TUKKIES PROFESSOR ELECTED AS VICE-PRESIDENT OF THE INTERNATIONAL WATER ASSOCIATION

Prof T Eugene Cloete was recently elected as Vice-president of the International Water Association (IWA), at an IWA board meeting held in Japan, during the Third World Water Forum in OSAKA and Kyoto.

Prof Cloete is at present Chairperson of IWA-SA and has been a member of the IWA Governing board for the past two years and was elected to the IWA Strategic Council during 2002 and previously served on the management and policy council for a number of years. He is also currently the Chairman of the IWA Specialist group on Bio-fouling and Bio-corrosion. Cloete has wide-ranging experience in water supply and sanitation as well as industrial and wastewater treatment and has published extensively in these fields with more than 90 publications in science citation indexed journals. He also holds 7 patents and has published two books. He is currently the Editor in Chief of a book on health-related water microbiology and was recently appointed as an Associate Editor of *Water Research*, which is the leading international journal in terms of its citation index rating in the field of water research.

CONTRIBUTION

His contribution to water issues lies in the practical implementation of his research, including the development of a solar water pasteurisation system for producing potable water in rural areas, a better understanding of biological phosphorus removal from activated sludge and the optimisation of the chemical control of bio-fouling and bio-corrosion. He is the Chairperson of the School for Biological Sciences at the University of Pretoria and also the Head of the Department for Microbiology and Plant Pathology at the same university.

IWA

IWA is the largest global network of water professionals, spanning the continuum between research and practice and covering all facets of water. One of its aims is the advancement of education in particular by the exchange of information and experience, and promotion of research into the scientific, biological, engineering, legal and administrative aspects of water pollution abatement and control and in the publication of the results of this research for the benefit of the public.

Through IWA, more than 6 000 members collaborate to lead the development of effective and sustainable approaches to water management, with emphasis on the science and management of drinking water, wastewater, storm-water and the conservation of water resources throughout the world. IWA seeks to create value and drive the advancement of both the science and best practice of water management in cooperation with other similar international efforts in the fields of water resources, and irrigation and drainage.

SPECIALIST GROUPS

The ultimate strength and potential of IWA lies in the professional and geographic diversity of its membership represented by 52 Specialist Groups consisting of a "mosaic" of member communities including academic researchers and research centres, utilities, consultants, regulators, industrial water users and water equipment manufacturers in more than 120 countries. IWA members from each of these stakeholders represent the leading edge in their fields of specialty, and together are building new frontiers in global water management through interdisciplinary exchange and collaboration. It joins the network of initiatives of the past decade, of the Stockholm Water Symposia, the World Water Forum, the Global Water Partnership, UNEP, UNESCO and the World Health Organisation. IWA and its members are committed to furthering sustainable and holistic resource management and service provision, built on the concept of the complete water cycle.

SARS AND THE DANGER OF WATERBORNE TRANSMISSION

Recent laboratory reports indicate that the SARS (Severe Acute Respiratory Syndrome) virus has been detected in the faeces of patients. This is unusual for pathogens associated with respiratory infections and raises the question whether SARS could be spread through waterborne transmission?

According to Professor Willie Grabow, Head of the Department of Medical Virology at the University of Pretoria, the chances are slim, theoretically, that water may play a role in the transmission of SARS for the following reasons:

All viruses are designed to enter the human body by a particular route to infect specific host cells. For instance:

- Respiratory viruses are designed for transmission primarily by the inhalation of airborne viruses which enables the viruses to infect their specific host cells in the respiratory tract. This includes the viruses which cause influenza, the common cold, and also SARS.
- Enteric viruses are designed for transmission by ingestion which enables them to infect cells of the gastrointestinal tract. This includes the viruses which typically cause gastroenteritis, viral hepatitis and poliomyelitis.
- Bloodborne viruses need to be inoculated directly into the bloodstream to reach their host cells in various organs of the body. This includes the viruses which cause Crim-Congo fever (inoculated into the bloodstream by the bite of a mosquito), rabies (inoculated into the bloodstream by the bite of a dog) and AIDS (inoculated into the bloodstream by sexual intercourse).

Consequently rabies, Crim-Congo fever and AIDS are not contracted by drinking sewage polluted water, and influenza is not contracted by the bite of a dog or a mosquito, etc.

CORONA VIRUS

Presently available information indicates that SARS is caused by a mutant of a corona virus, not known before the first clinical cases of SARS were diagnosed towards the end of February 2003.

This association of SARS with a corona virus may cause confusion, Professor Grabow says. Corona viruses are typical respiratory viruses and one of the most important causes of common colds and related respiratory infections all over the world. Corona viruses do, therefore, occur in abundance in most parts of the world.

It would appear that SARS is caused by one of these viruses that has undergone mutations resulting in a new highly virulent virus. Viruses undergo mutations all the time. Typical examples are other respiratory viruses such as the influenza viruses, which have new strains in circulation every year.

Confusion may be related to the fact that there are certain corona viruses which inhabit the gastrointestinal tract of many people without causing clinical disease. These enteric corona viruses are not associated with respiratory infections. This is confirmed by epidemiological data and genetic analysis of the viruses. Consequently there is no reason to believe that the respiratory corona virus associated with SARS is related to the enteric corona viruses, Professor Grabow says.

WHO

On 8-9 May 2003 the World Health Organisation (WHO) held an emergency meeting of international experts in Madrid, Spain, to investigate the possibility of the SARS virus being transmitted by water. This is part of international endeavours to control the spread of the virus by every possible route of transmission. The latest findings of research on the virus, and epidemiological data on the transmission of SARS, were analysed. The meeting concluded that so far there is no evidence that water or food may play a meaningful role in the spread of the virus. However, 321 cases of SARS at the Amoy Gardens complex of 33-floor apartment blocks in the suburb Kowloon Bay of Hong Kong, suggested that water may possibly have played a role in the infection of this large number of individuals. A seemingly significant number of cases lived in apartments close to a wastewater pipeline from top floors to the bottom. The theory is that cracks in the pipeline may have caused contamination of U-traps in bathroom floors, and that droplets containing the virus may have been spread when bathroom fans were in use. However, it would appear most likely that the viruses was spread by conventional respiratory transmission among these people who lived closely together. In other words, infections were contracted by the inhalation of airborne viruses excreted by infected individuals when sneezing or coughing.

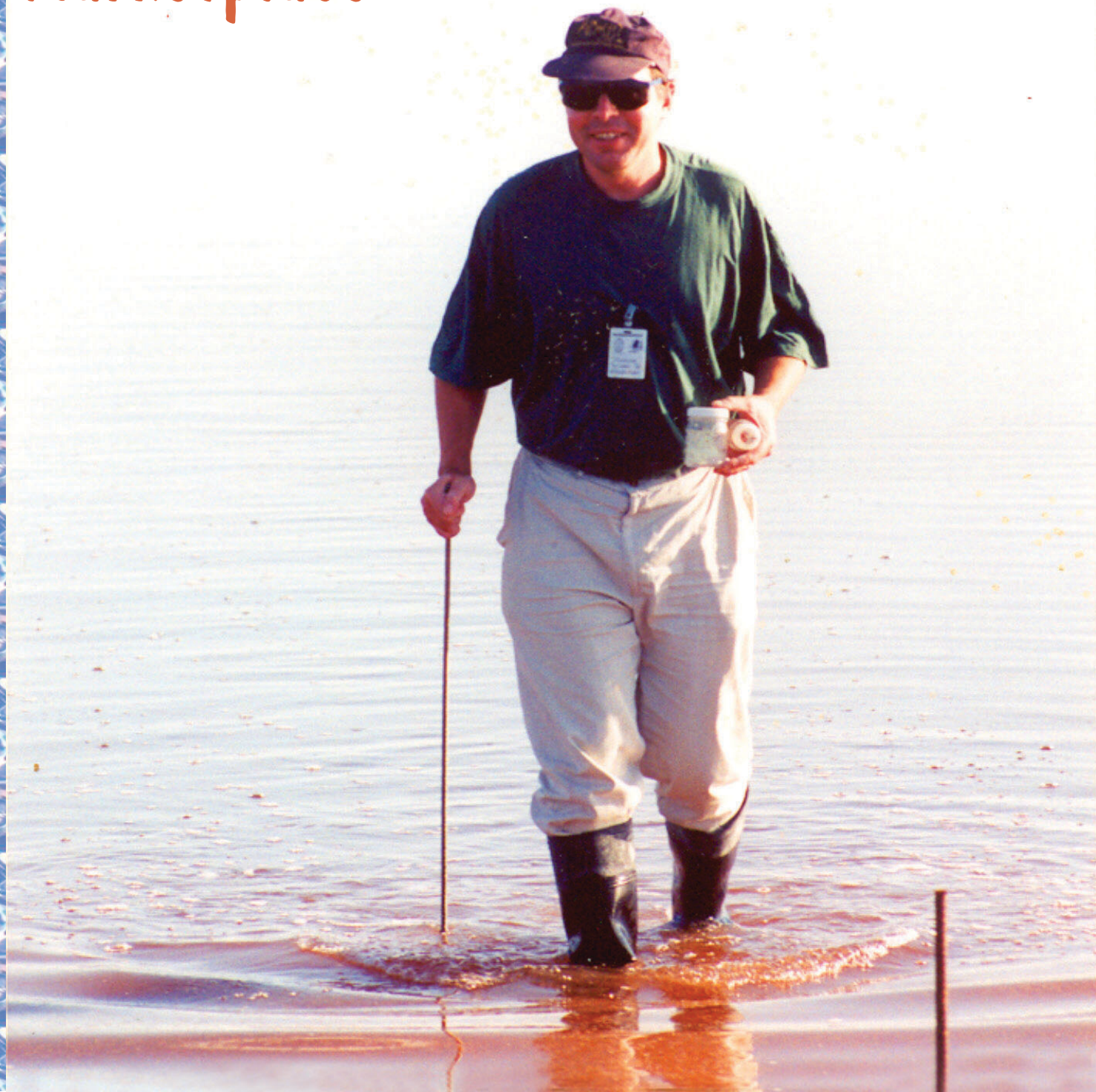
The meeting concluded that the SARS virus has a number of rather unusual characteristics and more detailed research was required for more reliable assessment of the risk of waterborne transmission of the virus. The unusual features include detection of the virus in both faeces and urine of patients for up to 21 days after onset of disease, which is most unusual for respiratory viruses. However, detection was by molecular techniques and the extent to which these viruses are infectious remains to be established. There is no meaningful information on the survival of the virus in sewage or polluted water environments. Another interesting feature of the SARS virus is that it seems to be highly host specific. In other words, contrary to well known other respiratory viruses such as influenza, it infects only humans and no animals or insects. This is rather fortunate since it seems to rule out animal reservoirs and insect vectors.

In view of the many questions about the SARS virus which remain unanswered, the WHO Working Group has embarked on the formulation of a research programme for more detailed assessment of the potential role of water and food in the transmission of this deadly virus that has far-reaching public health and socio-economic implications.

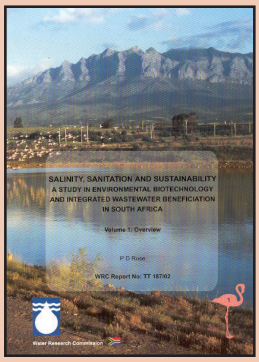
"Obviously, if there is any indication of a meaningful risk for waterborne transmission of the SARS or related viruses, the findings will immediately be applied in the formulation of control strategies," Professor Grabow says.

From the laboratory to the marketplace

Dunaliella is a green, salt-loving micro-alga that revels in hyper-saline water, harsh sunlight and extreme heat. It is also the Ingredient-X in cost-effective biological mass-production of high-value β-carotene - an anti-oxidant that is converted to Vitamin A by the liver. Environmental biotechnologist Peter Rose and his team came up with a process that uses polluted wastewater as a growth medium for this important harvest, reports Catherine Knox. Their initial laboratory work has been scaled up for evaluation as a commercial production process.



