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Editorial offices:
Water Research Commission, Private Bag X03, Gezina, 0031, Republic of South Africa. Tel (012) 330-9025. Fax (012) 331-1136.
WRC Internet address: http://www.wrc.org.za
Editor: Jan du Plessis, E-mail: jan@wrc.org.za. **Editorial Secretary:** Rina Human, E-mail: rina@wrc.org.za
Layout: Drinie van Rensburg, WRC. E-mail: drinie@wrc.org.za

IWR TEAM TAKES ON THE APPLE EXPRESS

The Institute for Water Research entered a team for this year's "Great Train Race" – an annual relay event where teams of 10 runners carry batons over a distance of 72 km from Port Elizabeth to the picturesque village of Loerie. The teams compete against each other and the narrow-gauge steam-driven Apple Express Train.

Teams from all over the country, and all levels of athleticism, came to run against the train. Each stage is between 5.7 to 8.5 km, with some undulating country and seriously steep hills to challenge the legs. The IWR team was entered in the social category, and included a number of brave souls who had never run further than 100m before. However, they all managed to complete their stages and hand on the baton, so that the final runner, Sekhonyana Lerotholi, reached the finish line at Loerie Station a full hour before the cut-off time (but some hours after the train, which was only beaten by the winning team).

IWR Research Officers Nikite Muller and Lil Haigh drove the seconding vehicle and provided sandwiches and drinks to revive the runners.

The runners, proudly wearing their finishers medals, beside the Apple Express.
***Left to right (back row)**: Jay O'Keeffe, Andrew Slaughter, Sekhonyana Lerotholi, Tarqyn Human, Carol Moffett.*
***(Front row)**: Lucy Scott, Andy Gordon (Team Recruitment Officer), Valisa Ntomboxolo, Samantha Browne (Team Manager), and Nosiphiwo Ketse.*

REPORTING BACK ON THE UNILEVER APPLIED AQUATIC ECOTOXICOLOGY COURSE

The Unilever Introduction to Applied Aquatic Ecotoxicology Course was held recently in Gauteng from 15-19 September 2003. Organised by Dr. Nikite Muller from the Unilever Centre for Environmental Water Quality (UCEWQ), in the Institute for Water Research at Rhodes University, it consisted of a 3 day theory course held at the CSIR Convention Centre, Pretoria and a 2 day practical course hosted by ECOSUN Environmental Consultants in Johannesburg. Delegates from the all over the country attended, representing government organisations (Department of Water Affairs and Forestry (DWAF) and eThekweni Municipality); educational institutions (Rand Afrikaans University, University of Cape Town and Technikon Northern Gauteng); and industry (SASOL, FOSKOR, and BHP Billiton).

Professor Tally Palmer and Dr. Nikite Muller of UCEWQ presented the bulk of the course material, providing insights on the application of toxicology in water law and policy, and covering a range of topics including aquatic toxicology theory, methods of conducting various toxicity tests, and analysis and interpretation of toxicity data. Guest lecturers Dr Sebastian Jooste of Resource Quality Services, DWAF; Dr. Hein du Preez of Scientific Services, Rand Water; and Dr. Lesley Phillips of SASOL provided specialist input regarding the role of toxicology within their respective organisations. A fourth guest lecturer, Ms. Elzabe Truter of the CSIR, concluded with a talk on Quality Assurance: Good Laboratory Practice and Accreditation. A combination of intensive lectures, specialist input and enthusiastic debate resulted in a rewarding, learning experience of the important role aquatic ecotoxicology has to play in resource management and industry, both now and in the future.

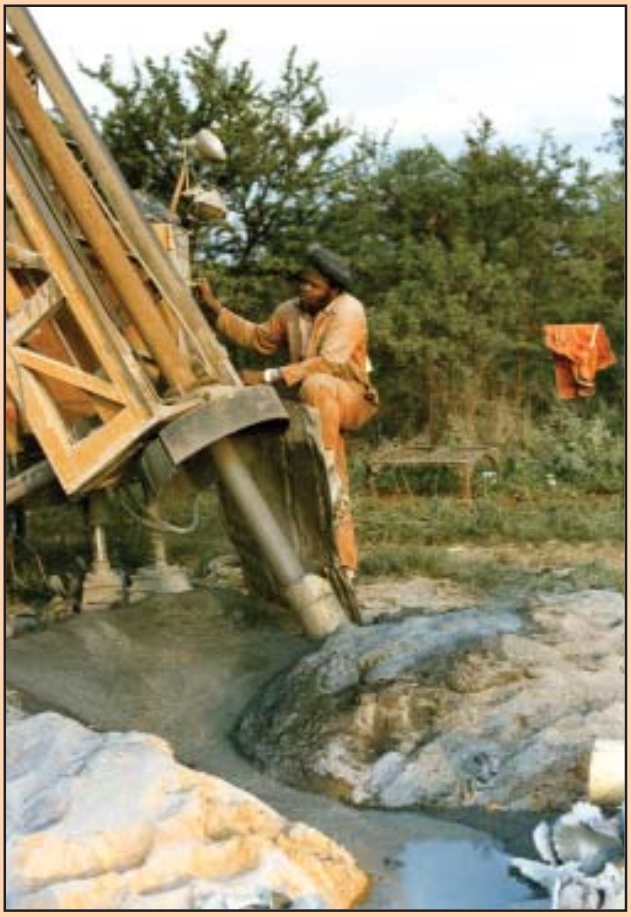
The Unilever Introduction to Applied Ecotoxicology Course delegates:
***Back row**: Mathew Ross, Sean Marr, Chris Williams, Randal Albertus, Ritva Mühlbauer, Boitumelo Mankazana, Prithie Naidoo, and Pieter Retief.*
***Seated**: Maryke Kruger, Nikite Muller (UCEWQ), Elmie Joubert, Aletia Chapman, and Riki Deale*
***Front row:** Fortunate Makhubu, Tally Palmer (UCEWQ), Zinhle Ngwenya, Suzan Oelofse, and Andrew Gordon (UCEWQ).*

UPDATED GROUNDWATER STANDARDS (SANS 10299) AVAILABLE

The complete series of the updated SANS 10299 series (*Development, maintenance and management of groundwater resources*), is now available.

'The publication of this series, updated to include a glossary of terms (Part 0) and four other new parts (Parts 2, 7, 8 and 9), and cross-referenced to the new SANS numbering system, is a major contribution to the sustainable use of groundwater in South Africa' said Dr C Johnston, Divisional Director of Standards South Africa, the standards-generating arm of the SABS.

'The SANS 10299 series of standards is a national guideline developed specially for South African needs, as an appropriate suite of international standards was not available for adoption' he concluded.



GROUNDWATER

Groundwater represents 97% of all the available freshwater supplies on Earth. According to a study commissioned by the Department of Water Affairs and Forestry, the total estimated yearly groundwater use of approximately 3 600 million cubic metres in South Africa accounts for 58% of the total quantity of groundwater (6 200 million cubic metres) available for exploitation and development in this country. This percentage takes into account the requirements of the ecological Reserve and basic human needs Reserve, as defined in the National Water Act (Act No. 36, 1998).

Under these circumstances, ensuring the sustainable use of groundwater is therefore an important priority for South Africa, and something the SABS 10299 series of standards developed under the mutual title of *Development, maintenance and management of groundwater resources* makes a significant contribution towards.

'The SABS 10299 set of standards brings together an updated synthesis of all the key elements associated with the use of groundwater in South Africa. It provides both the prospective and the existing groundwater user with a guide and easy reference to the best practices in this field', said Phil Hobbs, a well-known groundwater specialist and member of the technical committee.

'Whilst the set of standards provide the prospective borehole owner with a reference framework within which the necessary services can be secured and evaluated with confidence, more importantly, it also promotes the responsible development and sustainable use of this resource' he said.

"Deciding on the position of a borehole (as set out in Part 1) is, however, only the first step to owning a successful borehole. The other parts of the standard each address a specific milestone along this path, and are therefore equally significant in their contribution toward the sustainable use of groundwater" he concluded.

STANDARD

There are nine parts of the standard. The titles of the individual parts are:

Part 0: *Glossary of terms*
Part 1: *The location and siting of water boreholes*
Part 2: *The design, construction and drilling of boreholes*
(There is no Part 3)
Part 4: *Test-pumping of water boreholes*
Part 5: *The design, selection and performance of pumping equipment for water boreholes*
Part 6: *The installation and commissioning of pumping equipment for production boreholes*
Part 7: *The rehabilitation of water boreholes*
Part 8: *The management of water boreholes*, and
Part 9: *The decommissioning of water boreholes*.

To purchase any or all parts of the standard, please contact Terence Moodley by telephone ((012) 428-6834), fax ((012) 428-6928) or e-mail (sales@sabs.co.za) .

ICID WATSAVE AWARDS

The International Commission on Irrigation and Drainage (ICID) WatSave awards are presented to an individual or a team of individuals for an "outstanding contribution to water conservation/ water saving for increasing the beneficial and /or efficient use of water to develop and improve the sustainable use of this critical resource".

The award aims at:

- Promoting and encouraging the best technological applications or projects which have been successful in saving or recovering waste waters or poor quality water.
- Promoting other non-technological interventions or innovative land and water management techniques for increasing the availability of water for different uses.
- Promoting research that leads to substantial savings in water applications or uses.
- Promoting the development of new policies and approaches for water saving leading to the cost-effective and beneficial use of water.

The Awards are presented in three categories, namely: the WatSave Technology Award, the WatSave Innovative Water Management Award and the WatSave Young Professional Award.

All nominations received, are reviewed by a panel of judges, selected from the four regions of ICID: the Americas, Africa, Asia-Oceania and Europe.

The award consists of a honorarium (US$ 2 000 for the year 2003) and a citation presented at an IEC meeting.

SCIENTIST WINS INTERNATIONAL AWARD FOR DEVELOPING A CHEAP AND SIMPLE IRRIGATION SCHEDULING TOOL

The International Commission on Irrigation and Drainage (ICID) has recently awarded its Watsave Technology Award to Dr Richard Stirzaker, a research scientist from the CSIRO in Australia, for developing the Wetting Front Detector – an inexpensive and "farmer friendly" irrigation scheduling tool. Dr Stirzaker was nominated for the award by SANCID (the South African National Committee on Irrigation and Drainage).

