SA waterbulletin

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ESTUARINE RESEARCH
Looking at the importance and wise management of South Africa's estuaries

IRRIGATION
Researchers evaluate existing irrigation techniques used by small-scale farmers

ESTUARINE MANAGEMENT
An integrated approach in the Eastern Cape

Announcement of the next National Short Course on

THE ROLE AND USE OF BIOLOGICAL MONITORING IN AQUATIC RESOURCE ASSESSMENT

AIM OF THE COURSE

Aquatic biomonitoring, or response monitoring, is increasingly used as a monitoring and assessment tool in water resource management. This course will provide a basic understanding of the concepts, advantages, uses and limitations associated with different biomonitoring techniques, including field bioassessment and toxicity bioassays. The course is designed to address the relevant concepts and the interplay between biomonitoring and resource management, rather than the technical details of how to conduct monitoring. There will be a balance between theoretical lectures (presented by experts from various organisations), hands-on exposure in the laboratory and field, group discussions and problem solving. Presentations and course material will be in English.

WHO SHOULD ATTEND ?

Mid-level managers, planners and other officials from government or private institutions who need and want to improve their knowledge and use of biomonitoring in general.

WHERE AND WHEN ?

In Grahamstown, from the 18 - 22 February, 2002.

COST

The course fee is R4 500 per person (excluding dinner, bed & breakfast) and includes use of conference facilities, lecture material and the use of field and laboratory equipment.

Currently co-ordinated by: Institute for Water Research, Grahamstown

ENQUIRIES

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The National Short Course was initiated by :
The Institute for Water Quality Studies (IWQS)
of the Department of Water Affairs and Forestry and
CSIR's Division of Water, Environment and Forestry (Environmentek)

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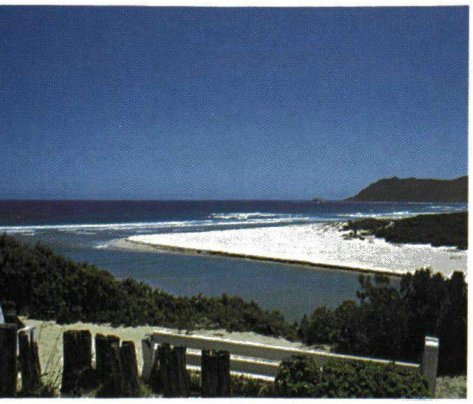

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Cover: River mouth at Sedgefield. (Photo: Helene Joubert)

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Southern African hydrology - *past, present and future*

Mr Hugo Maaren, Research Manager at the Water Research Commission, stressed the importance of hydrological process studies continuing.

Mr Eberhard Braune, Director, Geohydrology, at the Department of Water Affairs and Forestry, who together with Mr Hugo Maaren, was honoured for their contributions to SANCIAHS.

Professor Denis Hughes, from the Institute for Water Research at Rhodes University and Chairman of SANCIAHS, presented the first Professor Des Midgley memorial lecture. This designated lecture will become part of all future SANCIAHS symposia.

From the SA Waterbulletin archives - the late Professor Des Midgley, honoured at the symposium as "the father of hydrological science in Southern Africa".

The new National Water Act of 1998 and the importance of water in the future to urban and rural areas came under the spotlight at the 10th South African National Hydrology Symposium, hosted at the University of Natal by the School of Bioresources Engineering and Environmental Hydrology (BEEH). In celebration of the 10th anniversary, the conference highlighted the role hydrologists, water resources engineers, aquatic scientists and catchment managers played in the past, and will play in the present and in future developments in the study and management of Southern Africa's water resources.

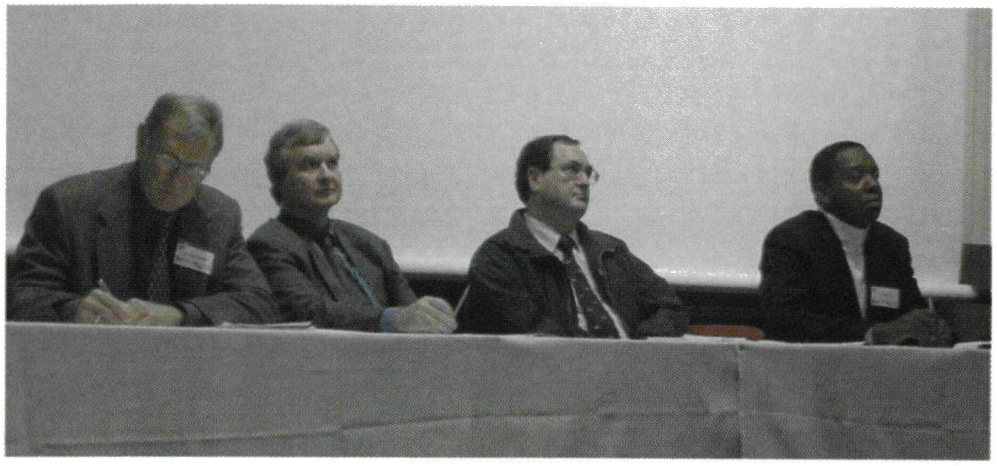
Authors and speakers concentrated primarily on the new Water Act, new methodology in the field and modelling for water resources management. "The amended Act now rightfully focuses on the environment and the individual consumer, but the challenges with the Act are in its implementation," said Dr. Graham Jewitt from the BEEH. He pointed out that controversial aspects of the Act, such as stream flow reduction activities and the Reserve (an amount of water set aside for environmental and human use) have no legal precedent. "The challenge that delegates concentrated on are the conversion of these somewhat academic ideas into real management tools and practices," Dr. Jewitt said.

The symposium ran over three days with the first day divided into three sessions: Integrated water resources management – the Reserve and water allocation; Integrated water resources management, and a dual session titled: Irrigation and drainage, and Environmental flows. The second day's sessions focused on Working for water; Water, forests and wetlands and a dual session: Statistical methods and Catchment studies.

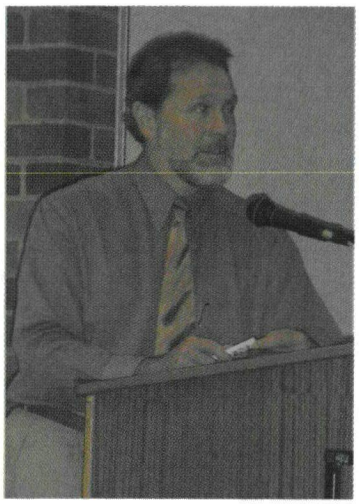
In the afternoon, delegates visited a research catchment operated by the CSIR's land use hydrology team and the University of Natal's BEEH. The project title was the Influence of *Acacia mearnsii* (black wattle) on the water yield of a first order catchment in the KwaZulu Natal midlands. Delegates separated into groups at the site and visited five stops within the catchment area. Each stop was assigned its own focus: Sap flow measurements in *Acacia mearnsii*; Soil water measurement; Bowen ratio measurement of evapotranspiration (ET); Rainfall, streamflow and groundwater measurement and finally Eddy correlation and scintillometry measurement of ET. Most delegates felt that the field trip was a worthwhile experience and added value to the conference. The trip was sponsored by the Mondi Paper Company. Many of the participating delegates lamented the decline in the number of active research catchments in the country and complemented the Water Research Commission for their continued support of such experiments.

HONOURED

SANCIAHS also honoured the contributions of Hugo Maaren and Eberhard Braune to the society with presentations made at the symposium dinner. Hugo paid tribute to the few remaining researchers involved in hydrological process studies and stressed the imperative of such research continuing. At the close of the symposium, delegates were urged to join the International Association of Hydrological Sciences (IAHS), of which membership is free. More information for prospective members is available from the IAHS

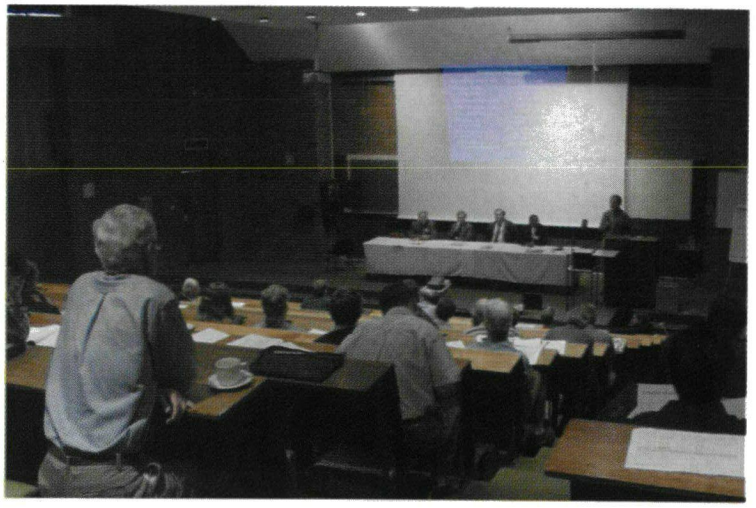


At the opening session of the 10th South African National Hydrology Symposium in Pietermaritzburg. From left – Professor Roland Schulze, School of Bioresources Engineering and Environmental Hydrology at the University of Natal, Dr Thinus Basson (BKS), Professor Peter Roberts, a forest hydrology consultant, and Mr Jean Boroto, Department of Water Affairs and Forestry.



(Left) Professor André Görgens, from the Department of Civil Engineering at the University of Stellenbosch, delivering his paper at the Symposium.

(Right) Delegates listening to a speaker during a plenary session.



web site - http://www.cig.ensmp.fr/~iahs/index.html.

At the start of the symposium, SANCIAHS and the Water Engineering Division (the South African Institution of Civil Engineering) honoured the late Professor Des Midgley - the father of hydrological science in Southern Africa - in the form of a designated memorial lecture. The lecture will become part of all future SANCIAHS symposia. The memorial lecture was introduced by Dr. Mike Shand, and presented by Professor Denis Hughes, Chairman of SANCIAHS. Dr. Shand pointed out that it was appropriate to hold the first Professor Des Midgley memorial lecture on the campus of the University of Natal, as it was Prof. Midgley's alma mater.

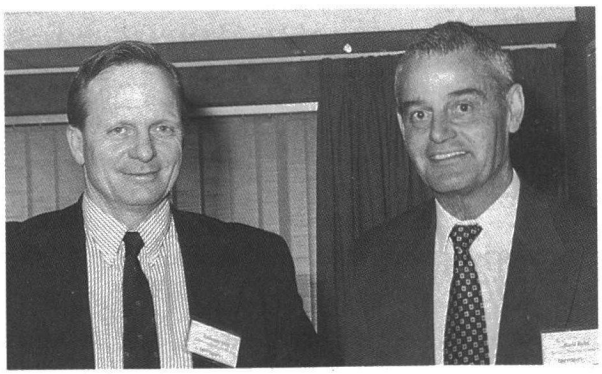
Professor Hughes spoke on the practical problems associated with the implementation of the ecological Reserve for rivers. In his paper he pointed out that there have been recent developments in the methods used to determine the ecological component of the Reserve. "There is now a range of approaches available that are based on the Building Block Methodology (BBM) but they are designed to provide results with different levels of confidence and which cost different amounts in terms of the resources required," stated Professor Hughes. These methods have been developed and improved over the last few years with the implementation of the Reserve in mind. "However," continued Professor Hughes, "it is now clear that there are other problems, which were not immediately apparent in the past, that must be addressed before the Reserve can be practically implemented throughout the country." His paper briefly reviewed the methods that have been developed to contribute to the implementation and further discussion of problems that have yet to be solved.

Papers and posters were burnt onto a CD and distributed to delegates at the event. All proceedings and posters can be found at http://www.beeh.unp.ac.za/sanciahs2001/.

Terrapinn's annual water meeting in Midrand

The 6th annual Water Africa 2001 conference, organised by Terrapinn Limited, was held earlier this year at the Volkswagen Conference Centre in Midrand, Gauteng.

Mr Ed Maani (left), Director: Group Business Development and Marketing, Umgeni Water who delivered a paper on "Increasing your business by broadening your market base - the Nigeria and South Africa experience". The Minister of Agriculture, Water and Rural Development in Namibia, Mr Helmut Angula (centre) discussed integrated water resource management in Namibia with specific reference to the establishment of the Orange-Senqu River Commission - an important forum where water matters of mutual interest to South Africa and Namibia are addressed at a more technical level. (Right) Professor Eugene Cloete from the Department of Microbiology and Plant Pathology, University of Pretoria, who chaired the first day's sessions and also delivered a paper on the business and social impacts of the global cholera pandemic.



Mr Anthony Still, Executive Director for Johannesburg Water (Pty) Ltd (left) explained the company's policies and tariffs and Mr Basil Bold, Managing Director of Invensys Metering Systems South Africa (formerly Meinecke Meters) who delivered a paper on how to apply the latest technology to improve water supply systems.

Professor Jeremy Ridl from the School of Law, University of Natal, in Durban (left) discussed South Africa's new National Water Act - Understanding its legal ramifications for your business, while Ms Thina Siwendu from Siwendu, Ngakane & Partners, explained the legal impact of the government's free water policy. Mr Derek Hazelton (right) manager of TSE Water Services - a company which he founded in 1998, spoke on "Creating a lucrative market for the implementation of the government's free water policy".

Mr Mark Shepherd (left) Director, Restor (Africa) (Pty) Ltd, Chairperson for Day Two of the conference, Ms Cathrine Wilson, Communications Co-ordinator: Water Demand Management, Bulk Water Department, City of Cape Town, who delivered a paper on managing water restrictions - marketing, education and awareness. The Minister of Public Works and Housing in Mozambique, Mr Roberto White. His paper was titled, "Managing water disasters and minimizing the vulnerability of Mozambique to floods". He stressed the importance of co-ordination on national level between countries, the establishment of hydrometeorological networks and communication systems as well as the improvement of long-term meteorological forecasts and flood warning systems.

Umgeni Water hosts the water utility partnership workshop

Delegates to the Water Utility Partnership (WUP) workshop pictured in front of the Durban International Convention Centre. A total of 53 delegates representing 31 water utilities from 13 countries in Africa attended the workshop.

Umgeni Water recently hosted the Water Utility Partnership - Southern Africa regional workshop on performance indicators and benchmarking. The workshop was held at Durban's International Convention Centre from 22 to 23 October 2001.

Lack of performance evaluation was one of the gaps identified to prevent overall improvement in service delivery by African water utilities. The Water Utility Partnership for capacity building in Africa (WUP) initiated a project to define and encourage the use of performance indicators as a management tool to evaluate and improve performance. Building on the lessons and achievements of this project, WUP launched the Water Supply and Sanitation Service Provider Performance Indicators and Benchmarking Network (SPBNET.Africa project) in September 2000.

A major component of the SPBNET. Africa project has been the identification and definition of indicators for use in the questionnaires. The Durban workshop was the culmination of a series of workshops around Africa where over 90 water utilities internationally (i.e. government, municipalities, public companies as well as private utilities) participated to define and refine the questionnaires. The aim of the Durban workshop was to present the analysed findings of the data gathered, to subsequently disseminate generally accepted performance indicators to make information available to policy-makers, regulators, users and organisations prepared to provide technical and financial assistance, for the improvement and extension of services. The water and sanitation indicators analysed, ranged from population served, public health education, routine monitoring of water quality in distribution, staff per 1 000 connections to tariff cost recovery, etc. All workshops were managed by WUP based in Cote D'Ivoire, a joint initiative between the Union of African Water Suppliers (UAWS), the Regional Centre for Low Cost Water and Sanitation (CREPA), and the Centre for Training, Research and Networking for Development (TREND), established in 1996 with the support of the World Bank. The SPBNET.Africa project was funded by the Department for International Development.