Part three of a series of good news water stories taken from Peter Rose's 12-volume report on an integrated WRC-funded project. Professor Rose is the director of Rhodes University's Environmental Biotechnology Unit (EBRU).



In Africa now, a sustainable process is one that pays for itself – this is one of the central tenets of a 10-year Water Research Commission (WRC)-funded research project initiated and led by Peter Rose into the bio-remediation of polluted water.

Rising salinisation caused by industry, agriculture and natural phenomena, poses a profound threat to South Africa's water resources. For Professor Rose, one of the first steps in helping to do something about this situation was re-imagining the threat as an opportunity. He is the head of Rhodes University's Environmental Biotechnology Unit (EBRU) and thanks to his vision, the integrated WRC project has developed biological methods that produce hard commercial benefits at the same time as they effectively de-salinate wastewater.

During the initial project which involved harvesting *Spirulina* as a side-benefit of the biological clean-up job in the meso-saline waste-stabilisation ponds at a tannery near Wellington (reported in *Water Wheel* Jan-Feb 2003), Rose's team of researchers noticed intermittent blooms of β-carotene-producing *Dunaliella* in the hyper-saline compartments of the ponding system.

The growth of *Dunaliella salina* was evaluated in a range of different effluent streams discharged by the tannery and the results were reported by MSc candidate Richard Laubscher in 1992. It transpired that hide soak liquors, generated in the process of rehydrating salt-cured hides, were *Dunaliella*'s preferred growth media. Cultivated in this heavy soup, the algae out-performed cell growth yields in custom-designed inorganic growth media developed specifically for *Dunaliella*. This was a surprising result for a photosynthetic organism apparently only able to grow in sunlight. The algal growth was accompanied by substantial reductions of organic load in the effluent.

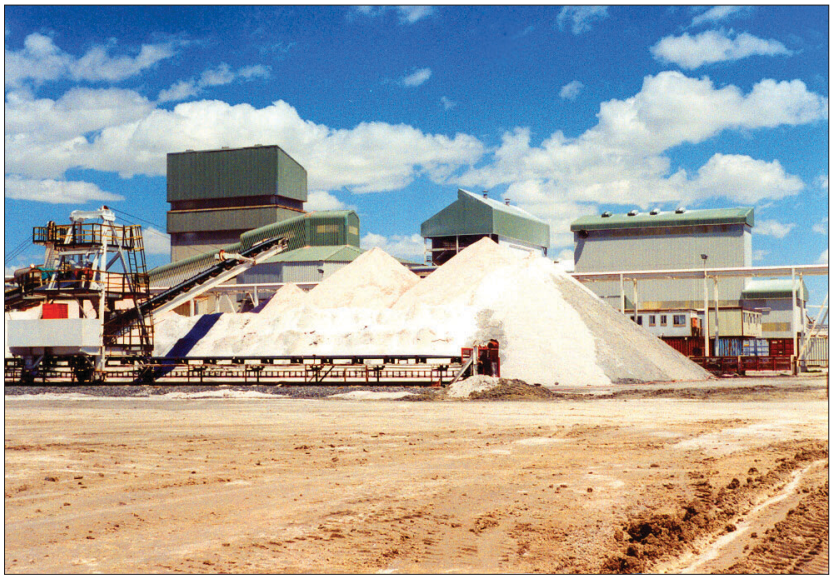
In order to protect itself from fluid loss by osmosis in hyper-saline medium, *Dunaliella* produces glycerol – a phenomenon Rose and his team felt should be investigated as a possible contribution to the performance of the organic hyper-saline high-rate algal pond. The stimulation of microbial activity in the algal-bacterial co-culture could contribute to the efficient break-down of complex organic compounds observed in the treated effluent.

Robin Emmett, another of Rose's MSc students, studied glycerol production by a range of 15 *Dunaliella* species. She showed that the optimal glycerol production in tannery effluent was as much as four times higher than the sustained production reported for inorganic media. A series of flask studies showed that the amino acid glycine, present in high concentrations in hide tissues, was associated with the induction of glycerol release by *Dunaliella* growing in tannery effluent.

But while *Dunaliella* cultures yielded bright green luxuriant growth when cultivated in the

The Dunaliella *high-rate algal pond pilot plant treating saline carbonate brines at Botswana Ash Co, Sua Pan.*

EBRU researcher Richard Laubscher wades out to the collection point in one of the huge shallow evaporation ponds in the soda ash plant at Sua Pan in Botswana.

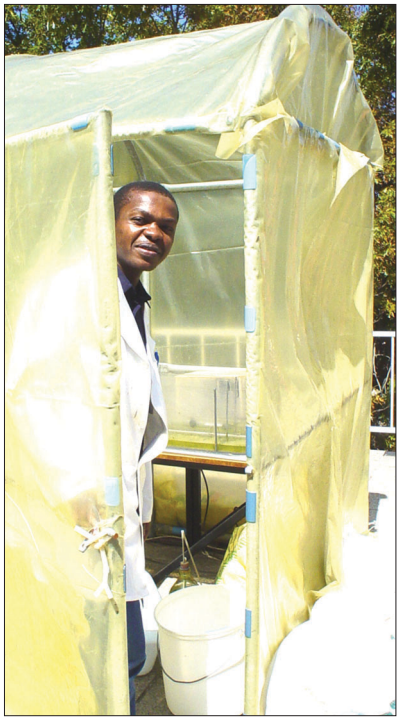


Organic contamination due to algal action threatens the economic viability of soda ash production at Sua Pan.

tannery medium, the downside was that β-carotene production was found to be extremely low under these circumstances. Nevertheless, when cells were transferred to a nitrogen-deficient stress medium, β-carotene production kicked into overdrive with an accumulation of the valuable chemical as high as 14% cell mass.

At this point the research team got another surprise: they found that the higher the organic strength of the original medium, the higher the production of β-carotene when cells fell on hard times in the stress medium.

Experimental studies in the laboratory and at Sua Pan in Botswana made it seem highly likely



In a sun-catching bivouac high on a rooftop at UCT, chemical engineering PhD candidate Njodzi Zizhou is researching the use of the Dunaliella *high-rate algal pond methodology with other carotenoids.*

that a *Dunaliella*-based high-rate algal pond process for treating hyper-saline wastewater was worth scaling up in the field for further evaluation, but this has yet to be done as the EBRU team were focused on their second observation to do with β-carotene production.

They designed a dual-stage process that was patented by the WRC in 1992. This process involves a growth stage where optimal biomass flourished in hyper-saline organic wastewater. Cells from this initial "crop" are separated and transferred to a second stage where the medium is nitrogen-deficient, resulting in cell stress and the consequent production of optimal quantities of β-carotene. The dual stage process offers a "have-your-cake-*and*-eat-it" scenario with

One of the outcomes of the EBRU's Dunaliella *work is a collaboration with Professor Sue Harrison of UCT's Department of Chemical Engineering – her group is investigating other uses for the technology.*

maximum cell growth and maximum β-carotene production. Detailed follow-up studies were carried out by three of Rose's PhD students – Trevor Phillips, Lesley Horne Phillips and Malcolm Logie.

Trevor Phillips' work showed that high light intensity was an essential co-requisite for optimal production.

After graduating, Phillips went on to work at Sasol Co who funded the scaling up of the project in facilities at Sasolburg. Studies at this stage included the evaluation of cell-harvesting techniques. The dual stage process was then subjected to extensive and detailed evaluation in pilot-scale studies in a custom-built plant in Upington.

The CSIR has taken over ongoing research into the commercialisation of this method of producing β-carotene. Raj Laloo, another of Peter Rose's ex-student heads the project under the CSIR's Environmental Biotechnology programme manager Dusty Gardiner.

SUGAR IN THE SALT - UNIQUE COMBINATIONS FOUND IN *DUNALIELLA* CULTURES

Evaporation ponds used for the production of salt, soda ash and other evaporates are particularly susceptible to blooms of salt-loving (halophilic) algae and bacteria and this often results in high levels of organic contamination of the final product.

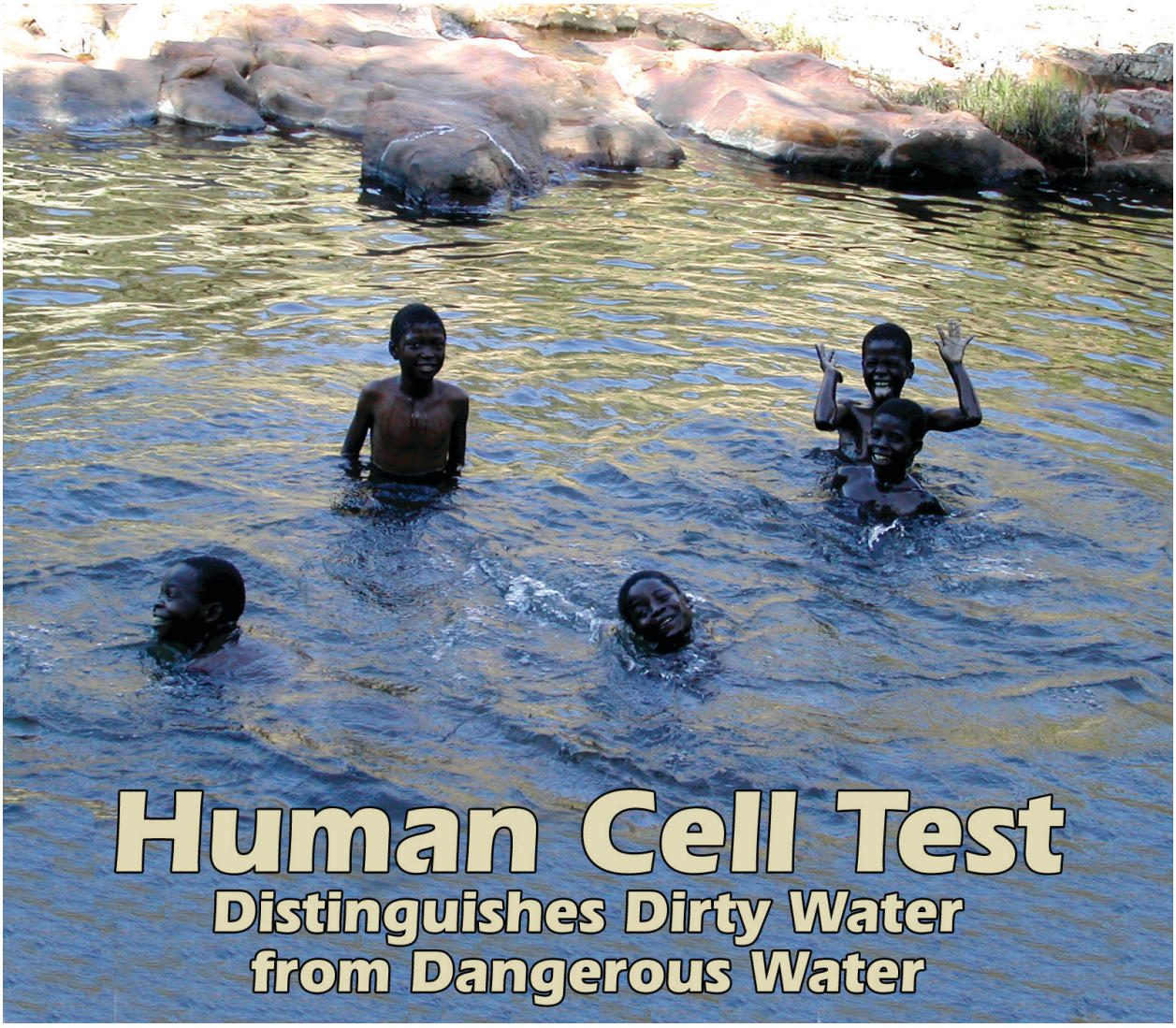
In 1991 Soda Ash Botswana (Pty) Ltd set up a solar evaporite production facility at Sua Pan in the Makgadikgadi region of central Botswana. Shortly afterwards, an accumulation of high levels of organic materials started to contaminate their final product. And so it happened that Prof Peter Rose's environmental biotechnology group got the chance to evaluate the performance of the *Dunaliella* high-rate algal pond in the treatment of solar evaporate brines.