The Chairman of SANCID, Dr Gerhard Backeberg from the Water Research Commission, says this award recognises "the achievements and the successful co-operation between various individuals and organisations. Dr Stirzaker from the CSIRO in Australia conceptualised and developed the technology. Together with Prof Annandale of the University of Pretoria they submitted a research proposal to test the Wetting Front Detector amongst subsistence and commercial farmers in South Africa. The Water Research Commission supported and funded the research project over three years and it was managed by Dr Sizwe Mkhize from the Water Research Commission."

Backeberg says this research has led to the commercialisation of the Wetting Front Detector and the product will be manufactured under licence by Agriplas (Pty) Ltd in South Africa.

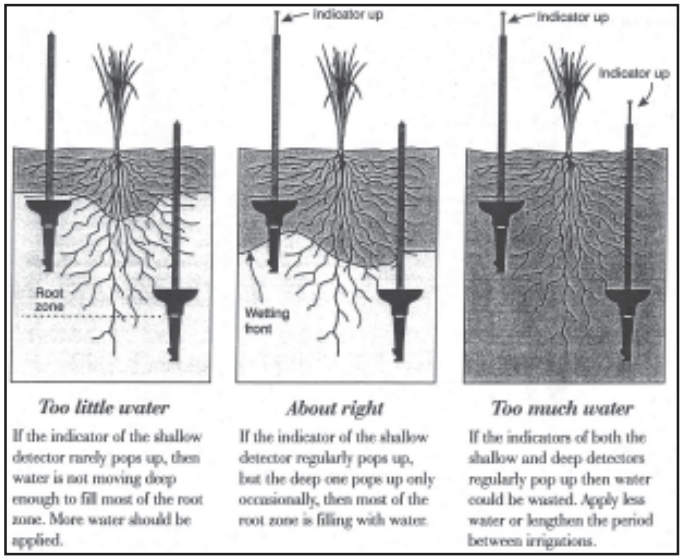
In an article on the Wetting Front Detector – From theory to Practice – researchers from CSIRO and the University of Pretoria say that there is an enormous gap between the science of irrigation and its practice on the ground.

"Although many good tools and methods to improve irrigation efficiency have been developed, most farmers do not use them. Therefore, the primary goal of the Wetting Front Detector is to reach farmers who are not making use of commercially available equipment due to its complexity or cost."

In South Africa, one of the priorities is that key constraints facing small-scale subsistence farmers must be identified and adaptive research done to overcome these problems. It is important for the farmers to decide when and how much to irrigate or to decide to stop irrigating to meet the water requirements of food crops under water scarce conditions. In this regard the Wetting Front Detector has shown exceptional merit.

THE DETECTOR

Basically, the Wetting Front Detector is simply a funnel, a filter and a float, buried in the root zone. The Detector gives a signal to the irrigator when water, percolating through the soil, has reached it.



Too little water
If the indicator of the shallow detector rarely pops up, then water is not moving deep enough to fill most of the root zone. More water should be applied.

About right
If the indicator of the shallow detector regularly pops up, but the deep one pops up only occasionally, then most of the root zone is filling with water.

Too much water
If the indicators of both the shallow and deep detectors regularly pop up then water could be wasted. Apply less water or lengthen the period between irrigations.

The researchers say the detector works on the principle of flow line convergence. Water moving downwards through the soil is concentrated after the water molecules enter the wide end of the funnel. The soil in the funnel becomes wetter as the funnel narrows and the funnel shape has been designed so that the soil at its base reaches saturation. Once saturation has occurred free water flows through a filter into a small reservoir and activates a float.

The Wetting Front Detector can be used to schedule irrigation because the time it takes for the water to reach a certain depth depends on the initial water content of the particular soil. If the soil is dry before irrigation the wetting front moves slowly because the water must fill the soil pores on its way down. Therefore a lot of water is needed before the detector will respond. If the soil is quite wet before irrigation, then the wetting front will move quickly through the soil. This is because the soil pores are already mostly filled with water so there is little space for additional water to be stored. Thus a short irrigation will cause the detector to respond.

The float in the detector is activated when free water is produced at the base of the funnel. Water is withdrawn from the funnel by capillary action after the wetting front dissipates. A water sample can be extracted from the detector for monitoring the concentration of salt and nutrients.

The detector has been tested in the irrigated gardens of subsistence farmers, amongst small-scale farmers (less than 3 ha) and amongst large-scale irrigators.

EXCHANGE VISIT SEMINAR FOR DIRECTORS HELD IN BOTSWANA RECENTLY

Botswana was honoured to be invited by IUCN to host the joint IUCN/SADC Water Demand Management Seminar for 2003.

The three-day event took place in the town of Selebi-Phikwe, approximately 400 km north-east of the capital, Gaborone, from 9 - 11 June 2003. Seventy delegates from six SADC countries attended the event, all of whom occupy senior positions with their respective organisations.

Day one was devoted to Welcome; Opening Address, Overview and Seminar Outline; and the Keynote address, which was presented by Seminar Facilitator, Simon Foster. This was followed after tea by eight prepared presentations. Botswana enjoyed the lion's share of four authors, two authors were from RSA and one each from Zambia and Zimbabwe.

Day two of the seminar took delegates on a visit to Botswana's largest dam, the Letsibogo Dam, just 10 km from Selebi-Phikwe. The dam supplies water to the 1.6 billion Pula North-South Carrier Pipeline project that was commissioned in April 2002. The pipeline stretches 360 km and delivers up to 90 million litres of water a day to the Mmamashia water treatment plant just to the north of Gaborone. The scheme is owned and operated by the Water Utilities Corporation who is responsible for the supply of water to the seven main towns and cities of Botswana.

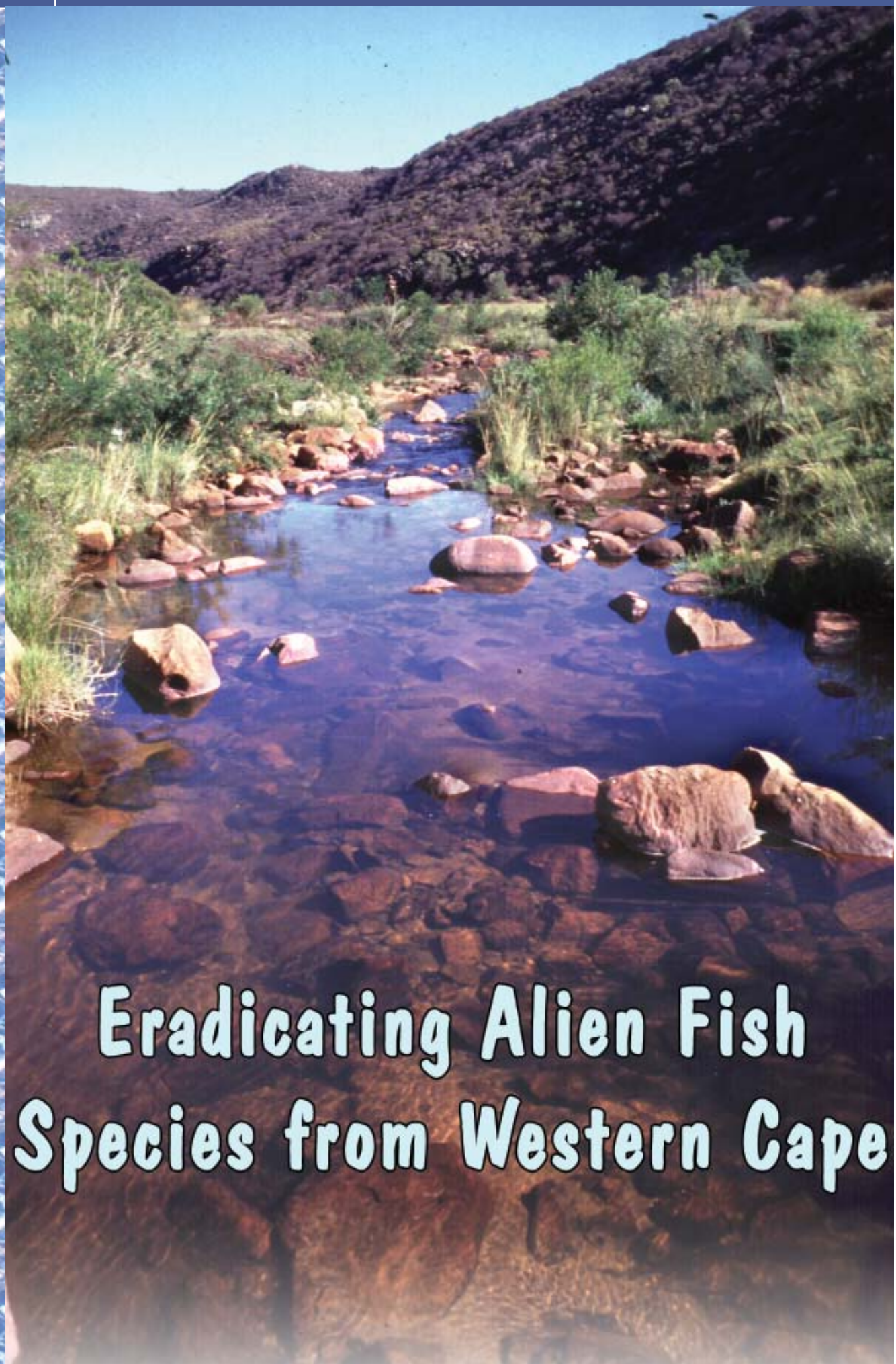
After tea the group visited the nearby tribal community, which had been heavily impacted by the construction of the Letsibogo Dam. Impacts were both positive and negative and the delegates were keen to try and establish some kind of ratio between the two extremes. The community issues were recognised by the delegates as of great importance and much interest was shown. A meeting with the community had been arranged in the local 'Kgotla', the traditional meeting place in rural districts. The primary negative impacts had been the restriction of access to traditional watering points for the local livestock farmers, and problems being experienced with cattle getting stuck in the mud around the shores of the dam during periods of low water levels, such as have been experienced in 2003. Over 600 dead cattle have been removed in the first few months of the year.

