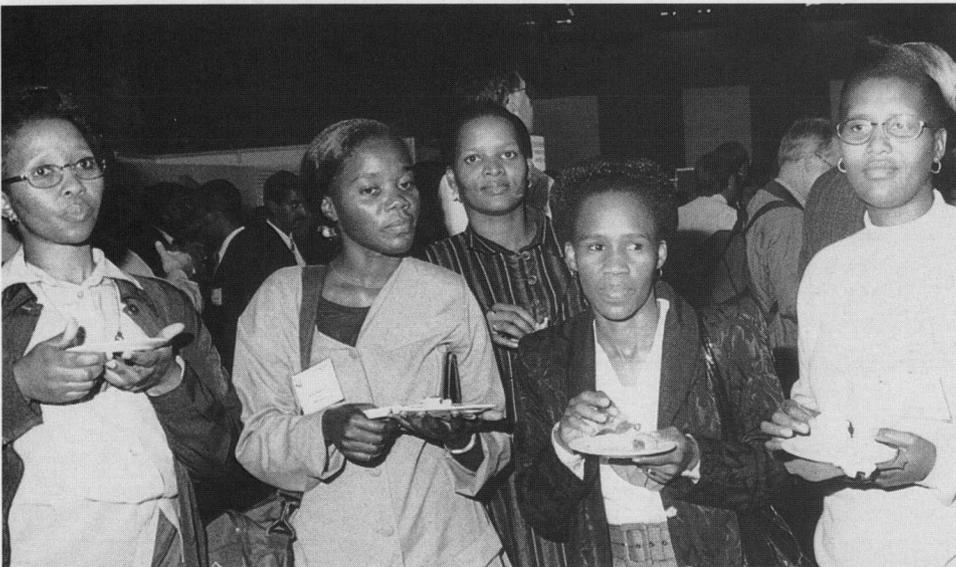
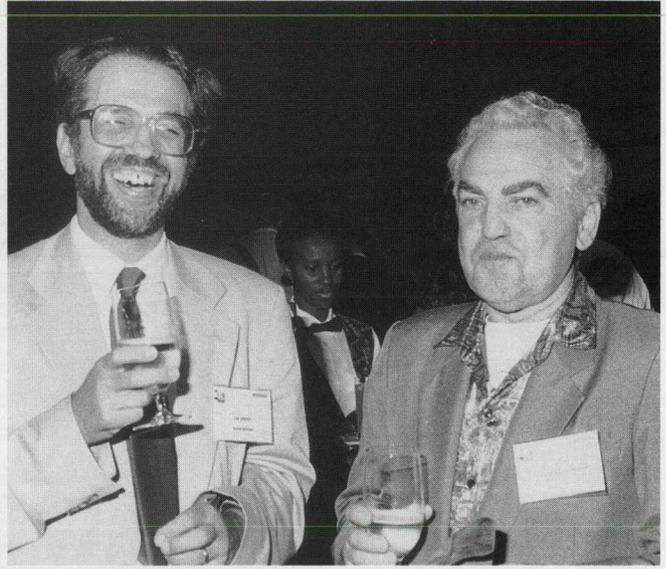
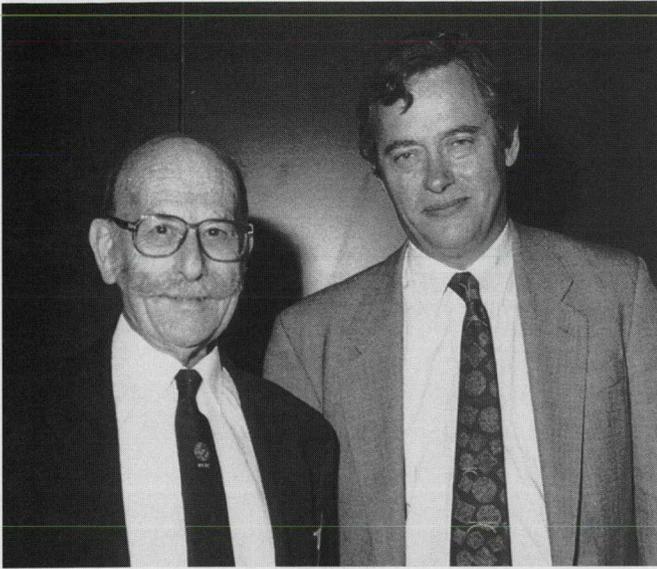
South Africans delivered some forty of the 120 papers presented at the conference, while delegates from other African countries contributed thirty three of the papers. Topics ranged from water supply and water resources, to water quality and treatment, through sanitation and solid waste management to community management, institutional development and finances. There was indeed a pooling and sharing of much experience, knowledge and ideas at the WEDC conference.

#### KEYNOTE ADDRESS

Mr Mike Muller, newly appointed Director-General of the Department of Water Affairs and Forestry, gave the keynote address at the opening of the conference. He highlighted the changes and measure of working together in the New South Africa, since attending the WEDC conference held in Lilongwe, Malawi, some ten years ago. He accentuated the importance of innovations and working together in partnerships to reach common goals. He said that there are still many problems with water supplies and a long way to go, and "with regard to affordable sanitation for all we are still in the learning stage", however his Department's BOTT (Build, Operate, Train and Transfer) approach combines both partnership and innovation. He concluded that the purpose of getting together at the WEDC conference was to learn from each other.

A number of technical tours afforded delegates the opportunity to see partnerships and innovation in practice in the greater Durban metropolis and further afield in KwaZulu-Natal.

SA Waterbulletin had the opportunity to see the just how innovative Durban Metro has become with regard to water supply, with three different levels of supply and affordability to accommodate all the users in this fast growing metropolis.



TOP LEFT: Professor John Pickford, from WEDC at Loughborough University, and Mr Mike Muller, Director-General of the Department of Water Affairs and Forestry, addressed delegates at the opening of the WEDC conference.

TOP RIGHT: Ian Smout (Loughborough University, UK) and Erik Nissen-Petersen (Arid and Semi-arid Land (ASAL) consultant, Kenya).

MIDDLE: (In front) Thembi Khuzwayo (Umgeni Water), Betty Kwagala (Makerere Institute for Social Research, Uganda), Agnes Zuma (Umgeni Water), Nokuhle Gontshi (Independent Development Trust (IDT) and behind, Sibongile Mthembu (IDT).

BOTTOM: Benedicte Majaya and Bekithemba Gumbo (University of Zimbabwe) with Columbus Chimani (National Action Committee for Rural Water Supply, Zimbabwe) and Bilkisu Odekina (National Water Resources Institute, Nigeria).

# New Water Law discussed at Agriculture workshop

"South Africa is a dry and drought-prone country, with or without El Nino. Our vision of water management, not only in the agricultural sector, but in all sectors, is driven by the need for equity, efficiency and sustainability", said the Minister of Water Affairs and Forestry, Prof Kader Asmal, at a "National Agricultural Workshop on Water Law" recently held in Pretoria.

The Minister said that he didn't want the delegates to get the impression that the water law was aimed only at the farmers. "Under the new law we will, along with the irrigation policy currently being developed, be developing policy for all major water user sectors, such as industry, urban and domestic use, in order to establish guidelines for conservation and beneficial use. No one will escape the need for better use of our limited water resources."



*Mike Muller (Director-General, Department of Water Affairs and Forestry), with Bongiwe Njobe-Mbuli (Director-General, Department of Agriculture), and Prof Kader Asmal, Minister of Water Affairs and Forestry.*

The two day workshop, under the auspices of the Department of Water Affairs and Forestry, and the Department of Agriculture, was organised by the National Irrigation Policy Secretariat to create an opportunity for the legal drafting team responsible for the National Water Bill to hear from the farming sector what practical problems they foresaw with the proposals presented in the current fourth draft of the bill. Some 220 delegates, which included large and small-scale farmers, as well as top officials and the legal drafting team attended this discussion forum. About seventy small farmer delegates, from across the country, had met the Minister the previous evening at a pre-workshop meeting to express their particular concerns about the new Water Bill. Even a group of delegates from Zimbabwe attended the workshop. The programme aimed at addressing the issues relating to water law review and concerns from an agricultural perspective, and gave an overview of water resources and demands along with sustainable agricultural resource utilisation.

Panel discussions touched on the various aspects of irrigation within the framework of agricultural policy, institutions for water management, water use authorisations and water pricing.

## **DECENTRALISED WATER MANAGEMENT**

The Minister of Water Affairs and Forestry, Prof Kader Asmal in addressing the workshop pointed out that decentralised management of water by catchment-based institutions was the eventual aim of the Department. He said many of the current water management functions of the Department will be progressively decentralised to Catchment Management Authorities or Agencies (CMA's), with significant delegated powers from the Minister, including the power to allocate water. Furthermore the composition of these institutions must ensure equitable access to all groups and sectors. The establishment of these agencies, however, will only take place over a period of time. Long term national strategies

are necessary to develop Catchment Management Authorities or Agencies.

**ENABLING ACT**

The chairman of the drafting team, Judge Antonie Gildenhuys, explained to the delegates that they attempted to write an "enabling act", with both flexibility and clarity, which would provide for a range of possibilities to suit varying circumstances. In the course of the workshop it became clear that in terms of the current draft either the Department of Water Affairs and Forestry, or a Catchment Management Authority, or a Water User Association (WUA) will be able to act as a water licensing authority, depending on the circumstances.

**FARMERS' PERSPECTIVES**

At the workshop there was a significant convergence on the proposed catchment-based approach for water management. The draft bill clearly became more acceptable with the proposed approach of delegation to Catchment Management Authorities and Water User Associations with local negotiation and decision-making powers.

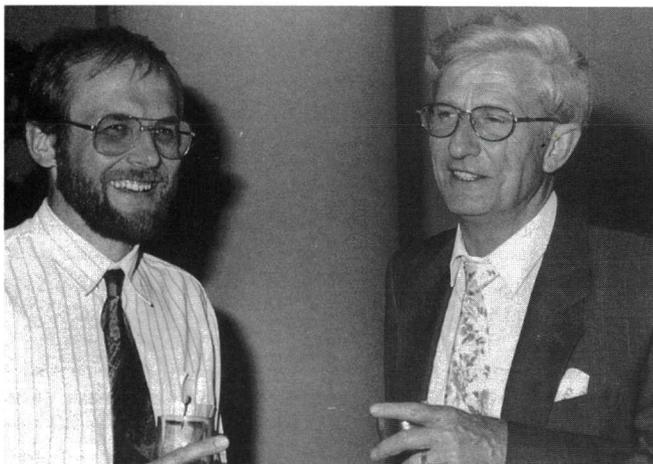
However, the workshop with the farmers indicated that key issues of the proposed water use licensing system required further discussion, notably the proposed time limit on licences for water use. The pricing policy was perceived to be less urgent presently, but not less important than the issues surrounding licensing and institutions.



*Delegates from neighbouring Zimbabwe attended the workshop: Zeb Murungweni, Gerry Davison and James Khotso.*



*Left: Petrus Khombisa (Mpumalanga farmer), Mike Walters (Agricultural Research Council (ARC)) and Solly Dondashe (Eastern Cape farmer) having a word with one another at the workshop.*



*Stephanus Smal (Gauteng Department of Agriculture) and Gerald Kraaij (South African Irrigation Institute) in a light moment of discussion.*



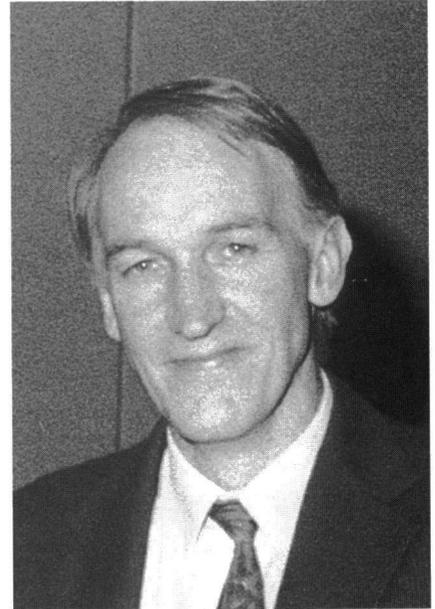
*Rejoice Mabudafhasi and Catherine Mabuza from the National Assembly Portfolio Committee on Agriculture, Water and Forestry attended the proceedings of the workshop.*

# INTERNATIONAL APPOINTMENTS



*Mr David van der Merwe*

Left: Mr David van der Merwe, Deputy Executive Director of the Water Research Commission, was recently elected Vice-President of the International Commission on Irrigation and Drainage (ICID) at an International Executive Council meeting of the ICID, held in Oxford, UK.



*Mr Piers Cross*

Right: Mr Piers Cross, previous Executive Director of Mvula Trust, has been appointed Regional Manager for South Asia of the UNDP - World Bank Water and Sanitation Programme, based in Delhi, India.