Preliminary evaporation pond ecology studies showed that *Dunaliella* was involved the process that was probably driven by the high levels of sulphide, phosphates and nitrates in the brine pumped into the evaporation ponds from wells in the pan. The combination of hyper-saline carbonate brines, blinding sunlight and searing temperatures acted as stress-factors on *Dunaliella* that reacted by producing large quantities of extracellular polymeric substances.

Patricia Masemola, one of Rose's MSc students, reported in 2000 on nuclear magnetic resonance studies which confirmed that *Dunaliella* was implicated in the contamination of soda ash at Sua Pan. Unique sugar combinations were found in the exopolysaccharide produced by *Dunaliella* cultures in laboratory flasks, pond brines and in the final soda ash produced.

The study included the evaluation of a *Dunaliella* high-rate algal pond that could be used to strip both nutrients and contaminating organics from the evaporation ponding process. Reducing nitrogen and phosphate levels was shown to be an effective way of manipulating microbial growth in the system. The growth of *Dunaliella* was substantially inhibited in the brines that had been treated in the high-rate pond.
"In other words," says Prof Rose, "where *Dunaliella* grew in an uncontrolled manner the organics problem resulted. We found that if we used the *Dunaliella* ponding process to remove the growth nutrients ahead of this stage in the system, then downstream growth was prevented. The β-carotene recovery was a high-value spin off of this treatment operation."

The pilot plant study has not yet been followed up with the full-scale application, but it was shown that the process could play an important role in the management of algal production in saline wastewater impoundments, specially where solar evaporates are to be produced, either as a product or for the linear removal of contaminating salts from the water system.



Human Cell Test
Distinguishes Dirty Water from Dangerous Water

The Human Cell Test (HCT), based on assays originally developed by the pharmaceutical industry to test the effect of drugs on the human body, is now being used in South Africa to test water for toxic substances.

Whereas other aquatic toxicity tests are aimed at finding pollutants that are harmful to the environment, the HCT targets toxic substances that could adversely affect human health.

How? "We look for a reaction when a water sample comes into contact with human leukocytic (white blood) cells. These cells are in contact with everything that goes into the body. Drinking water goes through the bloodstream so it would come into contact with these cells. If these cells cannot tolerate what is in the water, it is unlikely that a person would," explains Dr Mike Whitcutt, director of research for the Highveld Biological Association, a Section 21 company appointed by the Water Research Commission (WRC) to take the HCT from theory to practical application.

TOXICITY

Dr Whitcutt and his team have used the Human Cell Test in a pilot project on the East Rand, covering a large

Dr Mike Whitcutt, Director of Research for the Highveld Biological Association

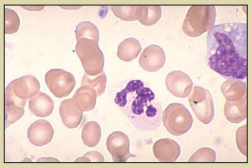
area from Soweto to Springs and down to Heidelberg and Vereeniging. They have identified two different types of toxicity in the water: one from very harmful substances, such as mercury or cyanide, and another from toxic overloads of substances, such as sulphates, which are tolerable in reasonable amounts but not in excess.

These toxic substances, says Dr Whitcutt, come from industry and homes in the area. "We have found that water coming through the taps is absolutely safe but the water that is released into the environment and seeps into the ground often contains dangerous agents, which could cause chronic illness." And there is no need for direct human contact as the contaminated water is sometimes used for irrigation and feeding of domestic animals.

Using the Human Cell Test, toxicity can be detected before it becomes a problem. When a pipe burst and wastewater flowed into environmental water sources on the East Rand last year, the Highveld Biological Association was called to do the HCT and discovered that the water in some recreational areas was completely toxic and unsafe. "Just a single HCT confirmed that there was a problem. The area was then mapped out and treated by the local authority. A month later, the water was safe again," says Dr Whitcutt.

COSTS

What's the cost? "It doesn't involve increased expenditure in terms of analysis, it is just more focused expenditure, which is ultimately profitable for everyone," continues Dr Whitcutt, pointing out that the HCT is particularly useful for checking water used for industrial purposes." An evaluation of the test would tell the organisation exactly what problematic substance it is discharging. Thereafter the offensive effluent could be monitored by simple chemical analysis."



Examples of leucocytes

HOW DOES THE HUMAN CELL TEST WORK?

- Water containing toxins is added to about 30 000 leukocytic (white blood) cells (stabilised K-562 cells).
- The water reacts with the cells for 18 hours during which it impairs the oxidative ability (central energy pathways) of the cells.
- After 18 hours, an indicator reagent (MTT) is added and left to react with the cells for three hours. Depending on the oxidative ability left in the cells, the MTT would change from yellow to blue.
- After three hours, a detergent is added to "freeze" the reaction.
- The colour of the solution is analysed spectrophotometrically to determine how far the colour reaction has progressed from yellow to blue.
- The results indicate the extent to which the oxidative ability of the cells was impaired – an indication of cytotoxicity.

The relatively low cost of the HCT allows concerned members of the public to take samples of the polluted water to a laboratory to determine the quality of drinking water

Annatjie Moolman, head of the WRC's Water and Health domain and research manager, says the research team has calculated the cost of the HCT at about R300 per sample (versus R1 800 per sample for a "full" probability test). The research team also finds that the turnaround time for the HCT is only two days. This makes it ideal as a screening test that could be used as a part of a suite of analyses in the identification of problems that need further investigation.

The relatively low cost of the HCT allows NGOs and concerned members of the public to take samples of the polluted water to a laboratory to determine the quality of drinking water. It could also be used by government, water utilities and catchment management agencies to test water over vast geographic areas. The authorities would then be able to quickly identify problem areas, allocate funds where they are most needed (for detailed analysis) and, ultimately, protect the health of the people who drink the water.

INNOVATIVE NEW IRRIGATION WATER MANAGEMENT TOOL ENHANCES PRODUCTION EFFICIENCY

With benefits at field, farm and irrigation scheme level

The level of subsidisation of agriculture in South Africa is one of the lowest in the world compared to other countries. Indirect government support to commercial farmers, such as through publicly-funded research and extension, has moreover declined in recent years. This means that South African farmers, like those in other developing countries, face greater challenges to raise the efficiency of their operations, which they must do if they – and the economies of their respective countries – are to prosper against the backdrop of a globalised market.

Water management, mainly in respect of irrigation practice, is one of the most critical determinants of economically efficient crop production, particularly in a seasonally dry country like South Africa. It is for this reason that the development of an integrated computerised information system for the management of irrigation water – at field, farm and irrigation scheme level – has been undertaken under the leadership of South Africa's Water Research Commission (WRC).

As with any other research, however, the irrigation water management model must be tested in practice and then transferred to those who are able to use it, if the ingenuity, effort and money that went into its development are to have the desired output at producer level. Field tests have been conducted at two irrigation schemes, and the WRC is now gearing itself up for a major technology transfer project, to commence in 2004.

The opportunity also arises for the integrated information system on irrigation water management to be used by the advisory bureaus of co-operatives or agribusinesses as part

of the service they provide to farmers. Furthermore, there is an opportunity for the establishment of private management consultancies – a relatively new service industry with potential for entrepreneurs skilled in this discipline. Their function would be to render water advisory services to irrigation farmers whose skills may be orientated more towards field crop production than to computers, and to irrigation schemes which may need some technical guidance in adopting the latest computer-aided technologies.

Water management is one of the most critical determinants of economically efficient crop production, particularly in a seasonally dry country like South Africa

The chairman of the steering committee that assisted the project team in integrating three high-tech water management models in such a way that they can be applied to optimal effect in irrigation schemes, Dr Gerhard Backeberg of the WRC, says that, initially, the model will perforce have application at the commercial farming level. Once it has been widely adopted by users, and the necessary infrastructure of practitioners and advisers has been built up, it will be possible to give attention to extending the system to the developing farmer level.

The basic requirement underlying the project was "that water resources be used productively and greater efforts be made to increase productivity growth and thereby the competitiveness of agriculture," emphasises Dr Backeberg.

The three computer models which were integrated into a workable irrigation-orientated Geographic Information System (GIS) are the **SWB**, **RiskMan** and **WAS** models. The purpose and functions of each model are briefly as follows:

SWB – SOIL WATER BALANCE MODEL

Soil Water Balance is a real-time irrigation scheduling computer model and was developed as an irrigation scheduling tool to help crop producers to save water, energy and fertiliser. It simulates the crop growth and soil water balance on field scale for the purpose of providing recommendations on irrigation timing and amounts. For research purposes at this stage, it can also calculate the salt balance.

When used as an irrigation scheduling tool, weather and irrigation data need to be entered into the model on a daily basis. SWB can also be used for scenario modelling and as a planning tool.

SWB can be run in three modes:

- **Irrigation mode** – the basic mode – for real-time use by farmers whose field and soil input data have previously been set up by irrigation consultants;
- **Consultant mode**, for use by consultants and by farmers able to run SWB independently;
- **Research mode** – the most complex mode – which is not recommended for consultants and farmers.

The extent of SWB's applications is illustrated by the fact that, among other capabilities, it takes into account no fewer than 11 layers in its soil profiling function, and that when applied to hedgerow-type crops it calculates canopy radiation interception, potential evaporation and transpiration and the limitation on supply of water to the soil surface or plant root system.

Mechanistic models such as SWB have to date been largely out of reach of irrigators in the past due to the specialist knowledge required to run them. The high management cost has been drastically reduced by packaging SWB in an extremely user-friendly format which eliminates the need for detailed understanding of the intricacies of the soil-plant-atmosphere continuum.

The main benefit of the SWB model lies in the accuracy that it makes possible in estimating crop water requirements.

THE RISK MANAGEMENT (RISKMAN) MODEL

The function of the RiskMan computer model is to enable or to assist farmers on irrigation schemes in their farm planning at enterprise or whole-farm level – assessing the various factors present in order make decisions with the best economic effect. It weighs up alternative actions in order to reduce exposure to unfavourable financial outcomes, and it provides reliable and relevant information on which decisions can be based. It supports, but does not replace, the decision-maker in risk management.

Amongst the factors that it takes into account are production, price, irrigation quantities, interest rate variability and hail damage – and

even the user's attitude toward risk, namely risk-seeking, risk-neutral or risk-averse.

Amongst the users to which RiskMan lends itself are:

- **Consultants**, to advise farmers according to their circumstances and needs;
- **Water User Associations** on irrigation schemes, to advise farmers;
- **Various agribusinesses** that provide inputs and have an interest in the welfare of the farming community, especially regarding the risks associated with various activities or enterprises;
- **Small-scale producers**;
- **Researchers and Extension Officers** in Provincial Departments of Agriculture;
- **Universities and colleges**, to demonstrate theoretical principles and to develop problem-solving skills.

Amongst the many benefits of RiskMan are the simulation of risks and definition of variables, including the effects of day-to-day changes such as variable interest rates, which are inserted into the program. Alternative production plans, including alternative crop rotation plans, are evaluated as routine.

WAS – WATER ADMINISTRATION SYSTEM MODEL

The Water Administration System (WAS) is a database for use as a management tool by irrigation schemes in managing their water accounts and their water supply to clients through canal networks, pipelines and rivers. It replaces the old manual water distribution system commonly used on government irrigation schemes.