Botswana, being a very flat country, does not have any suitable dam sites available for development. Letsibogo dam is very shallow with an extremely poor surface area to volume ratio and is also located in a very warm region resulting in extremely high evaporation losses. Reports suggest that for every cubic metre of water delivered, two cubic metres escape to the atmosphere. This has created a major dilemma for the Water Utilities officials who have to do a strategic balancing act between keeping the water in the dam and losing it to evaporation or using the water from the dam in preference to any other source to minimise the effects of evaporation (use it before it can evaporate) with the risk of emptying the dam at the height of the drought - the worst possible timing. This latter scenario will also expose the full extent of the mud-flats most frequently, resulting in high cattle losses for local community stock farmers.

After lunch the delegates visited the BCL copper and nickel mine and expressed concern at the apparent environmental havoc that met the group. The mine uses sodium chloride (salt) in its underground cooling plant which causes the salinity of the final mine effluent to rise to levels in excess of the limits for discharge to a natural stream. The mine has plans to dispose of the saline water onto a citrus orchard, which is currently being established.

To conclude the seminar, a number of "Theme Leaders" were identified and groups formed report back committees on the various issues of the site visits. Feedback by the Theme Leaders took place on the morning of the third day, which culminated with a session on the way forward and some of the broader issues relating to water demand management policies.

Consensus was that the seminar provided insight and opportunity for delegates and many friendships were formed between both individuals and nations from Mauritius to Angola.


Eradicating Alien Fish
Species from Western Cape

The Cape Floral Kingdom is world renown for its botanical diversity, being the most species-rich (for its size) but also the most threatened of the world's six floral kingdoms. Yet it is the freshwater fish of the region that perhaps warrant the most cause for concern, because 15 of the 19 indigenous species are threatened, and nine of these are listed as critically endangered or endangered. Sue Matthews reports from Cape Town.

Cape Nature Conservation (CNC) has now embarked on an ambitious rescue effort. Since invasive alien fish - along with habitat degradation and destruction - are considered largely responsible for the threatened status of indigenous fish, CNC plans to hit back by eradicating alien fish from high-priority rivers flowing through protected areas.

With funding from the Table Mountain Fund, administered by WWF-SA, a project will be undertaken to assess which rivers in the so-called 'Mega-parks' – the Cederberg, Gouritz and Baviaanskloof – as well as the Kogelberg and West Coast biosphere reserves and the Cape Peninsula National Park, are most suitable for alien eradication and rehabilitation work. Conservation International's Critical Ecosystem Partnership Fund, which is supporting many projects under the umbrella of the Cape Action Plan for People and the Environment, or CAPE, will then be approached for funding this work, which is generally quite costly.

UNIVERSITY OF CAPE TOWN PROJECTS

The effects of invasive alien fish in South Africa include predation, competition for food and space, habitat alteration, hybridisation and the introduction of diseases and parasites. To date, however, there have been no detailed studies in South Africa on most of these effects, so research is being conducted within this project to increase understanding of the impact of predatory invasive alien fish. Darragh Woodford, an MSc student at the University of Cape Town, is investigating the impact of smallmouth bass *Micropterus dolomieui* on indigenous fish of the Rondegat River, a tributary of the Olifants River.

The Olifants River system is recognised as being a biodiversity "hotspot" because it has 10 indigenous fish species, eight of which are endemic and threatened. The presence of smallmouth bass - a particularly destructive predator - is believed to be the main reason for the predicament of the endemic fish; indeed, this is regarded as the primary cause for the threatened status of endemic fish throughout the Western Cape.

"The Rondegat River is an ideal river to study the effects of invasive alien fish, primarily smallmouth bass, on indigenous fish," says CNC's Dean Impson, project leader of the broader study and co-supervisor of Darragh's project.

"The river rises in the Cederberg Wilderness Area, managed by CNC, and it has no instream or offstream dams, but about half way up there's a waterfall that the bass can't get up. Above the waterfall, very high numbers of indigenous fiery redfin, Clanwilliam redfin, Clanwillian yellowfish and Cape galaxias are found in the river, but below the waterfall there are only bass and large yellowfish."

Dean Impson of Cape Nature Conservation's Scientific Services division

"The river banks are also very infested in the middle and lower reaches by invasive alien plants, mainly black wattle, blackwood and bluegums. These certainly reduce the amount of water in the river during summer base flows, and probably also have an affect on riverine fauna by being a foreign source of food. So Darragh's research will look at the effects of not just bass but also invasive plants on the indigenous fish, and in 2004 another student will be taken on to study their impacts on macro-invertebrates in the river."

"The Rondegat River is going to tell us, we hope, what effect alien fish and plants are having on the riverine fauna, and these findings will be used to inform the broader study

The middle and lower reaches of the Rondegat River, which rises in the Cederberg mountains, are infested by invasive alien plants

on the Cape Floral Kingdom's rivers."

SMALLER PROJECTS

Two smaller projects by UCT Honours students have also helped to build the evidence against predatory invasive fish. In 2002, David Christie investigated the impact of smallmouth bass on the Cape whitefish, *Barbus andrewi*. This species is endemic to the Berg and Breede River systems and used to be widespread there, but now the only viable breeding population is in the upper Hex River, a tributary of the Breede. A road causeway splits a 9 km stretch of river into two, and acts as a barrier to upstream penetration by bass. In snorkelling surveys conducted during late summer, David could find no significant differences in riverine habitat between the two sections, but the change in fish assemblage was startling. In the upstream section, he found 345 Cape whitefish, numerous Burchill's redfin (*Pseudobarbus burchelli*) and Cape kurper (*Sandelia capensis*) – as well as five small bass, which must have been deliberately introduced since a previous survey in November 2001. Below the causeway the river was dominated by bass, and the only other fish David observed were five Cape whitefish.

This year another Honours student, Jeremy Shelton, looked at the impact of smallmouth bass on the indigenous fish community of the Witte River, which flows through the largely inaccessible Bain's Kloof. Bass have entered the river from the Breede River and have colonised a 6 km section in the lower reaches, but have been prevented from penetrating further upstream by a waterfall. During a snorkelling survey of five pools and three riffles above and below the waterfall, Jeremy counted 1667 Burchill's redfin and 353 Cape kurper in the upper section, but only 4 redfins and two kurpers, as well as 13 bass, below the waterfall. No marked difference in habitat could be found between the two sections,

The smallmouth bass Micropterus dolomieu *is a voracious predator.*

The endangered fiery redfin Pseudobarbus phlegethon *is endemic to the Olifants River system*

which are exposed to few, if any, anthropogenic activities, so bass are considered the chief suspects in killing off the indigenous fish.

But has the effect of introduced bass been this severe countrywide?

"No, because there's a big difference between the indigenous fish faunas of the Western Cape and up-country," explains Dean. "Up-country, the small species and the juveniles of large species evolved in the presence of predatory indigenous fish like tiger fish, sharptooth catfish and predatory cichlid species, so they know what to do in the presence of bass – they have various anti-predator behaviours. Here, fish evolved in systems where there were no naturally occurring predatory fish. As a result, when smallmouth bass and rainbow trout were put into our streams, they had a devastating impact. The indigenous fish didn't avoid them – they probably swam right up to them instead!"

ANGLING VALUE

Smallmouth bass were first introduced to South Africa in 1937 to improve freshwater fishing, something which Dean says was quite understandable then.

"Many rivers in the Cape Floral Kingdom have no indigenous fish species of angling value, and back then they really didn't know any better," he concedes. "But for the last 20 to 30 years CNC has been aware that invasive alien fish are spreading their ranges, and we've wanted to identify some pilot areas where we could reverse the process."

"We plan to target rivers in conservation areas, because we have control over what goes on there, and many of these rivers are rarely visited. The most likely candidates for rehabilitation work have no value for bass-fishing - most of the fish are only 15 to 20 cm long, so eradicating them in those rivers shouldn't cause any conflict with anglers.

It's clear that Dean is talking from experience.

DIFFICULT RELATIONSHIP

"CNC has had a difficult relationship with the bass-fishing fraternity until now, because there's a perception that we are anti-bass," he acknowledges. "That's certainly not the case, but we don't want to see bass being stocked into new areas. There are enough rivers and dams with alien fish species to cater for everybody."

"Clanwilliam Dam, for instance, has very good bass-fishing, but in the Rondegat River just upstream the bass are so small that they're not worth catching."

Fortunately, CNC's concerted efforts to raise awareness about the impacts of invasive alien fish have started paying off.

"As a gesture of goodwill, Peninsula Bassmasters has donated R10 000 towards the Rondegat River project," says Dean, "so the future holds a lot of promise for an improved relationship with freshwater anglers."

Question: Why is the tap water sometimes white when it comes out of the tap?
Answer: Air bubbles – due to the high pressure in the distribution system, any trapped air in the system will become dissolved in the water. As soon as the pressure is released by opening the tap, the bubbles reform, giving the water a white appearance. If you pour a glass of this water and allow it to stand, the water will clear from the bottom upwards as the air leaves the water.

Intriguing Discoveries from Mine Fissure Water Organisms

Unique organisms found in deep underground water pockets in South Africa's gold mines are redefining life as we know it. They may even help give earthlings an insight into whether life exists or at least existed on other planets. Marleen Smith reports.

How does life begin and evolve? Is there life else where in the universe? What is the future of life on earth and beyond?

These questions have for many decades, even centuries, been fundamental to man's natural curiosity over his immediate and not so immediate surroundings.

They are also the three great unknowns being pursued officially by the Astrobiology Institute of America's National Space Agency (NASA). Research now being done on underground water caught in deep anaerobic pockets in South Africa's gold mines - scientifically called fissure water - may provide more than one answer. In fact, intriguing discoveries have already been made - already redefining our conventional understanding of life.

Because these mines are the deepest excavations in the world, they provide easy access to rock formations and groundwater far below the earth's surface.

Although the research started a mere seven years ago, some of the

Dr Esta van Heerden, with a NASA sticker on her helmet, and Prof Derek Litthauer working in Kloof gold mine at Fochville in the North West to extract living organisms from fissure water.