## Obituary: Hulme Moolman

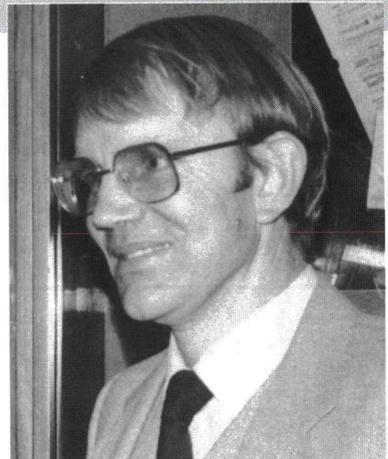
Joseph Hulme Moolman, one of the South Africa's eminent soil scientists and an internationally acknowledged expert on irrigation water quality, died on 25 October 1997 at the age of 47, after an eighteen-month fight against brain cancer. At the time of his death he was Head of the Department of Soil and Agricultural Water Science at the University of Stellenbosch, and serving as President of the Soil Science Society of South Africa (SSSSA).

Prof Moolman obtained his B.Sc (1973), M.Sc (1976) and Ph.D (Agric) (1982) degrees from the University of Stellenbosch. After a nine-year stint as researcher with the Department of Agricultural Technical Services, he joined the Hydrological Research Unit at Rhodes University as researcher in April 1982. In April 1985 he was appointed as senior lecturer at the University of Stellenbosch and was promoted to head of the Department in January 1990. Several M.Sc- and Ph.D-students graduated under his mentorship. He published widely in local and international journals and also pre-

sented several papers at local as well as international conferences.

He received several rewards of distinction during his career. He received both his B.Sc and M.Sc degrees cum laude, and was awarded the AI Perold gold medal as the best final year agricultural student in 1973. The SSSSA medal for the best paper by a person under 30 years of age was presented to him in 1980. He was awarded the prestigious SSSSA medal for exceptional service, and is the only person yet, twice to have received the SSSSA medal for the best scientific paper presented. Prof Moolman was an active member of several WRC Project Steering Committees and acted as research leader on six WRC projects. He completed the final report on one of these, **The Use of Saline Water for Irrigation of Grapevines and the Development of Crop Salt Tolerance Indices**, only a few weeks prior to his death.

Hulme Moolman was an ardent cricket fan, keen on the outdoors and camping, and often enjoyed listening to good



*Prof Hulme Moolman*

music. He will be remembered as a gentleman in his interaction and personal relationship with colleagues, subordinates and seniors. Most notable was his personal relationship with his Creator. He displayed an absolute dedication to all tasks he tackled and a passion for achieving excellence. His early death which prevented him from achieving his full potential leaves a great gap which will be difficult to fill. He is survived by his wife Gerida, their daughter Corlie and son Danie.

*Meiring du Plessis*  
WRC Research Manager

# WRC publishes atlas of water-related diseases

The Water Research Commission has recently published **An Atlas of Potentially Water-Related Diseases in South Africa**, researched and compiled by DE Bourne and N Coetzee of the Department of Community Health, University of Cape Town. The authors of this atlas in two volumes, say that very little information is available on the spatial variation of the health or ill health of the South African population.

The atlas, based on mortality for disease which are potentially water-related, gives a spatial indication of ill health and offers a perspective on mortality caused by potentially water-related diseases in relation to total mortality in South Africa. An analysis of childhood mortality forms part of the atlas.

The authors say that the most common measurable parameter employed to define ill health is mortality. The mortality rate, as an indicator of ill health, is useful because death is a definitive event, which is easily measured and can be quantified. However, a more complete assessment of ill health would include measures of disease prevalence and disability, but such data is not widely available for South Africa.

## AIMS

The aims of this research project funded by the Water Research Commission was:

- to produce an atlas of mortality from potentially water related diseases.
- to discuss the implications of the observed disease distributions.
- to supply information on the aetiology of potentially water related diseases in a concise form, suitable for non-medical professionals and to supply a bibliography relating to the occurrence of these diseases in South Africa.

## METHODS

A data set of which the individual records gave details of each death reg-

istered in the Republic of South Africa during 1990 was obtained from the Central Statistical Services. This data which was coded according to the age, sex, gender, place of residence and cause of death allowed for a detailed spatial analysis to be carried out.

### An Atlas of Potentially Water-Related Diseases in South Africa

Volume 1  
Mortality 1990

DE Bourne • N Coetzee

Report to the Water Research Commission  
by the  
Department of Community Health  
University of Cape Town

WRC Report No 584/1/96



Three categories of water-related diseases were included in the atlas:

- water-borne, such as gastro-enteritis, dysentery, cholera;
- water washed (transmission of disease results from lack of adequate water, or inadequate hygiene), such as shigellosis;
- water mediated (water plays a role in the life cycle of the pathogen or one of its hosts), such as schistosomiasis or malaria.

In addition an analysis of all other causes of death was carried out for each area to place the impact of potentially water-related diseases in the context of overall mortality.

The following 28 potentially water-related diseases were examined: amoebiasis, haemorrhagic fevers, balantidiasis, cholera, chlamydial conjunctivitis, cryp-

tosporidiosis, dengue fever, diarrhoea (intestinal infectious diseases), food poisoning, giardiasis, viral hepatitis A, viral hepatitis B, hookworm disease, legionellosis, leptospirosis, malaria, naegleria or acanthamoeba, paratyphoid fever(s), pediculosis, poliomyelitis, scabies, schistosomiasis, shigellosis, taeniasis, trachoma, typhoid fever, yellow fever, and yersiniosis.

Each of the more commonly occurring water-related diseases are described in Volume 2 of the report, along with details of its occurrence, mode of transmission or infection, as well as preventative and curative measures.

## RESULTS

Significant overall mortality was found for the following diseases:

- intestinal infections 2.87 per cent of all deaths,
- accidental drowning 0.6 per cent of all deaths,
- viral hepatitis 0.09 per cent of all deaths, and
- malaria 0.03 per cent of all deaths (mainly in the north-east of South Africa).

However, in the population group 0-6 years intestinal infectious disease accounted for 16.91 per cent of deaths, while in the 1-5 year old group the proportion is to 19.51 per cent and the leading cause of death in this age group.

The atlas gives detailed analyses by cause of death for each of the 9 provinces of South Africa, excluding the former homeland areas.

The report, **An Atlas of Potentially Water-related Diseases in South Africa** Volume 1 and 2 (WRC Report 584/1/97 and 584/2/97), is available free of charge, from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail: tineke @wrc.ccwr.ac.za (Foreign orders: US \$30 per set, via surface mail).

# Analysis of WATER ALLOCATION under South African law



**W**ater legislation in South Africa has, in the past, not provided protection for ecobiotic water requirements, and neither has it contained sufficient measures for the sustainable conservation of water as a scarce resource, says researcher M Uys in a report to the Water Research Commission. The report entitled **A Structural Analysis of the Water Allocation Mechanism of the Water Act 54 of 1956 in the Light of the Requirements of Competing Water User Sectors**, is an investigation and critical evaluation of the South African water allocation mechanism, its devel-

opment and its application. The aim of the investigation, which was initiated in 1991, was to propose fundamental principles whereby ecobiotic water requirements would be included amongst the water user sectors which enjoy statutory protection.

## REPORT

The report is a critical analysis of the legal system in terms of which water rights are allocated under South African law. In this analysis the historical development process of the South African water law was investigated. The main

tendencies followed in the Roman and Roman-Dutch law systems, as well as the principles of water allocation which had been adopted into the South African law system by the courts and legislature, were analysed. An analysis of the current water allocation mechanism of the Water Act 54 of 1956 indicated the lack of basic principles which could form the basis of an allocation system aimed at the protection of the environmental network of interdependency. The study concludes with proposals for fundamental principles to form the basis for revision of the South African water law, in order to create a system of water allo-

cation which will accommodate the water requirements of all user sectors in a balanced and equitable way.

### LETABA CASE STUDY

The report says that during a case study of the Letaba river system in Mpumalanga, it was realised that very little protection existed for ecobiotic water needs to ensure a prolonged water supply for natural ecosystems during drought conditions. It was noted that the typical, yet lawful, way in which water had been apportioned, was with preference to irrigation to the extent that the Letaba River was over-utilised, rendering the river system incapable of sustained yield and with detrimental effects on the natural aquatic ecosystem.

Past failure to recognise ecobiotic water requirements during the allocation of water rights, as well as a lack of measures to conserve the riverine systems, has resulted in a situation such as the Letaba River, where even a large-scaled impoundment is no longer sufficient in supplying the growing water needs of all users, including the riverine ecosystem, dependent on the water in the river.

Although basin planning, with due regard to ecological considerations, is nowadays regarded as a vitally important means to manage a river system in order to obtain a sustained yield, the lack of statutory protection of the ecobiotic environment, as a legal water user, can no longer be afforded. Therefore the legal system, which controls the apportionment of water, should accommodate protective measures for the water requirements of ecobiota as well.

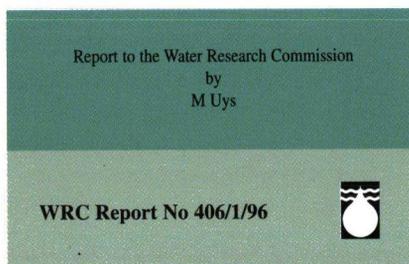
### WATER LAW HISTORY

In Roman law, water belonged to each and all in need of it for survival, with reasonable right of use. Natural law principles, based on justice and equity, did not tolerate apportionment of natural resources to the detriment of any of its users: it was available for common and reasonable use. However, due to Justinian's incorrect summary and interpretation of the texts of classical jurists regarding the classification of water in the legal system, a distinction between public and private water was established, which has influenced the water law ever since.

In Roman-Dutch law, the use of water was restricted to *cives* (citizens), which excluded not only political foreigners from the right to reasonable use of the rivers, but also non-human users. The *ius naturale* (natural law) was no longer the basis of the water law.



A Structural Analysis of the  
Water Allocation Mechanism of  
the Water Act 54 of 1956 in the  
Light of the Requirements of  
Competing Water User Sectors



### SOUTH AFRICAN WATER LAW

In South Africa the growing importance of irrigation agriculture and concurrent water requirements soon necessitated rules to apportion the scarce resource amongst those who demanded it for economic benefit. Lack of a statutory allocation mechanism forced the judiciary to develop a system to apportion water. The problem with this method of law-making, is that it was formulated for the benefit only of those who approached the court with disputes – in this case the agricultural sector. When the law was eventually codified, these rules made by the courts were used as the basis, which resulted in irrigation enjoying preferential statutory water rights. Only recently have voices been raised on behalf of environmental considerations such as integrated basin management and water rights for ecobiota.

### REVISION

The present problem is that many water sources are already in a state of over-utilisation and applying environmental

considerations may deprive the holders of existing lawful water rights of the use thereof. According to the report it is necessary, however, that the allocation system be revised to increase water availability to all users. One possible way would be to reconsider the distinction between public and private water which has been the cornerstone of the water allocation mechanism, and which has justified the exclusion of various water sources from the statutory allocation system.

Although cost-intensive solutions such as inter-basin water transfers may be considered to increase water availability, presently the underlying legal principles (such as the historically and practically unsound distinction between public and private water), and the sometimes confusing definitions in the Water Act of 1956, along with the difference in legal status of (and rights to) various forms in which water occurs, as well as inadequate administrative control, all contribute to the various water apportionment problems. The revision thereof in favour of fair and balanced integrated water management principles, might encourage the creation of an environmentally sound water allocation mechanism, says Uys in the report.

Dr Gerhard Backeberg, Research Manager at the Water Research Commission, says at the request of the Department of Water Affairs and Forestry the report was made available prior to publication to the team who undertook the Water Law review. In the recently published White Paper on the national water policy, provision has been made for the protection of river ecosystems by allocating water rights to the reserve which provides for instream water requirements and basic human needs.

The report entitled **A Structural Analysis of the Water Allocation Mechanism of the Water Act 54 of 1956 in the Light of the Requirements of Competing Water User Sectors** Volume I and II (WRC Report 406/1/96 and 406/2/96 as a set) is now available, free of charge, from the Water Research Commission, PO Box 824 Pretoria 0001 E-mail address: tineke @ wrc.ccw.ac.za (Foreign orders: US \$60 per set, via surface mail.)

# Nickel extraction from effluent shows promise

Successful experimentation with capsulated membrane extraction (CME) has yielded very promising results, particularly with regard to harsh chemical environments and superior transfer properties, as well as economic aspects such as size and configurational variables, says researcher JJ Smit of the Department of Chemical Engineering, University of Potchefstroom for CHE, in a report to the Water Research Commission.

The report entitled **The Extraction of Nickel with the Use of Supported Liquid Membranes (SLM)** (WRC Report 617/1/97) follows on research reported in two previous WRC reports (K5/617 and K5/431) which confirmed the technical feasibility of the supported liquid membrane (SLM) concept, however, it was evident that the sophistication of the various SLM reactor configurations implied high costs, both to manufacture and operate.