A total of 53 delegates representing 31 water utilities from 13 countries in Africa attended the workshop including representatives from relevant institutions like the Water Institute of Southern Africa and, the WRC. The two-day program included an opening address by the Ethekwini Municipality Councilor Sipho Ngwenya, a keynote speech by Mr Helgaard Muller who is DWAF's Director of Intervention and Operational Support, presentations and discussions on project results, implementation, experience and sustainability considerations by the project team members.

In sharing their benchmarking experience, Umgeni Water highlighted its three-pronged approach to improvement in their processes of quality management, safety, health and environmental management, which focuses on the customer, the infrastructure and the institution. The organisation played a significant role in hosting the event which involved conference and accommodation arrangements, an evening dinner with Umgeni Water members of the board and executive committee and, a technical visit to one of their largest waterworks, Durban Heights, which treats up to 650 megalitres per day to supply the Greater Durban Metropolitan area. The waterworks has recently been awarded an ISO 9002 accreditation.

Welcoming the participants during the dinner event, acting CEO of Umgeni Water, Mr Bongi Mshengu, appreciated WUP's role of creating partnerships between utilities in Africa aimed at permitting the weaker organisations to learn from the more experienced ones to become more effective service providers. This, as Mr Mshengu mentioned, is in line with Umgeni Water's developmental leadership approach of fulfilling water needs in partnerships, an approach the organisation adopted for the commercialisation of its activities throughout Africa and beyond.

Local Management of Estuaries:

An Integrated Approach in the Eastern Cape

Doh Ngcobo, Nhlanhla Sihlophe and Margaret McKenzie
– Institute of Natural Resources –

The successful management of an estuary is dependent on the active involvement of the people whose livelihoods are dependent on it, who live adjacent to it, or who have an active interest in a particular estuary or estuaries. It is the actions of these people that will dictate whether estuarine resources are utilised sustainably, whether development options hinder or help ecological functioning or whether pressure is placed on upstream users.

In 1998 the Institute of Natural Resources embarked on the Eastern Cape Estuaries Management Programme. The focus of the programme was and remains the support of local estuary management. It was soon realised that simply providing advice to local stakeholders was insufficient and that a comprehensive and integrated support service was required. With this in mind the programme was divided into four linked sub-programmes:

- Local estuary management
- Estuary management research
- Estuary management capacity building
- Estuary management institutional and policy development

LOCAL ESTUARY MANAGEMENT

The purpose of this component is to develop estuary management systems, and to promote the implementation of estuary management systems at a local level. Activities have focused on the following estuaries:

- Kowie and the Bushmans/Kariega complex where the focus is on resolving estuarine sedimentation issues;
- Tyolomnqa where an estuarine management forum has been established and the focus is on resolving access issues;
- Mtentu where support is being provided to the Amidaba community to develop eco-tourism opportunities on and around the estuary;
- Activities at Mngazana and Manteku will commence shortly.

Participants in the Mtentu Estuary management training workshop hosted under the auspices of the Eastern Cape Estuaries Management Programme (Picture: Charles Breen).

ESTUARY MANAGEMENT CAPACITY BUILDING

It is recognised that unless participants (whether they are local stakeholders, managers or researchers) understand how estuaries function and comprehend the major issues around estuary management, and have access to relevant information, management efforts will have limited success. Recognising this, the estuary management capacity building sub-programme has three goals:

- To build capacity of estuary management forums (and stakeholder groups that are likely to form forums) to participate in the management of their estuaries.
- To build the capacity of previously disadvantaged individuals and groups in the implementation of local estuary management systems and estuary management research.
- To build the capacity of Eastern Cape based researchers to implement local estuary management systems.

Examples of capacity building exercises that have been conducted include:

- Education and training workshops in

estuary management conducted in isiXhosa and involving local management and residents at the Mtentu Estuary. These workshops will be held at other estuaries where support is being provided.
- A strategic environmental assessment workshop focusing on estuaries involving NGO and government management agencies.
- The publication of a regular newsletter which is distributed to nearly 500 readers; and
- The development and maintenance of a comprehensive website *(www.inr.unp.ac.za/ecestuaries)*

ESTUARY MANAGEMENT RESEARCH

This research sub-programme, arose out of a recognition that to promote effective management of estuaries there is a need for a deeper understanding of issues that confront estuary managers, and a need to develop additional estuary management processes and tools to enhance estuary management decision making. Its goals are:
- To facilitate and enhance participatory management for the sustainable use of Eastern Cape estuaries through directed research which is informed through practical engagement of management of estuaries;
- To foster collaboration amongst estuary researchers and managers; and
- To establish a culture of integrated estuary management research.

The research sub-programme comprises seven individual projects that are being implemented by a range of different institutions:
- A legal and institutional framework for the effective co-operative governance of estuaries for the Eastern Cape, with potential application to other South African estuaries (CSIR, Environmentek);
- Biodiversity protection in Eastern Cape estuaries (Southern Waters Ecological Research and Consulting);
- The development of management protocols for the sustainable utilisation of living resources in Eastern Cape estuaries (Coastal and Environmental Services);
- Protocol for the rehabilitation of estuaries for adoption by appropriate authorities (Wetland Consulting Services);
- Development of a knowledge management system model for the Eastern Cape estuaries (Information studies, School of Human and Social Studies, University of Natal); and
- Generic systems for co-operative management of the use of estuaries (Institute of Natural Resources).

ESTUARY MANAGEMENT - INSTITUTIONAL AND POLICY DEVELOPMENT

In order for estuary management to be successful it requires organised people who have direction. The purpose of this sub-programme is to support the establishment of local institutions (management forums, etc) comprising stakeholders with a common vision to guide actions. It is envisaged that, in the future, these institutions will have legal status either through the Coastal Management Act (currently being drafted) or the National Water Act (No 36 of 1998). Focus is also on assistance to local, provincial and national government in the establishment of appropriate policies that facilitate effective estuaries management.

Funders
This programme enjoys the support of a number of organisations including:
- The Water Research Commission
- The Department of Environmental Affairs and Tourism
- South African Breweries
- The Tony and Lisette Lewis Foundation
- Anglogold

Research and Management of South Africa's Estuaries:

The supporting institutions

A number of South African Institutions play a crucial role in supporting research on the management of the country's estuarine systems.

THE ROLE OF THE DEAT IN ESTUARINE MANAGEMENT

The Department of Environmental Affairs and Tourism (DEAT)
Dr Alan Boyd

The role of the DEAT in estuaries management encompasses three primary areas:
- to institute appropriate policies and legislation to underpin coastal management,
- to bring about a suitable institutional framework and develop management tools, and
- to manage estuarine living resources.

New legislation on coastal management and conservation of biodiversity is currently in an advanced stage, and should be submitted to Parliament next year (in 2002).

Management of living resources in estuaries is undertaken in terms of the Marine Living Resources Act of 1998

(MLRA). This gives the DEAT the responsibility for ensuring sustainable use and conditions of access for recreational and subsistence fishers, and in a few instances small-scale commercial operators. The legislation enables holistic management of the many species, which utilise both estuaries and the sea. Protected areas can be declared in terms of the MLRA, but provision is likely to be made for additional local management measures (such as zonation of different beneficial uses) in the new Coastal Management Bill.

A number of projects with management-directed outputs are supported by the DEAT. These include encouraging viable local management structures, economic studies, understanding bio-physical estuarine functioning of estuaries, and assessing the impact of subsistence and recreational fisheries. The value of estuaries to tourism, and particularly eco-tourism is also acknowledged as a way of alleviating poverty and empowering poor coastal communities, without putting too much additional pressure on living resources. Rehabilitation of degraded areas, such as the Orange River Mouth Ramsar site, is also being supported. Estuarine habitats will be mapped during the national wetland inventory being undertaken by the DEAT. This information will assist in planning, management and decision-making at all levels.

THE CONSORTIUM FOR ESTUARINE RESEARCH AND MANAGEMENT (CERM)

Dr Guy Bate

The Consortium for Estuarine Research and Management (CERM) is an organisation started in the early 1990s by a group of scientists at universities, in government service and in their private capacities with the object of providing a platform for its members, who have a wide diversity of expertise, to collaborate in promoting the wise management of estuarine systems. The intention at the outset was that the object would be achieved through joint participation in directed research, training and technology transfer.

CERM aspires to ensure that the development of South African estuaries takes place in an environmentally sustainable manner. To achieve this, the intention is that members will participate in interdisciplinary research, with funds obtained via CERM where possible. An early intention was that CERM would be available to undertake consultancy work, however this was dropped when members recognised that this would make CERM a competitor to its affiliated organisations.

Membership of CERM is voluntary and to become a member all that is required is to write to the co-ordinator at *btagcb@upe.ac.za* and ask to be included on the list. There is no membership fee and members receive correspondence on relevant issues decided upon by the co-ordinator. At the same time any member can request information to be sent out to CERM. This is achieved by sending the information to the co-ordinator. At present there are 83 persons registered as members.

The first research undertaken by CERM was the interdisciplinary study of the "River/Estuary interface region – REI". This study included scientists from the CSIR, the University of Port Elizabeth and the JLB Smith Institute of Ichthyology. The team worked on the Gamtoos, Great Fish and Kariega estuaries. The Water Research Commission funded the work and a final report was submitted in 2001.

Funds for a second project have been awarded by the Water Research Commission for a project on "Information requirements for the implementation of resource directed measures for estuaries". This latter project will began in 2001 and will run until 2004. The participants include CERM members from, the Universities of Zululand, Natal, Port Elizabeth and Cape Town, together with a group of physical scientists from the CSIR (Environmentek), Stellenbosch. The work will relate to an identified gap in scientists' knowledge on temporary open estuaries and will focus on data required by the Department of Water Affairs and Forestry in the implementation of the new Water Act.

The CERM website can be accessed at *http://www.ru.ac.za/cerm/index.html*.

THE NATIONAL RESEARCH FOUNDATION (NRF)

Dr Johan Pauw

The National Research Foundation (NRF) through its Conservation and Management of Ecosystems and Biodiversity Focus Area Programme invests approximately R 600 000 per annum in ten ongoing estuarine research projects. A further R 1,02 million is invested in seven projects through the NRF's capacity building programme at historically black universities. Research grants would generally have in the order of 40 per cent of the total amount designated for student bursaries.

The Sea and Coast Programme II (S&C II), a subset of the Focus Area Programme, is funded and managed under a joint venture between the NRF and Marine and Coastal Management (MCM) of the Department of Environmental Affairs and Tourism. The South African Network for Coastal and Oceanic Research (SANCOR) was responsible for the development of the S&C II. The Consortium for Estuarine Research and Management (CERM) has strong collaboration with SANCOR. MCM provides in the order of one third of the budget for the S&C II. The research supported under the Historically Black University

Programme fits naturally into the Sea and the Coast Programme II but is funded and managed separately.

Areas of estuarine research supported currently include:

- Understanding how the physical, chemical and biological processes influence the structure and functioning of estuarine systems, inclusive of catchment-based drivers, in order to manage estuaries systems at the ecosystem level.
- Assessing and monitoring the factors that influence estuarine biodiversity to inform the development of management protocols for the conservation and sustainable use of estuarine resources.

Useful web-sites are: *www.nrf.ac.za* (NRF) and *www.botany.uwc.ac.za/sancor/* (SANCOR).

THE WATER RESEARCH COMMISSION (WRC)

Dr Steve Mitchell

Estuaries have attractive settings and support highly productive ecosystems. The goods and services they deliver contribute to the national economy both as natural resources for exploitation and as nodes for recreation, ecotourism and urban development. They are also under pressure disproportionate to the area of the country that they occupy. This pressure comes from two main sources. One of these, water resource development in the catchment, alters both the quality and quantity of freshwater inflow which in turn alters the functioning of the estuary. Urban development on estuaries impact on them in a number of ways, many of which detract from their intrinsic value. We need both the appropriate knowledge base and capacity to manage estuaries in a way that will sustain this intrinsic value. For these reasons, the Water Research Commission supports estuarine research.

The type of research supported by the WRC falls broadly into two categories, the development of techniques and methods for the management of estuaries, and the development of the capacity to enable people to make an input into the co-operative governance of estuaries. Topics being supported in the first category cover hydrology, sediment dynamics and management, water quality and quantity and the development of methods to assess estuarine importance and health. The second category covers the development of policies, procedures and structures for estuarine management, as well as the resource material to be used in the process.

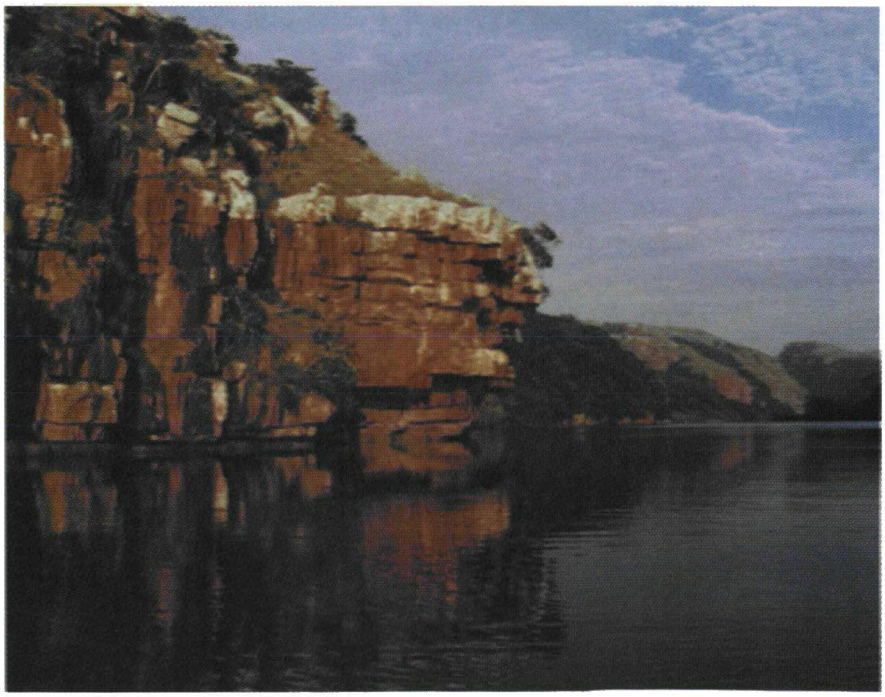
THE DEPARTMENT OF WATER AFFAIRS AND FORESTRY (DWAF)

Barbara Weston

The use and conservation of water has undergone a major paradigm shift from the old Water Act of 1956 (which was mainly concerned with providing water for irrigation and development), to the new National Water Act (Act 36, 1998) – which promotes protection of South Africa's water resources. Under the new Act there is no private water anymore, water is a national asset and thus there is a responsibility on all people in South Africa to protect the country's water. DWAF through the minister and national government is the public trustee of the nation's water resources, and this is made possible through the implementation of the new Act.

The purpose of the new Act is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways which take into account amongst other factors: Meeting the basic human needs of present and future generations;

- Protection of aquatic ecosystems;



The Mtentu Estuary (Picture: Margaret McKenzie).

and
- Protection of the water quality requirements of water users.

A water resource in the context of the new Act includes a watercourse, surface water, estuary or aquifer or any other underground collection of water.

The Reserve (part 3 of chapter 3 of the new Act) which is defined as the quantity and quality of water required to –
- Satisfy basic human needs for all people who are or who may be taking water from the relevant water resource; and
- To protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource,

is the tool that gives affect to the policy of protecting water resources, and must be set as soon as the class of the water resource has been determined.