WAS uses four modules – the Administration module, the Water Request module, the Water Release module and the Water Accounts module. The different modules are fully integrated, which makes it possible to cross-reference relevant information.

Among its many capabilities, WAS calculates water releases for canal networks and river systems, taking lag times and various water losses into account. All data are archived on a single database, enabling rapid accessing – only one file is used (which, as with all computerised data, must be backed up as protection against lost data). Enhanced financial control and the minimization of water losses through an improved water distribution system are further important features.

GEOGRAPHIC INFORMATION SYSTEM (GIS)

The major advance that the project team has now made under the auspices of the Water Research Commission – and the object of the important technology transfer project for which the WRC is gearing up – is the integration and practical implementation of the SWB, RiskMan and WAS databases by means of a purpose-built Geographic Information System (GIS).

The application area of this integrated management tool is to display relevant information from the SWB, RiskMan and WAS databases on irrigation scheme maps.

The main benefit of this is that information displayed spatially on a map gives the user a much better understanding of the available data and provides him with a tool to analyse the data in various ways. It is much easier to do one's planning with the aid of a map and to communicate information to others from this base.

The major advance that the project team has now made under the auspices of the Water Research Commission is the integration and practical implementation of the SWB, RiskMan and WAS databases by means of a purpose-built Geographic Information System (GIS)

When linked with strategically placed weather stations in the irrigation scheme, the GIS system is kept up to the minute in respect of current environmental conditions and thus of the water needs of individual farmers – whose soil types and current crops are known to it via the basic models integrated into the GIS.

In formal terms, this GIS, by integrating the SWB, RiskMan and WAS computer models, provides an irrigation system with an extensive suite of tools to improve irrigation scheme management, minimise water distribution losses, deliver an irrigation scheduling service to farmers and provide a tool that can be used by farmers to do on-farm planning, make the most economic decisions and minimise risk.

FIELD TESTING

It is of course necessary for computer models to be tested in the field before claims can be made that they are successful. For this purpose, the Loskop irrigation scheme in Mpumalanga Province and the Orange-Riet irrigation scheme in the Free State Province were selected for implementation of the integrated information system.

Automatic weather stations were successfully installed at both schemes, and can be remotely accessed by cellphone.

The project has demonstrated that a visual tool such as the GIS program is easily accepted by irrigation schemes and has great potential in managing the schemes and in communicating information

The WRC reports that although the project team did not successfully implement all modules of the integrated information system on both irrigation schemes, it managed to transfer new technology to both schemes, which will definitely grow and make a difference to their daily operations.

Some of the technologies are new and it will take some time before the majority of farmers accept them. The integrated information system cannot be forced onto given irrigation schemes, the report notes – but the project has demonstrated that a visual tool such as the GIS program is easily accepted by irrigation schemes and has great potential in managing the schemes and in communicating information.

The current project has shown that the implementation of the integrated system at two very similar irrigation schemes produced different outcomes. What is important to one scheme is not necessarily important to another. A given irrigation scheme might not be ready to implement the complete system, but can take advantage of parts of it.

It is therefore important to implement the system in stages and in manageable bits. Factors that influence the success rate include the availability of resources such as computer hardware and personnel.

The WRC reports, however, that once users have started using a model successfully, they seldom go back to the old methods.

The report recommends that the integrated information system should be introduced to other irrigation schemes and water management offices in South Africa.

"We have some of the tools to provide decision support to commercial farmers," Dr Backeberg says. "The objective of the Water Research Commission in the coming year is to market our research output – to inform farmers, irrigation scheme managers and consultants what is available to them at field, farm and scheme level. The subsidies on agriculture in the EU, US and elsewhere put pressure on South African farmers, and at present their best recourse is to greatly enhance their productivity, competitiveness and profitability. Our integrated information system for irrigation water management is an important tool in that direction, and we invite farmers and their advisers in South African agriculture to take a close look at what it offers."

Contact the following persons for specialist advice:

The Integrated Information System and Water Administration System:
Dr Nico Benadè:
Tel: 012-548 1005
E-mail: nicob@mweb.co.za
Mobile: 082 845 7255

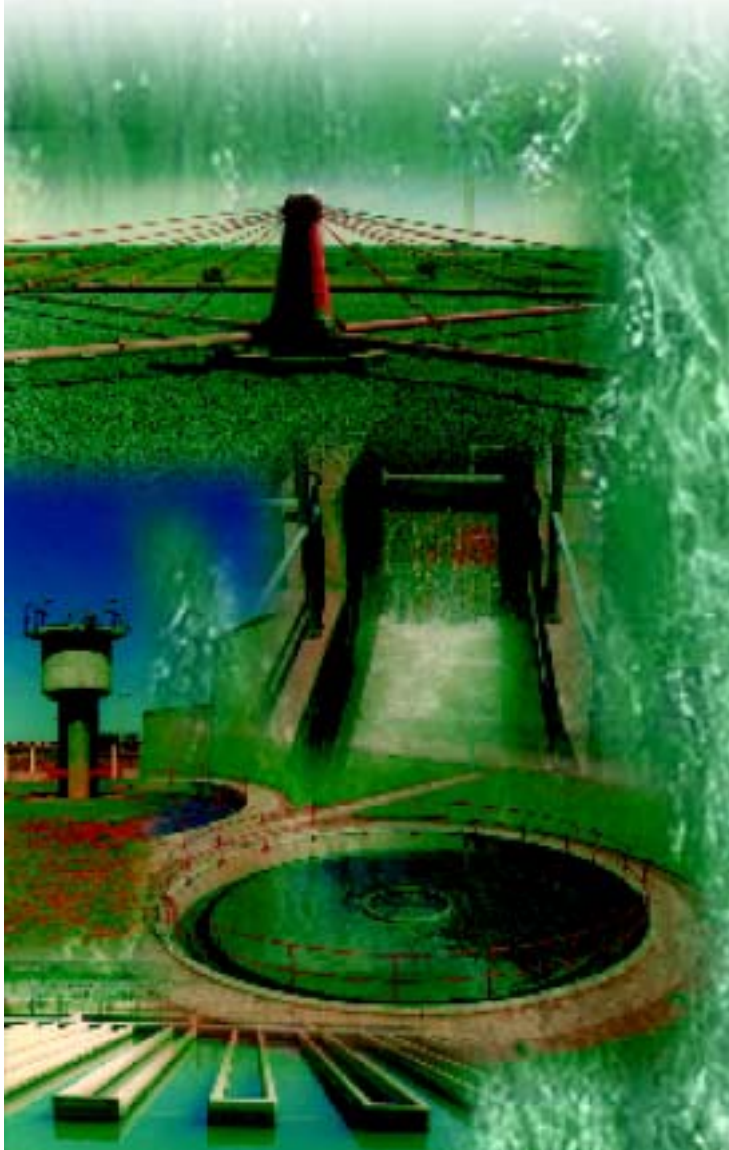
The Risk Management Model:
Prof Klopper Oosthuizen
Tel: 051-401 2390
E-mail: oosthlk@sci.uovs.ac.za
Mobile: 082 77 888 22
or
Prof Andre Meiring:
Tel: 058-871 3700
Mobile: 082 8249995
E-mail: meiringa@yebo.co.za

The Soil Water Balance Model:
Prof John Annandale:
Tel: 012-420 3223
E-mail:
jannanda@postino.up.ac.za
Mobile: 082 374 3706
or
Dr Martin Steyn
Tel: 012-420 4585
E-mail:
jmsteyn@postino.up.ac.za

Copies of the WRC Report No 946/1/02 titled ***The Development of an Integrated Information System for Irrigation Water Management Using the WAS, SWB and RiskMan Computer Models*** are also available from the WRC, Private Bag X03, Gezina 0031

TECHNIKON PRETORIA

Technikon Pretoria
Short Courses



OPTIMIZATION OF POTABLE WATER PURIFICATION PLANTS

Cost: R 3 900 per candidate (R3 600 if paid by 10 October 2003)

Dates: 10 to 14 November 2003

Course contents:

Optimization of the following unit processes:
- Pretreatment
- Chemical dosing
- Coagulation
- Flocculation
- Settling
- Filtration
- Disinfection
- Stabilization

OPERATION OF ACTIVATED SLUDGE PLANTS

Cost: R 3 900 per candidate (R3 600 if paid by 10 October 2003)

Dates: 3 to 7 November 2003

Course contents:

- Sources of wastewater
- Composition of wastewater
- Process description and microbiology
- Types of activated sludge processes (conventional; extended aeration; nutrient removal, etc.)
- Operational aspects:
  - Control of dissolved oxygen
  - Sludge age, etc.
- Operational problems:
  - Bulking
  - Scum
  - Rising sludge
  - Sludge
- Laboratory support
- Disinfection

BASIC CHEMICAL ANALYSIS OF POTABLE WATER

Cost: R4 600 per candidate (R4 200 if paid by 25 April 2003)

Dates: 19 to 23 May 2003

Course contents:

- Review of chemical terms and principles
- Introduction to laboratory techniques
- Sampling
- Data processing
- Chemical calculations
- Determination of physical parameters
- Principles of titration
- Alkalinity (OH^-; CO_3^{2-}; HCO_3^-)
- Chloride (Mohr)
- Sulphate
- Hardness (Ca^{2+}, Mg^{2+}, total)
- Basics of colorimetry / spectrophotometry
- Phosphorous (PO_4^{3-}, Total phosphate)
- Fluoride
- Nitrate
- Colour
- Chorophyll A
- Chlorine (Free chlorine, total chlorine)
- Basics of atomic absorption spectrometry
- Determination of trace elements
- Basics of ion-chromatography
- Laboratory flocculation tests (Jar tests)
- Interpretation of results

Technikon Pretoria Department of Water Care

Department of Water Care
2003

BASIC CHEMICAL ANALYSIS OF WASTEWATER AND INDUSTRIAL EFFLUENTS

Cost: R6 400 per candidate (R6 000 if paid by 10 October 2003)

Dates: 3 to 12 November 2003 ($1\frac{1}{2}$ weeks)

Course contents:

- Review of chemical terms and principles
- Introduction to laboratory techniques
- Sampling
- Data processing
- Chemical calculations
- Determination of physical parameters
- Principles of titration
- Alkalinity procedures
- Chloride (Mohr)
- Sulphate
- COD
- OA
- Settleable solids / suspended solids / total solids
- SVI (MLSS)
- Principles of colorimetry / spectrophotometry
- Phosphorous (PO_4^{3-}; Total phosphate)
- Nitrite-nitrogen
- Chlorine (Free chlorine, total chlorine)
- Kjeldahl digestions
- NH_3 (NH_4^+)
- TKN

WATER QUALITY MANAGEMENT IN THE NEW MILLENNIUM - QUO VADIS

Cost: R 5 500 per candidate (R5 000 if paid by 20 April 2003 and 24 October 2003respectively)

Dates: 13 to 16 May 2003, 18 to 21 November 2003

Course contents:

- Pollution Control versus Water Quality Management
- What a Water Quality Manager needs to know about the:
  - National Water Act
  - National Environmental Act
  - Minerals Act
- Licensing Procedure
- Reserve Determination
- Integrated Water Resource Management
- Catchment Management Agencies
- Resource Directed Measures
- Background to Catchment Management
- Basic Water Quality Chemistry
- Discussion on a selection of water quality related matters
- Case Studies