The emphasis of this follow-up project was the concept of an unconfined reactor which uses CME, and the technical feasibility of these capsules. The main thrust of this project was to demonstrate the potential of SLM extraction of various cations and anions from industrial effluents, such as the extraction of nickel from electroplating baths.

Nickel is a widely used metal and therefore expected to be reported in various effluents as a pollutant. The extraction of nickel at good prices could consequently be a strong incentive to recover nickel from effluents from various industries, mainly the plating and catalyst industries. It is for this purpose that the SLM and the newly proposed CME are expected to contribute to the general field of demineralisation.

## Project aims

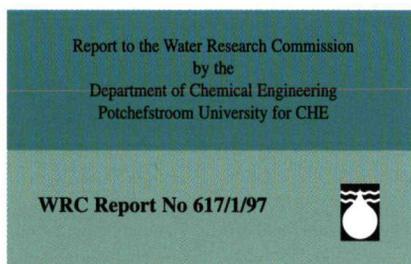
The main aims of the project were:

- to develop SLM extraction as a unit process to extract chemical species (selectively or non-selectively) from mineralised industrial effluents, and
- to establish the potential for extracting chemical species with capsulated membrane configurations.



The Extraction of Nickel  
with the Use of Supported  
Liquid Membranes (SLM)

JJ Smit



Using the concept of an unconfined reactor would obviate the need for the use of costly containment of membranes in expensive flow-through contractors.

## Selected Cations

Experiments were conducted to illustrate the capability of SLM extraction on more than one cationic species. For this purpose the cationic species of nickel, zinc, chrome (III) and calcium were selected. Calcium was included as a nuisance metal cation, to demonstrate the possible extraction of Calcium from wastewater to render it more suitable for purification by reverse osmosis.

## SLM results

The technical feasibility of SLM extraction by means of the hydrodynamically characterised cell was demonstrated on a number of chemical species:

- the extraction of anions such as  $\text{HPO}_3^{2-}$ ,  $\text{H}_2\text{P}^-_2$ , lactate and acetate was successfully achieved, and
- the extraction of calcium, nickel and chrome was effected from a synthetic sulphate medium, as well as an extraction of zinc from an industrial penstock return solution. The extraction rates were similar to those obtained by previous researchers.

## CME results

Results obtained with capsulated membrane extraction (CME) of nickel clearly show that CME attains extraction rates of at least an order of magnitude higher than those achieved by SLM extraction.

The CME configuration constitutes a membrane capsule, with the strip solution on the inside, which is submerged in the feed solution. This configuration has a relatively low cost and the advantage that very high acid concentrations can be used in the strip solution without the risk of high corrosion.

According to the report CME is a very viable technical possibility for the extraction and recovery of certain chemical species from aqueous media, such as industrial effluents, provided that the cost effectiveness for the removal of the specific species be established first.

The report (WRC Report 617/1/96) is available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail: tineke@wrc.ccwr.ac.za (Foreign orders: US \$25 per copy, via surface mail)

# Biodispersants help control biofouling

A report entitled **The Use of Biodispersants Available for Biofouling Control in Industrial Water Systems**, by researchers L Jacobs, EE de Bruyn and TE Cloete of the University of Pretoria, has recently been published by the Water Research Commission. According to the report water recycling and re-use in industry tends to a concentrate dissolved and suspended substances in industrial water systems, which stimulate microbial growth, biofilm formation and biofouling.

In this project biodispersants were investigated on a laboratory scale for two biofouling control properties:

- prevention of bacterial attachment;
- detachment of established biofilms.

## Spectrophotometric monitoring

Prevention and control of biofouling is important to industry, however, to date the monitoring of biofouling has been complicated and time-consuming, requiring the culturing and counting of bacteria, whether on culture plates or under the microscope. A spectrophotometric method using absorbance to quantify bacterial populations was developed to facilitate monitoring of biofouling.

A continuously circulating batch culture system was designed to study biofouling spectrophotometrically. Absorbance measurements of *Pseudomonas aeruginosa* attached to a glass tube was compared with direct counts of stained bacteria attached to 3CR12 steel coupons. The direct measurements of absorbance correlated well with the total counts obtained using the DAPI-staining technique and proved to be a rapid and reliable alternative to techniques requiring laborious counting of microorganisms.

## Biofouling control

Industries use biocides to control biofouling. However, biocides react only with the outer portion of the biofilm,

rapidly regrow and bacteria within the biofilm develop increasing resistance to biocides on repeated dosing. Recently surfactants have been employed to control bacterial adhesion to solid surfaces, as surfactants result in uniform wetting of the surface and have an additional cleaning effect. It is unlikely that surfactants will have any mutagenic effects on bacteria, or that microorganisms would become resistant to the action of surfactants.



The Use of Biodispersants  
Available for Biofouling Control  
in Industrial Water Systems

L Jacobs • EE du Bruyn • TE Cloete

Report to the Water Research Commission  
by the  
Department of Microbiology and Plant Pathology  
University of Pretoria

WRC Report No 592/1/97



In this project a range of nonionic and anionic surfactants, the combined effect of a nonionic surfactant and a biocide, as well as an enzyme, were evaluated for their efficiency in preventing *Ps. aeruginosa* adhesion to solid surfaces and removing established biofilms. The prevention of attachment of *Ps. aeruginosa* cells was monitored spectrophotometrically.

## Surfactants

All the surfactants tested resulted in more than 90 per cent inhibition of adhesion to the glass and metal surfaces. There was no significant difference in efficacy amongst the different

anionic surfactants nor amongst the different nonionic surfactants. However, the nonionic surfactants were more efficient in removing attached bacterial cells. A decrease of more than 80 per cent in the number of attached bacteria was obtained with nonionic surfactants, compared to an average of 63 per cent decrease using anionic surfactants. Comparing the results of the DAPI-staining technique with spectrophotometric evaluations, the researchers found no significant difference in the percentages of inhibition of bacterial attachment to solid surface using surfactants.

## Biocide combination

According to the report simultaneous use of a nonionic surfactant and an isothiazolone biocide resulted in more effective control of biofouling compared to the separate use of the biocide and surfactant. The surfactant used in combination with the biocide inhibited bacterial attachment by 95,5 per cent and removed 97 per cent of a mature biofilm. Separate use of the biocide and nonionic surfactant resulted respectively in a 93,4 per cent and 94,1 per cent inhibition of bacterial attachment, while an 88 per cent and 91 per cent removal of the mature biofilm were achieved.

The enzyme evaluated in this study displayed excellent anti-adhesive qualities, with 99 per cent prevention of bacterial attachment to 3CR12 metal coupons, but removed only 89 per cent of a mature biofilm.

The report **The Use of Biodispersants Available for Biofouling Control in Industrial Water Systems** (WRC Report 592/1/97) is available, free of charge, from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail: tineke@wrc.cwr.ac.za (Foreign orders: US \$20 per copy, via surface mail).

# Upgrading sewage effluent for municipal and industrial use

A research report on the evaluation of experimental membranes and module systems for upgrading secondary treated sewage is available from the Water Research Commission in Pretoria. The evaluation was carried out by EP Jacobs and JP Barnard of the Institute for Polymer Science (IPS) at the University of Stellenbosch.

The researchers say in the report that the objectives of the research were to determine to what extent medium-molecular-mass cut-off capillary ultrafiltration and tubular nanofiltration membranes, developed at the IPS, could be used to improve the quality of secondary treated sewage.

"It was not intended to develop a membrane-treatment process, but rather to evaluate the performance and integrity of the nanofiltration membranes and capillary membranes and modules over an extended period of operation under specific operating conditions."

Different cross-flow pressure-driven membrane processes fulfill different functions. Microfiltration membranes remove suspended solids and reduce bacteriological activity, but will not reduce the colour or dissolved organic content of the water. Ultrafiltration, in which a finer membrane filter is used, will remove medium-molecular-mass dissolved organics and reduce turbidity to levels of 0,1 NTU, but is unable to desalinate water. Nanofiltration membranes which are even finer can partly desalinate water (soften it, so to speak) and remove substantial quantities of low-molecular-mass organic materials as well as viruses. However, reverse osmosis can be used to produce higher quality filtrates by the use of increased operating or driving pressures to effect separation.

## MEMBRANES AND MODULES

The capillary membranes and modules used in the research programme were the research products of a previous Water Research Commission project (Project no. 387 entitled: *The development and production of membrane systems*). The ultrafiltration capillary membranes (coded #748) that were developed during this research programme were fabricated from poly(ether sulphone). The membranes had a molecular-mass cut-off of 35 000 dalton (tested on polyethylene glycol) and were internally skinned. Two module prototypes were developed during WRC Project no. 387 to house the capillary membranes. The one module, a 40 mm-diameter cartridge-type module with a transparent uPVC shroud, was secured in a manifold fabricated from standard uPVC T-pieces and sealed by means of O-rings. The other, a 50 mm module with a stainless steel shroud, was flange-mounted.

Copies of the report entitled **Investigation to upgrade secondary treated sewage effluent by means of ultrafiltration and nanofiltration for municipal and industrial use** (WRC report 548/1/97) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail order address: [tineke@wrc.ccwr.ac.za](mailto:tineke@wrc.ccwr.ac.za) (Overseas price, inclusive of surfacemil: US\$20.)

Investigation to Upgrade Secondary Treated Sewage Effluent by Means of Ultrafiltration and Nanofiltration for Municipal and Industrial Use

EP Jacobs • JP Barnard

Report to the Water Research Commission by the Institute for Polymer Science University of Stellenbosch

WRC Report No 548/1/97



The tubular cellulose acetate membranes used were also research products of WRC Project no. 387. These membranes were housed in PCI modules. The modules were fitted with perforated stainless steel tubes and sealed on either side with rubber grommets. Eighteen 2,4 m-long membranes were connected in series in each of these modules.

### CONCLUSIONS

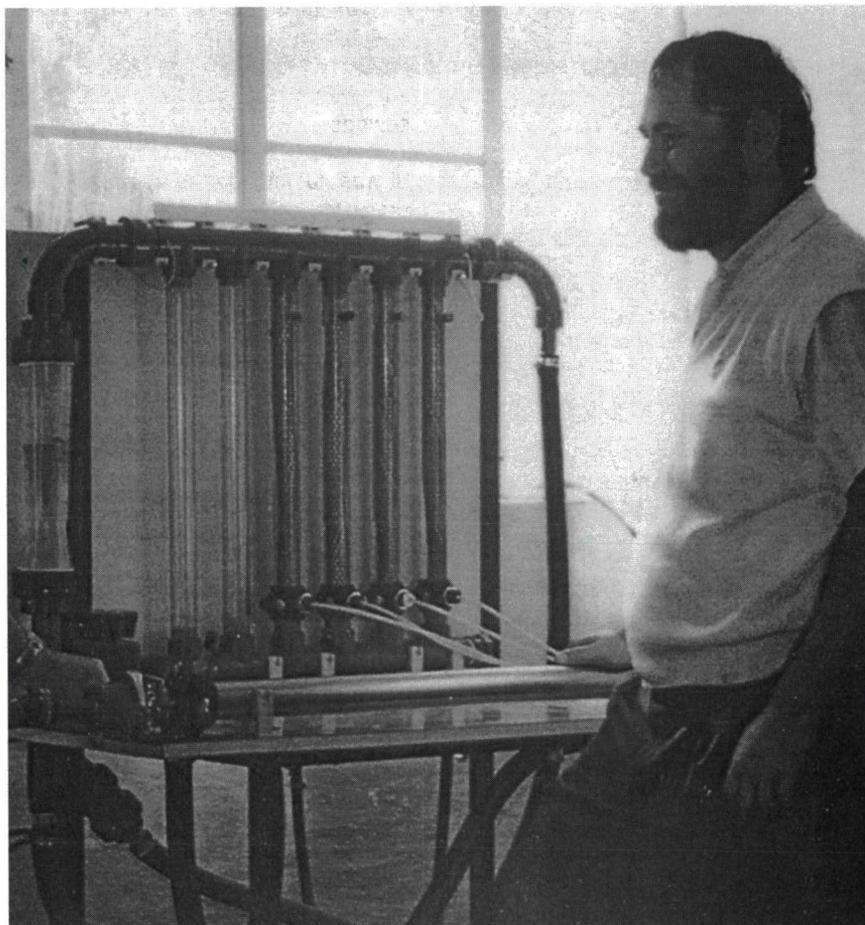
- The ultrafiltration capillary and nanofiltration tubular membranes performed well during the studies and no problems were experienced with their integrity over the 16 000 hour period tested.
- The turbidity of the ultrafiltered product was very low. The membranes showed good colour-removal capabilities, but the colour of the filtered product was still higher than the maximum specified for potable water.
- The COD load in the ultrafiltered product was low, but not as low as that in the nanofiltered product.
- The flux performances of the 40 mm and 50 mm modules did not correspond. The membranes were produced from the same formulation, but the fabrication protocol was slightly different. It should therefore be possible to improve the flux performance of the capillary membranes, without decreasing the retention performance, by modifying the membrane formulation and fabrication protocol.
- The 40 mm capillary membrane cartridge modules performed well. No leaks occurred between the tube sheet and the module shroud as the seal remained intact. The design of the 50 mm stainless steel capillary membrane cartridge module also proved to be adequate to sustain long-term use.
- The stainless steel shroud of the 50 mm module proved to be an advantage as no algal growth appeared on these membranes, as happened to the 40 mm modules which had transparent shrouds.
- u-PVC proved to be an adequate and inexpensive material for use in the construction of module shrouds. However, the u-PVC material did impose an upper operating temperature limit of 40°C.