Water for the Reserve enjoys priority of use by right; hence the Reserve must be determined in order to establish the allocatable portion of the water resource. The DWAF has over the past four years developed generic protocols for the determination of the Reserve. Various levels of Reserve determination are available depending on the confidence and quantity of data available for the particular reserve.

The Department sees it as part of its constitutional mandate to share information, to integrate estuarine management so as to avoid duplication of work (and thus to reduce costs) and to make the most effective use of resources. Various laws exist to manage estuaries, but all are mostly focused on different areas and aspects of an estuary. This often results in confusion as to which the relevant accountable authority is and what each organ of state's mandate function is. A forum is thus needed to enhance co-operative governance and to align and streamline the various laws, protocols and strategies to manage estuaries and to ensure responsibility and accountability.

Estuaries and People

Dr Alan Whitfield, JLB Smith Institute of Ichthyology, Rhodes University

To many South Africans an estuary elicits fond memories of long summer holidays at a coastal resort in KwaZulu-Natal, the Eastern or Western Cape. Very few people stop to think about what these estuaries represent or how their ecology can be affected by human activities. Although it may seem unusual, one way to put across important ecological concepts is to draw analogies between the functioning of a human body and the functioning of an estuary.

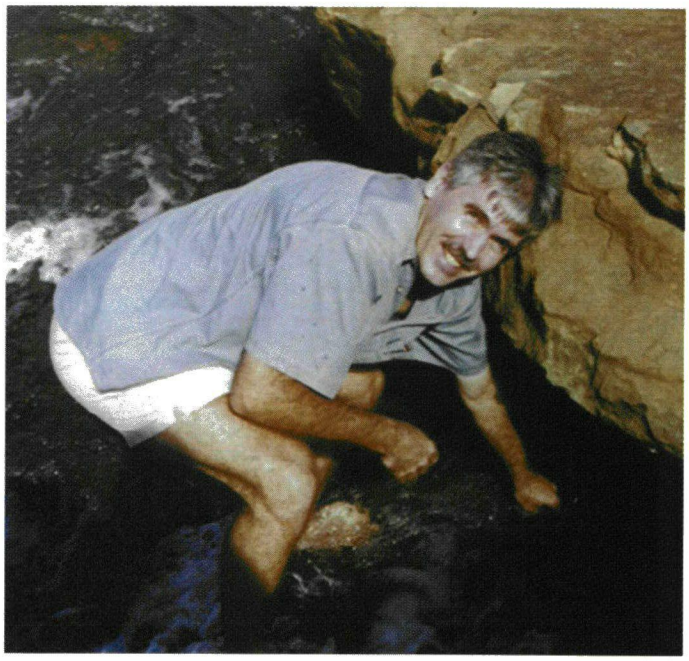
The mouth of an estuary is its vital link with the sea – the mouth of the Umzimvubu Estuary. (Picture: Bruce Mann)

In reality an estuary is the heart of a much bigger system, with its veins radiating out into the catchments and bringing lifeblood in the form of nutrients, organic material and fresh water. If a person's finger is damaged and blood poisoning occurs, this poison is carried to the heart of the individual via the venous system. In the same manner, soil erosion in a distant mountain catchment is carried by streams and rivers into the estuary which has a certain capacity to absorb a degree of siltation. Just as a human body can heal itself, so the estuary can cleanse itself of pollutants, provided the source of the problem is dealt with adequately. If blood poisoning turns into gangrene, due to neglect or poor medication, the life of that individual is then threatened. Similarly, excessive soil erosion or pollution in a catchment, without ameliorative measures being taken, can lead to the ultimate death of an estuary. Southern Africa and the rest of the world are littered with numerous examples of estuaries that have been damaged or destroyed through neglect and abuse of essential ecological processes. How many systems have to be degraded before we sit up, take note and then reverse the process?

We use our mouth for the intake of food, which in turn supplies energy and nutrients for the functioning of vital processes within our bodies. In the same way that we could not exist without a mouth, so the mouth of an estuary is vital to its long-term existence. Not only are nutrients and important trace elements imported from the marine environment through the mouth, but the migrations of many fish and invertebrate species are only possible if an estuarine system is open to the sea. We also drink water through our mouths, which is then used in water balance, cooling and waste removal. Similarly an open estuary is able to facilitate a water balance through the mixing of seawater and fresh water, the exposure and inundation of habitats

through tidal action, and the export of accumulated organic material from the estuary into the marine environment.

People have a tendency to categorise or compartmentalise things in life, including themselves. This tendency has also been favoured by scientists and managers, who attempt to group estuaries according to particular features. In general, this is a useful approach in identifying common threats to estuarine systems and proposing management principles which apply to particular types of estuaries. However, no two people are identical and in the same way each estuary, from the smallest to the largest, is an unique system. Although there will inevitably be similarities between estuaries within a particular group, each system tends to respond to changes in a slightly different way. Just as a doctor or psychologist analyses and treats each patient as an individual, so scientists and managers need to analyse and treat each estuary on an individual basis. If we were to gain an in-depth ecological understanding of our estuaries, and conserve each system as though it were a delicate living organism, the benefits would accrue not only to estuaries but also to society at large.



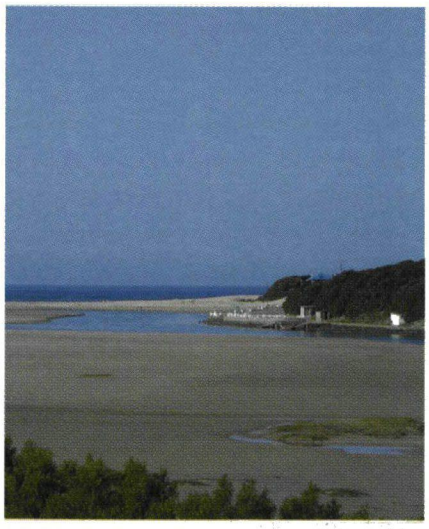
Unpolluted river water is the lifeblood of an estuary - Andrew Lucas from the Department of Water Affairs and Forestry sampling water on the Mzamba River. (Picture: Margaret McKenzie)

Estuarine Sedimentation in South Africa

Eckart Schumann
University of Port Elizabeth

Most South African estuaries are small by world standards - freshwater volume flows of about one cubic metre per second are common. Further, in a country thirsting for water, dams have been built in catchment areas which limit this flow even further. Estuaries are also areas of extraordinary natural beauty, which at the same time offer protection from, and access to, the open sea. As such communities have settled there, developing roads and infrastructure which serve to stifle the functioning of the estuarine systems even further.

South Africa's fine beaches of white sand, combined with a high-energy wave climate, leads to a dynamic and variable coastline. The mouths of estuaries are continually changing under these natural conditions, with waves and tides moving sand along-shore and, on average, into the estuaries. Sandbanks grow and move upstream, limiting channels, constricting the estuary mouths, and in some cases closing them altogether. However, because of the dams in the catchment areas the regular floods at 10 or 20-year intervals are no longer capable of scouring out the accumulated sediment. Estuarine systems have been modified, and the estuaries are changing in response. In some cases artificial means are being used to move unwanted sediment as people perceive their jetties being sanded up, and boat channels becoming un-navigable. Ecological processes are also suffering, with some marine sands reaching upstream to different, muddy substrates.



Sedimentation in the Kariega Estuary (Picture: Duncan Hay)

This all cries out for proper management. An understanding is required of these estuaries, acknowledging that each system is unique. This requires monitoring for as long as possible so that the necessary knowledge can be built up for wise decisions. Of course, such management must involve all interested and affected parties. Moreover, new laws and regulatory bodies have been established to ensure continued proper functioning of the estuaries, and adherence to these regulations is essential.

The breaching of an estuary mouth

Piet Huizinga and Lara van Niekerk – CSIR-Environmentek

An example of a closed estuary (Picture: Bruce Mann)

About 70 per cent of South Africa's estuaries are periodically closed and, due to encroaching developments, many are artificially breached. Some reasons for breaching are flooding of low-lying developments, damage to infrastructure, inundated septic tanks, nocuous algal growth and recreational needs.

Sound breaching methods are critical for maintaining healthy environmental conditions. A number of recommendations are listed below:

- The water level in the estuary should be as high as possible. This is the most important recommendation, because ongoing sedimentation is occurring in many estuaries, caused by the reduction in flushing of sediments when estuary mouths are breached at low water levels. Natural breaching of SA estuarine mouths normally occurs at levels between +2.5 and +3.0 m of the mean sea level (MSL).
- The mouth of an estuary should be breached as late in winter or spring as possible. Migration of juvenile fish into estuaries and the germination of saltmarsh vegetation occur mainly during spring and summer. Water quality problems are more likely to develop when the temperatures are higher and pollutant loading increase. High wave conditions occur less often in summer than in winter along the South African coast.
- The mouth of an estuary should ideally be breached three or four days before springtide. This ensures good flushing during the following springtide. This recommendation is important for small estuaries (e.g Great Brak), where the mouth might close at the following neap tide, and less relevant for larger systems (e.g. Klein Estuary), where the mouth normally stays open for several months after the breaching.
- The position where the mouth should be breached depends on local conditions. Strong controversy often exists over the mouth location, but the best position depends on local conditions and expert advice should be obtained. Consideration should be given to the configuration of ebb and flood tidal channels in selecting a position for the breaching.
- A deeper and wider channel should be excavated before breaching. A considerable amount of water is generally used to flush a small and narrow trench open to a medium sized trench. A larger initial channel will cause higher initial flow velocities, causing more sediment to be flushed out.
- Breaching should occur at high tide or as close after it as possible, waves permitting. The high outflows after breaching which causes scouring, last several hours and sometimes more than a tidal cycle. The maximum outflow normally occurs approximately 4 to 8 hours after a breaching. If wave conditions were to interfere with the breaching process, it may be better to postpone the breaching by a day.

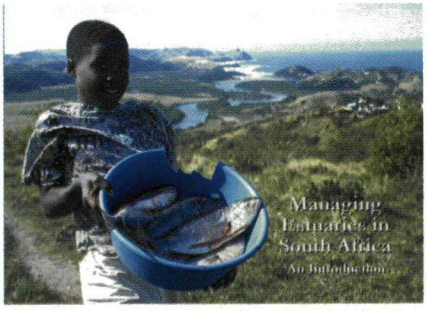
Managing Estuaries in South Africa: An Introduction

"Estuaries, just like any other natural system, provide goods and services useful to society. The value we ascribe to estuaries reflects the costs and benefits we experience from the use of these goods and services. Value, therefore, changes in response to the way we use and abuse estuaries. We cherish and look after the things we value and we abuse those that we perceive to have little or no value."

This is said in a recently published booklet on the managing of South African estuaries.

The purpose of the book is to promote the wise and sustainable use of all estuaries. It is premised on the belief that informed people will act wisely and seek to protect South Africa's heritage for future generations.

The South African coastal zone is estimated to contribute about R168 billion to the country's economy. Since there are in the region of 260 functional estuaries on the South African coast, and they are favoured sites for urban development, commercial activity and recreation, it is easily appreciated that estuaries are very important in coastal economies. Assets of such value demand attention and commitment to the application of best management practices. Estuaries are common property: they belong to all South Africans. Those who benefit from estuaries, in whatever way, are accountable for how their actions affect the estuary and its use by others. However, this cannot happen if users do not have access to the information necessary for enlightened actions.



The front cover of Managing Estuaries in South Africa.

This book will help those who wish to contribute constructively to promoting the wise use of estuaries. Six topics cover the most important foundations for estuary management.

These are:

- ❒ The value of estuaries
- ❒ Structure and functioning
- ❒ Influence of human activities
- ❒ Becoming involved in management
- ❒ Assessing the state of an estuary
- ❒ Policy and legislation

Although this is a 'starter kit' readers will gain sufficient information and understanding to engage others in conversation about estuary management, and to jointly engage in planning actions that will contribute to the improved conservation and sustainable use of estuarine resources.

The Water Research Commission, Department of Environmental Affairs and Tourism and Anglogold jointly funded the compilation and publication of this handbook.

ORDER INFO

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The importance and freshwater requirements of South Africa's estuaries

By Dr Janine Adams, University of Port Elizabeth*

Estuaries, the meeting place of land and sea, are diverse and rich systems. The biogeographical zonation of South Africa's coastal zone (Figure 1) contributes to this diversity and estuaries vary from the relatively pristine Olifants Estuary on the dry west coast, where large supratidal marsh areas occur to the estuarine bay of Knysna, boasting the second largest intertidal salt marsh area in the country, to Lake St Lucia on the east coast, one of South Africa's three National Heritage sites. The estuarine area of St Lucia is approximately 32 000 ha, an order of magnitude greater than any of the other estuaries. There are a diversity of different estuary types (Table 1, permanently open, temporarily open/closed, river mouths, estuarine lakes, estuarine bays and river mouths) that are characterised by specific biota. For example, mangroves and intertidal salt marsh occur in permanently open estuaries, whereas temporarily open closed estuaries particularly along the east coast are characterised by a diversity of reeds and sedges.

Figure 1:

ECONOMIC IMPORTANCE

Estuaries are important as recreational sites, some have marina developments such as the Kromme, Berg and Kowie estuaries, others serve as coastal resorts or upmarket residential areas. Pursuits such as boating and fishing are popular. Besides fish, other estuarine resources that are utilised include crabs, bait species such as the mudprawn and plants such as reeds are harvested for thatching and weaving material whereas mangroves are utilised for wood. Estuaries such as, for example, Kosi Bay, Swartkops and Olifants have important subsistence uses.

Last year it was estimated that coastal resources contribute R168-billion a year to the South African economy. A component of this revenue is generated from estuaries that function as ports such as Durban Bay, Richards Bay and the Buffalo estuary. Many other estuaries serve as nodes for tourism (e.g. Knysna, Keurbooms at Plettenberg Bay).

Many businesses rely on estuaries to perform functions which have an economic value such as transport, tourist facilities and a nursery for marine fish and crustaceans. The value of estuaries to the South African fishing community was estimated by Lamberth and

Table 1: Number of estuaries of each physical type in each biogeographical zone (Turpie et al. 2001)

	Cool temperate	Warm temperate	Subtropical
Estuarine bay	0	1	3
Permanently open	2	29	16
River mouth	2	6	4
Estuarine lake	0	4	4
Temporarily closed	5	85	94

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Turpie at R951 million (in 1997 prices). Recreational fishing mostly generated this.

The properties of and processes occurring in and around estuaries provide options for use i.e. goods and services (Table 2). For example, local households and tourists can directly use estuary goods such as fish, plant fibres and bait. Estuary processes provide services such as waste treatment, floodwater control and erosion control. It has been estimated that Durban Bay contributes approximately R150 million each year in terms of income generated and cost savings from "free" services such as wastewater treatment (McKenzie and Breen 2001).

Economic approaches have the disadvantage that not all features of the environment can be given a monetary value and thus the intrinsic value of natural assets (i.e. sense of place, scenic views) is often overlooked.

CONSERVATION IMPORTANCE

In a recent project the conservation priority status of 250 estuaries in South Africa was assessed (Turpie et al. 2001). The conservation importance of different estuaries is used in estuary management decisions and freshwater requirement studies. Estuaries received scores based on their size, type and biogeographical zone (Table 1), habitats and biota (plants, invertebrates, fish and birds). The larger an estuary the more important it is. If the estuary is only one of its type within a biogeographical zone then it receives a high score (for example in the cool temperate west coast region there are only two permanently open estuaries and thus they receive high scores for zonal type rarity). Estuaries with that have a variety of habitats and many different plant and animal species receive high habitat and biodiversity scores. Table 2 indicates the top 50 South African estuaries ranked in terms of their conservation importance.