OPERATION OF BIOLOGICAL FILTERS

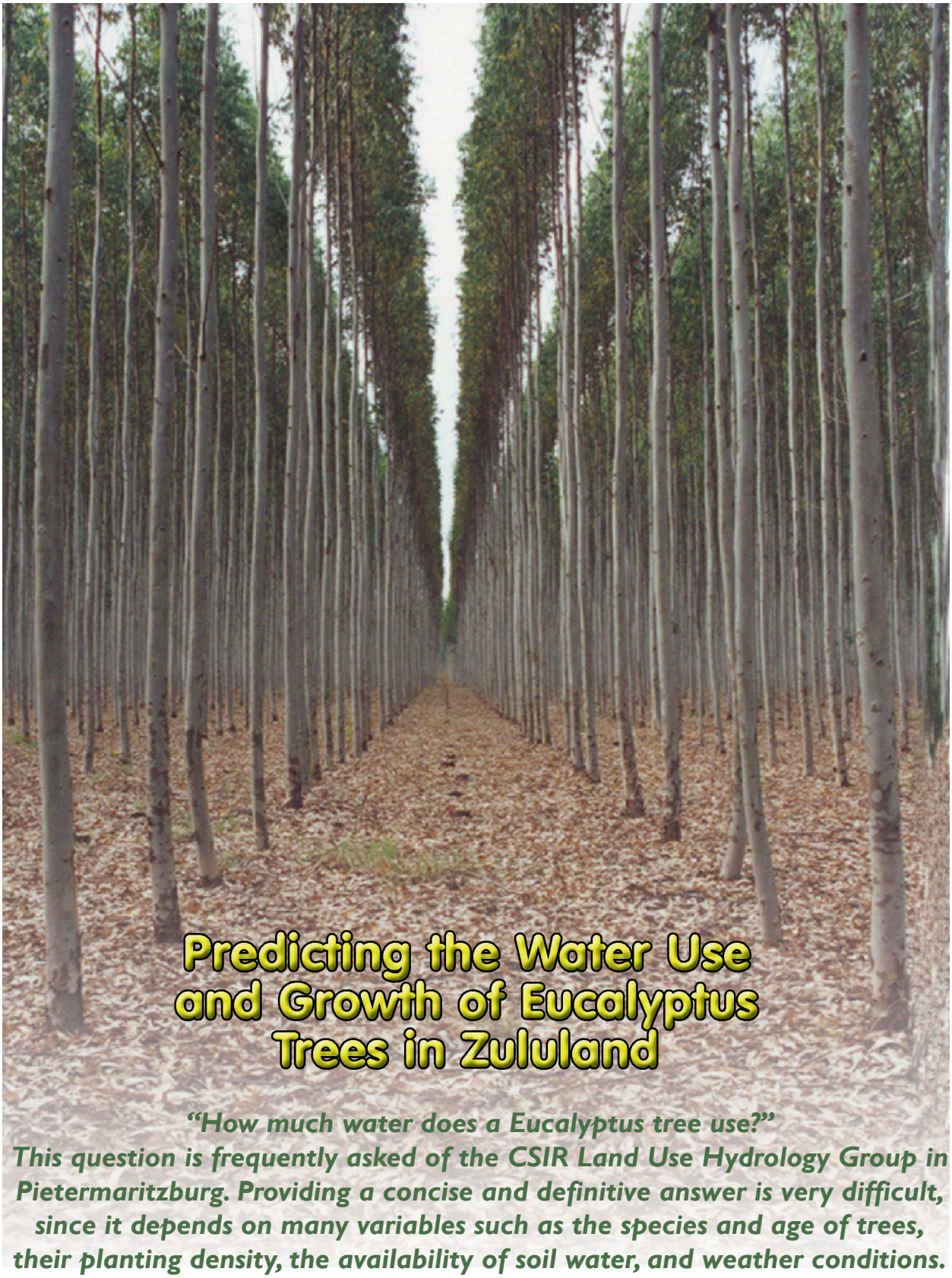
Cost: R 4 700 per candidate

Dates: 19- 23 May 2003

Course contents:

- Sources of wastewater
- Composition of wastewater
- Process description and microbiology
- Types of biological filters
- Operational aspects: (Loading rates, recycle rates, etc.)
- Operational problems
- Disinfection
- Anaerobic digestion of waste sludge

CONTACT DETAILS: Ms Zicki Joubert, Tel: (012) 318-6232 Fax: (012) 318-6233 E-mail:zicki@techpta.ac.za



Predicting the Water Use and Growth of Eucalyptus Trees in Zululand

"How much water does a Eucalyptus tree use?"
This question is frequently asked of the CSIR Land Use Hydrology Group in Pietermaritzburg. Providing a concise and definitive answer is very difficult, since it depends on many variables such as the species and age of trees, their planting density, the availability of soil water, and weather conditions. A similar question might be "how much does a man drink?", and we all know that this is a highly variable quantity!

Questions on tree water use reflect the widespread and longstanding concern in South Africa over the effects of forest plantations on water availability. Our forests are necessarily concentrated in the higher rainfall areas of the country, which also provide a major proportion of the total quantity of water in our streams and rivers. Experience over the past century has shown that streamflows decline when catchments are converted from grassland or Fynbos to forest plantation. This has much to do with the fact that the seasonally dormant grasses or Fynbos are replaced by evergreen trees that maintain a high rate of transpiration throughout the year. Eucalypts are generally perceived to be particularly thirsty trees. This view may have been shaped by an earlier controversy over *Eucalyptus* plantings in India, but is supported locally by the extraordinary vigour of these trees, their known ability to extend their roots to great depths, and the speed with which they reduce stream flows and groundwater supplies.

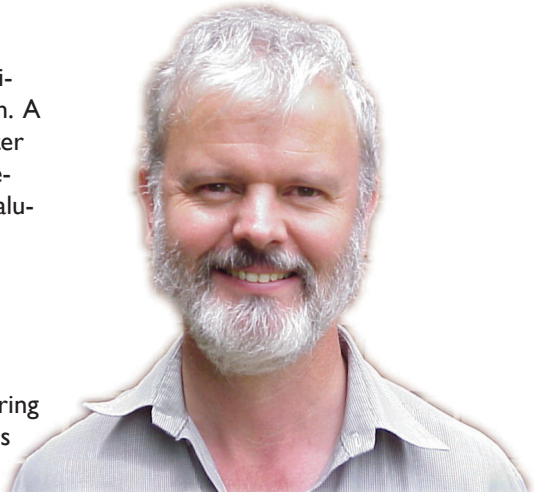
Given the wide variety of tree species and growing conditions in South Africa, it is important to get better information on the impacts of forest plantations on water resources. However, it is also important to take into account the productivity of forest plantations, and the overall economic and productive efficiency of water use. Forest plantations are efficient producers of biomass, and sustain an enormous wood products industry. Water used by forest plantations may be more efficient than for some other land-use or industrial purpose further downstream. Catchment Management Agencies will be tasked in future with regulating water resources in 19 different Water Management Areas around the country. Efficiency of water use will become an increasingly important criterion in deciding on optimum catchment water allocation. A clear picture of growth **and** water use of forest plantations is therefore required to assist in this evaluation.

MEASURING TRANSPIRATION

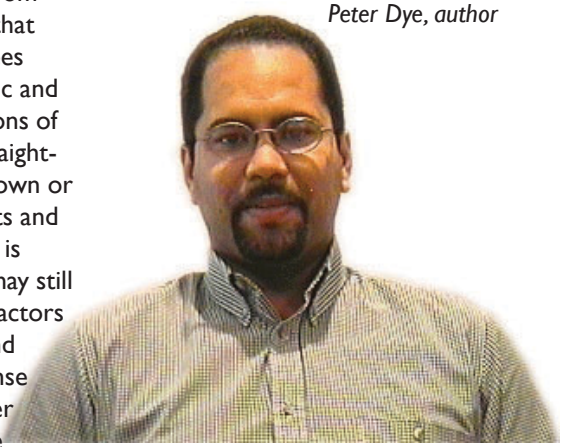
How does one set about measuring transpiration and growth in trees and forests? The answer is with great difficulty! Evaporation from leaves is an invisible process that varies continuously as the trees adapt to changing atmospheric and soil conditions. Even predictions of tree growth rates are not straightforward. Growth may slow down or stop during and after droughts and dry periods. When soil water is ample for the trees, growth may still be strongly affected by such factors as soil fertility, tree density and weather conditions. In response to these complexities, forester researchers resort to the use of computer models that keep track of changing growing conditions, often on a daily or monthly basis.

PC MODEL

One recently developed model (3-PG; Physiological Principles of Predicting Growth) appears to have struck the right balance between simplicity and realism, and shows great promise as a useful PC-based tool for predicting water use and growth in South African forest plantations. A recently completed Water Research Commission report (K5/1194) describes a project in which the 3-PG model was evaluated on 12 diverse clonal *Eucalyptus* stands on Mondi Forest estates in the Kwambonambi and Hluhluwe districts of Zululand. The purpose of the project was to test the practicality of setting up 3-PG for a range of tree stands over a short space of time, and also to evaluate the accu-



Peter Dye, author



Shayne Jacobs, author

Dave Drew (author) measuring the leaf area of Eucalyptus stands with an instrument which measures light interception beneath the tree canopy

racy of the model predictions. An important additional objective was to test the usefulness of satellite remote-sensing data in spatial applications of 3-PG. Efforts were focussed on predicting the total leaf area of forest stands, since this is a very important feature of forests that influences the rate of growth, and transpiration of water.

Over a 12-month measurement period, the research team recorded various properties of the soil, trees and weather conditions in each stand. Changes in stem, branch and leaf biomass were calculated from measurements of tree diameters and heights, as well as from field measurements of stem, branch and leaf mass of a sample of harvested trees. The leaf area of the whole stand was estimated using an instrument that compares sunlight measured above and below the forest canopy. The loss of old leaves from the canopy was recorded in collection trays sited in random positions on the forest floor. Tree transpiration rates were measured with the heat pulse velocity technique, which provides information on the flow of sap through the sapwood portion of the tree trunk. The availability of soil water to the trees was estimated at intervals during the dry winter months. The tree physiological technique used for this purpose requires measurements to be performed on leaves before dawn, when the trees have had an entire night to reach equilibrium with the water content of the soil. Two weather stations and several additional rain gauges were used to gather information on those weather conditions that have an effect on transpiration rates.

All available field information was used to set up the model to predict monthly growth and water use for each stand. The modelled annual growth increment was then compared to the measured growth difference after 12 months, while the modelled monthly water use rates were compared to observed sap flow measurements.

RESULTS

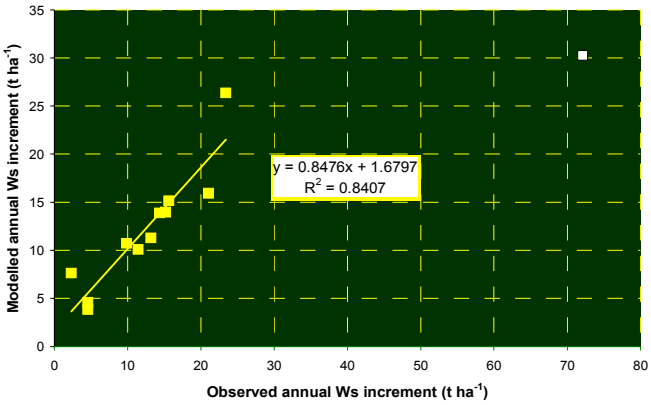
3-PG yielded good predictions for 11 of the 12 stands of trees. The one exception was a stand of trees that showed an exceptionally high growth rate and also very high leaf areas. These trees were known to have easy access to a shallow water table, and may therefore have adapted physiologically to this situation.