Another organism, as yet an unnamed new species, was isolated aerobically at 60°C. (For each kilometre one descends beneath the earth's surface, the temperature increases with between 10 to 15°C).

Three new organisms, unknown to man until now, have been found in the fissure water pockets. A further 20 to 30 are also presumably new, although tests are still being conducted to verify this.

Esta forms part of a group of researchers whose work on the mine fissure water is being funded by NASA, the US's National Science Foundation and South Africa's National Research Foundation. The funding is channeled through a program called Life in Extreme Environments (LexEN).

HOW IT ALL STARTED

The project started in 1996 when American geological researchers discovered a living micro-organism at a depth of 3,2 km in a borehole in a South African gold mine. It was alive despite having been trapped there for millions of years.

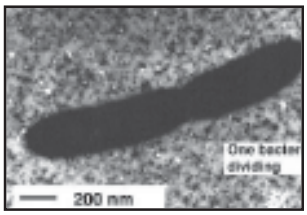
Further investigations led to the discovery of more "extremophile" organisms (living in extreme environments), which prompted establishment of a new research project. It has since been led by the US' Princeton University. The group, predominantly American, recently received membership of NASA's Astrobiology Institute (NAI). American interest in the project revolves in large part around its potential contribution to space research, particularly relating to the question whether there is, or has been, life on Mars.

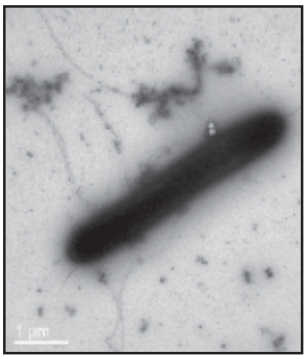
"The ecosystems we are investigating represent the closest analogy to

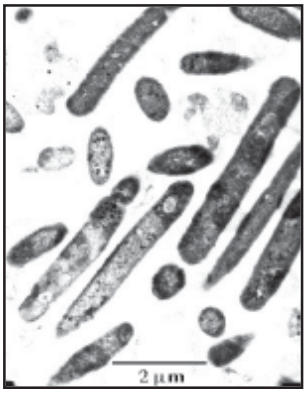
A team of Free State University researchers collecting fissure water samples in the Kloof gold mine at Fochville in North West. From left are Prof Derek Litthauer, student Mieder Foster, Dr Esta van Heerden and student TJ Malindi. The humidity at the borehole where they are working is 100% plus and the water temperature between 55 and 60°C.

discoveries have already stretched the known habitat limits for life, says Free State University biochemist Dr Esta van Heerden.

Living organisms have been found as deep as 3,2 km. *Alkaliphilus transvaalensis*, a new genus and species, was isolated from a water containment dam with a pH of 11,3. It is one of the most alkali-loving organisms ever described.







Top right
An electron-microscopic enhancement of the anaerobic microbe Thermus multireducens, *a fissure water organism that can reduce a range of metals and survives at very high temperatures.*

Middle right
An electron-microscopic image of Alkaliphilus transvaalensis, *a new genus and species, that was discovered in fissure water. It is one of the most alkali-loving organisms ever described.*

Bottom right
Geobacillus thermoleovorans *survive in fissure water as hot as 60 to 65°C.*

Three students at the Free State University applying an advanced DNA technique to determine the nature of organisms found in mine fissure water. From the left are Michelle Pienaar, Dr Carlien Pohl and Jay Lee.

Dr Esta van Heerden (left) and Free State University student Jacqueline van Marwijk test the reduction of metals by organisms found in fissure water.

what might exist beneath the surface of Mars," Esta says.

Their research became particularly relevant after water was discovered on Mars three years ago.

Water is known to currently exist on the Red Planet as ice in the northern ice cap and as vapor in faint clouds. Planetary geologists believe, however, that vast quantities could remain trapped under the surface.

According to a CNN report many theorise that such groundwater remains in a frozen state. However, some images suggest that recent underground volcanic forces have heated this water into a liquid state or that seepage of liquid water into some of the many canyons on Mars may have occurred.

GUIDELINES

Which is where Esta's group comes into the picture. Their research can provide invaluable guidelines for the future design of instruments to detect life in these presumed waters on Mars missions.

The next mission will take place in January 2004, during which three craft will be deployed on Mars. Two of them will be large versions of the small space rover which earlier sent back amazing pictures of the planet. Together with the third, a craft of the European Space Agency, they will investigate its atmosphere and composition of its rocks. More importantly, they will be able to drill into Mars' surface to sample the soil for signs of life.

Soil samples will be heated up to temperatures of 800°C and the emitted gases analysed to ascertain if life exists or existed. The ultimate proof will be if they succeed in isolating the organic compounds associated with life: DNA and proteins.

"The study of deep underground ecosystems in ancient groundwater is directly relevant to the search for

extant life in the subsurface of Mars," Esta explains further.

"Our investigations determine the type of pre-biotic (pre-life) compounds that can be formed in an isolated geological terrain where a thermal event has eradicated microbial life. We also try to establish whether life itself could have been spawned there.

"If life can exist in geological formations up to three kilometres below the earth's surface, it makes discovery of life on planets such as Mars or the moons of Jupiter so much more plausible."

OLDEST 'FOSSIL IMPRINTS' OF LIFE ON EARTH

As far as the origin of earthly life goes, fissure water has the potential to provide some of the most reliable clues yet: "The water pockets are like fossil imprints — literally as ancient as earth itself," Esta says.

"They have been among a few closed, undisturbed environments since the formation of the world."

The microbial communities they are discovering now, have been sequestered from earth's surface and its atmosphere for tens to hundreds of millions of years. They have likewise been isolated from the environments that support their activities, and have thus turned into a dormant state.

Esta and her fellow researchers are spending much time to find the necessary means to reactivate and cultivate each found organism. New DNA techniques have simplified this work significantly by enabling them to isolate microbial DNA directly from soil or water samples taken at these great depths.

MORE BENEFITS TO SOCIETY

By finding and cloning the functional genes of the fissure water organisms, natural products can be produced to benefit society. It is believed that the unique organisms and enzymes found in fissure water may hold many advantages to especially the mining industry.

More particularly, it may advance bioleaching or bioremediation technologies and the environmental rehabilitation of areas contaminated by heavy metals. Such biological rehabilitation methods are much more cost-effective than the alternative chemical and mechanical techniques, both in terms of money and environmental and human exposure.

For instance, one of the anaerobic microbes discovered in fissure water at a heat of 60°C – *Thermus multireducens* – can reduce a range of metals. These include hazardous cadmium and radio-active uranium. It also converts chrome (VI), which is particularly hazardous to humans, into the less dangerous chrome (III). This organism should therefore be a handy tool in the remediation of mine wastes.

Other fissure water micro-organisms may be used to reduce the levels of hazardous gases in mines. A number have been found to be autotrophic, meaning they make organic carbon from carbon dioxide while consuming sulphide, methane and hydrogen.

It has been proven that methanotropic micro-organisms (living off methane), as found in fissure water, can cost-effectively degrade trichloroethylene in groundwater. This pollutant is associated with almost all industrial processes.

Fissure water organisms may also have a host of applications on a level different from mining. The simplest example, Esta says, are the enzymes used in washing powders to remove protein and fatty stains. They can also serve as biological catalysts to manufacture specialist compounds, such as medicines, that are normally very difficult to manufacture through conventional chemistry.

As the fissure water organisms are used to function at high temperatures, their applications can be used effectively in heated environments, such as warm water.

HIGH DIVIDENDS FOR FREE STATE UNIVERSITY

The project is yielding high institutional dividends for the Free State University, Esta says.

Apart from international exposure and publicity, they also gain in large additional amounts of research funds and expensive equipment. American and Free State students are participating in an exchange scheme as a further consequence of the project.

Although these extras are all important to Esta, she finds the primary significance of their project on a more fundamental level:

"Someone had the vision to check whether there is, or at least was, life so deep under the earth's surface," she says.

Enquiries:
Esta van Heerden, tel (051) 401 2472
Derek Litthauer, tel (051) 401 2122

The Registration of Irrigation Water Use

The registration of agricultural water use in South Africa can be seen as the first major building block in ensuring the correct and equitable application of the National Water Act (1998).

As about two thirds of South Africa's developed water supply is used by agriculture and principally for irrigation, the registration process required that all existing irrigation water uses had to be registered with the Department of Water Affairs and Forestry (DWAF). Thereafter, based on the principle that proper water resource management is for the benefit of all users, users are being billed by DWAF to cover the costs of the management function, on the basis of the registered volume of water used.

ESTIMATING CROP IRRIGATION REQUIREMENTS

The registration process required that farmers complete a series of forms that included the volume of water they used for irrigation, as well as the irrigation system used, the crops grown and the area irrigated. Where data on actual water use was not available, which was the rule rather than the exception, the quantity had to be estimated, usually by regional personnel of DWAF with the support of consultants. Farmers were normally well informed on the areas of crops grown but required guidance on the water use of the crops (the other input needed to arrive at the volume used). SAPWAT, an irrigation planning and management tool developed for the Water Research Commission by MBB consulting engineers, had already been specified in the DWAF Pricing Strategy as the computer program to be used in the determination of water volumes for irrigation. SAPWAT is a relatively simple program but its effective use requires insights into irrigation practices. At the outset of the registration process, training in irrigation principles and the application of SAPWAT was provided for DWAF personnel and consultants in the regions. The agricultural aspects of irrigation are not generally well understood, and the appreciative interest shown by engineering-oriented personnel was most encouraging.

THE REGISTRATION PROCESS

The registration of water uses is far advanced but it is only the beginning of a process that will ultimately lead to compulsory licensing. It was, therefore, decided to review the effectiveness of SAPWAT in the process and evaluate how it will be applied in the future, through discussions with the Brits-based consultants Schoeman and Partners. The company was contracted to undertake the registration of in-field irrigation water use in the Crocodile/Marico Water Management Area and subsequently was awarded the contract to undertake the next step in the process, namely registration verification. for the Upper Vaal catchment. This is the first verification study and is serving as a pilot project to test the methodology to be applied countrywide. Concurrently Schoeman and Partners, in conjunction with Thompson & Thompson and Copad, are developing an official DWAF manual spelling out both the legal and technical details of the verification procedure that will be contracted out to consultants across the country.