The functional importance of estuaries is also important but currently difficult to determine and can be summarised as:

- estuaries input detritus and nutrients to the coastal zone, this is what the Tugela study highlighted;
- estuaries provide a nursery function for marine fish and invertebrates, South Africa's seas are deep and turbulent, only estuaries offer a sheltered habitat;
- provide a movement corridor, migratory route for river and sea organisms; and
- estuaries are important for birds as stop over and roosting areas.

FRESHWATER REQUIREMENTS OF ESTUARIES AND THE NATIONAL WATER ACT

The fundamental features of estuaries are that they are characterised by river inflow interspersed with droughts and floods, they have an unblocked connection with the river (which is not the case in many of South Africa's estuaries because of dam and weir construction) and they have a continuous or discontinuous connection with the sea. Approximately 72 per cent of South Africa's estuaries are temporarily closed.

In many estuaries particularly the small ones, the most important factor keeping the mouth open is river flow and particu-

Table 2: The top 50 South African estuaries ranked in terms of Conservation Importance (IMP). Conservation importance is calculated on the basis of weighted size (S), habitat (H), zonal type rarity (Z) and biodiversity (B) importance scores (FROM TURPIE ET AL. 2001)

Rank	Estuary	S	H	Z	B	IMP	Rank	Estuary	S	H	Z	B	IMP
1	Knysna	100	100	100	99.0	99.8	26	Richard's Bay	100	50	80	85.0	81.8
2	Berg	100	100	90	94.0	97.5	27	Kariega	90	80	20	94.0	81.5
3	Olifants	100	100	90	94.0	97.5	28	Mbashe	90	90	30	80.0	81.5
4	Kosi	100	100	70	99.5	96.9	29	Mtata	90	90	30	79.0	81.3
5	St Lucia	100	100	70	98.5	96.6	30	Mkomazi	100	60	30	90.0	80.5
6	Swartvlei	100	100	70	97.0	96.3	31	Kowie	90	80	20	89.0	80.3
7	Orange	100	100	90	88.0	96.0	32	Goukou	90	90	20	76.5	79.6
8	Bot/Kleinmond	100	100	70	94.5	95.6	33	Duiwenhoks	90	90	20	75.0	79.3
9	Klein	100	100	70	93.0	95.3	34	Uilkraals	90	90	10	77.5	78.9
10	Mhlathuze	100	100	80	82.0	93.5	35	Matigulu/Nyoni	90	70	30	89.0	78.8
11	Swartkops	100	100	20	100.0	92.0	36	Mzimvubu	90	90	30	67.0	78.3
12	GreatFish	100	100	20	97.0	91.3	37	Xora	90	80	30	75.5	77.9
13	Mfolozi	90	100	70	92.5	91.1	38	Mgeni	80	90	10	88.5	77.6
14	Gamtoos	100	100	20	95.5	90.9	39	Sundays	90	70	20	87.5	77.4
15	Keiskamma	100	100	20	93.5	90.4	40	Nhlabane	100	50	70	70.0	77.0
16	Keurbooms	100	90	20	94.5	88.1	41	Nxaxo/Ngqusi	90	80	10	79.5	76.9
17	Kromme	100	90	20	87.5	86.4	42	Kabeljous	90	80	10	75.0	75.8
18	Breë	100	90	20	85.5	85.9	43	Seekoei	90	80	10	74.0	75.5
19	Mtati	100	100	10	79.0	85.8	44	Bushmans	90	60	20	89.5	75.4
20	Mlalazi	90	90	30	94.0	85.0	45	Mtentu	80	80	30	81.0	75.3
21	Mgwalana	100	100	10	75.0	84.8	46	Sand	90	70	10	81.5	74.9
22	Mngazana	90	100	30	82.0	84.5	47	Mzamba	80	80	30	79.5	74.9
23	Mpekweni	90	100	10	86.5	83.6	48	Bira	90	70	10	81.0	74.8
24	Wilderness	90	70	70	89.5	82.9	49	Groot Brak	90	80	10	70.5	74.6
25	Heuningnes	90	90	20	87.5	82.4	50	Gourits	90	60	20	83.0	73.8

ESTUARY SERVICE	ECOSYSTEM FUNCTIONS	EXAMPLES
Food and bait production	Production for food	Fish, crabs, prawns
Water sports	Provision of opportunities for sport in water	Swimming, sailing, canoeing, skiing
Waste treatment	Removal and breakdown of excess nutrients	Breaking down waste
Genetic resources	Unique biological materials and products	Genes for mariculture, ornamental species, fibre
Scenic views	Provision of scenic views	Houses, flats and offices with views
Cultural	Providing opportunities for non-commercial uses	Aesthetic, educational, spiritual, intrinsic and scientific values of ecosystems
Erosion control	Retention and protection of soil	Prevention of soil loss by vegetation cover

larly base flow. The flow required to keep the mouth of temporarily open/ closed estuaries open, varies due to local coastal conditions i.e. Great Brak on the southern Cape coast requires approximately 0.5 m^3/s whereas the Mgeni Estuary on the east coast requires approximately 10 m^3/s. Factors that influence the mouth condition are the size of the estuary, tidal prism, availability of sediment, wave action in the mouth, beach slope and protection of the mouth. A steep beach means that there is high wave action and therefore a high suspended sediment load. Understanding of these processes is important in determining the water requirements of estuaries. Two estuaries occurring adjacent to one another may have completely different flow requirements, as the mouth of one estuary could be protected by a headland and less prone to mouth closure. Therefore estuary water requirements cannot be extrapolated between estuaries even if they occur adjacent to one another.

The National Water Act (Act 36 of 1998) makes provision for a Reserve to be determined prior to authorisation of water use (e.g. for agriculture or industrial uses). The Reserve is the water required to satisfy basic human needs (i.e. 25ℓ per person per day) and to protect aquatic ecosystems to ensure biological sustainable development and use of the resource. A desired level of protection is set for the water resource and resource quality objectives are defined for water quantity and water quality (the Reserve), habitat and biota.

The resource directed measures procedure includes documenting the geographical boundaries for the estuary, comparing the present state and a predicted reference condition and using an estuarine health index to determine the present ecological status. The importance of the estuary is taken from a national rating system and together with the present ecological status is used to set an ecological Reserve category for the estuary. This category represents the protection status afforded to an estuary. The Reserve (water quality and quanitity requirements) is set to maintain the estuary in that state. Other resource quality objectives are set and monitoring requirements identified to improve the confidence of the Reserve determination.

PROGRESS WITH RDM METHODOLOGY

The resource directed measures (RDM) methodology for estuaries was written up in 1999. Since then it has been applied to the Mtata and ten adjacent estuaries, the Nahoon and Breede estuaries. An intermediate Reserve determination is currently underway for the Tugela Estuary. The Tugela functions as a river mouth particularly during the high flow summer months, when the system is fresh to the sea. The estuary - the brackish interface zone occurs out at sea and this is where the system is most productive. The Tugela provides sediment and nutrient rich water to the marine environment, sediment is important for beach nourishment. The Tugela bank prawn industry is fed by the nutrients brought down from the Tugela River. The contribution of the Tugela Bank Prawn Fishery to the GDP is in the order of R70-million per year.

This methodology and the understanding of the freshwater requirements of estuaries in South Africa has developed over the last ten years through the Department of Water Affairs and Forestry projects on the freshwater requirements of estuaries and also research studies. The Water Research Commission is currently funding a Consortium for Estuarine Research and Management (CERM) project on "Information requirements for the implementation of RDM in estuaries".

This is a three year study beginning in July of 2001. This is a multi-disciplinary programme of the CERM and includes individuals from universities and institutes throughout the country.

The aim of this programme is to provide data and understanding to support the estuarine component of the Resource Directed Measures programme of the Department of Water Affairs and Forestry. The Amazon team (Adams, Taljaard, Turpie, Van Niekerk and Weston) will administer the project. This team, with inputs from other CERM members, was responsible for the development of the RDM methodology for estuaries. Recent application of the methodology has identified research gaps that this programme will address.

There are three projects within the programme:

Project 1 - Improving the biodiversity importance rating of South African estuaries.

Project 2 - Quantifying water quality changes that effect different estuarine taxa.

Project 3 - The importance of the river – estuary interface (REI) zone in temporarily open / closed estuaries.

❒ *Project 1 - Improving the biodiversity importance rating of South African estuaries*

This project is managed by Dr Jane Tur-

pie (Percy FitzPatrick Institute & Southern Waters) and specialists throughout the country are involved in the study. In the RDM methodology for estuaries the Ecological Reserve Category is selected based on an estuary's health and its importance in terms of biodiversity conservation. While the health of an estuary can be determined in isolation, understanding its biodiversity importance requires knowledge of estuarine biodiversity in all South African estuaries. Readily available existing information has been collated into a database, which has formed the basis of a preliminary assessment of the relative biodiversity importance of individual estuaries (Turpie et al. 2001). This project will address data gaps in order to come up with a more confident and robust rating of estuarine importance. The study will concentrate on invertebrates with some input on birds and fish.

The four main tasks of the project are:

- Improvement of the existing biodiversity database through collation of existing data.
- Sampling of estuaries in the Transkei region to fill information gaps.
- Developing predictive models of estuarine biodiversity.
- Updating the biodiversity importance rating of all South African estuaries on the basis of improved information and understanding.

- ***Project 2 - Quantifying water quality changes that effect different estuarine taxa.***

The water quality component of the estuarine reserve requires that there is a sound understanding of the inter-relationships between the different abiotic and biotic components in an estuary. One such inter-relationship is that between water quality and estuarine biota (e.g. microalgae, macrophytes, invertebrates and fish). Information is not readily available for estuarine environments as it is for coastal marine waters. The aim of this project is to collate available data (preferably quantitative) on the response of different estuarine taxa to changes in water quality that are relevant to South African estuaries.

Different groups have been tasked with addressing microalgae, macrophytes, invertebrates and fish and summarising the data in templates. Where available, detail on tolerance curves, tolerance bands and exposure time curves will be included. The information will then be made available on a CD for use by DWAF personnel and individuals involved with reserve studies.

- ***Project 3 - The importance of the river – estuary interface (REI) zone in temporarily open / closed estuaries.***

The objectives of this project were finalised at a workshop in October 2001. The research will mostly be carried out by the University of Natal Durban on the Mdloti and Mhlanga estuaries.

ACKNOWLEDGEMENTS

To all Consortium for Estuarine Research and Management members who have contributed to our current understanding of the importance of estuaries and their water requirements.

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Planning & design procedures suitable for small-scale farmer irrigation projects

The Water Research Commission has released the results of a study aimed at evaluating existing irrigation techniques and equipment used by small-scale farmers, in an effort to establish design methods and norms that would facilitate the future planning and development of small-scale farmer irrigation projects.

The researchers, CT Crosby, M de Lange, CM Stimie and I van der Stoep, all from MBB Consulting Engineers, say that field visits paid to small-farmer irrigation schemes and farms across South Africa afforded the research team an invaluable opportunity for observation and discussion. Evaluations of irrigation systems were carried out in the field during normal operation and the team came to realise that the purely technical evaluation of irrigation systems as a basis for design norms is not enough. It is essential to adopt a participatory "bottom up" approach to irrigation planning. However, technical aspects remain important and the successful development of small-scale farmer irrigation in South Africa requires exceptionally high technical and organisational proficiency on the part of planners, designers and implementing agencies.

Small-scale irrigation farmers in the communal land tenure areas can be categorised in terms of their water supply, namely:

- farmers on irrigation schemes;
- vegetable gardeners (served by communal water supply infrastructures), and
- independent farmers, each with a "private" water supply.

The researchers say a further distinction should be made between full-time and part-time farmers, in order to understand the technology requirements. Irrigated agriculture is almost invariably aimed at generating a cash income or at least replacing expenditure on food through own production. Even individuals growing vegetables in community gardens normally only use a small portion of their produce for home consumption. The bulk is sold to augment the family income.

Small- and micro-scale vegetable farmers represent an important sector of irrigation farming in rural and urban areas. It is estimated that at least 150 000 growers participate in community gardening projects in South Africa and an unknown number grow food in home gardens. Community gardens are the market gardens of rural and sometimes urban gardens, so that millions of people benefit from the availability of locally produced fresh vegetables at reasonable prices, while growers strengthen the family budget.

Regarding the management systems followed on small-farmer schemes the researchers say that a World Bank study into successful irrigation projects in the Sahel (West Africa) concluded that there are two models that are sometimes successful, namely, small privately-owned enterprises and large irrigation estates, employing paid labour. Problems are encountered where these two concepts are mixed, as was the case in South African schemes - when so-called "farmers" are settled on centrally-managed estates, where the "farmer" has no decision-making power, yet carries the risks of failure.

The sharing of a common water source by a group of farmers limits members' flexibility in terms of irrigation. Therefore, the choice of suitable technology is important to ensure as much flexibility for each individual farmer as possible. A crucial element in the successful sharing of a water source is that the group of farmers be well organised and equipped and trained to control, operate and maintain their infrastructure and manage their finances.

The research team believes that there is a great need to look urgently at real crop water requirements under the conditions prevailing in some small-farmer irrigation areas. They say the limited irrigation and low planting density situation serves as an example - it is highly unlikely that crop water requirements under these conditions will be the same as the requirements under intensive full irrigation. Over-estimation of the crop water requirements can lead to waterlogging, low irrigation water use efficiency and unnecessarily large and expensive irrigation systems.

FEASIBILITY STUDIES

The researchers say it is important to appreciate the present position in respect of small-scale farmer irrigation projects in South Africa. The record of the past is one of failure. The infrastructure of the state and parastatal schemes is in a state of collapse and budgets for rehabilitation are restricted. Policy is therefore that the "farmers" take over the schemes and accept full responsibility. It is a prerequisite for any degree of state support that schemes are sustainable. The researchers say a paradigm shift in approach is unavoidable and the suggestions for modified approaches to feasibility studies must be seen against this background.

A major change takes place in the planning relationship when an engineer accepts that the social scientist can make valid contributions to the engineering aspects of an investigation, and vice versa, and when they both accept that it is the community that counts and not academic disciplines

Clear, proven procedures have still to be established. The experience in other parts of Africa can provide useful guidelines but circumstances are different and, in years to come, South Africans will have to find their own answers. However, what is important is that the new procedures conform to the now-established principles of participatory development.

Pre-feasibility studies are the essential, concise, first screenings - the "go/no-go" phase. The pre-feasibility study is not only a technical exercise, but also a crucial instrument in "selling" the idea to the decision-makers. It is therefore important to present the report convincingly and thoroughly, without being verbose - too much detail may bore and confuse, while too little may cause scepticism

The practice in the past has been to analyse each irrigation project as an entity, with the emphasis on the well-being of the irrigation farmers themselves. This situation has changed and the National Water Act (No 36 of 1998) leaves no room for doubt that the contribution an irrigation project can make to its socio-economic hinterland must be a main concern of the pre-feasibility study. Four pre-feasibility study methods have been developed and subjected to limited testing, namely, the "National Geographic" method (based on annotated maps), the SAPFACT method, the bussing method and the Adendorff method. In addition, the Sondeo and Participatory Rural Appraisal methods discussed in the researchers' report can also be utilised to support pre-feasibility studies. There is no reason why these methods should not overlap or be combined with more conventional approaches. It is the approach that is adopted that counts, not the specific method alone.