□ The performance of the nanofiltration membranes declined with time. This was ascribed to hydrolysis of the cellulose acetate membranes as no acid was used to adjust the pH of the feed water to a more suitable level.

□ The quality of the nanofiltered water was very high, and nanofiltration could be useful for the treatment of secondary treated sewage, to produce high quality water for industrial use.



*A 50mm axial-flow membrane cartridge with flanged connector design.*



*Across-face manifold for 40mm modules*

# Technique studied for controlling **BULKING SLUDGE**



*Chlorination of activated sludge is the most economic*

**F**ilamentous sludge bulking is a complex biological problem affecting a large number of activated plants in South Africa and is caused by the proliferation of filamentous organisms. However, in the last decade important progress has been made in bulking sludge control technologies." This is said in a research report released by the Water Research Commission on the chemical control of bulking sludge.

The researchers, GB Saayman, J van Leeuwen and CF Schutte from the University of Pretoria, say in the report there are currently two approaches to bulking control:

- Specific control measures aimed at eliminating the conditions which favour the growth of filamentous organisms, and
- non-specific control measures involving the use of chemicals to inhibit the growth of, or to selectively kill, the filaments.

"From the evidence available on specific bulking control in nutrient removal activated sludge removal systems it seems that it is impossible to design and operate an activated sludge plant that would not bulk with low food to micro-organisms (F/M) filaments. The researchers say most of the reports on non-specific control of sludge bulking in biological nutrient removal systems in South Africa deal with laboratory-scale and pilot plants. In spite of all the progress that has been made operators of full-scale plants are hesitant to use preventive non-specific control measures, because of the potentially detrimental effect of the chemicals on the nutrient removal process."

## **AIMS**

The aims of this study were:

- To investigate the effectiveness of preventative non-specific bulking con-

control measures in a full-scale biological nutrient removal plant and to demonstrate the feasibility of applying chlorine, ozone and hydrogen peroxide on full-scale.

- To determine the effect of hydrogen peroxide, ozone and chlorine on biological nitrogen and phosphorus removal, as well as on the filamentous species composition.

## **CONCLUSIONS**

The final conclusions, as summarised in the report, are the following:

- Chlorination of activated sludge is



ical non-specific method of controlling bulking sludge.

the most economical non-specific method of controlling bulking sludge in a nutrient removal activated sludge plant. With the necessary precaution such as a daily trend plot of the sludge volume index values to follow the effect of chlorination and dosing at the minimum effect dose, bulking can be controlled by chlorination with only a marginal effect on phosphate removal.

- Hydrogen peroxide controls bulking during the initial stage of treatment. Regrowth of the low F/M filaments occurs even while hydrogen peroxide was being dosed.
- Ozone improves sludge settleability

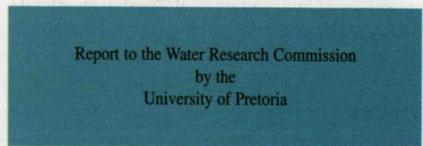
consistently and stabilises nutrient removal. However, the dose of 1,42 g ozone per kilogram mixed liquor suspended solids per day was too low to effect a dramatic improvement in sludge settleability - a prerequisite to demonstrate the success of the method.

Copies of the report entitled **Full-scale chemical control of sludge bulking** (WRC report 328/1/97) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail order address: tineke@wrc.ccw.ac.za (Overseas price, via surface mail: US\$ 20.)



**Full-Scale Chemical Control  
of Sludge Bulking**

GB Saayman • J van Leeuwen • CF Schutte



Report to the Water Research Commission  
by the  
University of Pretoria

WRC Report No 328/1/97



# Irrigation demand estimated from satellite imagery

The WRC has recently published a report entitled **Identification of Irrigated Land in an Intensively Cultivated Agricultural Area in the South Western Cape by Means of Satellite Remote Sensing** by researchers HL Zietsman, AC Vlok and I Nel of the Institute for Geographical Analysis at the University of Stellenbosch.

This study set out to evaluate the potential of SPOT and Landsat TM satellite data to identify vegetation in quantifiable terms, so that the irrigation requirements of the Wolseley-Worcester area of the Upper Breede River

Catchment could be determined. The land cover in this area ranges from natural veld through dryland cereals to irrigation crops. As the water resources of the valley are increasingly under pressure, future planning and allocation to various user categories are progressively becoming important. There are similar situations elsewhere in South Africa.

However, effective methods to speedily obtain and accurately monitor land cover data, on which to base water management decisions, will greatly contribute to water management and allocation.

**E**ffective management of natural water resources in catchment areas requires information on the current land use patterns and trends. Conventional methods of data collection used in making an inventory of land use, such as land use surveys, field work and aerial surveys are expensive, cumbersome and time-consuming. Modern technology, such as remote sensing and Geographic Information Systems (GIS), is a means of collecting information on land use and research has shown that it is possible to map irrigated areas fast and reasonably accurately with the aid of satellite data. However, the capability of relatively high resolution satellite data to identify irrigated areas has not yet been fully tested in intensively farmed areas, such as the Southwestern Cape.

## AIMS

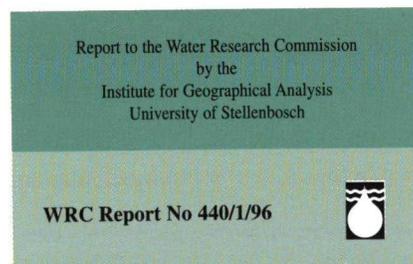
The specific aims of the project were the following:

- to identify, classify and map land cover types with particular emphasis on irrigated land in a section of the Breede River Valley by analysing multi-temporal SPOT and Landsat TM digital imagery;
- to refine the results obtained by digital image processing techniques by combining ancillary information such as



The Identification of Irrigated Land  
in an Intensively Cultivated  
Agricultural Area in the  
South-Western Cape by Means of  
Satellite Remote Sensing

HL Zietsman • AC Vlok • I Nel



Report to the Water Research Commission  
by the  
Institute for Geographical Analysis  
University of Stellenbosch

WRC Report No 440/1/96



soil types and slopes with a GIS using polygon overlaying techniques;

- to investigate the usefulness of land cover data gathered by the abovementioned techniques for quantifying water abstraction by irrigation through field surveying techniques.

## STUDY AREA

The study area comprised the Breede River Valley in the South Western Cape of South Africa from where the river

emerges from Mitchell's Pass in the vicinity of Wolseley to just north of Worcester. The valley is intensively cultivated (Figure 3). Vines, orchards, vegetables and pastures under irrigation are the main crops. Dryland farming of wheat is also significant. The rest of the area is utilized for pine plantations or still under natural veld, mostly Cape Fynbos. Figure 2 shows the location of the study area superimposed on a Landsat TM image.

## METHODOLOGY

The diagram in Figure 1 summarises the steps and procedures followed to achieve the aims of this study.

## DATA

In order to achieve the goals set for this research four different data sets were required:

- Spot XS
- Landsat TM
- Ancillary GIS data
- Ground truth data

Data from a questionnaire survey of 21 farms in the study area provided detailed land use data and information on irrigation practices from which it was possible to compute the amount of irrigation water applied per land cover type.

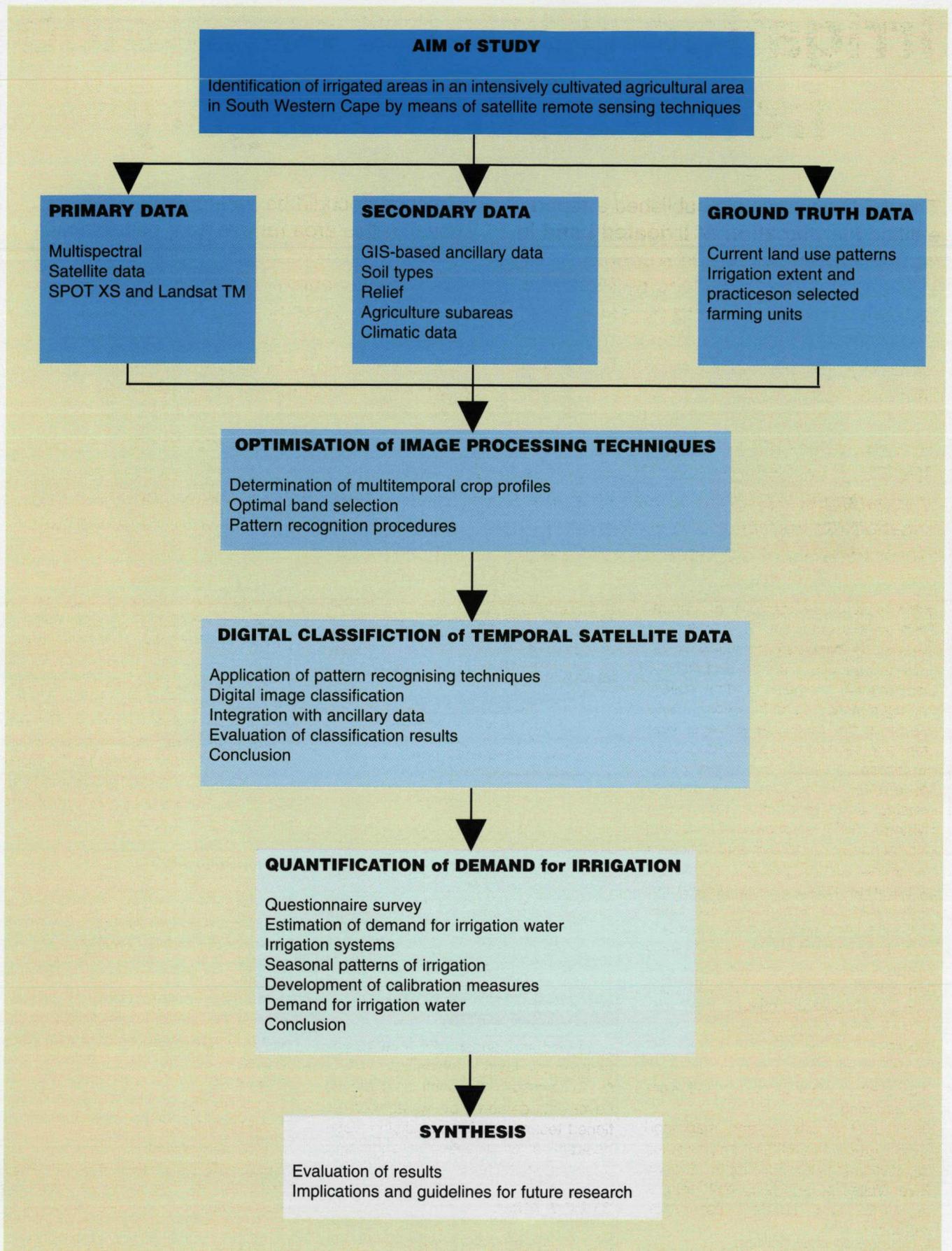


Figure 1. Schematic representation of the research methodology.