Mr Hennie Schoeman, the responsible partner, explained how they had approached registration:

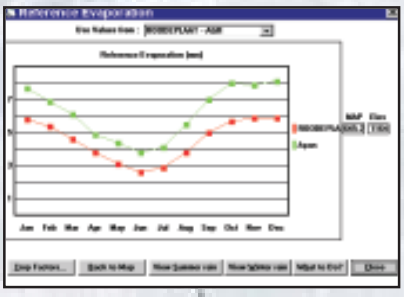
"SAPWAT was employed to develop information on crop irrigation requirements. This is a powerful programme, with many different parameters that can be changed. Although any person can use this programme, expert knowledge of crop characteristics, crop requirements and irrigation practice is necessary to produce a reliable answer. Our initial task was to standardise water volumes to avoid a scenario in which the same crop under the same conditions has different requirements at different locations within the same homogeneous climate zone. SAPWAT runs were done for the crops in each sub-area, applying the irrigation method and crop production practice most generally adopted. The monthly and seasonal volumes of water required per hectare for each crop were transferred to a spreadsheet.

"The spreadsheets were invaluable. Significant disparities in the initial estimates made by farmers were immediately identified. The spreadsheet values then formed the basis for establishing the causes of the disparities. In a few cases these were legitimate and could be explained by innovative irrigation methods, management practices or circumstances, and this was acceptable. The objective of registration was to establish a reasonable estimate of actual water use, not irrigation efficiency or even legitimacy. That will come later in the process!

"It soon became evident that a significant number of farmers required assistance with their registrations, and we arranged venues where we would be available to assist them. We had coffee and rusks on hand, and two computers installed and manned, the first loaded with GIS and all farm details and the second with the crop irrigation requirement spreadsheet and SAPWAT. At the first monitor the farmers were intrigued by the maps and detail available, and the administrative and legal aspects were soon cleared up. At the second monitor, what could have been an ordeal became a fascinating computer game as the graph of monthly water use developed on the screen. In the rare cases where there was disagreement, SAPWAT was called up and production methods and irrigation management practices reviewed and alternatives

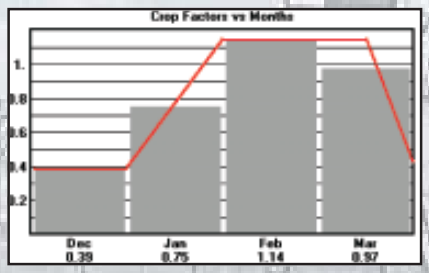
SAPWAT - An Irrigation Planning and Management Tool

The SAPWAT computor program is an irrigation planning and management tool. It is not a crop growth model or a scheduling procedure. It is designed to facilitate rapid decision-making involving alternative irrigation methods and strategies. It is especially suited to diagnosing weaknesses in existing irrigation systems making it an appropriate extension and training tool.



SAPWAT utilises a reference evapotranspiration that provides a base for calculating specific crop evapotranspiration at any stage in the growth cycle. This is the internationally recommended hypothetical "short grass" reference calculated from weather data using the FAO Penman-Monteith equation. Inputs are incoming solar radiation, air temperature and humidity and wind speed. There is direct access to a file of 350 weather stations and "own" weather stations can be set up. Average daily evapotranspiration in mm is plotted for each month and A-pan values are provided for comparison purposes

The short grass reference automatically caters for climatic zone differences.



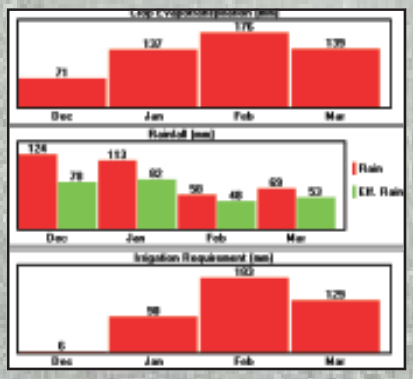
Crop Evapotranspiration = **Crop Factor** x Reference Evapotranspiration

The crop factors are based on the FAO four stages of crop development and are interpolated to provide monthly values.

Stage one is the period until ground cover reaches 10%, stage three is when the cover is complete, stage two is the intermediate period when the cover is increasing and the evapotranspiration changes from being largely evaporation from the soil surface to transpiration from the crop with stage four is the period when the vegetative growth dies off.

SAPWAT is unique as a planning model in that the crop factor can be modified to account for irrigation method, crop management practices including emerging farmers and irrigation strategies.

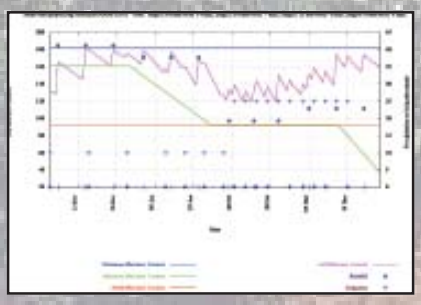
Default values are provided for all crops grown under irrigation in South Africa. A major asset is that the process of developing crop factors is logical and holds no secrets.



Monthly crop evapotranspiration is calculated by multiplying reference evapotranspiration by the average monthly crop factor.

Monthly rainfall is modified to reflect how much of the rain becomes available to the crop and is not lost by run off or deep percolation. This is influenced by irrigation method and management.

The irrigation requirement takes into account irrigation efficiency and yield targets.



Irrigation method and management are dependent on such factors as soil type, rooting depth, water content of the soil profile at the commencement of the season, frequency and amount of irrigation, planting date, and crops and varieties grown.

In addition the influence of the irrigation method, condition of irrigation equipment, and target yields on the percentage of water supplied that becomes available to the crop is estimated.

Output is in the form of tables and graphs that facilitate planning and management decision-making.

Enquiries - Charles Crosby: Tel 012 803 2870 or 083 456 9489; e-mail crossbee@mweb.co.za
Pieter van Heerden: Tel 051 446 1521 or 072 209 9329; e-mail psvh@mweb.co.za
Down-load the SAPWAT computer program gratis from the website: sapwat.org.za

considered until agreement was reached."

THE VERIFICATION OF REGISTRATIONS

The next questions put to Mr Schoeman concerned the verification of registrations and the significance of the process in practice. He put us in the picture:

"The registration process required that all water uses, without consideration of legal status, had to be registered. The only requirement was that it must be an existing use, whether lawful or not. The verification of registered water use is critical since lack of proper verification may lead to a situation in which the injustices of the past, such as where a water user is using more than his fair share, are perpetuated unnoticed.

"After a detailed study and a comparison of every registered water use against water use entitlements, controls and restrictions, and after all other supporting material such as satellite imagery, aerial photographs and field survey information have been consulted, the registrations can be classified as shown in Table 1.

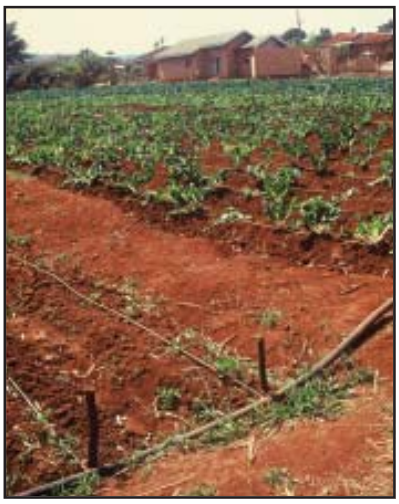
TABLE 1

Category	Description
Correct registration	Users who have registered all their water use entitlements correctly.
Over-registrations/ unlawful use	Users who have registered uses to which they are not entitled.
Under-registration	Users who have omitted to register uses to which they are entitled, and are using in fact.
Failure to register	Users who have not registered any identified water use at all.
Insufficient information	Users where there is insufficient information available to make a determination.

"The process of data verification and capture on GIS is exhaustive. It involves the acquisition and validation of information on existing entitlements, title deeds, cadastral updates and all the data created by the registration process - quite apart from the detailed evaluation of the crop irrigation requirements."

The approach to arriving at crop irrigation requirements is an extension and refinement of the process followed when doing the registrations. Here it is even more important to standardise water volumes to avoid a scenario in which the same crop differs materially as a consequence of the variations in irrigation method and management. This has been achieved to a satisfactory degree by the following procedure:

- Homogeneous climatic zones are defined by using the data available in SAPWAT and WR 90 as well as agricultural information. From experience, these climate zones will follow the boundaries and will include one or more quaternary catchments.
- A summary of all the crops registered within a zone can be produced. This summary includes the total hectares under irrigation for a particular crop under a specific irrigation system.
- Target efficiency values are defined for use in SAPWAT after consultation with DWAF regional personnel.
- With the list of crops and target efficiencies, crop irrigation requirements can be determined for each identified climatic zone. An irrigation quota is developed on the basis of the weighted average crop and irrigation system, for a specific climate zone.
- New water use requirements are now calculated for each registration. A specific user's water requirements may either be case specific, or may be based on the quota. The latter is a welcome simplification that is generally accepted, but where case specific consideration is justified SAPWAT facilitates the development of defensible values.



The objective of registration was to establish a reasonable estimate of actual water use, not irrigation efficiency or even legitimacy. That will come later in the process!

The process that has now commenced is immense and demands meticulous attention to detail, informed judgment and the very latest in technology.

Tshepo Maeko: Rooted in Africa

Tshepo Maeko is a young man with both feet firmly planted on South African soil.

As a Master's graduate of the University of Pretoria's Department of Plant Production and Soil Science, Tshepo has the kind of talent and passion for his subject that could open international doors. But, he says, he's not going anywhere just yet.

"Global experience would be great, but as an irrigation management specialist, I think there's a lot of work to be done here first," he smiles.

Most recently, this has involved the practical research and testing of a new irrigation management device, the Wetting Front Detector (WFD). Originally, WFD was developed by Professor Richard Stirzaker at CSIRO in Australia, the commercial product is expected to be available on the local market towards the end of this year. Tshepo has played an integral role in the fieldwork conducted at the university, which has since led to the patenting of the product in South Africa.