The procedure for compiling a feasibility study described in the report was developed with the rehabilitation of small-farmer irrigation schemes in the Northern Province of South Africa in mind. It should comprise four parts -

- Section 1 of the study should be a description of the scheme, and the writer is led by paragraph headings and suggested approaches. This section should be a simple narrative and can be regarded as a rapid pre-feasibility study to enable preliminary decision-making on the viability of the scheme. Information for this section should be just sufficient to decide whether or not it is warranted to engage the community in a participatory procedure that will inevitably raise expectations. Information for this section can be gathered from literature and "rapid rural appraisal"-type field investigations.

- Section 2 of the feasibility study should cover key questions on the present situation. The answers to these questions can be generated with the community through a combination of participatory approaches like the "participatory rural appraisal" or Adendorff's pre-development survey.

- Section 3 should contain detailed multi-disciplinary technical and institutional information required for assessing future development possibilities. This is best generated through a Sondeo-type field investigation, where specialists of different disciplines together assess the resource potential, infrastructure, institutional and social factors, with an emphasis on generating possible

Appropriate technology, low planting density and short furrow irrigation.

scenarios in accordance with opportunities and constraints.

- Section 4 should address typical areas that must be covered in the community's development plan, and the subsequent evaluation of progress towards the agreed goals. The development plan is discussed, adapted and accepted in a community mass meeting and forms the basis for the training and development initiatives.

PLANNING

The project research team coined the phrase "participatory irrigation planning". It is a synthesis of various rural appraisal methods and implies that the community is invited to take part in the process of identifying, analysing and solving problems so that all options are considered before recommendations are made.

It has been established both internationally and in South Africa that engineers and social scientists and others from widely differing disciplines and interests can harmonise when involved in development. A major change takes place in the planning relationship when an engineer accepts that the social scientist can make valid contributions to the engineering aspects of an investigation, and vice versa, and when they both accept that it is the community that counts and not academic disciplines.

The researchers say participatory planning cannot be done in a hurry. A week to ten days is required. No matter what technique is used, it is essential to ensure that the community becomes thoroughly familiar with the issues at stake, and it takes time to build up the necessary relationships with the various members of the community so that good communication can occur. It takes even more time to guide the community in analysing their own situation and planning for the future.

The basic truth that must be clearly understood for every irrigation project is that water is the economic lifeblood of the farmers. If it is provided in an uncertain and unreliable fashion, anarchy quickly develops as individual farmers try to prevent their personal destruction.

CROP WATER

This project has disclosed that in South Africa practitioners have so far not been particularly concerned with factors that influence the relationship between crop production and crop water requirements in irrigation. This is to the detriment of all irrigation, but especially in the case of small-scale farmers facing resource, market and management constraints.

Present methods of estimating crop water requirements do not take account of the production strategies of risk-averse small-scale farmers. The project team saw examples of over-irrigation but also found cases where it was hard to credit that the farmer could "get by" with a very limited water supply. In almost all cases it was possible, on analysis, to find a satisfactory explanation.

Therefore, when both designer and farmer have the same understanding of crop/irrigation relationships, significant improvements and savings can be achieved through design. There are ways of designing to promote simpler and more efficient management of irrigation for the farmer. Small-scale farmers face constraints that make non-standard irrigation management procedures more the rule than the exception and these should be addressed from the outset.

The report includes valuable notes on how to select and manage crops in water-short situations, derived from the book Efficient use of irrigation water by Professor GH Sankara Reddi and Dr T Yellamanda Reddy of the Andhra Pradesh Agricultural University in India.

The report also includes details of the Water Research Commission spon-

sored program SAPWAT which has updated procedures for estimating crop irrigation requirements and caters for non-standard situations and non-standard agronomic factors, which should be considered in modern irrigation design but which have received little attention in the past. They include: maximum canopy cover achieved, area of soil wetted, frequency of irrigation, the influence of varieties and climate on growing season length, and location. By taking these factors into consideration, it is possible to develop crop factors that are applicable to most irrigation methods and irrigation farming practices and are especially important in the case of small-scale irrigation.

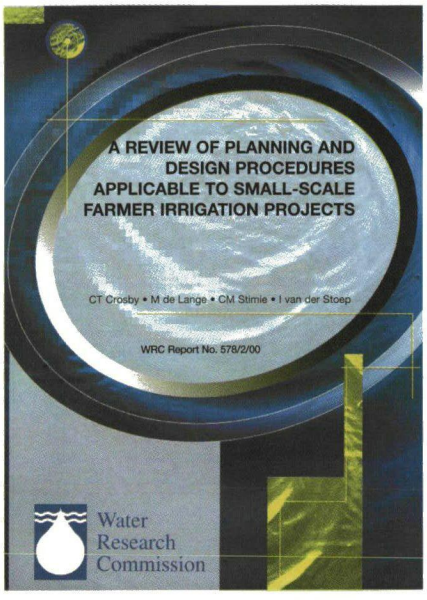
WATER SUPPLY

One of the most important chapters in the report is the one on water supply and management. Throughout this investigation, a major objective has been to identify the reasons for the general failure of irrigation in the context of development. The researchers say the hope was that, once these reasons had been identified, viable recommendations for remedial action could be devised. It now appears that the management of water delivery to small-scale farmers could be a key to the failures of the past and that, in many cases, there may be no obvious short-term solution. Innovative thinking is therefore essential if the assets of infrastructure, natural resources and experience are to be gainfully exploited. Restoring the status quo does not seem to be enough. The report discusses the researchers' observations derived from field work, the concept of indigenous irrigation schemes, developing a water supply schedule in practice as well as water delivery control, flexibility and reliability, irrigation efficiency and pumping.

The researchers say that these problems relate to the basic truth that must be clearly understood for every irrigation project - Water is the economic lifeblood of the farmers. If it is provided in an uncertain and unreliable fashion, anarchy quickly develops as individual farmers try to prevent their personal destruction.

PRESSURED SYSTEMS

There was a general swing to pressurised irrigation systems on small-scale farmer irrigation schemes in the 1980s, due to the problems experienced with flood irrigation at the time. The systems installed were conventional sprinkler systems with portable laterals (although there were exceptions) including a limited number of centre pivot installations. In later years, dragline systems became popular.



The researchers say the importance of sprinkler distribution characteristics has come to the fore. This is far more involved than simply achieving a satisfactory coefficient of uniformity. Little attention has been given in the past to analysing the operation of sprinklers in isolation (dragline), along a lateral (conventional hand move), and when a segment of a field is irrigated at one time (permanent set). The impact on application rates and losses can be significant and, while analytical approaches are useful, more field testing is required. Greater flexibility will also be possible if the areas irrigated can be broken down into smaller management units. The possibilities of pumping units based on tractors of the new generation of small diesel engines should also be considered.

The filling of soil profiles prior to planting, using single non-overlapping laterals and the application of skip-a-position lateral spacing, depends on the selection of sprinklers with a flat, rectangular distribution characteristic. The development of a new generation of relatively low-cost, plastic sprinklers is a plus factor, while the potential of the floppy sprinkler has not been fully exploited.

SHORT-FURROW IRRIGATION

In the past, the majority of small-scale farmer irrigation schemes were based on flood irrigation. Far from being a crude, primitive system, applied by relatively untrained and inexperienced people, conventional field scale flood irrigation requires great experience and skill - the soil surface must be uniform and well-graded and the water flow rate must be adequate and consistent.

However, two irrigation methods that are not nearly as sensitive to these factors are small-basin and short-furrow irrigation. Short-furrow flood irrigation has been practised in South Africa for many years but there has been a complete lack of theory to support rational design. The project team has extensively investigated short-furrow irrigation, with the lead being taken by the Institute for Agricultural Engineering of the Agricultural Research Council, under the guidance of research team member, CM Stimie.
The work done included field evaluations and computer simulations of the efficiency of distribution in the short furrows and losses in the earth supply furrows. Full-scale field tests at the Silverton terrain of the Institute, backed by in-field applications by I van der Stoep, confirmed the simulation results.

The report contains the necessary information for short-furrow systems to be designed according to a rational procedure. Guidelines for on-scheme water distribution design, including the layout of plots and secondary canals have also been included. Aspects discussed are: laying out short-furrow schemes, design of infrastructure, supply furrow losses, distribution uniformity in short furrows and recommendations for design.

COMMUNITY GARDENS

Community gardens can vary in size, anything from a hectare to ten hectares. They are communal in the sense that a number of people share the infrastructure and there is generally an overall management committee responsible for the maintenance of infrastructure and the orderly management of the garden.

For all practical purposes, the participants are market gardeners. They usually each work their allocated area for

their own profit. There are sometimes a number of communal plots on which the participants take turns to provide labour and inputs, and the proceeds are used to provide for fuel, repairs and similar common expenses.

Some community gardens are successful, many are not. The successful gardens were usually developed on the initiative of the community. It is where the infrastructure was provided by an external agency and the community was presented with a fenced area, irrigation system, water supply, etc. on a plate, that the results are often unsatisfactory.

The availability of water is a major problem. Sinking and equipping a borehole is expensive, and mechanical maintenance of engines and pump can be a difficulty, so some community gardeners carry water by hand over considerable distances to water the crops.

In gardens that are developed with outside funding, there is a tendency to over-elaborate the irrigation equipment. Often, what is required is just a source of water. The actual application can be done by hose or by bucket, provided that there is sufficient water and it is in the right place.

A number of community garden case studies are included in the report and specific information is provided on aspects such as planning, water delivery and administration.

Copies of the report entitled **A review of planning and design procedures applicable to small- scale farmer irrigation projects** (WRC report 578/2/00) are available free of charge (in South Africa) from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price US$ 25, via surface mail).

Independent farmer pumping from river, both farmer and engine old but effective.

It is suggested that this report should be read in conjunction with the following parallel Water Research Commission reports developed by MBB Consulting Engineers:

- De Lange, M; Adendorff, J and Crosby, CT (2000). Developing sustainable small-scale farmer irrigation in poor rural communities - Guidelines and checklists for trainers and development facilitators.
- Du Plessis, FJ and Van der Stoep, I (2000). Evaluation of the appropriateness and management requirements of micro-irrigation systems in small-scale farming.
- Crosby, CT and Crosby, CP (1999). SAPWAT - a computer program for establishing irrigation requirements and scheduling strategies in South Africa.

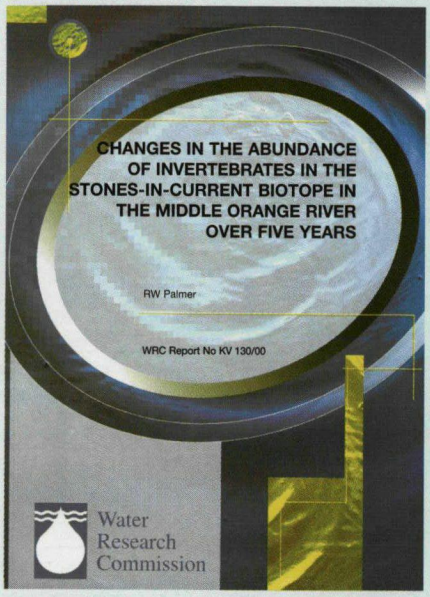
New reports published by the Water Research Commission

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

Report KV130/00 - Changes in the abundance of invertebrates in the stones-in-current biotope in the middle Orange River over five years

Report to the Water Research Commission by AfriDev Consultants, White River.

Author: RW Palmer
Overseas price: US$ 20 (via surface mail)



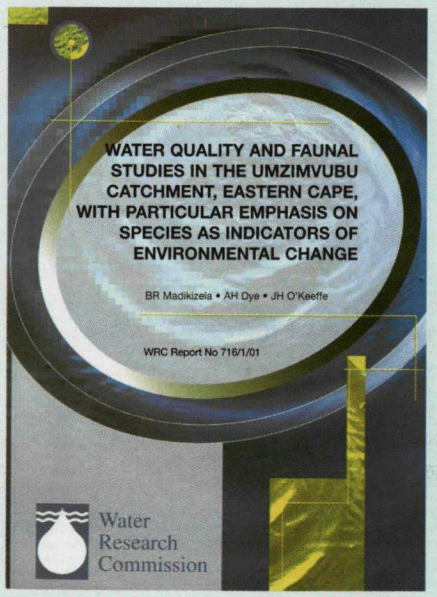
This report emanates from two three-year projects funded by the Water Research Commission on the control of pest blackflies along the middle and lower Orange River. In the course of the blackfly project, data were collected on various aspects of the ecology of the Orange River. These data were used as baseline information for the control of pest blackflies, but had wider potential application, such as for the assessment of Ecological Flow Requirements and the National River Health Programme. It was therefore considered important to make these data available to a wider audience than the blackfly control programme.

This report provides a detailed account of the temporal (monthly) changes in the abundance of invertebrates at a single site near Upington (the Gifkloof rapids) over five years. This is the longest and most detailed study of invertebrates in a South African river. Conditions during this period were highly variable, and this provided an opportunity to examine the relations between river conditions and the abundance and species composition of invertebrates over time.

Report 716/1/01 - Water quality and faunal studies in the Umzimvubu catchment, Eastern Cape, with particular emphasis on species as indicators of environmental change

Report to the Water Research Commission by the Department of Zoology, University of Transkei, Umtata, in conjunction with the Institute for Water Research at Rhodes University in Grahamstown.

Authors: BR Madikizela, AH Dye and JH O'Keeffe



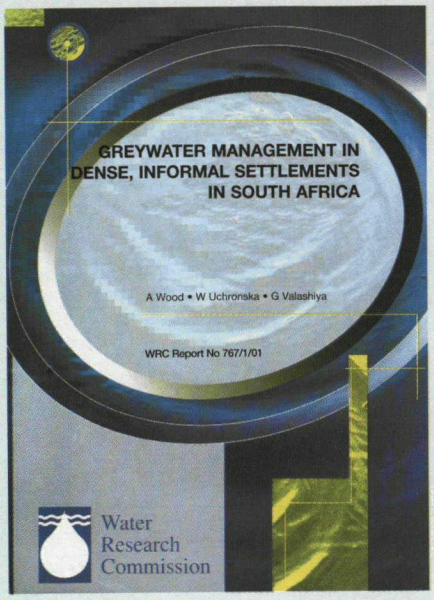
Overseas price: US$ 25 (via surface mail)

The aim of this study was to establish a water quality database and an inventory of aquatic fauna for the Umzimvubu River and its four main tributaries. The identification of species that are sensitive to environmental threats and that might be used as future indicators of environmental change, was the secondary aim. The results are outlined in Chapters 2, 3 and 4 of the report while Chapter 5 reflects on the conclusions and recommendations for further research. The researchers found that, based on the water quality data and the macro-invertebrate scores, the quality of the water in the Umzimvubu is good, suggesting that the catchment is not significantly degraded, except for threats by soil erosion leading to high total suspended solids loads.

Report 767/1/01 - Greywater management in dense, informal settlements in South Africa

Report to the Water Research Commission by SRK Consulting

Authors: A Wood, W Uchronska and G Valashiya
Overseas price: US$ 15 (via surface mail)



The report deals with an investigation in which an extensive number of dense, urban, informal settlements were chosen to be audited against a predesigned settlement service and greywater management questionnaire in consultation with local authorities and communities. Issues assessed included: community size, water and sanitation service provision, solid waste and stormwater management practices, causes and contributing factors to greywater generation and poor service sustainability, social structures and financing of services. Dense urban informal settlements range from basic illegal squatter settlements to semi-formal residential developments.