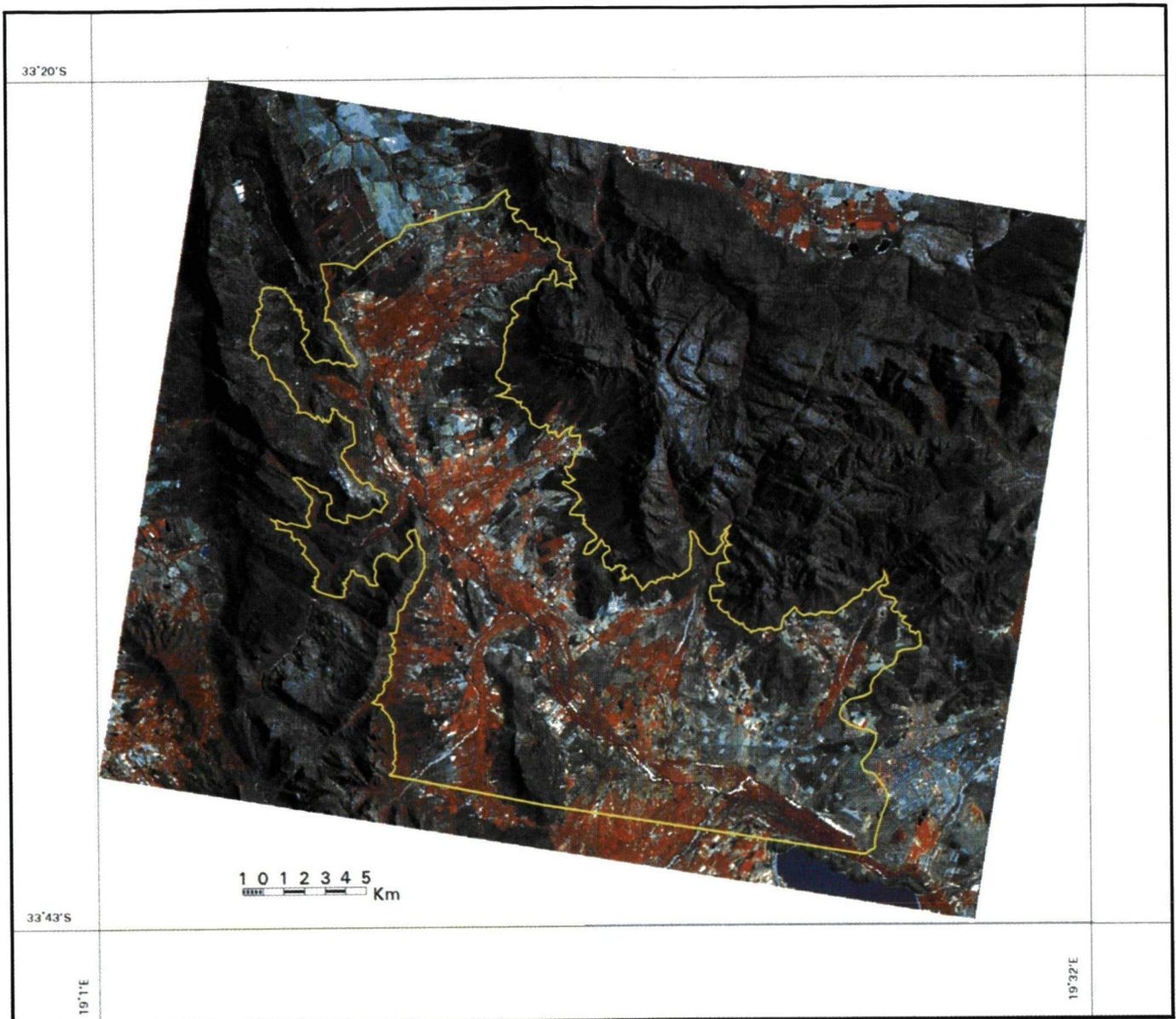


Figure 2: Landsat image of the study area as indicated.

## IMAGE PROCESSING

Two image processors were used to analyse the data, namely an older version of Easi Pace on a 386 PC to process the SPOT XS data and the latest version of Erdas Imagine on a SUN workstation to analyse the Landsat TM data. The data were subjected to the following image processing techniques:

- Unsupervised classification,
- Principle Component Analysis,
- Normalised and Transformed Normalised Difference Vegetation Indices, and
- Supervised classification.

These procedures are discussed in the

report as applied to the Spot and Landsat TM images respectively.

## GAUGING DEMAND FOR IRRIGATION WATER

Based on a questionnaire survey of 21 farms in the area the mean volume of irrigation water per hectare applied annually to each of the major land cover types were established. Using these mean values and information on the proportional area of each land cover type which is under irrigation, the total demand for irrigation water was estimated. This was done by applying computed conversion factors to the land cover areas obtained from the different classification techniques.

Demands for irrigation water varied substantially, due to widely differing area estimates. The SPOT XS and Landsat TM estimates differed greatly, as did estimates of the different classification techniques. The Landsat TM data sets were capable of distinguishing between more categories of land cover types than the SPOT analyses, while supervised classifications produced the most consistent results.

## CONCLUSIONS

The overwhelming impression gained during the course of this research was that, in attempting to achieve better results by enhancing spectral, spatial

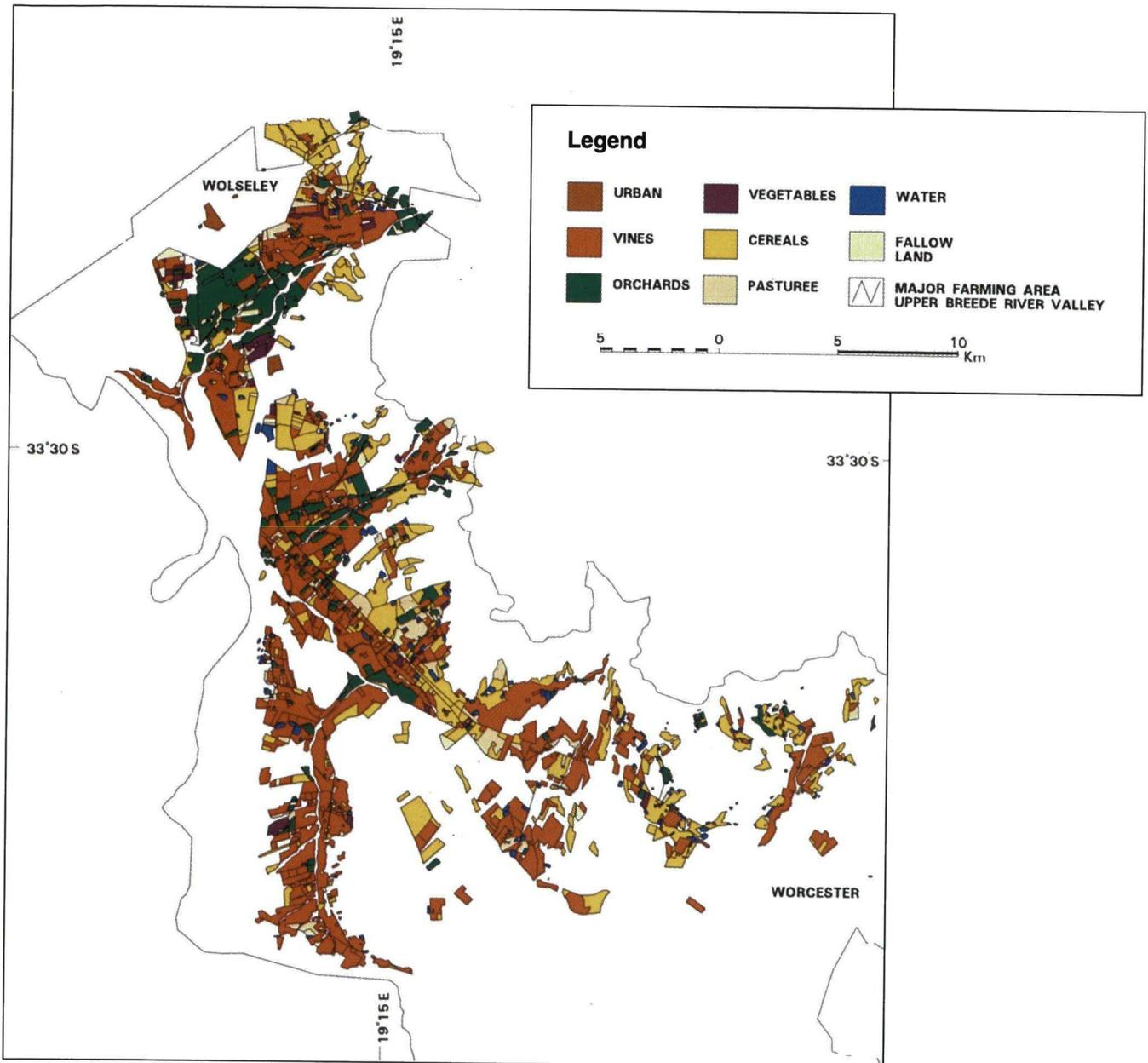


Figure 3: Breede Valley land use map.

and temporal resolutions of satellite imagery, the level of complexity has been increased many times.

Although data volumes and costs increase proportionately, by adding a time dimension the spectral signatures become disproportionately more complex. The analyst not only has a multi-spectral situation to contend with, but also many combinations and permutations of land cover changes on different land parcels as crops are rotated. Planting of annual crops are not simultaneous by all farmers. Selecting appropriate calibration samples under these conditions is virtually impossible. The fact that only three spectral bands are

visible at any one time also make the choice of sample areas increasingly difficult. These confounding factors indicate a need for new approaches which will directly address the multitemporal and multispectral nature of current satellite imagery.

However, in conclusion it seems that digital image analysis enhanced with GIS data is a valid means of obtaining land cover information of sufficient quality and accuracy for planning and monitoring catchments and their agricultural water requirements. It remains the most appropriate technology for cost-effective mapping of land cover over large areas or obtaining up to date information of

land cover changes on a fairly regular basis.

The report **The Identification of Irrigated Land in an Intensively Cultivated Agricultural Area in the South-Western Cape by Means of Satellite Remote Sensing** (WRC Report 440/1/96) is now available, free of charge, from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail: tineke@wrc.cwr.ac.za (Foreign orders: US \$30 per copy, via surface mail).

# Dilution coefficients unpredictable

A simple equation is not always sufficient to provide reliable quantitative results on achievable secondary dilutions of deep sea outfalls, particularly if the consequences of possible detrimental impacts on the environmental ecology, health and economical aspects are taken into consideration. This is the conclusion of researchers WAM Botes and S Taljaard in a recent report **Comparison of Predicted Secondary Dilutions to Measured Field Data and the Determination of Prototype Diffusion Coefficients** (WRC Report 6675/1/96) to the Water Research Commission.

The researchers say that irrespective of the procedure or method (whether analytical methods or numerical modelling) used to predict the behaviour of a moving effluent waste field, a thorough understanding of the physical processes, the sensitivity and limitations of the prediction method or procedure to all variables, as well as the applicability of a certain method to a specific area or near shore conditions is essential before any quantitative conclusions can be made with regard to the detailed outfall design.

## DILUTION

The expected total achievable dilution of deep sea outfall effluent at a distant location, is the product of:

- the initial dilution,
- secondary dilution,
- dilution due to die-off of microbial organisms, and
- the chemical/biological dispersion of non-conservative substances.

The initial dilution is the dilution achieved by the entrainment of seawater at the periphery of the plume during the rise of the buoyant effluent from the diffuser to the surface of the sea, thereby reducing pollutant concentrations in the effluent.

The subsequent transport of the effluent waste field, away from the initial surfacing plume, brings about further reduc-

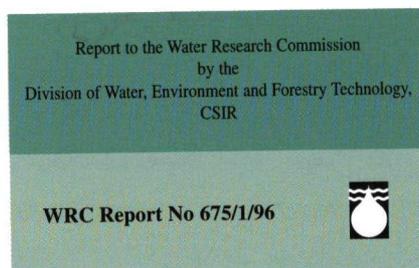
tion of the pollutant concentrations. This process is generally referred to as secondary dilution, which is caused by turbulence, eddies and shears, causing further mixing and entrainment of seawater.

Chemical and biological dispersion of non-conservative substances and the die-off or decay of certain organisms during the transport of the waste field (dilution due to decay), along with the initial dilution and secondary dilutions determine the ultimate concentration of pollutants, determine the ultimate concentration of pollutants originating from an effluent, and the subsequent impact thereof at any location away from the discharge location.



Comparison of Predicted Secondary Dilutions to Measured Field Data and the Determination of Prototype Diffusion coefficients

WAM Botes • S Taljaard



## AIM

The aim of this project was to compare actual secondary dilutions obtained from field data with predicted secondary dilutions, as well as to determine prototype diffusion coefficients at a number of areas along the South African coast to verify the applicability of a standard prediction method used in South Africa for marine outfall design purposes.

## DATA REQUIREMENTS

The dispersion of a waste field, after surfacing of the plume, is a spatial and time dependent process, therefore the following data are required to predict behaviour and subsequent impact of the moving waste field:

- ambient current velocities,
- frequency of occurrence of these current speeds and directions,
- frequency of occurrence of wind speeds and directions,
- spatial behaviour of the current, i.e. the near-shore circulation patterns, and
- typical diffusion coefficients.

## DIFFUSION COEFFICIENT

The accuracy of the predicted secondary dilutions depends on the accuracy and completeness of the above-mentioned data sets. If prototype tests are not conducted at a specific location, the diffusion coefficient (for both analytical and numerical methods) has to be estimated from experience or relevant data. The diffusion coefficient cannot be 'modelled' due to the complex physical processes causing the eddy diffusion.

The physical measurements of the dispersion characteristics are a time consuming and costly operation. A 'general' dissipation parameter, referred to as a  $\alpha$ -value of  $0,0005 \text{ m}^{2/3} \text{ s}^{-1}$ , has been applied until now to determine the secondary dilutions for all deep sea outfalls in South Africa. This 'general dissipation parameter was based on the proposals of several researchers and from a once-off field exercise conducted on the Natal coast. The prediction method basically relates to the method of Brooks (1960) applying the so-called '4/3 law', considered to be applicable to 'open sea' conditions.