The detector – an affordable irrigation management tool – addresses what Tshepo describes as a major

challenge facing the South African agricultural industry. "There is a huge resource gap between big commercial farmers and small-scale producers," he says. "For example, the new water laws mean farmers have to be far more knowledgeable about how they use and manage water for irrigation. But most irrigation management products and technologies in the market are complex and costly, and far beyond the reach of small-scale farmers. The Wetting Front Detector is a very simple, user-friendly and highly effective product that could cost less than a tenth of other irrigation management tools."

Tshepo explains that the detector enables farmers to monitor the depth of water penetration into the soil during and after irrigation or rainfall. The design is simple enough that anyone can use it without having to understand the science behind it.

"With this kind of information, farmers can quickly establish whether they are over- or under-watering, and can adjust the amount or regulate their irrigation accordingly. It also helps farmers to learn from previous irrigation patterns, and use this experience to make future decisions. By not over-watering farmers also prevent the leaching of nutrients in the soil."

SCIENCE AND FARMING

It's not often that students get the chance to see their research in practice, and this quietly-spoken 23-year-old agrees that it has given him valuable new insight into the role of science in agriculture.

"Many people don't really appreciate the real value of science in farming," he says. "In terms of an academic career, farming is often classed as 'dirty work', but – as any water professional or agriculturist knows – there is a lot more science behind it than you think. In South African agriculture, science seems to have a very low profile. It's time we gave it more credit."

Tshepo's fieldwork has also taught him that "science and technology" is more about people than it is about laboratories. "Good technology is useless without good communication," he says. "By working side by side with the farmers to establish their real needs, and by communicating our progress, we have been able to make a real difference in their lives. We need more effective communication between farmers, scientists and various organisations. Successful water management in South Africa depends on it."

HOME TOWN

While Tshepo's recent experiences may have "unleashed" his research capabilities, the university's experimental farm is many miles from his home town, and he is quick to credit his parents for making his journey to academic excellence possible.

Born and raised in the rural village of Ga-Modjadji, north-east of Tzaneen, Tshepo attended the local primary school before his parents sent him to Tshebela High, a boarding school near Pietersburg (now Polokwane). Having discovered a passion for science, agricultural studies and geography, he matriculated in 1996 and completed his degree at the University of the North, before enrolling for his Master's in Pretoria, in 2001.

"I have a great deal of respect for Tukkies as a scientific and agricultural research institution," he says. "What South African learners need is good mentorship, and I have been lucky enough to have it. I have been blessed with the guidance and tutorship of people like the department's Professor John Annandale, and Dr Martin Steyn, who I have worked with on a daily basis. Fellow researcher, South African-turned Aussie, Professor Richard Stirzaker, has also been the wind beneath my wings. They have all made it simple for me."

One of Tshepo's long-term goals, ("apart from making loads of money and establishing my reputation as a scientist", he laughs), is to improve general awareness of the importance of irrigation management in South Africa.

WATER USE

"Despite our erratic rainfall and strict new water regulations, there is still vastly inefficient water use in South Africa. Greater awareness of the importance of irrigation management will lead to a more productive agricultural sector, sustainable crop production and therefore food security for a very large segment of the population. It will also allow us to build up a strong scientific basis for meeting the needs of local farmers."

Tshepo backs this up with a refreshingly positive view of the future of local agriculture. "With the training and capacity building that is starting to take place, we can expect to see many more young people entering the market, who are well-equipped to give South African farming a boost," he says.

If they're anything like Tshepo, the industry has a lot to look forward to.

World Commission on Dams Report: What South Africa is Doing About It

Large dams have figured in national economic development programmes throughout the world for the best part of a century, but it was only in 1998 that the first comprehensive global and independent review was conducted into their performance and impacts and the range of alternative options available for water and energy development. The final report of the World Commission on Dams (WCD), which undertook the study, was published in November 2000. The objective of the WCD was to review the effectiveness of large dams and develop internationally acceptable principles, strategic priorities, criteria and guidelines for their application. The WCD then passed the baton to the nations of the world. *"We have told our story,"* it said. *"What happens next is up to you."*

The purpose of this article is to look at what South Africa has done and is doing, within its own environment, to further the debate about dams – a debate which the WCD described in its report as relating to "the very meaning, purpose and pathways for achieving development."

PHYSICAL BACK-GROUND

The subject of large dams is highly relevant to this country, in that its rainfall patterns are among the most variable in the world. Some 60% of South Africa's river flows are generated from only 20% of the land. The need for water management is further illustrated by the fact that, in the summer rainfall region of the country, more than 80% of the rain falls within the six summer months.

South Africa has more than 500 large dams, of which 50 have a storage capacity exceeding 100 million m^3. The country's reservoirs store about 746 m^3 of water per person – an order of magnitude higher than that for the rest of Africa. Indeed, 60% of the large dams in Africa are situated in South Africa and Zimbabwe. The main purpose of dams in South Africa is irrigation and urban/ industrial water supply – less than 2% of the country's electricity is generated by hydropower.

Dam development is markedly different in the 21st century than when South Africa's first large dams were built in the late 19th century. A significant portion of the country's water resources has been developed, and very few new large dams are to be initiated in the coming two decades. The population of the country has increased and spread out over the various catchments, and the natural environment is under threat.

Many negative technological, economic, social and environmental impacts of large dams have been identified. It is now accepted that dam development requires joint decision-making to take the interests of various stakeholders into account, and that dam construction is just one of many options to be considered in water and energy planning processes. The range of options includes water and energy demand management, alternative energy sources and integrated catchment management.

THE SOUTH AFRICAN INITIATIVE

It was against this background that South Africa took up the challenge of the World Commission on Dams – namely that *"what happens next is up to you"*. Representatives of the country's stakeholders (in respect of water management) gathered together in a symposium in July 2001 to consider the WCD report. They declared themselves to be broadly supportive of the strategic priorities outlined in the WCD report but believed that the guidelines needed to be contextualised in the South African situation. A Steering Committee was accordingly elected under the title *"The South African Multi-Stakeholder Initiative on the World Commission on Dams"* with a mandate to carry the local contextualisation process forward. The composition of the Steering Committee included representatives of government, the private sector, NGOs, affected parties, research and finance, and utilities.

The declared objectives of the Multi-Stakeholder Initiative were to:

- Contextualise the WCD report in the South African situation;
- Identify elements in the report that could be beneficially implemented or reinforced in South African large dam practice;
- Make recommendations to all stakeholders on the implementation of such elements in their work;
- Make recommendations on policy, regulation and legislation;
- Identify constraints to the implementation of the recommendations; and
- Propose institutional structures for multi-stakeholder participation in follow-up and monitoring.

The Multi-Stakeholder Initiative appointed a Co-ordinating Committee to guide the preparation of a ***Scoping Report*** to be laid before the multi-stakeholder forum, in which relevant issues should be broadly analysed, contentious issues identified, avenues of research identified, and recommendations made on the way forward. The resulting document – which is not to be regarded as a blueprint for physical action – has been released for consideration by the multi-stakeholder forum.

THE SCOPING REPORT

The purpose of the Scoping Report, according to the Co-ordinating Committee which compiled it, is to develop a tool for decision-making that reflects the potentially disparate views of the range of stakeholders. In this regard, the Co-ordinating Committee noted the WCD's observation that decisions on dams and their alternatives, like all development choices, had to respond to a wide range of needs, expectations, objectives and constraints, and the further observation that while consensus could be found on many issues, intractable fault lines still separated critics and proponents on a number of financial, economic, social and environmental issues.

The Scoping Report noted the presence of such fault lines in South Africa, e.g. the belief amongst Labour and NGO sectors that marginalisation of the majority by means of "unjust technologies" like large dams was leading the country along the path of unsustainability,

and the contrasting belief that increasing the amount of water stored in Africa could and should play a role in the eradication of poverty. Between these and other opposing viewpoints, the Co-ordinating Committee observed that adoption of the rights-and-risks approach advocated by the WCD required acknowledgement of associated obligations between diverse stakeholders during the consensus-building and decision-making processes.

The Co-ordinating Committee accepted the five Core Values to which all could subscribe, raised during the WCD's Global Review – namely Equity, Efficiency, Participatory Decision-making, Sustainability and Accountability. The Scoping Report noted that these values accorded with the international norms articulated in the UN Declaration of Human Rights.

The Scoping Report also noted synergies between the WCD's principles and existing South African policy principles post-1994, characterised by the notion of democracy through participatory, co-operative and developmental governance. South Africa's Constitution – one of the most progressive in the world – provided a strong anchor for the rights-and-risks approach proposed by the WCD. Participation of all interested and affected parties had become a widespread fundamental principle of numerous pieces of legislation, including two Acts of particular relevance for dams and development. These are the National Water Act and the National Environmental Management Act, both of which provide for equitable and inclusive decision-making.

The National Water Act ensures that water is viewed in law as a national asset (rather than that of the landowner on whose property it occurs as groundwater or through whose property it passes as a river). The Act gives priority to water for ecological needs and for basic human needs; no other water entitlements are guaranteed. The National Environmental Management Act, in turn, includes a people-centred approach to environmental management, combined with a risk-averse and cautious approach. Taken together with numerous other pieces of policy and legislation, these two Acts provide an indisputable basis for the core values of the WCD in the new South African governance framework.

SEVEN STRATEGIC PRIORITIES

Building on the five Core Values and the rights-and-risks approach, the WCD identified seven strategic priorities to guide water and energy planning and decision-making. These are sketched – necessarily very briefly in this article – as follows, together with the key issues for South Africa identified by the Multi-Stakeholder Co-ordinating Committee:

Gaining public acceptance

The message of the WCD is that, to be socially legitimate and produce positive and lasting outcomes, it is essential to gain public acceptance for key decisions on equitable and sustainable water and energy resources development. Demonstrable public acceptance of all key decisions is achieved through agreements negotiated in an open and transparent process, conducted in good faith and with the informed participation of all stakeholders.

The Co-ordinating Committee observed that in the South African context participation might occur in name only, unless there is real capacity-building, information sharing, economic empowerment and skills transfer to local people. A range of institutional mechanisms for participation in decision-making on water resources development is evolving. The primary mechanism is the Catchment Management Agency, currently being established in the first of 19 water management areas in South Africa. A further example is the Gauteng Water Cycle Management Committee.