Landsat imagery was purchased for two periods that coincided with leaf harvesting in the field. The

MEASURING SAP FLOW IN TREES

The heat pulse technique was used to measure the flow of sap in the sapwood of the tree

Plants need to take up soil water and transport it to the leaves where it is transpired through microscopic pores called stomata. In trees, this transport of water (sap) occurs in the outer, sapwood part of the stem. The older, inner part of the stem is called heartwood, and is blocked by resin-like substances that prevent the flow of water. The heat pulse velocity method allows one to measure the rate of sap movement in the sapwood. A metal probe is inserted into the wood and electronically regulated to briefly heat up at specified intervals during the day. This heat is absorbed by the wood and sap close to the probe. A second type of heat-sensing probe is implanted a fixed distance above the heater probe. An attached data logger then records the time it takes for the pulse of heat to be transported by the moving sap over the known distance to the sensor probe. The faster the rate of water use by the trees, the quicker the sap flow and the shorter the time it takes for the pulse of heat to be registered by the sensor probes. Various other sapwood characteristics are taken into account to permit calculation of the total flow of water through the tree.



The agreement between observed and model predicted growth increment in the twelve Eucalyptus stands

Landsat imagery of the Hluhluwe district showing the location of six Eucalyptus stands

exact position of the experimental stands was located on these images. The spectral properties recorded at these precise points were then analysed and correlated to the observed measurements of leaf area. These correlations proved to be disappointingly poor, indicating that we need to continue estimating leaf areas at ground level for the foreseeable future.

The project was successful in demonstrating that the 3-PG model can be set up relatively easily to produce realistic predictions of growth and water use in a wide range of tree stands. A current project funded by the Innovation Fund is extending the use of the 3-PG model to all the major forestry species in South Africa, and aims at providing the forestry industry with useful decision support tools to improve predictions of tree growth and water use throughout the forestry regions of South Africa.

HOW CAN ONE DETERMINE IF A TREE IS WATER-STRESSED?

The Scholander pressure chamber

One method involves measurement of the water tension within the conducting plant tissue using a device called a Scholander pressure chamber. As trees transpire during daylight hours, the water within the conducting cells of the roots, stem and branches comes under tension, behaving somewhat like a stretched rubber band. During the night when transpiration stops, the tree continues to absorb soil water and is therefore able to release this tension. If there is insufficient soil water for this equilibration process, then the tension may be only partly relieved. One can measure how complete this equilibrium process has been by cutting a leaf from the tree just before dawn. If the sap is still under tension, it withdraws away from the cut surface back into the leaf tissue. By applying a counter pressure to the leaf suspended in a sealed pressure chamber with the stalk protruding through a rubber bung, one can measure how much pressure is required to push the sap out again to the cut surface. The greater the shortage of soil water, the greater the required pressure to counteract the sap tension in the leaf. Some problems encountered in our use of this technique included:

- Getting out of bed early enough in the morning!
- Finding sites in the pre-dawn darkness. It is often difficult to navigate around forestry estates even during the daytime.
- Obtaining leaves from tall Eucalyptus canopies. We resorted to using a catapult to knock down leaves. Finding these leaves required following their descent to the ground with torches!

Waste Minimisation Makes Good Business Sense at Berg River Textiles

Berg River Textiles is a medium-sized textile factory situated in Paarl, Cape Town. The company is part of the Frame Textile Group, and has been in operation since 1948. Berg River Textiles first became involved in waste minimisation initiatives, when two staff members participated in a waste minimisation auditor-training course in 2002 funded by the Danida Cleaner Textile Production Project. During this course, the participants were given the necessary tools to make changes within their companies to reduce water, energy and chemical use; to reduce emissions to the environment; and to save their company money.

"It is all about becoming aware", says Juan Laubscher, Total Quality Manufacturing Manager of Berg River Textiles. "We have made significant savings just through raising awareness in our company. To date, we have saved 1% of our annual turnover, with a payback period of days!".

Prior to 2003, Juan Laubscher was the Factory Manager at Berg River Textiles. Once the company started to realise the benefits of implementing and maintaining a waste minimisation programme, a new position was created for him as a Total Quality Manufacture Manager.

"We have made significant savings just through raising awareness in our company. To date, we have saved 1% of our annual turnover, with a payback period of days!"

This new responsibility put him in charge of managing and monitoring all waste minimisation programmes at Berg River Textiles, and savings that are made are used to fund new projects. "We started by looking at our operation on a global level, then per department, then per process. The more we looked, the more we realised how little we know about our operation and realised the need for measurement", comments Juan. "Changes that have been made are not rocket science – we just question the current operations".

WATER AND STEAM

The company has focused their projects on reducing water and steam use in the factory. Information boards have been placed at each machine in the factory showing the volume of water and steam used per metre of fabric processed each week, so that everyone can see how they are performing. Targets are set each month and all operators strive towards this improvement. Measurement and monitoring

TABLE 1
Waste minimisation options implemented and resultant savings at Berg River Textiles

Project	Type of change	Resource saved	Quantity/year
Jet cooling water	Re-use	Water Steam	1 020 kl 7 ton
Bleaching rinse water flow rate	Optimisation	Water Steam	13 464 kl 3 699 ton
Caustic recovery cooling water	Re-use	Water Steam	16 152 kl 3 177 ton
Caustic recovery condensate	Optimisation	Water Steam	8 508 kl 1 248 ton
Bleaching rinse water pH control	Elimination	Water Steam	13 464 kl 3 699 ton
Merceriser rinse water	Re-use	Water Steam	24 235 kl 2 040 ton
Bleaching & merceriser integration	Re-use	Water Steam	~40 000kl ~5 200 ton
Padsteam range flow rates	Optimisation	Water Steam	~22 500 kl ~4 245 ton

Juan Laubscher (left) receiving the Cotton SA Merit Award for Cleaner Production *in 2002 on behalf of Berg River Textiles, from Karen Lundbo, Chief Technical Advisor for the Danida Project, and Mr Leonard Venter, Chairperson of Cotton SA*

have played a key role in the success, as it is a well-known fact that you can't manage what you can't measure.

Changes that have been made to achieve these savings are shown in Table 1. As can be seen, most have involved the reuse of water. Since this water is quite often hot, there is an additional saving in energy. Effective use of counter-current washing in one process has reduced water use from 26 500 litres per hour to 9 000 litres per hour! A further 37 projects have already been identified.

The company was recognised for their hard work and progress in reducing wasteful behavior by being awarded the Cotton SA Merit Award for Cleaner Production in 2002.

Juan sums up their success as follows: "What has been done so far is just addressing the obvious. We have optimised our business and put money straight on bottom line. Waste minimisation means a total commitment – from the sweeper to the CEO".

Based on the results achieved to date, and the projects planned for the coming year, it is evident that this commitment exists at Berg River Textiles. The savings achieved indeed prove that waste minimisation makes good business sense!

Using Space Technology to Verify Water Use

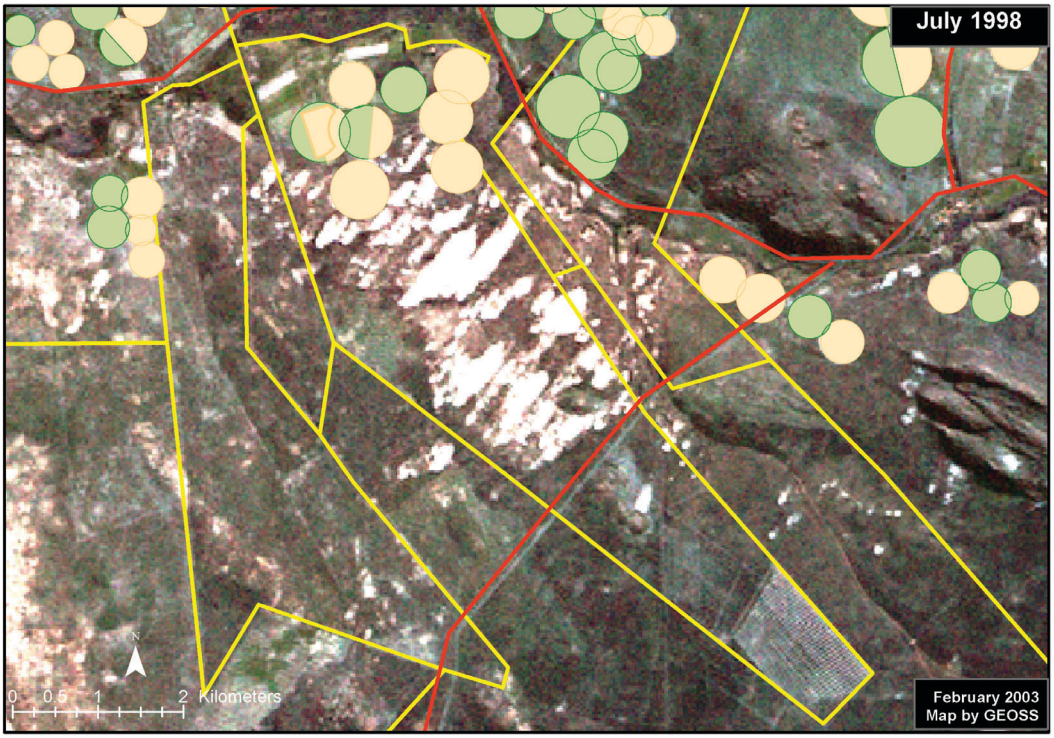
The Department of Water Affairs and Forestry can now literally with the click of a computer button access information about South African irrigators. Johan Wentzel and Julian Conrad** tell the story.*

A 1998 LANDSAT satellite image on which the pivots can be seen. The farm boundaries are shown in yellow.

The National Water Act of 1998 states that water rights that were exercised in October 1998 would be regarded as lawful use. This implies that an irrigator can carry on with their activities unless there is reason to believe that the resource is over allocated. In that instance, the Department of Water Affairs and Forestry will implement a process of Compulsory Licensing. This is a process that is carried out in conjunction with the irrigators and will not be discussed further in this article. If a user wants to expand their existing irrigation activities, which requires increased water usage, they must apply for a license to do so.

In order to assess the water use situation and to quantify the amount of water actually used, a process was initiated where all water users were required to **register** their use. This information is required to assess the current use of the water resource and will also be used for billing purposes. This process is not the same as the **licensing** process.

* Department of Water Affairs and Forestry, Pretoria (wentzelj@dwaf.gov.za)
** GEOSS cc, Geohydrological and Spatial Solutions, Stellenbosch (jconrad@geoss.co.za)



The green circles on this picture indicates the active circles and the white ones the inactive circles. This image was captured in 1998 and reflects the existing lawful users.

The registration information, which includes the user's personal details as well as their water use, is subsequently captured electronically and a database called WARMS, was created within the Department of Water Affairs and Forestry to manage this information.

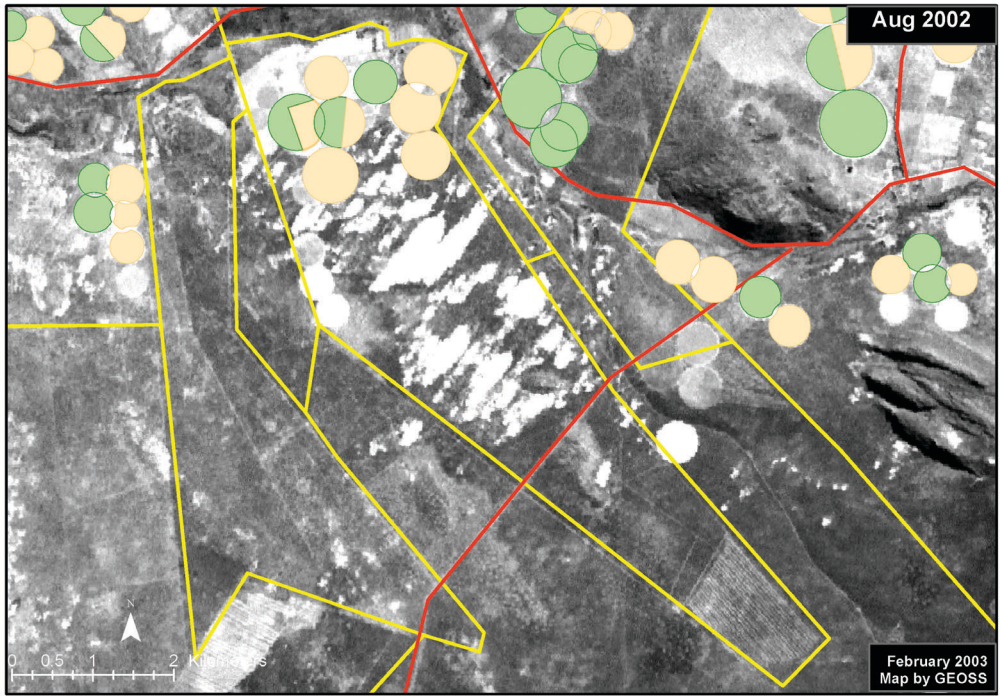
The next phase, which is happening now, is to verify this information. It is important that this validation be done on an independent platform. For practical reasons, it is not possible for officials to visit every user to verify their use.