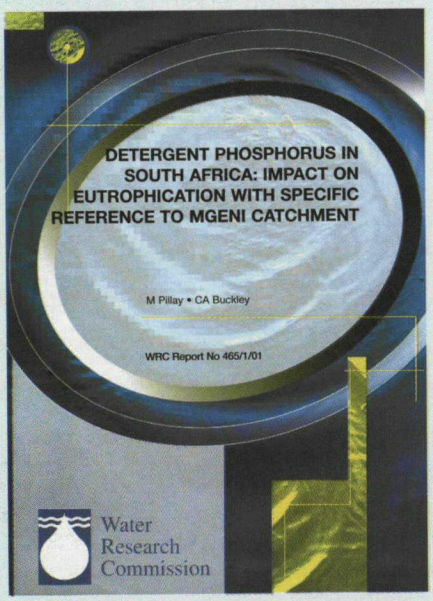
It is clear from the research that greywater is a ubiquitous problem throughout South Africa in all categories of dense informal settlements. The factors contributing to the problem can be identified on the basis of four factors:

- Physical - inadequate or inappropriate services to meet community and environmental needs.
- Institutional - unplanned development and service provision, lack of community consultation, lack of funds and capacity in the local authority, NGO's and community.
- Educational - lack of an understanding of technology use and maintenance by the local authority and the community, lack of environmental and health care education, lack of community structure in the establishment of new informal settlements.
- Socio-economic factors - overpopulation of informal settlements exceeding design service capacity, general poverty levels and unemployment in dense settlements and continued culture of non-payment for services the community does not believe in.

Report 465/1/01 - Detergent phosphorus in South Africa: impact on eutrophication with specific reference to Mgeni catchment

Report to the Water Research Commission by the Water Quality Department, Scientific Services, at Umgeni Water, Pietermaritzburg, in conjunction with the Pollution Research Group, Department of Chemical Engineering, University of Natal, Durban.

Authors: M Pillay and CA Buckley
Overseas price: US$ 15 (via surface mail)



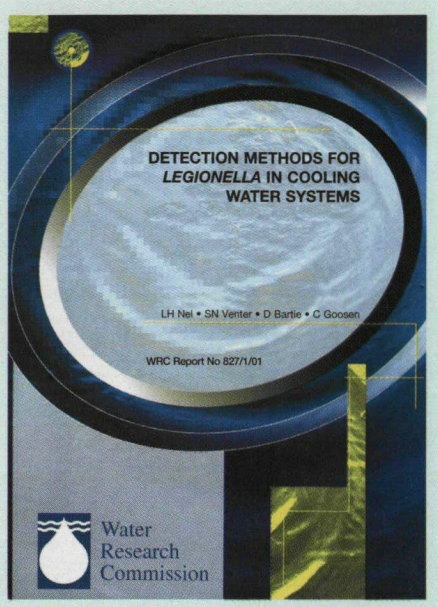
The topic of detergent phosphorus and its contribution to eutrophication, or nutrient enrichment, is particularly relevant to South Africa where many impoundments have become eutrophic or are threatened by eutrophication. In 1986 two researchers of the Water Research Commission, Heynike and Wiechers, assessed the contribution made by detergent phosphorus to wastewater phosphorus charges in South Africa and its impact on eutrophication. Their study showed that detergents comprised between 35 and 50 per cent of the total wastewater phosphorus load and thus presented a significant source of phosphorus to the environment, but the costs associated with eliminating or banning detergent phosphorus outweighed the benefits.

In this study the aim was to assess the contribution of detergent phosphorus to eutrophication in the Mgeni system and determine the economic and water quality consequences. The results were basically the same as the Heynike & Wiechers investigation, namely, that detergents made a significant contribution to the phosphorus loading on the environment and that the costs of eliminating detergent phosphorus outweighed the advantages. For the Inanda system, the cost of treating nuisance algae was cheaper than either detergent reformulation or phosphorus removal at a wastewater works.

Report 827/1/01 - Detection methods for *Legionella* in cooling water systems

Report to the Water Research Commission by the Department of Microbiology and Plantpathology at the University of Pretoria in conjunction with the National Council of Occupational Health.

Authors: LH Nel, SN Venter, D Bartie and C Goosen
Overseas price: US$ 20 (via surface mail)



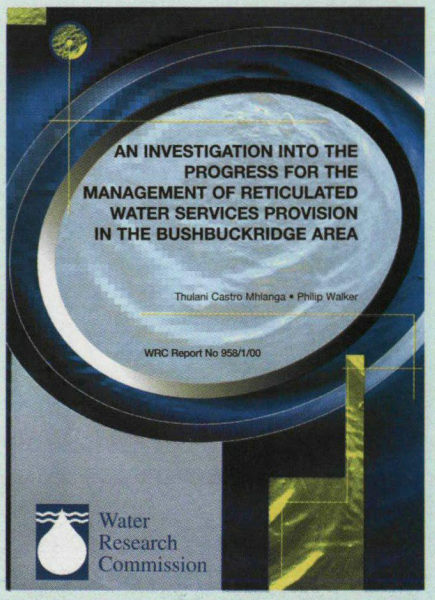
The presence of large numbers of *Legionellae* in water distribution systems and in industrial waters, including cooling tower environments, presents a potential serious health risk to both workers and the general public. No official guidelines exist in South Africa for the maintenance of water distribution systems or for the treatment of such systems contaminated with *Legionella*. Treatment procedures currently available are expensive and only successful in the temporary reduction of bacterial numbers. All the methods currently used in South Africa for the detection and quantification of *Legionella* are conventional methods, dependent on the culturing of Legionellae prior to identification. These methods are reported to be time consuming and to require special identification reagents and culture media as well as a high degree of technical skill in their application.

The report contains a summary of the results and conclusions reached when researchers isolated *Legionella* species present in South African industrial cooling water systems and evaluated the currently available identification and enumeration methods using type cultures and isolated *Legionella* species. They also compared all methods in terms of cost, applicability to field conditions, sensitivity, specificity and availability and determined the ecology of *Legionella* in the biofilm and water phase of cooling towers.

Report 958/1/00 - An investigation into the progress for the management of reticulated water services provision in the Bushbuckridge area

Report to the Water Research Commission by the Association for Water and Rural Development (AWARD).

Authors: Thulani Castro Mhlanga and Philip Walker
Overseas price: US$ 15 (via surface mail)



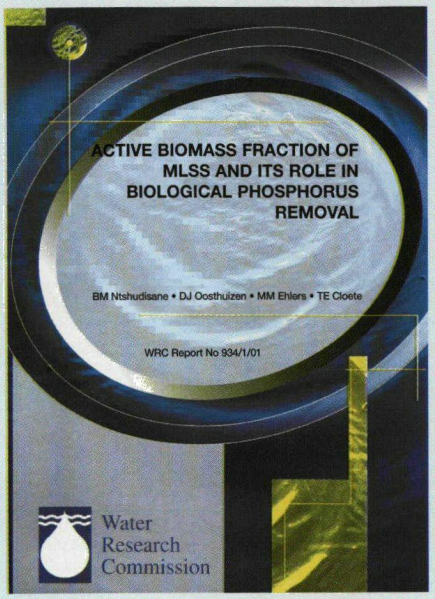
The Department of Water Affairs and Forestry in 1994 decided to build the Inyaka Dam in the Sabie-Sand water catchment with the aim to provide domestic and agricultural water to the communities of Bushbuckridge in the Northern Province and Nsikazi North and Hazyview in Mpumalanga. Following the decision to construct the dam, the Department recognised that a water management vacuum existed in the area and that it was necessary to establish a water board as a bulk supply agent together with an appropriate structure for local government to manage reticulated water services. As this was one of the first institutional development projects undertaken by the Department of Water Affairs in South Africa to build the capacity of new and predominantly rural local governments to manage water and sanitation, it was felt that there were many important lessons that could be disseminated to others throughout the country undertaking similar schemes. Accordingly, the researchers was commissioned to document the progress, successes and difficulties encountered during the project.

The report provides an overview of the current legislative and policy frameworks that impact upon local government responsibilities, particularly in the water and sanitation arena. It also provides a descriptive history of the project from its inception in late 1994, initially known as the Bushbuckridge institutional development project. A survey of key stakeholders involved in the process is provided as well as recommendations for various tiers of government.

Report 934/1/01 - Active biomass fraction of mixed liquor suspended solids (MLSS) and its role in biological phosphorus removal

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

Authors: BM Ntshudisane, DJ Oosthuizen, MM Ehlers and TE Cloete
Overseas price: US$ 20 (via surface mail)



The activated sludge process has been designed and operated for excess phosphate removal to reach effluent concentrations of 0.5 to 1.0 mg phosphate per litre. Unfortunately, many activated sludge systems fail to achieve this standard, necessitating chemical augmentation. This has mainly been attributed to the lack of knowledge about the role microorganisms play in biological phosphate removal processes as well as the optimum conditions required for their growth, enabling them to facilitate phosphorus removal.

Research has indicated that there were no differences amongst the bacterial community structures of different activated sludge zones or amongst different activated sludge systems. Hence, phosphorus removal cannot be attributed to the activity of a single population, but rather to the combined activity of all the populations in the microbial community. Researchers have found that an increase in biomass resulted in an increase in phosphorus removal. This raised the question whether wastewater treatment systems could be bioaugmented to increase biomass.

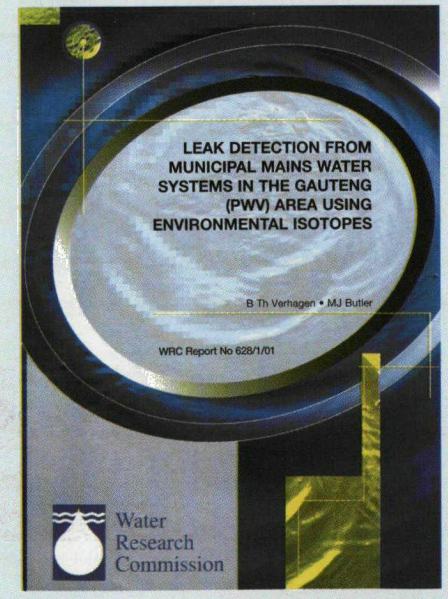
The report discusses the results of laboratory experiments in which the effect of bioaugmentation on phosphorus removal was determined by adding commercially available bioaugmentation products as inocula in sterile anaerobic mixed liquor medium.

An investigation was also done into the relationship between the mixed liquor suspended solids and the mixed liquor volatile suspended solids fractions of activated sludge, as measures of total biomass, and phosphorus removal. In this study, by means of two independent experiments, differences in orthophosphate uptake ability of different activated sludges treated in exactly the same way were observed. Orthophosphate removal was consistently high with higher biomass concentrations as measured by the total plate counts and by adenosine diphosphate. This supports the notion that the viable biomass fraction of the mixed liquor suspended solids is the key to orthophosphate removal by activated sludge.

Report 628/1/01 - Leak detection from municipal mains water systems in the Gauteng (PWV) area using environmental isotopes

Report to the Water Research Commission by the Schonland Research Institute for Nuclear Sciences at the University of the Witwatersrand.

Authors: B Th Verhagen and MJ Butler
Overseas price: US$ 15 (via surface mail)



The distinctive stable isotopic composition of water supplied by Rand Water in Gauteng was used in a feasibility study to detect leakage from mains supplies. The strategy used was to employ mainly privately owned boreholes as sampling points of groundwater. The isotopic contrast between mains water and that of most naturally recharged groundwater allows for the determination of the admixture of as little as ten per cent of mains water. The parameters measured are the concentrations of deuterium and oxygen-18 as fractional deviations from a standard. In addition, environmental tritium was measured in a selection of cases to establish the mobility of groundwater. Electrical conductivity, total alkalinity, temperature and pH were measured in the field for supporting information.

According to the report ground truthing of leakage sites identified by this method has to date not produced any physical evidence of mains leakage. However, the research "has shown that, given the basic techniques, individual problems require unique approaches. Sampling is simple, the measurement technology is standard and the expected costs involved in most investigations modest."

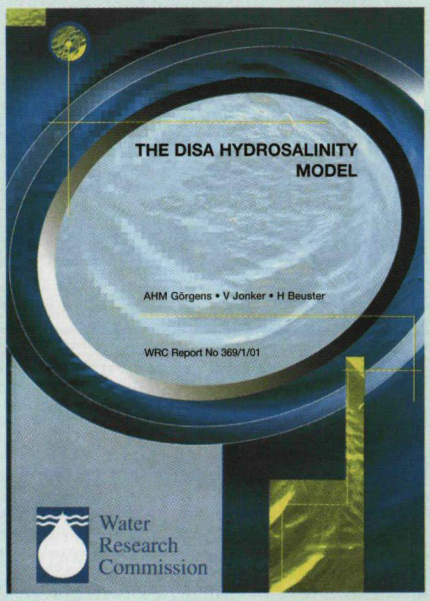
Report 369/1/01 - The DISA hydrosalinity model

Report to the Water Research Commission by Ninham Shand Consulting Engineers, Cape Town, in conjunction with the Department of Civil Engineering at the University of Stellenbosch.

Authors: AHM Görgens, V Jonker and H Beuster
Overseas price: US$ 15-00 (via surface mail)

The Department of Water Affairs and Forestry appointed Ninham Shand in 1988 to develop a computer model capable of predicting the impact of irrigation development on river flow and salinity in the Greater Brandvlei Dam Government Water Scheme supply area. This Water Scheme is situated in the Breede River catchment area - one of South Africa's primary vine and deciduous fruit growing areas.

The DISA model (Daily Irrigation and Salinity Analysis) was developed and implemented to examine the potential impacts of a number of planning scenarios in the Brandvlei Dam Water Scheme supply area. Aspects addressed included future salinity and flow patterns in the Breede River, as well as requirements for future freshening releases from Brandvlei Dam.



In 1987 an intensive five year hydrosalinity field research programme to support the development of the DISA model was initiated and conducted by the Hydrological Research Institute in the Breede River Valley. This research was based on an intensive monitoring programme at measurement points in the main river, tributaries, canals, deep and shallow boreholes, piesometers in alluvial soils, tensiometer fields and rainfall stations. By 1990 Government spending cuts and subsequent Departmental budgetary constraints necessitated a curtailment of some longer term projects, which included a premature end to the Hydrological Research Institute's Breede River salination research programme. The timetable for this termination required the conclusion of all Breede River field studies, including intensive monitoring by the end of the '89/'90 irrigation season. This timetable meant that certain ongoing aspects related to the model development had to be regarded as provisional, as continued field research and monitoring was required for further model verification.

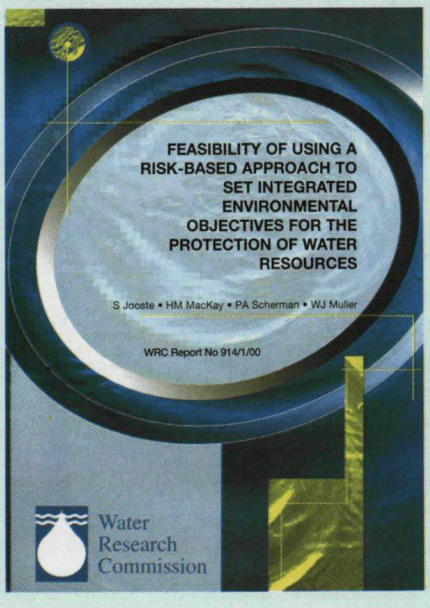
To ensure that the full potential of the Breede River salination research programme be realised, an agreement was subsequently reached whereby the Water Research Commission would provide funding to ensure that certain actions relating to the original project specifications could be finalised. These included a further year of intensive monitoring, refinements to certain aspects of the DISA model and effective technology transfer.