Key issues for this country include the timing of participation (to be meaningful, it must commence at an early stage of planning), the extent to which policy principles on participation are translated into action, and the question of whether informed participation is taking place (i.e. the awareness of stakeholders and their capacity to participate). Key debating points include the question of rights-and-risks identification, and the question: "When can it be said that public acceptance has been demonstrated?" Amongst many other issues, the Co-ordinating Committee raised the notion that free, prior and informed consent by indigenous and tribal peoples requires clarification in the South African context.

The Committee identified a number of studies required to guide the implementation of public participation in South Africa.

Comprehensive options assessment

The key message from the WCD is that alternatives to dams do exist. To explore these alternatives, it is necessary to assess water, food and energy needs and clearly define objectives. It is critical that the assessment process be participatory and that social and environmental aspects have the same significance as technical, economic and financial factors. The Co-ordinating Committee noted that in South Africa, as globally, the environmental and

social impact of dams has been far greater than initially envisaged.

A trend in South Africa is that the thrust for building dams has diminished in the Department of Water Affairs and Forestry (DWAF), with the focus now on a range of other options such as water demand management, conservation and the protection of water resources.

Addressing existing dams

Dams and the context in which they exist should not be seen as static over time. Changes in water use priorities, and physical and land use changes in the river basin, could transform benefits and impacts. The key message from the WCD was that opportunities exist to optimise the benefits of many existing dams, address outstanding issues and strengthen environmental mitigation and restoration measures. The WCD had also stated that outstanding social issues associated with existing large dams should be identified and assessed, and processes developed with the affected communities to remedy them.

The Co-ordinating Committee noted the consensus amongst South African stakeholders that social issues required priority – in particular compensation for loss of property and livelihoods and, of even greater importance to some communities, remedies for the inundation of land on which their ancestors had been interred. There were also environmental and operational concerns around existing dams, primarily related to deteriorating water quality.

A key debating point, the Committee noted, was that of how to define the parameters for auditing existing dams. A further key debating point: "Should a moratorium be placed on dam construction? Until what conditions are met? Or should we ensure that committed steps be adhered to?"

Sustaining rivers and livelihoods

The key message from the WCD is that rivers, watersheds and aquatic ecosystems are the biological engines of the planet and the basis of life and the livelihoods of local communities. Dams transform landscapes and create the risk of irreversible impacts. Understanding, protecting and restoring ecosystems at river basin level is thus essential to foster equitable human development and the welfare of all species. This involves basin-wide understanding of the ecosystem's functions, values and requirements, a national policy for maintaining rivers with high ecosystem values in their natural state, policy options that avoid significant impacts on threatened species, and the modification and operation of large dams to release environmental flows to help maintain downstream ecosystem integrity and community livelihoods.

The Co-ordinating Committee noted that the Reserve requirements in South Africa's National Water Act provide a statutory basis for the WCD principle requiring basin-wide understanding of ecosystem functioning. Generic protocols for determining the Reserve are being developed. Answers are required to numerous questions related to the fine-tuning of the Reserve, not least the question of who pays for the ecological Reserve. For example, should the owners of a forestry plantation on the top of a hill be made to pay?

Research is also required on releases from dams, needed to maintain ecosystems and cater for downstream users. One perspective holds that the large dams contribute to flood control, whilst the opposing view suggests that large dams control small floods, thereby giving a false sense of security leading to resettlement of the floodplain, with devastating effects when really large floods occur.

Recognising entitlements and sharing benefits

The key message from the WCD is that joint negotiations with adversely affected people result in mutually agreed and legally enforceable mitigation and development. These provisions should recognise entitlements and improve livelihoods, with affected people as the beneficiaries.

There is consensus in South Africa on this aspect, the Co-ordinating Committee reported, but a number of basic and procedural questions and some unrealistic expectations need to be addressed. A key debating point relates to the matter of how widely the benefits of a dam development should be shared. Also, will an approach that is acceptable for one dam be feasible for every dam?

Ensuring compliance

The key message from the WCD is that ensuring public trust and confidence requires that governments, developers, regulators and operators meet all commitments made in the planning, implementation and operation of dams. This requires a compliance plan with clear and consistent criteria and guidelines, including for costs, incentives and anti-corruption measures.

Many participants felt that in the South African context the water sector needed an independent regulator to ensure compliance with all commitments and obligations. The Co-ordinating Committee quoted numerous aspects needing resolution between diverse stakeholders, including the composi-

tion of a multi-stakeholder structure to ensure compliance, determination of the indicators required in the compliance process, and the institution of processes to eradicate corruption.

Sharing rivers for peace, development and security

The storage and diversion of water in the case of trans-boundary rivers has been a source of tension between countries and within countries. The key message of the WCD is thus that constructive co-operation is required between countries on such issues. "States need to be innovative in defining the issues for discussion." The principles enunciated by the WCD extend to shared river basins, and call for negotiation on the basis of good faith between riparian states, and between political units within countries.

South Africa has a number of formal water agreements with its neighbour states. The SADC Protocol on Shared Watercourses, adopted in 1995, is indeed more extensive than the relevant WCD guideline. The Co-ordinating Committee noted however that dam development in South Africa had had negative ecological and social impacts, and it had been proposed that this be included in an audit proposed as a first step to addressing the situation relating to existing dams.

A further key issue in the South African context is that of the way in which WCD strategic priorities and principles should be carried forward into the New Partnership for Africa's Development (NEPAD).

PRIORITIES FOR ACTION

Participants in the Multi-Stakeholder Forum in July 2002 were polled on the weight which they attached to the wide range of debating points identified in the Scoping Report. Four clear priorities emerged from this exercise as deserving of further exploration and action, namely:

- The question of reparations/ compensation for outstanding problems from existing dams;
- Whether social and environmental issues are accorded equal weight with economic, financial and technical issues when assessing water development options, and how this should be improved;
- The meaning of stakeholder involvement in South Africa, and how the rights-and-risks method of identifying stakeholders should be used;
- How to determine the point at which it can be said that public acceptance has been demonstrated.

The Co-ordinating Committee observed that, while the Scoping Report was not required to be analytical, but rather to reflect the range of different perspectives concerning the further implementation of the WCD in the South African context, it was nevertheless clear that for each of the seven strategic priorities, institutional issues were emerging as a clear cross-cutting issue for the further implementation of the WCD proposals.

Two main institutional issues arose here, which were merely noted for further discussion by the Co-ordinating Committee. The first related to institutional capacity at local level. The overriding challenge in South Africa was to achieve effective local government that enhanced the quality of life – which was clearly important for the management of water resources at local level. The second issue concerned the nature of the multi-stakeholder institutional mechanisms which would be needed at different levels to take both the WCD and South African policy principles forward.

THE WAY FORWARD

The way forward indicated by the Multi-Stakeholder Workshop is for the above priority areas to be addressed over the following 24 months. Further discussion by the Co-ordinating Committee will result in some decisions to implement action steps. One of the actions already agreed is to establish a Working Group on Reparations, which will explore mechanisms, timeframes and procedures for addressing the issue of outstanding reparations relating to existing dams.

The Multi-Stakeholder Forum was also unanimous that the South African Initiative to contextualise the WCD report should continue. Stakeholders should be divided into six sectors, each with two representatives.

"The ongoing process needs to ensure that there is commitment from all stakeholders to adhere to certain milestones in this Initiative. The Co-ordinating Committee will identify the specific studies or actions that need to be undertaken."

The Scoping Report noted that the end product would not be the result of the studies undertaken, but rather implementation of the recommendations of the studies.

The outcomes of the studies and activities undertaken by the Co-ordinating Committee will be discussed at a Multi-Stakeholder Forum.

Persons wishing to be kept informed of the progress made by the Initiative are invited to contact Cathy Sepeng of the Secretariat at tel (011) 313 3615, fax (011) 313 3086 or e-mail catherines@dbsa.org.

SOUTHERN AFRICA & AFRICA 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.

WATER AFRICA 04
MARCH 17-19

The Water Africa 2004 sub-Sahara international exhibition and seminars will be held in Maputo, Mozambique.
Enquiries: Jacqui Hepworth, ACE Event Management, Johannesburg. Tel/Fax: 011 705 1648. Cell: 083 626 5882.
E-mail: jacqui-acesa@mweb.co.za

WISA
MAY 2-6

The biennial conference and exhibition of the Water Institute of Southern Africa (WISA) will be held at the International Convention Centre in Cape Town.
Enquiries: The Secretariat. WISA, PO Box 6011, Halfway House 1685. Tel: (011) 805 3537. Fax: (011) 315 1258.
E-mail: conference@wisa.co.za

WASTEWATER
JUNE 27-30

An IWA specialist conference on water and wastewater management for developing countries will be held at Victoria Falls in Zimbabwe.
Enquiries: Innocent Nhapi, Department of Civil Engineering, University of Zimbabwe, Box MP167, Mount Pleasant, Harare, Zimbabwe. Tel: 263 (0) 4 303288.
E-mail: wamdec2004@eng.uz.ac.zw
Web: www.uz.ac.zw/engineering/civil/wamdec2004

WATER RESOURCES
AUGUST 3-6

An international conference on Water Resources of arid and semi-arid regions of Africa (WRASRA) – Issues and Challenges will be held in Gaborone, Botswana.
Enquiries: EM Shemang, c/o Department of Geology, Faculty of Science, University of Botswana. Private Bag UB 00704, Gaborone, Botswana. Tel: (+267) 355 2537. Fax: (+267) 3185 097. E-mail: waterconference@mopipi.ub.bw or shemae@mopipi.ub.bw

SOLIDS-LIQUIDS
NOVEMBER 8-9

The 2nd international symposium on Solid-Liquid Separation (SLS '04), organised by Minerals Engineering International, will be held at the Mount Nelson Hotel in Cape Town.
Enquiries: Dr Barry Wills.
E-mail: bwills@min-eng.com

OVERSEAS 2004

WASTEWATER
JANUARY 26-29

A conference on wastewater treatment for nutrient (nitrogen and phosphorus) removal and reuse will be held in Bangkok, Thailand.
Enquiries: Dr Ajit Annachhatre, School of Environment, Resources and Development, Asian Institute of Technology, PO Box 4 Klong Luang, Pathumthani 12120.
Tel & Fax: 662 524 5644.
E-mail: ajit@ait.ac.th

WEATHER RADAR
FEBRUARY 2-4

The 6th international symposium on hydrological applications of weather radar with the theme – "Success stories in radar hydrology" – will be held in Melbourne, Australia.
Enquiries: The Secretariat of HAWR2004, Bureau of Meteorology Research Centre, GPO Box 1289K, Melbourne, Vic., Australia. Fax: 61 3 96694 660.