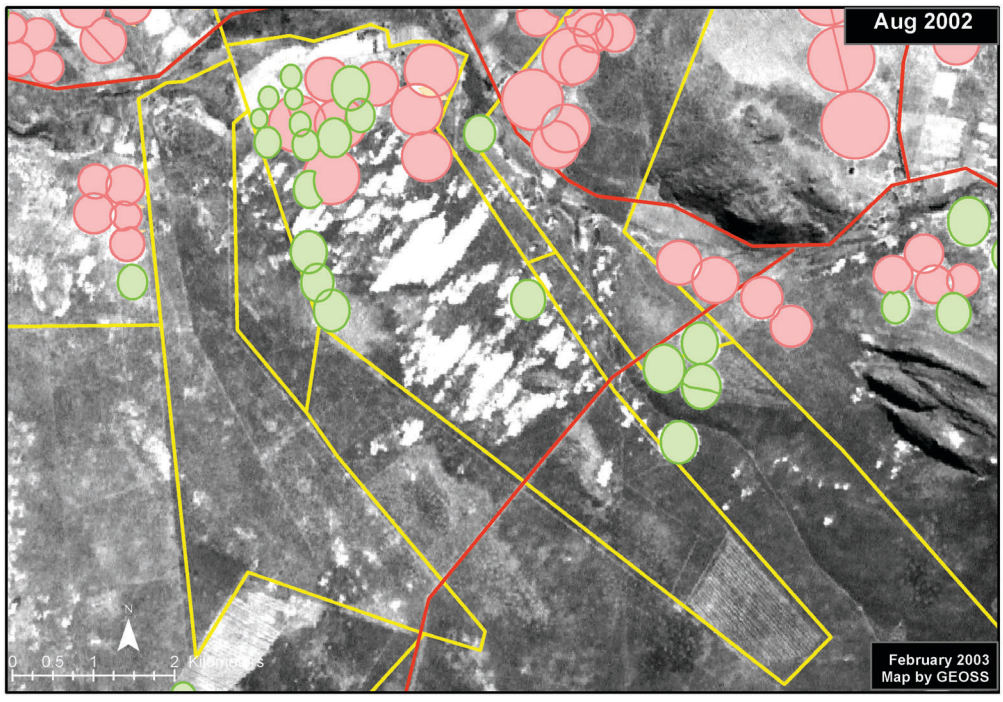
The most cost-effective way this can be done is with the aid of satellite images which have a high enough resolution so that centre-pivots can be identified with a fair degree of accuracy. There are two main sources of satellite images namely SPOT and LANDSAT. SPOT images have a higher resolution, but are very expensive and will only be utilised where very detailed information is required. The Department is currently using LANDSAT images for the verification process. The first LANDSAT satellite was launched in 1972 and the most recent, LANDSAT 7, was launched on April, 1999. The earlier satellites did not have a very good resolution, but from about 1984, the resolution of the satellite images improved to the extent that the information can be utilised for the verification process. The resolution with LANDSAT 7, for instance is 30 m (multi-spectral) and 15 m (panchromatic). Satellite images consist of multi-spectral bands, where a band is a slice of wavelengths from the electromagnetic spectrum. All objects that reflect green light for instance, will be captured in one band. (the colour *per se* is not captured, only the frequency). These spectral bands can then be manipulated electronically to highlight certain features on the earth's surface, such as centre-pivots.

The information from the WARMS database was linked to the national farm coverage of the Department of Land Affairs. The picture on p..... illustrates farm boundaries superimposed on a LANDSAT 7 image.

It is now possible to display this information on a computer. If one "clicks" on a particular farm, it is possible to see immediately who the owner is and look at their registration details. The actual pivots are captured and the area of the pivots calculated. By comparing the area with crops that are registered, it is possible to calculate a water use per centre-pivot. This can be compared to the value that was registered. The picture below shows a 1998 satellite image and superimposed on that the pivots that were electronically captured.

In order to establish expansion that has taken place since 1998, the latest satellite images were obtained and put through the same process.





A comparative view (1998 irrigation circles in red and post-1998 irrigation circles in green)

The picture below illustrates the differences. The circles coloured in red also appeared on the 1998 satellite images and the circles coloured green have been developed since 1998. With a "click" of a button the details of a farmer where expansion has taken place, can be accessed and this information captured separately. This will then be followed up and if there is no justification for this expansion, the irrigator will be requested to stop his activities immediately or face prosecution.

This is the most cost-effective way to verify use and to keep track of developments taking place. The LANDSAT satellite takes the same picture every sixteen days, which implies that this approach can also be used in future to ensure that users don't exceed their allocations. For further information, please do not hesitate to contact the authors.

Letters to the Editor
(E-mail jan@wrc.org.za)

TO: THE EDITOR
VIEWPOINT – WATER WHEEL

Dear Sir

A Southern African Example – The Kasikili Island in the Chobe River, Water Wheel, January/February 2003 - Vol 2 No 1

- This article portrays the situation after the International Court of Justice (ICJ) allocation to Botswana of Sedudu Island [wrongly named Kasikili Island in the title] as follows:

  "There are still five islands in the Caprivi sector whose territorial sovereignty or 'ownership' is contested: three of these islands are in the Chobe River and two are in the Zambezi River."

  It is not known what specific islands in the Chobe River are referred to. As a matter of fact, however, the whole boundary line, over a length of 300 km, was not defined by the 1890 colonial treaty, but it is now no longer an issue of contest at all, also not for any islands.

  There is also no knowledge of islands in the Zambezi River in dispute in the Caprivi sector:
  - Between Namibia and Botswana, as the Zambezi River never and nowhere was the agreed boundary line.
  - Between Namibia and Zambia, where the boundary line and the position of the islands in the Zambezi River were decided upon more than 40 years ago.
  - Between Botswana and Zambia, as the area of the boundary line, as far as still to be finalised, includes no islands.

- The ending of this article may also be outdated, where it states, in reference to Botswana and Namibia:
  - "Unless these two countries develop a formal protocol to address this type of situation…"
  - "Without wishing to pre-empt any options that may be considered by the countries concerned…"

  Quite some time ago, Botswana and Namibia already agreed on the establishment of a Joint Commission of Technical Experts, whose consensus on the boundary along the Chobe River would be binding for the two countries. The Commission finalised its investigations and reached the requested consensus in June 2002.

- The article refers to the resolution of water conflicts by relying on an independent third party, giving the impression that this is a preferable approach. No mention is made of the prolonged tension, both on the ground and on the judicial level, and risk of failure, and also of the time and money, involved in this type of solution.

  In the above example of the Chobe boundary between Botswana and Namibia, however, a healthier approach was successfully taken, namely:
  - The two countries mandated the resolution of existing and possible future differences to a joint technical commission of experts, acting with competence and in a spirit of "give-and-take" co-operation.
  - This proved to be a much more effective, amicable and time-/money-saving solution.

- The approach followed didn't involve the involvement of international, including South African, experts for an expensive and drawn-out procedure as in the case of Sedudu/Kasikili Island, and it may therefore have received less publicity. It is nevertheless trusted that you will be able to publish the above for the better information of your South African as well as international readers.

Guido van Langenhove
PO Box 30715
Windhoek
Namibia

Dear Guido,

Perhaps I can take this opportunity to respond to the points you raised in the hope that I can provide some additional clarity.

- I fully agree with you that the island name in the title of the boxed text ("Kasikili Island") is incorrect if it does not acknowledge its other name, namely: "Sedudu Island". The title of the original article did indeed contain both names.

- You are also quite correct in saying that the 1890 colonial treaty did not "define" the boundary line over a distance of some 300 km (In fact, the treaty wording was particularly vague and uninformative). The Anglo-German agreement stated that the boundary was the "middle of the main channel" - information that I obtained from Dr L. Hangula's book "*The International Boundary of Namibia*" (published by Gamsberg Macmillan Press, Windhoek), where the details of issues, treaties, etc. for every one of Namibia's boundaries are discussed in detail.

- In broad terms, (at Government level), there is no "dispute" per se over ownership ("sovereignty") of other islands in the Chobe/Linyanti or Zambezi rivers. On the ground, (i.e. at local level), however, this is another matter altogether. Discussions with Botswana citizens in Kasane and Kazangula (as well as Ngoma Bridge Border Post) indicated that individuals and small communities were concerned over access to, and ownership of, resources on islands in the Chobe/Linyanti system. In particular, three islands (other than Sedudu/Kasikili Island) were cited as 'points of tension' where Botswana citizens had been "chased away" by Namibian citizens (Caprivi residents) when attempting to gather reeds and fish. A similar situation was cited to me by residents of Mongu, Livingstone, Kazangula and Sesheke in Zambia, where they had been "chased away" by Caprivi residents when attempting to gather reeds and fish on two islands in the Zambezi River. Thus, whilst there may be no "official" (i.e. inter-Governmental) disagreement (or dispute) about contested islands, there most certainly are disputes at local level.

  In a slightly different vein, some Botswana residents in Kasane and some Zambian residents in Kazangula felt that the ownership ("sovereignty") of Impalila Island is in question, and that it should belong to Botswana, rather than Namibia. Clearly, this is not the official view held by Government officials in Namibia or Botswana, but a view held by some residents at local level. If the position of the Chobe main channel changes due to severe floods, there is a possibility that the main channel would shift from south of Impalila Island to west of Impalila Island. In terms of the wording of the boundary treaty, ownership of Impalila Island would then be difficult to establish.

- Namibia and Botswana have no shared boundary on the Zambezi River, though their territories (territorial boundaries) meet at the junction of the Chobe and Zambezi River, to the east of Impalila Island, in the centre of the main channel of the Zambezi River, overlying the thalweg.

- There are no significant (i.e. "large-sized, permanently exposed") islands along the stretch of Zambezi River between Botswana and Zambia, though several small rocky islets are visible at low flows. These are away from the route operated by the Kazangula-Kasane Ferry between Zambia and Botswana and do not appear to pose any grounds for discussion between the countries, despite being used at odd intervals for fishing purposes by residents of both Zambia and Botswana.

- The ending of the article (taken from a longer, more detailed version) was designed to create awareness that situations could arise where neighbouring countries could disagree over the ownership ("sovereignty") of, for example, islands in a river where the main channel is mobile, or is likely to shift its position. As a proactive measure it would be useful for such countries to have an agreed protocol (or methodology) in place that would define a process of reaching agreement. This type of situation also applies to islands in the Orange (Gariep) River, if the "new" boundary is accepted. The type of situation described here is frequently encountered at the junction of the Cuito and Kavango rivers, for example. The Cuito has shifted its position by as much as 500 m after a single large flood event.

- The Joint Commission of Technical Experts from Botswana and Namibia have indeed reached their anticipated consensus in June 2002. But, no provision has been made for actions or decisions to be taken in those cases where natural changes to the position or size of river channels (e.g. through flood action) could result in a change to the position of an international boundary.