## DROGUE DATA

Various theories can be used to estimate the diffusion coefficients for a specific site, including a procedure whereby 'drogue pair' measurements are

used. Between 1981 and 1992, the CSIR undertook numerous studies at a number of coastal development areas to determine the feasibility of ocean outfalls as options for sewage disposal. These studies included the Lagrangian recording of currents, using surface and subsurface drogues. The path of the drogues were recorded by accurate position fixing in time and space. Drogue data collected were from Noordwesbaai (on the west coast), Hout Bay, False Bay, Vlees Bay and East London.

This valuable source of data is also assessed in this report to estimate the magnitude of the diffusion coefficient at various coastal regions. Tracer measurements, collected at Richards Bay, Vlees Bay and Hout Bay, were also assessed to estimate diffusion coefficients on the days of the exercises. The comparison between predicted and measured secondary dilutions yielded are discussed in detail in the report.

## CONCLUSIONS

The researchers say that the following conclusions can be drawn from the findings of this project:

□ Results from this project indicate that the 'general' procedure applied in the prediction of achievable secondary dilutions for deep sea outfall along the South African coast, i.e. the method of Brooks (1960) assuming the '4/3 law' and a  $\alpha$ -value of  $0,0005 \text{ m}^{2/3} \text{ s}^{-1}$ , does not always apply.

□ Although the median  $\alpha$ -value of  $0,0005 \text{ m}^{2/3} \text{ s}^{-1}$ , obtained for grouping all available drogue measurements, confirmed the 'general'  $\alpha$ -value suggested by numerous authors, the  $\alpha$ -values estimated for the individual sites, clearly showed the diversity of conditions along the 3 000 km South African coastline.

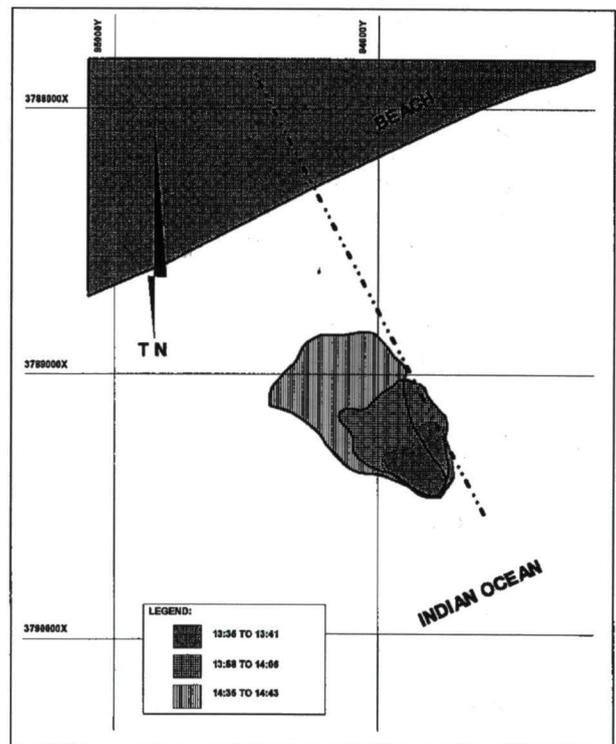
□ Based on the findings of this report the use of a 'general'  $\alpha$ -value is not recommended in determining the secondary dilutions and subsequent impact of an effluent waste field at distant locations in South Africa. The most typical values for certain areas should be considered and if detailed field measurements cannot be obtained to establish the actual diffusion coefficients, at least a range of values should be considered. The diffusion coefficients and



*Vlees Bay: Transport of an effluent field, made visible with the tracer Rhodamine-B, was transected and sampled continuously to determine the degree of secondary dilutions achieved.*

$\alpha$ -values determined in this report could be used as a rough guideline.

□ According to the report prediction of achievable secondary dilutions and subsequent impact at distant locations may be appropriate for the planning and feasibility phases of an outfall project, however, considering near shore processes and the coastline configuration, it is strongly recommended that field measurements be conducted to obtain more accurate, site specific diffusion characteristics of the area for the optimisation of an outfall during the detailed design phase.



*Transport of a waste field at Vlees Bay as on 10/11/1992.*

The report **Comparison of Predicted Secondary Dilutions to Measured Field DATA and the Determination of Prototype Diffusion Coefficients** (WRC Report 675/1/96) is available, free of charge, from the Water Research Commission, PO Box 824, Pretoria 0001. E-mail: tineke@wrc.cwr.ac.za (Foreign orders: US \$20 per copy, via surface mail)

# Conference on Flow Regimes from International Experimental and Network data (FRIEND'97)

The 3-d FRIEND (Flow Regimes from International Experimental and Network Data) Conference was held in Ljubljana, Slovenia in October 1-4 1997. The FRIEND research programme is an international collaborative study into regional hydrology. It was first established by UNESCO in Northern Europe in 1985 as part of the International Hydrological Programme. The primary objective of the FRIEND project is to improve the understanding of hydrological variability and similarity across time and space in order to develop hydrological science and practical design methods. The very definition of FRIEND implies that hydrological research has to cross national boundaries. This is being done in two ways. First, by developing international hydrological databases of time series and spatial data including catchment boundaries, climate, land use and soil type. Second, by establishing project groups (low-flows, extreme rainfall and runoff, processes of streamflow generation in small basins) that could exchange models and analysis techniques and interpret the results using a common approach to analysing data from different regions. The FRIEND research programme is therefore essentially a coordinated collection of individual research projects, undertaken by international groups.

The successful development of the FRIEND project in the Northern and Western Europe gave the impetus to a number of other regional FRIENDs in different parts of the world. FRIEND groups have been established in the Alpine and Mediterranean Hydrological region of Europe (AMHY), in Southern Africa and in West Africa. Research programmes are being planned in the Hindu Kush - Himalayas region, in South-East Asia, South America and the Nile basin.

## CONFERENCE

Slovenia, chosen for the third FRIEND international conference has a central position for the AMHY FRIEND group and symbolises the collaboration between countries connecting Western and Eastern Europe. This collaboration is, effectively one of the "horizontal" developments of the European FRIEND. Slovenia is already known in the hydrological community as the place where, in 1990 in Ljubljana, one of the first international conferences on regional hydrology was held.

The Conference Program included several themes with corresponding sessions:

- International Hydrological Databases
- The spatial and temporal variability of hydrological processes
- Hydrological Extremes (including low flows, floods and extreme rainfall)
- Hydrological processes, catchment planning and sustainable water resource development

These sessions have been primarily composed of the presentations on recently completed on-going FRIEND projects, such as North-Western Europe FRIEND, Alpine Mediterranean FRIEND and Southern Africa FRIEND. It is therefore not surprising that a number of papers presented reflected the results of regional hydrological studies in the SADC (Southern African Development Community) region that includes Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

The highlight of the first session was the paper presented by Serge Pieynès (World Meteorological organisation -

WMO) describing the World Hydrological Cycle Observing System (WHYCOS).

Although FRIEND projects have already succeeded in establishing some regional hydrological databases, such databases are only one piece of a much broader set of activities harmoniously integrated in what was referred to as a hydrological information system. This system should include collection and dissemination of data and "play an important role in estimating the quantity and quality of water available, as well as the current and prospective water use and demand patterns". WHYCOS - a programme aimed at the establishment of hydrological information systems - is promoted by the WMO with the support of the World Bank since 1993. The global approach is being implemented through the establishment of the regional components (HYCOSs). All components will be developed within the framework of common guidelines and standards, but are designed to meet regional priorities expressed by participating countries. MED-HYCOS for Mediterranean countries and SADC-HYCOS for Southern African countries are the first components to be implemented, whereas the West and Central Africa, Congo River basin, Aral Sea components are planned.

Each regional project will be implemented by a Pilot Regional Centre (PRC), hosted by an operational organization existing in the region under the control of a Regional Technical Committee with representatives of all participating countries. Technically WHYCOS is implemented through (a) the installation of a network of key stations (with multi-sensor equipped Data Collection Platforms - DCPs) on major rivers for the collection and transmission of several variables related to water resources moni-

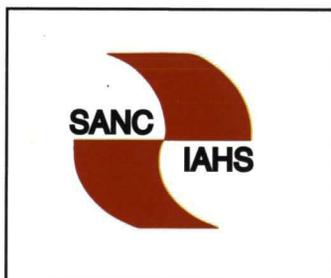
toring and (b) the development of regional databases with an integrated Web server.

The problem of international information transfer in hydrology has also been discussed by Dr W.Grabs, Director of the Global Runoff Data Centre (GRDC-Koblenz, Germany). He identified major concepts regarding the international exchange of hydrological data and presented several basic models for information transfer, ranging from controlled access for identified users only to unrestricted access through the Internet. FRIEND information exchange is currently an intermediate model which implies the dissemination of data for project participants only, until the project reaches the stage when the participants decide to make data and results accessible to the public.

The presentations in the session "Spatial and temporal variability of hydrological processes" discussed such issues as the derivation of a runoff grid for southern Africa for climate change impact analyses, the estimation of renewable water resources in the European Union (also using a grid-based approach), automatic derivation of flow discharges from specific runoff maps and digital terrain models, overview of spatial and temporal variability of the hydrological regimes in the AMHY area, the nature of the associations between atmospheric circulation and variability of river flow regimes in North-Western Europe, the pattern of historical runoff variation in the Nordic countries, analysis of river flow variability in the Southern African FRIEND region, etc.

The presentations on low-flow hydrology and drought analysis formed the bulk of the session "Hydrological extremes". One of the highlights of this session was the presentation from the Institute of Hydrology (A.Gustard et al) on the use of regional hydrology for assessing spatial and temporal variability of low flows at the European scale. The first approach described in the paper focused on the integration of several national approaches to low-flow estimation into one where the overall objective is to derive a composite grid of flow exceeded 90% of the time (Q90) in Western and Mediterranean Europe. The second approach described the

spatial coherence of European droughts by calculating the flow duration percentile experienced on each day of the year and mapping its spatial variation (on selected dates) across Europe. The latter approach allows the development of droughts at the regional scale to be illustrated and presented in a transparent form. Other presentations on low-flows and droughts included the overview of low-flow analysis techniques used in different countries: South Africa, Slovenia, Turkey, Germany, Poland or larger geographical regions like Scandinavia and southern Africa. A number of presentations discussed the impacts of land-use, climate change and groundwater abstractions on streamflow droughts and the use of physically-based models to predict these impacts or to identify the factors causing droughts.



## FLOODS

Presentations on floods described the results of application of Discharge-Duration-Frequency (DDF) models (based on the concept of threshold flows) in European catchments, the combination of statistical and conceptual approaches for index flood estimation, alternative techniques for the estimation of design storms and floods, several regional models for extreme discharge estimation etc. A separate session on hydrological processes, catchment planning and sustainable water resource development included the presentations which illustrated possible applications of the regional hydrological studies. Also an informative and informal poster session was presented in parallel with the oral presentations.

The oral presentations are published in one of the IAHS "red books" - IAHS Publication No 246 (FRIEND'97 : Regional Hydrology: Concepts and

Models for Sustainable Water Resource Management) which was made available to the conference participants at the registration. A selection of the FRIEND activities during the period 1994-1997 is presented in the third general report which includes the main results obtained by Northern Europe FRIEND and FRIEND AMHY with contributions from Southern Africa and Western/Central Africa FRIEND groups.

The Conference was undoubtedly an overall success. It has been mentioned several times during the closing session that FRIEND research has made hydrology a really international science. The future developments which are expected withing FRIEND are also very impressive. Since several new regional FRIEND groups have been established, the FRIEND activities will grow geographically. Also a number of new research directions have been formulated for "experienced" groups, like Northern Europe FRIEND which will now concentrate on further development of the European Water Archive, on in-depth studies of relationships between low-flow response and catchment hydrogeology and evaluation of the growth and decay of droughts (the READ initiative - Regional European Assessment of Droughts - was specifically mentioned). Other regional groups have different priorities mainly brought about by regional conditions. For example the focus of the HKH (Hindu Kush-Himalayas) FRIEND will be on prevention and management of environmental hazards, while SADC group aims to focus on three aspects : droughts, sediment transport and large regional scale training for hydrologists and for hydrological services.

Several new directions have been formulated for the global FRIEND initiative. These include, amongst others, the linkage of regional hydrological research to integrated water management, quantification of societal and economic vulnerability to floods and droughts, establishment of regional hydrological determinants for instream ecology. Future FRIEND directions have the full agreement of UNESCO's International Hydrological Programme. The results of the future FRIEND research are expected to be published in the next, fourth FRIEND General Report, in the year 2001.

# Harding heads investigation into eutrophication of African lakes

The Committee for Inland Fisheries of Africa, CIFA, a committee of the Food and Agriculture Organisation of the United Nations, UN-FAO, noted during its fourth session that eutrophication was an emerging problem for most African lakes, even the largest among them. Accordingly, CIFA has appointed a working party to examine and report on the problem posed by phosphorus in African lakes.