SMALL SYSTEMS
FEBRUARY 11-13

The 6th IWA Specialist Conference on Small Water and Wastewater Systems will be held in Fremantle, Western Australia.
Enquiries: Dr Kuruvilla Mathew, Environmental Technology Centre – Murdoch University, South Street, Murdoch, WA, 6150, Australia. Tel: +61 (0) 8 9360 2896. Fax: +61 (0) 8 9310 4997. E-mail: K.Mathew@murdoch.edu.au

WASTEWATER TREATMENT
FEBRUARY 11-13

The 1st international conference on Onsite Wastewater Treatment and Recycling will be held in Fremantle, Western Australia.
Enquiries: Dr Kuruvilla Mathew, Environmental Technology Centre – Murdoch University, South Street, Murdoch, WA, 6150, Australia. Tel: +61 (0) 8 9360 2896. Fax: +61 (0) 8 9310 4997. E-mail: K.Mathew@murdoch.edu.au

FISH INTERNATIONAL
FEBRUARY 12-15

An international exhibition will be held at the Bremen Fair Centre in Germany.
Enquiries: MGH GmbH, Bürgerweide, 28209 Bremen. Tel: +49 (0)421 3505-260. Fax: +49 (0) 421 3505-681. E-mail: info@fishinternational.de

SLUDGE
MARCH 1-2

A conference with the theme "Resources from sludge: forging new frontiers" will be held in Singapore.
Enquiries: Ms Tan Kim Suan. Tel:+65 6794 1533/1534. Fax: +65 6792 1291.
E-mail: kstan@ntu.edu.sg

DRAINAGE
MARCH 21-24

The 8th international drainage symposium together with the 10th national symposium on individual and small community sewage systems, will be held in Sacramento, California, USA.
Enquiries: American Society of Agricultural Engineers, 2950 Niles Road, St Joseph, MI 49085. Tel: 269 429 0300. Fax: 269 429 3852. E-mail: AS31@umail.umd.edu Web: http://www.asae.org/meetings/sew04/index.html

AUTOMONET
APRIL 19-20

An international conference on automation in water quality monitoring - networks for surveillance, early warning and process control strategies and techniques of real time water quality assessment - will be held in Vienna, Austria.
Enquiries: Bernadette Ebner, KUONI Incoming Service GmbH, Wahringer Str 2-4/40, A-1090, Vienna, Austria.
Tel: +43(0)1 319 7690-26.
Fax: +43(0)1 3191180. E-mail: bernadette.ebner@kuoni.at

FILTRATION
APRIL 19-23

The 9th world filtration congress, sponsored by the American Filtration and Separations Society, will be held in New Orleans, Louisiana, United States.
Enquiries: Ms Kathy Hemming – Tel: 1 703 538 1000. Fax: 1 703 538 6305. E-mail: Kathleen.hemming@verizon.net
Web: www.afssociety.org

PIPES
APRIL 19-22

A conference called Plastic Pipes XII will be held in Milan, Italy.
Enquiries: Michael Ball, PPI – Tel: (202)462 9607. E-mail: mball@plasticpipe.org
Web: www.plasticpipe.org

SERVICE RESERVOIRS
MAY 12-14

The 1st international conference on service reservoirs in drinking water distribution systems will

take place in Geneva, Switzerland.
Enquiries: Storage 2004, Geneva Water, SIG, PO Box 2777, CH-1211 Geneva 2, Switzerland. Tel: +41 22 4207381. Fax: +41 22 4209457. E-mail: info@storage2004.org

HYDROSCIENCE MAY 30 - JUNE 3

The 6th international conference on hydro-science and engineering (ICHE-2004) will be held in Brisbane, Australia, with the central theme: "Enhancing the sustainable water resources and environmental quality of the world through the advancement of hydro-science and engineering".
Enquiries: Dr Mustafa Altinakar, NCCHE, School of Engineering, the University of Mississippi, Carrier Hall, Room 102, University MS 38677 USA. E-mail: iche@ncche.olemiss.edu

WASTEWATER TREATMENT JUNE 1-4

The 2nd IWA leading-edge conference on water and wastewater treatment technologies will be held in Prague, Czech Republic.
Enquiries: International Water Association, Alliance House, 12 Caxton Street, London SW1H0Qs, United Kingdom. Tel: +44 (0)20 7654 5500. Tel: +44 (0)20 7654 5555. E-mail: LET2004@iwahq.org.uk

ECWATECH JUNE 1-4

The 6th international trade fair and conference about water, ecology and technology will be held in Moscow, Russia.
Enquiries: Mr Sergey Malygin. SIBICO International Ltd, PO Box 173, Moscow 107078, Russia. Tel: +7 (095) 975 5104. Fax: +7 (095) 975 3423. E-mail: ecwatech@sibico.com Web: www.ecwatech.com

WATERSHED 2004 JULY 11-14

The Water Environment Federation (WEF) will sponsor an international speciality conference in Dearborn, Michigan, USA, on integrated resource management and environmental protection using watershed approaches.
Enquiries: WEF, 601 Wythe Street, Alexandria, VA 22314-1994, USA. Tel: 703 684 2400 x 7010. E-mail: watershed04@wef.org

HYDROLOGY JULY 12-16

This conference – Hydrology: Science and Practice for the 21st Century – will be held in London, United Kingdom, and is designed to bring together hydrologists involved in scientific research and operational practice to address key issues affecting hydrology in the new century.
Enquiries: For more information, please visit the website: www.hydrology.org.uk/bhs2004/welcome.htm

WATER GOVERNANCE AUGUST 29 - SEPTEMBER 1

An international speciality conference on "Good water governance for people and nature: What roles for law, institutions, science and finance?" will be held in Dundee, Scotland.
Enquiries: American Water Resources Association – 4 West Federal Street/PO Box 1626, Middleburg VA 20118-1626. Tel: (540) 687 8390. Fax: (540) 687 8395. E-mail: info@awra.org

ANAEROBIC DIGESTION AUGUST 29 - SEPTEMBER 2

The 10th World Congress – Anaerobic Digestion 2004 - with the theme: Anaerobic Bioconversion for Sustainability will be held in Montreal, Canada.
Enquiries: Mrs Marie Lanouette, National Research Council Canada, 1200 Montreal Road, Building M-19, Ottawa, ON, Canada K1A0R6. Tel: (613) 993-0414. Fax: (613) 993 7250. E-mail: ad10.2004@nrc-cnrc.gc.ca Website: http://www.ad2004montreal.org

BIOTECHNOLOGY SEPTEMBER 6-8

The first international meeting on environmental biotechnology and engineering will be held in Mexico City in Mexico. Delegates will be provided with up-to-date information on advances the remediation of soils and aquifers, microbial ecology and the application of molecular biology to solve environmental problems.
Enquiries: Dr Hector M Poggi-Varaldo, CINVESTAV-IPN, Department of Biotechnology and Bioengineering, PO Box 14-740, Mexico DF 07000 Mexico. Tel: 52(55) 5061 3800 (ext 4324 or 4336). Fax: 52(55) 5061-7002

TROUT FARMERS SEPTEMBER 16-18

The 50th conference and trade show of the US Trout Farmers Association will be held in Twin Falls, Idaho, United States.
Enquiries: Mary Lee. Tel: 304 728-2167. Fax: 304 728 2196. E-mail: ustfa@intrepid.net

WORLD WATER SEPTEMBER 19-24

The International Water Association (IWA) will hold its 4th world water congress in Marrakech, Morocco.
Enquiries: AMEPA – Tel: +212 3763 2093. Fax: +212 3763 7682. E-mail: sehi@elan.net.ma Web: http://www.iwahq.org.uk/

AQUACULTURE SEPTEMBER 26-29

The Australasian Aquaculture 2004 conference will be held in the Sydney Convention and Exhibition Centre in Darling Harbour, Australia.
Enquiries: Dr Tom Lewis. 73 Lansdowne Crescent, West Hobart 7000. Tel/Fax: (03) 6231 9230. Cell: 0417 537 806.

DAM SAFETY SEPTEMBER 26-29

The 21st annual dam safety conference and exhibition will be held in Phoenix, Arizona, USA.
Enquiries: Susan Sorrell. Tel: 859 257 5140. E-mail: info@damsafety.org Web: http://www.damsafety.org

WETLANDS SEPTEMBER 27-30

The 9th international conference on Wetland Systems for Pollution Control will be held in Avignon, France.
Enquiries: The Secretariat. CEMAGREF – 3, bis quai Chauveau, 69336 Lyon Cedex 09, France. Fax: +33 4 7847 7875. E-mail: wetlands@lyon.cemagref.fr

AQUACULTURE OCTOBER 20-23

The conference "Aquaculture Europe 2004: Biotechnologies for Quality" will be held in Barcelona, Spain.
Enquiries: The Secretariat. Tel: +32 59 323859. Fax: +32 59321005. E-mail: ae2004@aquaculture.cc Web: http://www.easonline.org

FISHERIES NOVEMBER 30 - DECEMBER 4

The 7th Asian Fisheries Forum and conference will take place at the Hotel Equatorial in Penang Malaysia. The theme will be "New dimensions and challenges in Asian Fisheries in the 21st century". Special symposia will include: Advances in shrimp biotechnology; Technology needs and prospects for Asian aquaculture – participation of the poor; and Biotechnology for growth and reproduction in fish.
Enquiries: The Secretariat, 7th Asian Fisheries Forum, School of Biological Sciences, University Sains Malaysia, 11800 Minden, Penang, Malaysia. Tel: 60 4 6533 888 ext 3961. Fax: 60 4 6565125. E-mail: 7aff2004@usm.my