- I apologise if the edited version of this article gave the impression that I was suggesting or promoting the use or actions of an independent third party as being the most preferable option for a country. Clearly, it is always in the best interests of countries to solve their own issues without outside interventions. You are quite correct to state that there are many risks associated with the involvement of external parties, including the costs of time, money and manpower. The formal ruling by the International Court of Justice in The Hague illustrated the costs and time-consuming nature of this solution. The subsequent amicable agreement between Namibia and Botswana to rely on their own teams of experts is a welcome addition, but does not overturn or negate the International Court of Justice (ICJ) ruling.

- The use of international experts by the ICJ in the Sedudu/Kasikili Island judgement (e.g. Professor WRJ Alexander was part of the ICJ Expert Panel), may have contributed to a "sound" decision, but did take time and cost money. The amicable agreement between Botswana and Namibia to rely on their own panel of experts is indeed a most welcome improvement.

  Overall, Guido, I do support much of the detailed explanation that you provide in your letter. However, there are linked items of information or associated levels of detail that you have left out of your arguments (just as some of the linked details in my longer original article were also left out in the *Water Wheel* version). I have attempted to provide some additional information in the points I list above; hopefully, we can arrive at a more balanced viewpoint.

Peter Ashton

SOUTHERN AFRICA & AFRICA 2003

ENVIRONMENTAL COURSES

A series of environmental courses on the new environmental law, implementing environmental management systems and audits, water quality management, environmental risk assessment, air quality management, the legal framework for managing water in South Africa, etc will be held throughout the year by CEM (the Centre for Environmental Management) at the University of Potchefstroom (PU for CHE).
Enquiries: Mrs Dydre Greeff/Mrs Madel Lottering.
Tel: (018) 299 2714 or (018) 299 2725.
Fax: (018) 299-2726.
E-mail: aokdg@puknet.puk.ac.za
or aokml@puknet.puk.ac.za
Web: http://www.puk.ac.za/education/shortcourses/environment.html

STORMWATER DRAINAGE
JUNE 24 - 27

A South African workshop and conference on storm water drainage modelling will be held at UCT in Cape Town.
Enquiries: The Conference Secretary (Debbie). Tel: 021-712 0102.
E-mail: urbandrainage@intermail.co.za.
Web: http://www.eng.uct.ac.za/~armitage/urbandrainage

SASAQS/ZSSA
JUNE 29 - JULY 4

A joint conference of the Southern African Association of Aquatic Scientists and the Zoological Society of Southern Africa will be held at the University of Cape Town.
Enquiries: Mrs H Battle.
Tel: (021) 650 3603.
Fax: (021) 650 3301.
E-mail: hbattle@botzoo.uct.ac.za
Web: http://ww.wetandwildlife.uct.ac.za

WATER RESOURCES
JULY 26 - AUGUST 1

A special session, sponsored by the Water Research Commission, with the theme "Rangeland and Water Resources" is being convened during the 7th international Rangeland Congress which will be held at the International Convention Centre in Durban.
Enquiries:
E-mail: delegates@sbconferences.co.za
Tel: 031 3032480.
Fax: 031 3129441.
Web: http://www.ru.ac.za/institutes/rgi/irc2003/IRC2003.htm

HYDROLOGY
SEPTEMBER 3 - 5

The 11th South African national hydrology symposium and workshop will be held at the PE Technikon in Port Elizabeth, Eastern Cape. The theme will be: "Water resources in Southern Africa – the future is not what it used to be!"
Enquiries: Juanita McLean.
Tel: (046) 6224014.
Fax: (046) 622 9427.
E-mail: juanita@iwr.ru.ac.za
Web: http://www.ru.ac.za/institutes/iwr/

SANCIAHS2003
IWA
SEPTEMBER 14 - 19

The International Water Association (IWA) will host a regional conference in Cape Town with the theme: *Water as the key to sustainable development in Africa*. Simultaneously with this event, the IWA specialist group on biofilms and the specialist group on health related water microbiology will also be having their international specialist conferences.
Enquiries: Prof TE Cloete, IWSA National Committee.
Tel: (012) 420 3265.
Fax: (012) 420 3266.
E-mail: tecloete@postino.up.ac.za
Web: http://www.iwaconferences.co.za/

WATER MICROBIOLOGY
SEPTEMBER 14 - 19

An international symposium on health-related water microbiology will be held in Cape Town.
Enquiries: Ms Heidi Botha, Organising Committee, 2003 Cape Town symposium (HRWM), Department of Virology, University of Pretoria, Pretoria.
Tel: (012) 319 2351.
Fax: (012) 325 5550.
E-mail: bothah@med.up.ac.za

ENVIRONMENTAL MANAGEMENT
OCTOBER 7 - 9

A short course on environmental management will be held at the Post-Graduate Centre of the University of Pretoria.
Enquiries: Ms Marina Nell.
Tel: (012) 420 5010.
Fax: (012) 362 5285.
E-mail: marina.ce@up.ac.za

MINE WATER
NOVEMBER 3 - 5

A conference with the theme "Implementing sustainable development in mining: From talk to action" will be held at the Indaba Hotel in Sandton.
Enquiries: The Conference Administrator – attention: Ms Ammie Wissing, Conference Planners, PO Box 36782, Menlo Park 0102.
Tel: 012-348 4493.
Fax: 012-348 1563.
E-mail: wissing@iafrica.com

2004

WATER SUPPLIERS
FEBRUARY 19 - 24

The Union of African Water Suppliers (UAWS) will be holding its 12th bi-annual African congress in Accra, Ghana.
Enquiries: Mr Dennis D Mwanza, Water Utility Partnership (WUP), 05 BP 2642, Abidjan, Cote d'Ivoire.
Tel: +225 21 2408 28.
Tel (direct line): +225 21 2408 13.
Cell: +225 07 0199 01.
Fax: +225 21 75 8656/7.

OVERSEAS

GROUNDWATER
MAY - DECEMBER 2003

The Centre for Groundwater Studies (CGS) in Australia will be organising short courses on groundwater related themes throughout the year. CGS courses can be counted towards a

Master of Science in Groundwater Hydrology degree offered by Flinders University in Adelaide, Australia.
Enquiries: Trevor Pillar
Tel: 61 8 8201 5632.
Fax: 61 8 8201 5635.
E-mail: cgs.training@groundwater.com.au
Web: http://www.groundwater.com.au

ACTIVATED SLUDGE
JULY 28 - AUGUST 1

The 14th annual short course on the methodologies and laboratory techniques to generate process control parameters for operating an activated sludge process will be held in Estes Park, Colorado.
Enquiries: Thomas G Sanders, Course Director, Department of Civil Engineering, Colorado State University, Fort Collins, CO 80523.
Fax: (970) 491 7727.
Tel: (970) 491 5448.
E-mail: TGS@engr.Colostate.Edu
Web: http://www.engr.colostate.edu/depts/ce/

BASIN MANAGEMENT
AUGUST 17 - 22

The 7th international conference on diffuse pollution and basin management will be held in Dublin, Ireland.
Enquiries: IWA Conference Secretariat, Centre for Water Resources Research, Civil Engineering Department, University College Dublin, Earlsfort Terrace, Dublin 2, Ireland.
Tel: 00 353 1 7167 499.
Fax: 00 353 1 7167399.
E-mail: dipcon@ucd.ie
Web: www.ucd.ie/~dipcon/dipcon.htm

BIOFILM SYSTEMS
SEPTEMBER 2003

The 5th international conference on biofilm systems will be held in Noordwijkerhout, the Netherlands.
Enquiries: Mark van Loosdrecht, TU-Delft, Julianalaan 67, 2628 BC Delft, the Netherlands.
Tel: +31 15278 1618.
Fax: +31 152 78 2355.
E-mail: m.c.m.vanloosdrecht@tnw.tudelft.nl

WASTEWATER PLANTS
SEPTEMBER 1 - 4

The 9th conference on the design, operation and costs of large wastewater treatment plants will take place in Prague, Czech Republic.
Enquiries: Prof Dr Jiri Wanner, Dept of Water Technology and Environmental Engineering, Prague Institute of Chemical Technology, Technicka 5, CZ-166 28 Praha 6, Czech Republic.
Tel: +420 2243 53149.
E-mail: jiri.wanner@vscht.cz

IRRIGATION
SEPTEMBER 1 - 5

The 4th international symposium on irrigation of horticulture crops will be held in Davis, California, USA.
Enquiries: Conference & Event Services, One Shields Avenue, Davis, CA 95616, USA.
Fax: (530) 752 5791.
Web: http://www.cevs.ucdavis.edu

RIVER MANAGEMENT
SEPTEMBER 2 - 5

The sixth international river management symposium with the theme – Urban rivers: Balancing the expectations – will be held in Brisbane, Queensland, Australia. The symposium brings together world authorities to share the world's best practise in river management issues, including river ecology, land use planning, community partnerships, institutional arrangements, economics, coastal systems, engineering and technology.
Enquiries: Mr Stephen Nelson.
Tel: +61(0)7 3846 7444.
Fax: +61(0)7 3846 7660.
E-mail: symposium@riverfestival.com.au

DRAINAGE
SEPTEMBER 10 -13

The 9th international drainage workshop - drainage for a secure environment and food supply - will be held in Utrecht, the Netherlands.
Enquiries: Alterra-ILRI, PO Box 47, 6700 AA Wageningen, the Netherlands.
Tel: +31 317 495 549.
Fax: +31 317 495 590.
E-mail: drainage2003@ilri.agro.nl
or ilri@ilri.nl

ODOUR CONTROL
SEPTEMBER 14 - 17

The second IWA international conference on the development of odour measurement, regulation and control techniques will be held in Singapore.
Enquiries: Ms Tan Kim Suan, Corporate Communications Manager, Institute of Environmental Science & Engineering Innovation Centre (NTU), Block 2, Unit 237, 18 Nanyang Drive, Singapore 637723.
Tel: +65 6794 1533/1534.
Fax: +65 67921291.
E-mail: KSTAN@ntu.edu.sg
or KSTAN@iese.ntu.edu.sg
Web: www.eti.org.sg
or www.iese.ntu.edu.sg

ICID
SEPTEMBER 14 - 19

The 54th IEC meeting and 20th ICID regional conference on irrigation and drainage will be held in Montpellier, France.
Enquiries: Mr Francois Lacroix, AFEID, Parc de Tourvoie, 92160 Antony, France.
Tel: +33 01 40 966197.
Fax: +33 01 40 966196.
E-mail: francois.lacroix@cemagref.fr
Web: http://feid.montpellier.cemagref.fr/cei2003.htm

WATER MANAGEMENT
SEPTEMBER 15 – 18

The Monitoring Tailor-Made IV conference will be held in St Michielsgestel, the Netherlands. The conference deals with strategies and practices for the collection and dissemination of information in support of integrated water resources management.
Enquiries: The Conference Secretariat, IWAC (International Water Assessment Centre), PO Box 17, 8200 AA Lelystad, the Netherlands.
Tel: +31 320 298 894.
Fax: +31 320 297 642.
E-mail: mtm@riza.rws.minvenw.nl
Web: http://www.mtm-conferen.nl

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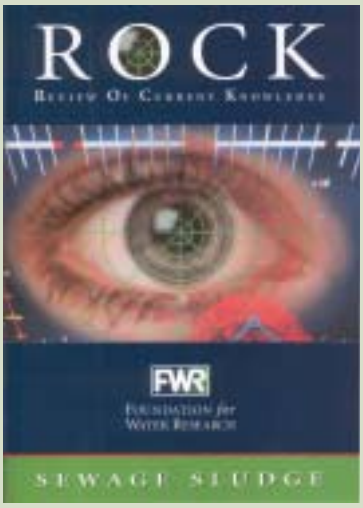

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