Dr Bill Harding of Cape Town has been appointed to lead this exercise together with Dr Jeff Thornton of Waukesha, Wisconsin, USA. Dr Harding is one of the few South Africans working intensively on lake ecosystems, and Jeff, formerly of the CSIR and the City of Cape Town, is well acquainted with African lakes, both north and south of the Zambezi. Other members of the team are based in Ghana, Uganda, Ivory Coast, Egypt and Zimbabwe. The



*Dr Bill Harding*

team will meet in Accra, Ghana, during December 1997 to report on and assess its findings and to review the use of models and phosphorus export coefficients which are applicable to the African continent. The working party is currently compiling data on phosphorus

concentrations, sources and loads, as well as other physico-chemical and biological limnological information. The data will be assessed using a variety of models currently in use in other regions of the world. These models are very appropriate for the calculation of non-point source phosphorus loads under specific African conditions.

According to Dr Harding attention to the problem of eutrophication in African lakes is long overdue and the findings of the working party on phosphorus should enhance the current understanding of pollution across a broad spectrum of aquatic environments in Africa. The study will encompass conditions in freshwater lakes and reservoirs, saline and internally-drained lakes such as those which are common in East Africa, and deep water marsh-type ecosystems, such as Naivasha, Nakuru and Banguelu.



## TECHNIKON NORTHERN GAUTENG

Department of Civil Engineering  
Post-Diploma Studies

### B.Tech. Civil Engineering: Water Option

#### Course contents

- ❑ Eight subjects, five compulsory and three elective, as well as a short course in entrepreneurship, are required.
- ❑ Compulsory subjects: Hydraulics IV, Hydrology IV, Water Treatment Technology IV, Wastewater Treatment Technology IV, Reticulation Design and Management IV, and Entrepreneurship.
- ❑ Elective subjects (3 required): Irrigation IV, Principles of Dam Engineering IV, Solid Waste Management IV, and Hydrogeology III.

Duration of the course is a minimum of one year full-time and a maximum of three years part-time.

Please contact the course leader for detail of admission requirements.

The course will commence in January 1998.

#### For further information and application please contact:

Mr Jim Corlett, Post-Diploma Course Leader  
Department of Civil Engineering  
Technikon Northern Gauteng  
Private Bag X07 Pretoria North 0116

Tel: (01214) 91-2211 • Fax: (01214) 91-2203

# INFORMATION NETWORKS

*http://www-wrc.ccwr.ac.za*

The Internet connects millions of people throughout the world, from Pretoria to Perth, from Novosibirsk to New York. Once on the system, you can cruise around in cyberspace, travelling from computer to computer, continent to continent.

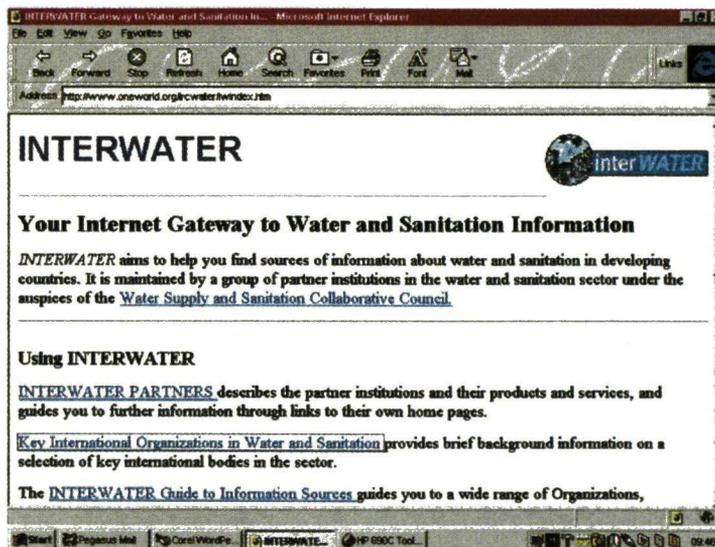
This unique facility offers the opportunity to an unlimited number of individuals, who share the same interest but are located in different parts of the world, to communicate regularly and share resources. Indeed, the concept of networking has taken on a new definition since the Internet and the vast communicating facility it offers, has arrived!

The Water Research Commission had been involved in the formation of several interest-based networks and direct links to some of those are available from the WRC's website.

## INTERWATER

The web pages of INTERWATER act as an Internet Gateway aiming to help users to find information about water and sanitation in developing countries. It is maintained by a group of partner institutions in the water and sanitation sector under the auspices of the Water Supply and Sanitation Collaborative Council. Information available from their web site covers the following:

- INTERWATER Partners: describes the partner institutions and their products as well as services, and guides users to further information through links to their own home pages.
- Key International Organizations in Water and Sanitation: provides brief



background information on a selection of key international bodies in the sector.

- INTERWATER Guide to Information Sources: guides users to a wide range of organisations, directories, databases, dictionaries and glossaries, Thesauri and bibliographies and literature reviews relating to water supply and sanitation in developing countries. It includes sources available on the Internet and through e-mail, as well as those published in conventional forms.

## EMILY

The web pages of the Electronic Membrane Information Library provides information for researchers and engineers in the field of membrane technology. The following information is covered:

- Background information on EMILY, including details on the aims and policy of the group.
- List of contact names and addresses of individual members.
- Facility to subscribe to become a member of EMILY and its Listserv.
- Manufacturers catalogue listing com-

panies that manufacture or supply membranes and related equipment. Contact details and a brief summary of company expertise are listed.

- Newsletter of the WISA Membrane Technology Division.
- WWW links to membrane manufacturers.
- Facility to add details on current or proposed membrane projects.
- Facility to add information for inclusion into EMILY's International Directory of Membranes

## KZNWRN

The KwaZulu Natal Water Research Network (KZNWRN) is a collaborative network of individuals, groups and institutions involved in the water research sector of KwaZulu Natal. The following information is available on the website of KZNWRN:

- Minutes of the inaugural meeting held on 12 June 1996.
- Terms of reference of the network.
- List of network members and contact details.
- A list of possible sub-projects that have resulted from past or on-going research undertaken in the region.
- A facility to submit current or past project details for inclusion into the official list.
- A facility to subscribe to become a member of the network.

## Contact persons @ WRC for enquiries:

Martha Pretorius  
mpretori@wrc.ccwr.ac.za  
or  
Francette Myburgh  
fmyburgh@wrc.ccwr.ac

# 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.

## 1997

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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.

## 1998

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SOUTHERN  
AFRICA

1997

## WATER &amp; SANITATION

DECEMBER 1 - 5

A conference on standard setting, quality control and coordination for training in the water and sanitation sector will be held in the Gauteng Province.

Enquiries: The Coordinator: ITN Africa Conference, PO Box 95557, Waterkloof, Pretoria 0145. Tel/Fax: (012) 46-5453.

1998

## LEGIONELLA

FEBRUARY '98

The Legionella Action Group (LAG) will present a series of one-day seminars. For more information see advertisement on page 2 of this Bulletin.

## CEMSA '98

FEBRUARY 9 - 11

An international conference and exhibition on Integrated Environmental Management (IEM) in South Africa will be held in East London.

Enquiries: Professor OS Fatoki, University of Fort Hare, Analytical Chemistry, Private Bag X1314, Alice 5700. Tel: 404-22094. Fax: 404-31643. E-mail: FATOKI@UFHCC.UFH.AC.ZA

ENVIRONMENTAL  
MANAGEMENT

MARCH 2 - 6

An international (ISO 14001) environmental management and auditing course will be held at the ESKOM Conference Centre in Midrand, Gauteng.

Enquiries: The Organisers, Crystal Clear, PO Box 1982, Bramley 2018. Tel: 011-8823368. Fax: 011-8823395. E-mail: crystal.clear@pixie.co.za

## WISA '98

MAY 4 - 7 1998

The biennial conference and exhibition of the Water Institute of Southern Africa (WISA) will be held in Cape Town.

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

## AQUACULTURE

SEPTEMBER 13 - 19

An international conference on African fish and fisheries - diversity and utilisation will be held in Grahamstown in the Eastern Cape. The objectives of the conference are to address and discuss issues surrounding African fish biodiversity and sustainable utilisation of marine and inland fisheries resources and to consider recent advances in aquaculture in Africa.

Enquiries: JLB Smith Institute of Ichthyology, Private Bag 1015, Grahamstown 6140. Tel: +27 461 311002. Fax: 0461-22403. E-mail: fishcon@ru.ac.za Website: <http://www.ru.ac.za/affiliates/jlb/finshcon>

## WASTECON '98

OCTOBER 13 - 15

This international conference will be held at the World Trade Centre in Kempton Park and is intended to explore new perspectives in waste management, particularly those applicable to the southern African region. Topics will include management aspects such as auditing, reporting, monitoring, environmental management systems, legal institutional and policy developments, alternative and appropriate technologies and public participation.

Enquiries: Piet Theron or Sonja Havenga at the Institute for Waste Management. Tel: (011) 787-1151. Fax: (011) 787-1086.

## OVERSEAS

1998

## GROUNDWATER

FEBRUARY 8 - 13

A conference with the theme "Groundwater - sustainable solutions" will be held in Melbourne, Australia.

Enquiries: Convention and Incentive Services, Level 2, 370 Glenhuntly Road, Elsterwick, VIC 3185, Australia. E-mail: cis@ozemail.com.au Tel: +61-3-9523-8290. Fax: +61-3-9528-4046.

## WATER QUALITY

FEBRUARY 25 - MARCH 1

The first international specialised conference on water quality and its management will be held in New Delhi, India.

Enquiries: CVJ Varma, Central Board of Irrigation & Power, Malcha Marg, Chanakyapuri, New Delhi 110021, India. Tel: +91 11 3015984. Fax: +91 11 3016347. E-mail: cbip@cbipdel.uunet.in

## WEFTEC ASIA

MARCH 7 - 11

The premier Asian technical conference and exhibition on international wastewater and water quality technology, WEFTEC Asia, will be held in Singapore.

Enquiries: Water Environment Federation, WEFTEC '98 Registration, 601 Wythe Street, Alexandria VA 22314-1994 USA. Fax: 1 703 684 2471. E-mail: [confinfo@wef.org](mailto:confinfo@wef.org)

## WATER MANAGEMENT

MARCH 11 - 13

A symposium to evaluate and discuss the technological, economical, social and ecological feasibility and the implementation of sustainable urban water management systems.

Enquiries: Dr Hans Aalderink, Wageningen Agricultural University, Dept of WKAO, PO Box 8080, NL-6700 DD Wageningen, The Netherlands. Fax: +31 317 484411. E-mail: [Hans.aalderink@wkwa.wkao.wau.nl](mailto:Hans.aalderink@wkwa.wkao.wau.nl)

## ACTIVATED SLUDGE

MARCH 16 - 18

A seminar on the modelling and microbiology of activated sludge processes will be held in Kollekolle, Denmark.

Enquiries: MiaCon, Dept of Environmental Science and Engineering, Building 115, Technical University of Denmark, DK-2800 Lyngby, Denmark. Tel +45 4525 1613. Fax: +45 4593 2850. E-mail: [bn@imt.dtu.dk](mailto:bn@imt.dtu.dk)

## RIVER SYSTEMS

MARCH 25 - 27

A conference with the theme "Man and River Systems - the functioning of river systems at basin scale" will be held in Paris, France.

Enquiries: F Bourgain, Conference Secretariat, ENPC, 28 rue des Saints-Peres, 75007 Paris, France. E-mail: [bourgain@paris.enpc.fr](mailto:bourgain@paris.enpc.fr) Tel: +33-1-44-582822. Fax: +33-1-44-582830.

## STORM DRAINAGE

MAY 4 - 6

A conference on innovative technologies in urban storm drainage (Novatech 1998) will be held in Lyon, France.

Enquiries: GRAIE, BP 2132, 69603 Villeurbanne Cedex, France. Tel: +33 472 438368. Fax: +33 472 449277. E-mail: [graie@urgc-hu.insa-lyon.fr](mailto:graie@urgc-hu.insa-lyon.fr)

## DRINKING WATER

MAY 10 - 13

The first international symposium on technology, operation and economics of providing safe drinking water in small systems will be held in Washington DC, USA.

Enquiries: NSF International, 3475 Plymouth Road, Ann Arbor, MI, USA 48105. Fax: 202-289-2149. E-mail: [cotruvo@nsf.org](mailto:cotruvo@nsf.org)

CHLORINATED  
COMPOUNDS

MAY 18 - 21

The first international conference on remediation of chlorinated and recalcitrant compounds will be held in Monterey, California, USA.

Enquiries: The Conference Group, 1989 West Fifth Avenue Suite 5, Columbus, Ohio 43212-1912 USA. Tel: 614-424-5461. Fax: 614-488-5747. E-mail: [102632.3100@compuserve.com](mailto:102632.3100@compuserve.com)

## WATER QUALITY

MAY 20 - 23

An international conference on water quality management in national parks and other protected areas will be held in Primosten, Croatia.

Enquiries: Bojan Zmaic, Rakusina 1, 10000 Zagreb, Croatia. E-mail: [bzmaic@zg.igh.hr](mailto:bzmaic@zg.igh.hr) Tel: +385-161-19-588.