This report describes the refined version of the DISA model, including model verification and sensitivity analyses. It also serves to upgrade the existing documentation, which is in the form of consulting reports to the Department of Water Affairs, to a research oriented communication. The DISA model provides a useful tool for anticipating the effects of various irrigation and operational planning scenarios on river salinity.

WRC Report 914/1/00

Feasibility of using a risk-based approach to set integrated environmental objectives for the protection of water resources

Report to the Water Research Commission by the Institute for Water Research at Rhodes University, Grahamstown, in conjunction with the Institute for Water Quality Studies at the Department of Water Affairs and Forestry in Pretoria.



Authors: S Jooste, HM MacKay, PA Scherman and WJ Muller
Overseas price: US$ 20 (via surface mail)

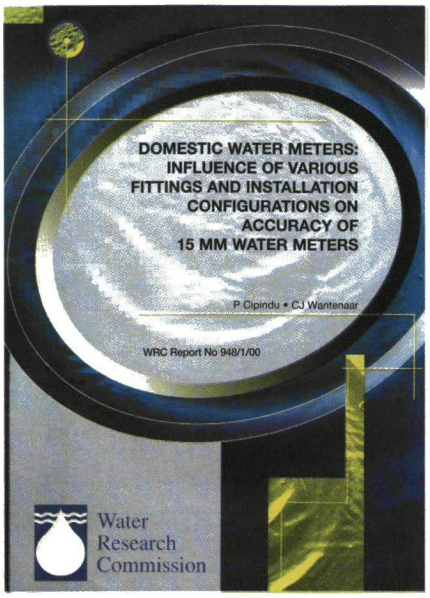
The report is presented in three parts: Part 1 comprises background literature on risk concepts and the use of a risk-based approach in water resource management, while Part 2 documents the discussion and findings of a workshop on the use of risk-based objectives in water resource management, and highlights the requirement for information on stressor-response relationships.

Part 3 records the discussion and findings of a workshop on using risk-based objectives to set flow requirements for rivers.

Report 948/1/00 - Domestic water meters: influence of various fittings and installation configurations on accuracy of 15 mm water meters

Report to the Water Research Commission by the South African Bureau of Standards, Pretoria.

Authors: P Cipindu and CJ Wantenaar
Overseas price: US$ 15 (via surface mail)



This research was aimed at establishing the influence of various fittings and installation configurations on the accuracy of water meters. The current situation is that the installation of meters is done by plumbers who are in some cases oblivious of the effect of haphazard installations and choice of fittings adjacent to the meter. As these meters are used for both domestic and industrial billing of consumers, the overregistration or underregistration due to their incorrect installation can result in false billing of consumers with resultant audit imbalances between the quantities of water actually supplied against water consumed. Water loss management as prescribed in the National Water Supply Regulations can only be as accurate as the instruments used to measure the volumes of water.

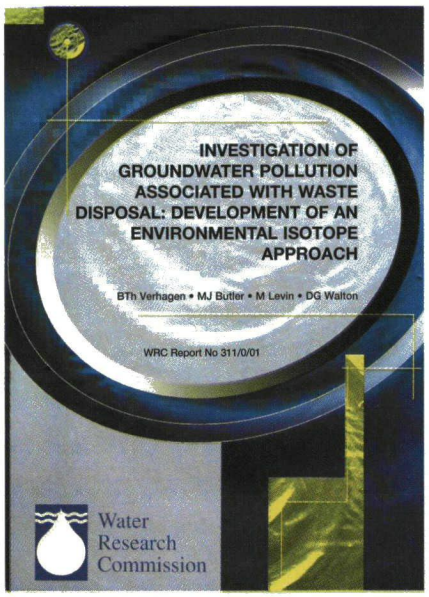
In the report the results emanating from the research are summarised as follows:

- The 15 mm ball valve in various positions of opening at the inlet of the meters as well as the above ground installation did not produce any consistent notable effect on the meter accuracies.
- The accuracy of certain models of volumetric meters was affected by the 45 degrees tilt configuration.
- The accuracy of the inferential, multi-jet type meters was affected in the lower flow rates (transitional flow rate) when the meters were rotated 45 degrees from the vertical.

Report 311/1/01 - Investigation of groundwater pollution associated with waste disposal: development of an environmental isotope approach

Report to the Water Research Commission by the Schonland Research Centre for Nuclear Sciences at the University of the Witwatersrand in conjunction with the Earth and Environmental Technology Department at the Atomic Energy Corporation of South Africa Ltd.

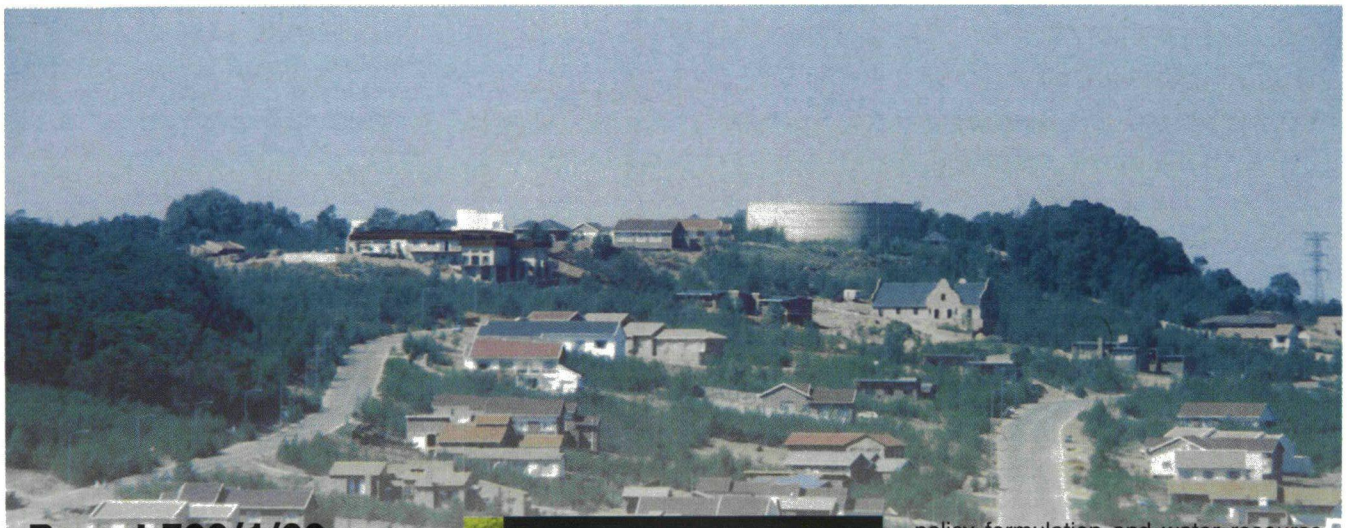
Authors: BTh Verhagen, MJ Butler, M Levin and DG Walton
Overseas price: US$ 20 (via surface mail)



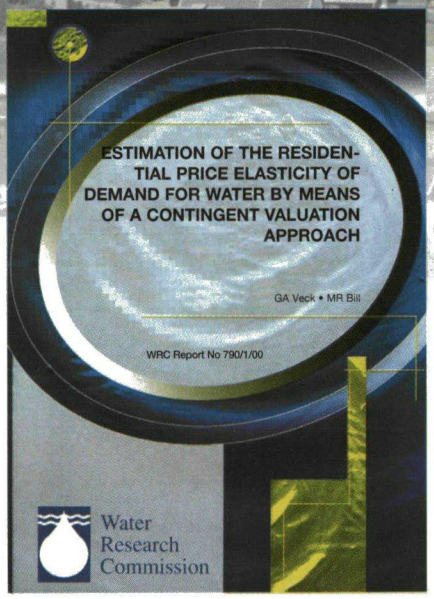
In this study the researchers tried to determine the most appropriate methodologies to be employed when determining the feasibility of a specific site for waste disposal. Conventional geohydrological methods were applied, including geological and geophysical investigations followed by exploratory drilling to form a basic understanding of the local geology, water levels and hydrogeochemistry. In addition to these conventional approaches, measurements of environmental isotopes were incorporated to provide information on groundwater residence times and origin together with the outlining of recharge areas, and mechanisms by which pollution could enter the groundwater system.

To test the various isotope methodologies in different geological environments, five areas were studied on a site specific basis, namely, Olifantsfontein/Clayville in Midrand, incorporating Karoo outliers within dolomite (infilling of old clay quarries), Limbro Park in Sandton with weathered granites (infilling of borrow pit/landfill), the Western suburbs of Johannesburg with diorite gneisses and granite and Bloemfontein North on dolerite (landfill) and Bloemfontein South with siltstones and sandstones (landfill).

The study has shown the intrinsic power of environmental isotope techniques in analysing various geohydrological aspects of waste disposal. Environmental isotopes, as tracers of water, enable the investigation of the transport of groundwater and the contaminants it carries. When applied during the initial stage of an investigation, environmental isotope measurements can quite rapidly assess aspects of the geohydrology, such as recharge areas, groundwater flow in relation to depth, discharge points and turnover time.



Report 790/1/00 - Estimation of the residential price elasticity of demand for water by means of a contingent valuation approach



Report to the Water Research Commission by the company Economic Project Evaluation (Pty) Ltd.

Authors: GA Veck and MR Bill
Overseas price: US$ 30 (via surface mail)

An important factor in managing metered water effectively is knowledge of its price elasticity of demand or how much consumers are prepared to buy as the price of the water is increased.

In studying the literature on determining the price elasticity of demand for water as a consequence of price increases, the authors found that econometric analysis was the common approach adopted. This approach requires a substantial database for exogenous and endogenous variables. Unfortunately such a database is not readily available to researchers in South Africa in an appropriate form at present. A study undertaken in Australia in 1987, however, approached the problem of estimating the price elasticity of demand for residential water by using a contingent valuation methodology (CVM). The same CVM approach was followed in this study making it a unique initiative as far as South Africa is concerned. The research was undertaken in the residential areas of Alberton and Thokoza in Gauteng where 161 people were interviewed.

The results obtained from the surveys, summarised in the report, indicate that the price elasticity of demand for total water usage in Alberton and Thokoza is -0.17. This suggests that if the price of metered water for residential use is increased by ten per cent, the total water demand would be reduced by 1.7 per cent.

This study has shown that water pricing is one of the most important economic instruments that does work for controlling consumers' demand for water. Knowledge of people's behaviour under increasing price regimes is therefore an important piece of information for those charged with water policy formulation and water resource planners. The contingent valuation methodology has been shown in this study to provide this information in a relatively simple way.

As a result of the experience gained in this study the authors suggest that a very important consideration when selecting policy instruments for conserving and managing water efficiently, is the need to act at three levels of intervention for achieving these objectives, namely:

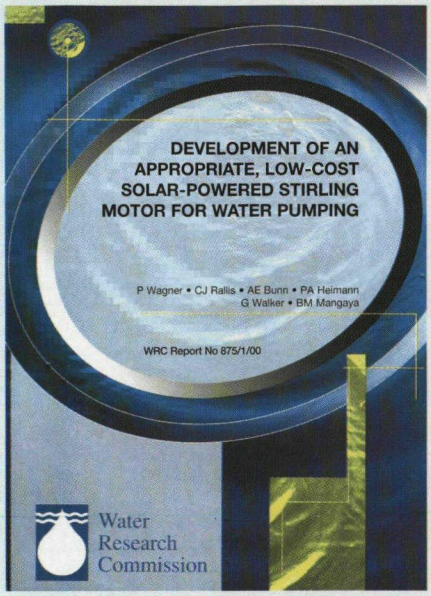
- First, national policies and strategies are needed at the macro-level, which set the basis within which the water supply and sanitation industry can operate.
- Secondly, a set of actions is required at the user's level. They can take two forms - they may act as incentives for water users who can themselves determine the most efficient and cost-effective water usage patterns, or they can be direct regulations that prohibit or limit excessive use of water along with monitoring and enforcement systems, i.e. command and control instruments.
- Thirdly, incentives are needed at utility level to influence the provider's management of the resource. Such actions would of course have to take cognisance of the utility's own financial health.

The levels of intervention are not alternatives, but instead they reinforce each other. What is needed is a balance of the three layers to create a critical mass and synergy.

Report 875/1/00 - Development of an appropriate, low-cost solar-powered stirling motor for water pumping

Report to the Water Research Commission by Wagner Systems.

Authors: P Wagner, CJ Rallis, AE Bunn, PA Heimann, G Walker and BM Mangaya
Overseas price: US $ 20 (via surface mail)



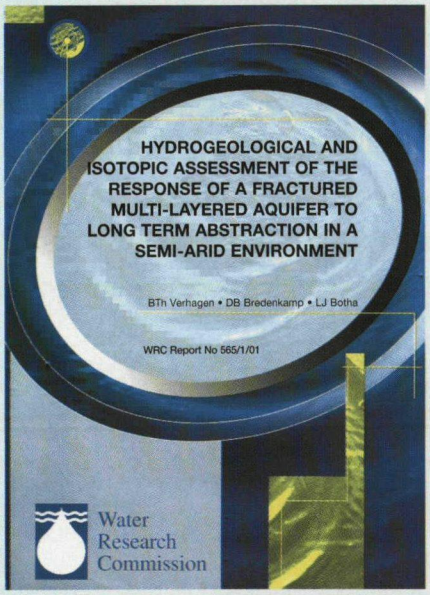
This report consists of two parts. The first, called solar engineering, deals with the transient energy input to the system and the projected losses by re-radiation, convection and conduction. This is used to delineate the operating domain throughout the day for specified values of engine and ambient parameters.

The second part of the report is a first-order, time-independent thermodynamic model for predicting pressure/volume diagrams for the working fluid. This is used to provide information on the effects of various engine parameters. These include clearance space volumes, regenerator/displacer stroke length and initial cycle pressure. Although admittedly simplistic this model provides useful comparative information. The researchers conclude that the engine delivers insufficient power for this particular application.

Report 565/1/01 - Hydrogeological and isotopic assessment of the response of a fractured multi-layered aquifer to long term abstraction in a semi-arid environment

Report to the Water Research Commission by the Schonland Research Centre for Nuclear Sciences at the University of the Witwatersrand in conjunction with the Department of Water Affairs and Forestry and Water Resources Evaluation and Management.

Authors: BTh Verhagen, DB Bredenkamp and LJ Botha



Overseas price: US$ 15 (via surface mail)

The assessment of recharge to fractured Karoo aquifers, especially below a substantial cover of Kalahari deposits, has occupied the minds of many researchers.

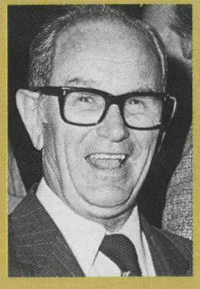
The report deals with several approaches to the problem. Isotope data obtained from pumping tests are used to assess ground water mean residence times from which integrated recharge rates can be deducted. The method of cumulative rainfall departures is applied to long-term rest level, pump rate and rainfall observations.

The study originated as an attempt to use long-term, well-documented abstraction of groundwater at the Orapa mine in Botswana, toevaluate critically borehole pumping tests of fractured Karoo aquifers, which are of necessity limited in their duration.

Dr GG Cillie Award - Call for applications

The GG Cillie floating trophy, certificate and cash prize of R1 000 are awarded by the WISA-Anaerobic Processes Division (APD) for the best contribution to anaerobic digestion research in Southern Africa by a university student.