## ECWATECH-98

MAY 25 - 30

The third international congress and exhibition on water, ecology and technology will take place in Moscow, Russia.

Enquiries: The Organising Committee, PO Box 173, Moscow 107078, Russia. Tel/fax: +7 (095) 207 6360 E-mail: [ecwatech@sbico.msk.ru](mailto:ecwatech@sbico.msk.ru)

## WATER RESOURCES

JUNE 3 - 6

An international conference on world water resources at the beginning of the 21st century: Water - a looming crisis? will be held in Paris, France.

Enquiries: UNESCO, Division of Water Sciences, 1 rue Miollis, 75732 Paris Cedex 15, France. Fax: +33-145-68-5811.

### MEMBRANE SCIENCE

JUNE 9 - 12

An international conference on membrane science and technology (ICMST '98) will be held in Beijing, China.

Enquiries: Mrs Yanqiao Shi, ICMST'98, c/o Institute of Chemistry, Chinese Academy of Sciences, Zhongguancun, Beijing 100080, China. Fax: +86-10-62569564 or: 62559373.

### IWSA

JUNE 17 - 18

An IWSA specialised conference on master plans for water utilities will be held in Prague, Czech Republic.

Enquiries: Mr Lubomir Macek, Faculty of Civil Engineering, CTU Thakurova 7, CZ 16629 Praha 6, Czech Republic. E-mail: macek@fsv.cvut.cz Tel: +420-2-2435-4608. Fax: +420-2-2435-4607.

### IAWQ

JUNE 21 - 26

The 19th biennial conference of the International Association on Water Quality will be held in Vancouver, BC Canada.

Enquiries: IAWQ, Duchess House, 20 Mason Yard, Duke St., St James's, London SW1Y 6BU, United Kingdom. Tel: 44 (0) 171-839 8390. Fax: 44 (0) 171-839 8299.

### MINERAL WATER

JUNE 24 - 27

An international symposium on mineral and thermal groundwater will take place at Miercurea Ciuc, Romania.

Enquiries: Romanian Association of Hydrogeologists, Symposium Secretariat, c/o Iulian Popa, 6 Traian Vuia Str, R-70139 Bucharest, Romania. Fax: +40-1-212-3385.

### GROUNDWATER

JULY 12 - 16 1998

An international conference with the theme Future groundwater resources at risk will be held in Changchun, China.

Enquiries: Professor Lin Xueyu, Changchun University of Earth Sciences, Changchun, Jilin 130 026, China. Fax: 86 431892 8327.

### FOG COLLECTION

JULY 19 - 24

The first international conference on fog and fog collection will be held in Vancouver, Canada. Scientific sessions will include: Fog physics and chemistry; Fog - vegetation interactions; Fog deposition to temperate forests; Fog deposition to tropical forests; Fog contributions to sub-surface water supplies; Construction and use of fog collectors; Measurement of fog fluxes and collection rates and the Assessment of the role of fog in specific ecosystems. Enquiries: Dr Robert S Schemenauer, Conference Chair, Environment Canada. Tel: (416) 739-4606 Fax: (416) 739-4211. E-mail: robertss@armph3.dow.on.doe.ca

### IRRIGATION

JULY 20 - 25

The 10th Afro-Asian regional conference on irrigation and drainage will be held in Bali, Indonesia.

Enquiries: Dr A Hafied A Gany, c/o Director-General, Water Resources Development, JL Pattimura 20, Kebayoran 12067, Indonesia. Tel: +62-21-739-6616. Fax: +62-21-726-1956.

### BRACKISH WATER

JULY 23 - 24

An international workshop on the use of saline and brackish water for irrigation - implications for the management of irrigation, drainage and crops will be held in Bali, Indonesia.

Enquiries: ICID Workshop, Dr R Ragab, Institute of Hydrology, Wallingford Oxon. OX10 8BB UK. Tel: +44 1491 692303. Fax: +44 1491 692424. E-mail: R.Ragab: ua.nwl.ac.uk

### CLIMATE & WATER

AUGUST 17 - 20

The second international conference on climate and water will be held in Espoo, Finland.

Enquiries: Risto Lemmela, HUT/Water Res. Eng., Huhtatie 12, 04300 Tuusula, Finland. Tel: +358 9 275 3835. Fax: +358 9 451 3827. E-mail: rlemmela@ahti.hut.fi

### HYDROINFORMATICS

AUGUST 24 - 26

This is the third in a series of conferences held every two years on all aspects of data and information management related to hydrology. It will be held in

Copenhagen, Denmark.

Enquiries: Dr Vldan Babovic, Danish Hydraulic Institute (DHI), Agern Alle 5, 2970-DK Horsholm, Denmark. Tel: +45 45 179133. Fax: +45 45 762567. E-mail: vmb@dhi.dk

### IAHR

AUGUST 26 - 28

The biennial conference of the International Association of Hydraulic Research (IAHR), African Division, is to be held in Hurgada on the Red Sea, Egypt. Theme: Coping with water scarcity. Topics: Integrated management in arid zones; Environmental impact; Surface and groundwater hydraulics and Alluvial hydraulics.

Enquiries: Hydraulics Research Institute, Delta Barrage 13621, Egypt. Fax: (202) 218-9539 or Professor D Stephenson, PO Box 277, WITS 2050. Fax: (011) 403-2062.

### WETLANDS

SEPTEMBER 98

A conference on wetland systems for water quality control will be held in Sao Paulo, Brazil.

Enquiries: Dr Samia Maria Tauk-Tornisielo, Centro de Estudos Ambientais/UNESP, Avedida 24-A, 1515 Bela Vista, CEP 13506-900, Rio Claro (SP), Brazil. Tel: +55 019 534 7298. Fax: +55 019 534 2358. E-mail: cea@life.ibrc.unesp.br

### WATERSHED MANAGEMENT

SEPTEMBER 7 - 10

An international symposium on comprehensive watershed management (ISWM-98) will be held in Beijing, China.

Enquiries: Mr Tan Ying, IRTCES, PO Box 366, Beijing 100044, China. Tel: +86-10-68413372. Fax: +86-10-68411174. E-mail: irtces@public2.bta.net.cn

### HEALTH RISKS

SEPTEMBER 7 - 10

A conference on health risks in drinking water will be held in Santiago, Chile.

Enquiries: Dr EG Reichard, USGS, 5735 Kearny Villa Road, Suite O, San Diego, CA 92123, USA. E-mail: egreich@s101pcasnd.wr.usgs.gov Fax: +56-2-689-4171.

### RIVER BASINS

SEPTEMBER 13 - 16

The 8th river basin conference - Management of large river basins will be held in Budapest, Hungary.

Enquiries: TRIVENT Conference Office, Szamoca u6/b, H-1125 Budapest, Hungary. E-mail: trivent@mail.elender.hu Fax: +36-1-156-6240.

### WASTEWATER TREATMENT

SEPTEMBER 14 - 16

A conference on advanced wastewater treatment, recycling and reuse will be held in Milan, Italy.

Enquiries: ATW98, Scientific Secretariat, DIAR - Sezione Ambientale, Piazza Leonardo da Vinci 32, 20133, Milano, Italy. Tel: +39 2 23996416. Fax: +39 2 23996499. E-mail: milano98@amb1.amb.polimi.it

### ENVIRONMENT-WATER

SEPTEMBER 16 - 18

The first inter-regional conference on environment-water - innovative issues in irrigation and drainage will take place in Lisbon, Portugal.

Enquiries: Portuguese National Committee of ICID, Instituto da Agua, Av. Almirante Gago Coutinho 30, 1000 Lisboa, Portugal. Fax: 351-1-8473023. E-mail: lenamar@inag.pt

### UDM '98

SEPTEMBER 21 - 24

A conference with the theme Developments in urban drainage will be held in London, UK. This conference is the fourth in a series of specialist conferences on aspects of urban drainage.

Enquiries: Dr D Butler, Imperial College of Science, Technology and Medicine, Dept of Civil Engineering, Imperial College Road, London SW7 2BU, UK. Tel: +44 171 594 6099. Fax: +44 171 225 2716. E-mail: d.butler@ic.ac.uk

### TISAR '98

SEPTEMBER 21 - 25

The third international symposium on artificial recharge of groundwater will be held in Amsterdam, the Netherlands.

Enquiries: Symposium Secretariat, Buerweg 51, 1861 CH Bergen, the Netherlands. Tel: +31 72 5899062. Fax: +31 72 5899040. E-mail: R.R. Kruijze@inter.nl.net



## 2-DAY HANDS-ON COURSE

# PC-ACRU

## AGROHYDROLOGICAL MODELLING SYSTEM

**2-3 FEBRUARY 1998**

The daily time step *ACRU*-system can simulate, with risk analysis, daily/monthly/annual soil budgets for use in hydrological and agrohydrological applications, including:

- \* streamflow and peak discharge
- \* sediment yield
- \* irrigation water supply/demand
- \* flow routing and wetlands
- \* reservoir yield and off-channel storage
- \* crop yield
- \* impacts of land use/global climate change
- \* extreme value and other statistical analyses

### COURSE OUTLINE

Day 1 (09:00-17:00)	Day 2 (08:00-16:00)
<p><b>Lectures:</b> Modelling Concepts, <i>ACRU</i> Structure, Rainfall, Soils, Potential and Total Evaporation, Land Cover, Streamflow Generation.</p> <p><b>Practical:</b> <i>ACRU</i> Menubuilder and Utilities, Running <i>ACRU</i>, Graded Exercises, Output and Interpretation.</p>	<p><b>Lectures:</b> Peak Discharge, Sediment Loss, Irrigation Demand/Supply, Reservoir Yield, Flow Routing, Wetlands, Crop Yield, Extreme Value Analysis.</p> <p><b>Practical:</b> Further Fraded Exercises, Specialist Applications.</p>

**Cost:** R1 250 including documentation (*ACRU* Text 552 pp; User Manual 372 pp; *ACRU* Software and utilities), lunches, teas and computing facilities. Cost reductions available to *bona fide* postgraduates and WRC funded researchers as well as to participants who have already purchased *ACRU* documentation and/or software.

**Venue:** Faculty of Agriculture Building, University of Natal, Pietermaritzburg.

I wish to participate in the  
**COURSE ON THE PC-ACRU MODELLING SYSTEM**  
**2 - 3 February 1998**

Name: ..... Tel: .....

Occupation: ..... Fax: .....

Affiliation: ..... E-mail: .....

*ACRU* Software to be licenced to: ..... Postal address: .....

.....

- A cheque of R1 250 made out to "University of Natal" is included.  I will pay at the course.
- I would appreciate assistance with Bed and Breakfast type accommodation

Please mail to:

Department Agricultural Engineering  
**Attention:** *ACRU* Course, Prof RE Schulze  
 University of Natal, Pietermaritzburg  
 Private Bag X01, 3209 SCOTTSVILLE

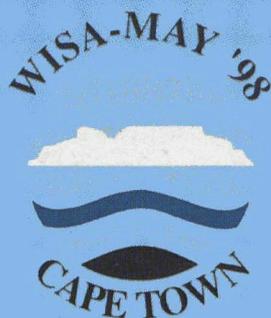
Tel: 0331-2605489  
 Fax: 0331-2605818  
 E-mail: schulze@aqua.ccwr.ac.za

### MY MAIN OBJECTIVES IN ATTENDING THE COURSE ARE TO:

OBTAIN AN OVERVIEW OF <i>ACRU</i> 'S CAPABILITIES	GET PRACTICAL EXPERIENCE IN RUNNING <i>ACRU</i>	GET SPECIALIST KNOWLEDGE OF .....	OTHER (PLEASE SPECIFY) .....
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# THE WATER INSTITUTE OF SOUTHERN AFRICA (WISA)

## BIENNIAL CONFERENCE AND EXHIBITION



**CAPE TOWN SOUTH AFRICA**

**4 to 7 May 1998**

### CONFERENCE TOPICS

- Anaerobic processes
- Aquatic ecosystems
- Collection and reticulation systems
- Community based projects
- Consumer education
- Developing communities
- Education and training
- Environmental aspects
- Groundwater management
- Health related aspects
- Industrial water and effluent treatment
- Infrastructure and management in the water industry
- Laboratory services
- Landfills and leachate management
- Marine disposal
- Membrane development and operation
- Mine water quality management
- Nutrient removal
- Plant operation
- Potable water treatment
- Public participation
- River basin management
- Sludge management
- The role of the water scientist
- Urban runoff
- Wastewater technology
- Water distribution
- Water quality management

### EXHIBITION

An exhibition - a showcase for all water related industries - will be held concurrently with the conference. Manufacturers, suppliers, consultants and contractors who supply goods and services to the water industry are invited to apply for an exhibition stand.

### ENQUIRIES

The Conference Secretariat: Conference Planners, PO Box 36782, Menlo Park 0102.  
Tel: (012) 348-4493 Fax: (012) 348-1563 E-mail: [wissing@iafrica.com](mailto:wissing@iafrica.com)