Students who wish to be considered for this award for 2000/2001 must submit recent published research or a conference paper before 28 February 2002 to the following address:



WISA- Anaerobic Processes Division, PO Box 6011, Halfway House 1685. For more information and enquiries call (011) 413-1030 or fax (011) 413 1022.

A panel comprising of specialist APD management committee members will select the recipient of the award.

SOUTHERN AFRICA 2002

WASTE SA
JANUARY 22 - 24
The 12th annual Waste SA congress will be held at the Holiday Inn, Johannesburg International Airport.
Enquiries: The Conference Administrator, Institute for International Research, PO Box 2353, Parklands 2121. Tel: 011- 880-6000 or 011-340-1200. Fax: 011-880-8260 or 011-880-6789.

PUMPS
JANUARY 23 - 25
The 4th annual pumps & valves summit will be held at the Indaba Hotel, Fourways, Johannesburg.
Enquiries: The Conference Administrator, Institute for International Research, PO Box 2353, Parklands 2121. Tel: 011- 880-6000 or 011-340-1200. Fax: 011-880-8260 or 011-880-6789.

WATER AFRICA
FEBRUARY 13 - 15
The Water Africa Exhibition will be held alongside Aquatec 2002 at the Cairo International Conference Centre in Egypt.
Enquiries: Margo Lubbe, Ace Event Management SA, PO Box 7958, Albemarle, Gauteng 1410. Tel: (011) 902-2342. Fax: (011) 902-2342. Cell: 082 463 8082. E-mail: margodemos@hotmail.com

ENVIRONMENT
FEBRUARY 18 - 22
The ISO 14001 Environmental Auditor training course will be held at the Eskom Conference Centre in Midrand, Gauteng.
Enquiries: Crystal Clear - Tel: (011) 882 3368. E-mail address: info@crystalclear.co.za

RIVER SYSTEMS
MARCH 3 - 8
The 4th international ecohydraulics symposium with the theme "Environmental flows for river systems" will be held in Cape Town.
Enquiries: Conference Secretariat, Southern Waters Ecological Research and Consulting (Pty) Ltd. PO Box 13280. Mowbray 7705. Fax: (021) 6503887. E-mail address: conference2002@southernwaters.co.za. Web: http://www.southernwaters.co.za

HYDROLOGY
MARCH 18 - 22
UNESCO's 4th international conference on Flow Regimes from International Experimental and Network Data (FRIEND) with the theme "Bridging the gap between research and practice" will be held in Cape Town.
Enquiries: Juanita McLean, Institute for Water Research, Rhodes University, PO Box 94, Grahamstown 6140. Tel: (046) 622-4014. Fax: (046) 622-9427. E-mail: Juanita@iwr.ru.ac.za

DESERTIFICATION
APRIL 8 - 10
An international symposium on alternative ways to combat desertification - Connecting community action with science and common sense - will be held in Cape Town.
Enquiries: Mary Seely, Desert Research Foundation of Namibia, PO Box 20232, Windhoek, Namibia. Tel: +264 61 229855. Fax: +264 61 230172. E-mail: mseely@drfn.org.na

NOSHCON 2002
MAY 7 - 10
NOSA will be hosting the 41st international Occupational Safety, Health and Environmental Risk management conference and exhibition - NOSHCON - at Sun City.
Enquiries: NOSA, PO Box 26434, Arcadia 0007. Tel: (012) 303 9700. Fax: (012) 303 9856. E-mail: noshcon@nosa.co.za

WISA
MAY 19 - 23
The Water Institute of Southern Africa (WISA) will hold its next biennial meeting at the ICC conference centre in Durban. Call for papers.
Enquiries: Roelien-M Bakker, WISA. Tel: (011) 805-6368. Fax: (011) 315-1258. E-mail address: conference@wisa.co.za

AQUATIC SCIENCE
JUNE 30 - JULY 5
A joint congress of the Southern African Society of Aquatic Scientists (SASAqS) and the Southern African Institute of Ecologists and Environmental Scientists (SAIE & ES) will be held at the University of the Free State in Bloemfontein. The theme will be "Research, conservation and management of ecosystems in Southern Africa".
Enquiries: Dr JC Roos, Centre for Environmental Management, UFS, PO Box 339, Bloemfontein 9300. Tel: (051) 401 2265. Fax: (051) 401 2629. E-mail address: roosjc@sci.uovs.ac.za

SACI2002
JULY 1 - 5
The 36th convention of the South African Chemical Institute will be held in Port Elizabeth.
Enquiries: Dr CD Woolard, Department of Chemistry, University of Port Elizabeth, PO Box 1600, Port Elizabeth 6000. E-mail: SACI2002@UPE.AC.ZA

HYDRAULIC ENGINEERING
DECEMBER 4 - 6
The International Association for Hydraulic Research (IAHR) African Division's biennial congress with the theme " Water - the lifeblood of mankind" will be held in Arusha, Tanzania.
Enquiries: The Institution of Engineers, PO Box 2938, Dares-Salaam, Tanzania. E-mail: iet@iet.co.tz Tel: +255 22 212 4265. Fax: 212 2836. Web: http://www.iet.co.tz

OVERSEAS 2002

UAWS
FEBRUARY 18 - 21
The 11th congress of the Union of African Water Suppliers (UAWS) will be held in Libreville, Gabon, with the theme, "Water and the environment, strategic factors in poverty alleviation".
Enquiries: Administrative Secretary of UAWS, 01 Bp 1843 Abidjan 01, Côte d'Ivoire. E-mail: susher@sodeci.ci. Tel: (225) 2124-1443. Fax: (225) 2124-2629.

GROUNDWATER
FEBRUARY 20 - 22
An international groundwater conference on sustainable development and management of groundwater resources in semi-arid regions with special reference to hard rocks will be held in Dindigul, Tamilnadu, India.
Enquiries: Conference Secretariat IGC2002, NGRI, Uppal Road, Hyderabad 500007, India. Tel: +91 40 7170141. Fax: +91 40 7171564. E-mail address: postmast@csngri.ren.nic.in

FLOODS
MARCH 6 - 8
An international conference on flood estimation will be held by the Federal Office for Water and Geology in Berne Switzerland.
Enquiries: Tel: +41 31 324 7758. Fax: +41 31 3247 681. E-mail: floodestimation@bwg.admin.ch Web address: http://www.admin.ch/bww/d/news

GROUNDWATER
MARCH 25 - 29
An international groundwater symposium - bridging the gap between measurments and modelling in heterogeneous media will be held at Berkley, California, USA.
Enquiries: Dr Angelos Findikakis, Bechtel, Mail Stop 333/12/C34, PO Box 3965, San Francisco, California, USA. Tel: +1 415 768 8550. Fax: +1 415 768 4898. E-mail: anfindik@bechtel.com

SEWER PROCESSES
APRIL 15 - 17
The 3rd international conference on sewer processes and networks will be held in Paris, France.
Enquiries: GRAIE - 3rd SPN Conference, Secretariat, BP 2132, 69603 Villeurbanne cedex - France. Tel: +33 4 72438368. Fax: +33 4 7239277. E-mail: graie@urgc-hu.insa-lyon.fr

BIOTECHNOLOGY
APRIL 15 - 17
The 2nd environmental biotechnology conference focusing on applications of biotechnology for treatment and utilisation of industrial wastes and by-products will be held in Palmerston, New Zealand.
Enquiries: Conference Secretary, Office of the Principal, Massey University, Private Bag 11-222, Palmerston North, New Zealand. Tel: +64 63505243. Fax: +64 63505862. E-mail: M.K.Edwards@massey.ac.nz

GROUNDWATER
MAY 12 - 17
An international groundwater conference with the theme - Balancing the groundwater budget - will be held by the International Association of Hydrogeologists (Australian Chapter) in Darwin, Australia.
Enquiries: Des Yin Foo IAH (NT), PO Box 95, Palmerston, NT 0831, Australia. Fax: (61) 8 8999 3666. E-mail: des.yinfoo@nt.gov.au

WATER QUALITY
MAY 21 - 22
A conference on automation in

water quality monitoring will be held in Vienna, Austria.
Enquiries: E-mail address: Mail@iwga-sig.boku.ac.at Web: www.iwga-sig.monet.boku.ac.at Tel: +43 (0) 1 36006 5800. Fax: +43 (0) 1 3689949.

ECWATECH-2002
JUNE 4 - 7
The 5th international congress and trade fair - Water, Ecology and Technology will be held in Moscow, Russia.
Enquiries: Sergey Malygin, SIBICO International Ltd, PO Box 173, Moscow, 107078 Russia. Tel/Fax: +7 (095) 975 1354, 975 5104. E-mail: ecwatech@sibico.com Website: www.sibico.com/ecwateche/index.htm

WATER UTILITIES
JUNE 12 - 14
A conference on the management of productivity at water utilities will be held at Praha in the Czech Republic.
Enquiries: Katerina Slaviakova, Aquion s.r.o., Delnika 38, CZ-170 00 Praha 7, Czech Republic. Tel: +420 283872265. Fax: +420 283872266. E-mail address: ManProWU@aquion.cz

AWWA
JUNE 16 - 20
The American Waterworks Association's annual conference and exhibition will be held in New Orleans, USA.
Enquiries: David Rossiter, AWWA, USA. E-mail: rossiter@awwa.org Tel: +303 347 6209. Web: http://www.awwa.org/tande/awwaconf.htm

GROUNDWATER
JUNE 17 - 19
A conference on soil and groundwater pollution induced by the transport industry will be held in Oslo, Norway.
Enquiries: Transport and Pollution, Department of Geology, PO Box 1047, Blindern 0316 Oslo, Norway. Fax: +47 22 85 42 15. E-mail address: transp-pollution@geologi.uio.no

GROUNDWATER
JUNE 17 - 20
ModelCARE 2002 - the 4th international conference on calibration and reliability in groundwater modelling (a few steps closer ro reality) will be held in Prague, Czech Republic.
Enquiries: Conference Secretariat, ModelCARE 2002 Guarant Ltd, Opletalova 22, 110 00 Prague 1, Czech Republic. Tel: +420 2 8400 1444. Fax: +420 2 8400 1448. E-mail: modelcare2002@guarant.cz Website: http://www.guarant.cz/ModelCARE2002

HYDROINFORMATICS
JULY 1 - 5
The 5th international conference on hydroinformatics - Hydroinformatics 2002 - will be held in Cardiff, UK. Hydroinformatics is concerned with the application of computer and networking technology for the planning, management and protection of the water environment.
Enquiries: Cherrie Summers, Hydroinformatics 2002, Conference Secretariat, Cardiff University, Cardiff School of Engineering, PO Box 925, Newport Road, Cardiff CF24 0YF, UK. Tel/fax: +44 29 20874421.
E-mail: summersc@cardiff.ac.uk Web: http://www.cf.ac.uk/engin/news/confs/hydro

ISWA 2002
JULY 8 - 12
The International Solid Waste Association (ISWA) world environment congress and exhibition will be held in Istanbul, Turkey. Theme: Appropriate environmental and solid waste management and technologies for developing countries.
Enquiries: MICWORLD, Bagdat Cad. No: 254/2-8 81060 Göztepe, Istanbul, Turkey. Tel: +90 216 467 5398. Fax: +90 216 302 5216. E-mail: iswa2002@iswa2002.org Web: http://www.iswa2002.org

IRRIGATION
JULY 21 - 28
The 53rd IEC meeting and 18th international congress on irrigation and drainage will be held in Montreal, Canada.
Enquiries: Jean-Marcel Laferriere, Chairperson of the Organising Committee, CIDA, 200 Promenade du Portage, Hull, QC K1A 0G4 Canada. Tel: +1 819953 4327. Fax: +1 819 994 0251. E-mail: jeanmarc-laferriere@ACDI-CIDA.GC.CA

CSCE/ASCE
JULY 21 - 24
The 2002 joint CSCE/ASCE international conference with the theme - An international perspective on environmental engineering will be held at Niagara Falls in Canada.
Enquiries: Professor Richard G Zytner. E-mail: CSCEASCE_2002@yahoo.ca Web-address: www.eos.uoguelph.ca/webfiles/CSCE_ASCE_2002

WATER RESOURCES
JULY 22 - 26
The 3rd international conference on water resources and environmental research (ICWRER) with the theme "Water quantity and quality aspects in modelling and management of ecosystems will be held in Dresden, Germany.
Enquiries: Conference Secretariat ICWRER 2002, Institute of Hydrology and Meteorology, Dresden University of Technology, Wuerzburger Str 46, 01187 Dresden, Germany. Tel: +49 351 463 3931. Fax: +49 351 463 7162. E-mail address: icwrer2002@mailbox.tu-dresden.de Website: www.tu-dresden.de/fghhihm/hydrologie.html

SOIL SCIENCE
AUGUST 14 - 21
The 17th world congress on soil science - confronting new realities - will be held in Bangkok, Thailand.
Enquiries: Mrs Catherine Vachon. Tel: 1 403 317 2257. Fax: 1 403 382 3156. E-mail: vachonc@em.agr.ca Web: www.res2.agr.ca/lethbridge/hebei/confindex.htm

ACID SOILS
AUGUST 25 - 30
The 5th world acid sulphate soils conference will be held at the Quality Resort Twin Towns, Tweed Heads, NSW Australia.
Enquiries: Jacki Rose. Tel: 0011 61 75536 4000. Fax: 0011 61 7 5599 5167. E-mail: hwtweedm@onthenet.com.au Website: www.acrose69.webcentral.com.au/aciddates.html

FLUVIAL SYSTEMS
SEPTEMBER 2 - 6
An international symposium on the structure, function and management implications of fluvial sedimentary systems will be held in Canberra, Australia.
Enquiries: Dr Fiona Dyer, School of Resource, Environment and Heritage Sciences, University of Canberra, Canberra ACT 2601, Australia. Tel: +61 2 62012267. Fax: +61 2 62012328. E-mail: fiona.dyer@canberra.edu.au Web site: http://lake.canberra.edu.au/~iahs2002

ANAEROBIC DIGESTION
SEPTEMBER 11 - 13
The 3rd international symposium on anaerobic digestion of solid waste will take place in Garching, Germany.
Enquiries: Rüdiger Dalhoff, Am Coulombwall, D-85748 Garching. Tel: +40 89289 13710. Fax: +49 89289 13718. E-mail: Dalhoff@bv.tum.de

DRY AREAS
SEPTEMBER 15 - 19
An international conference on environmentally sustainable agriculture for dry areas for the 2nd millennium will take place in Shijiazhuang, Hebei, People's Republic of China.
Enquiries: Mrs Catherine Vachon. Tel: 1 403 317 2257. Fax: 1 403 382 3156. E-mail: vachonc@em.agr.ca Web: www.res2.agr.ca/lethbridge/hebei/confindex.htm

MINE WATER
SEPTEMBER 15 - 21
The 8th international Mine Water Association congress will be held in Freiberg, Germany.
Enquiries:
UMH@geo.tu-freiberg.de or http://www.geo.tu-freiberg.de/institut/hydro/UMH

GROUNDWATER
SEPTEMBER 22 - 26
The 4th international symposium on artificial recharge of groundwater with the theme - Sustainability of artificial recharge - will be held in Adelaide, Australia.
Enquiries: Conference Manager, Hartley Management Group Pty Ltd, PO Box 20 Kent Town, South Australia 5071. Tel: +61 8 8363 4399. Fax: +61 8 8363 4577. E-mail adress: isar4@hartleymgt.com.au

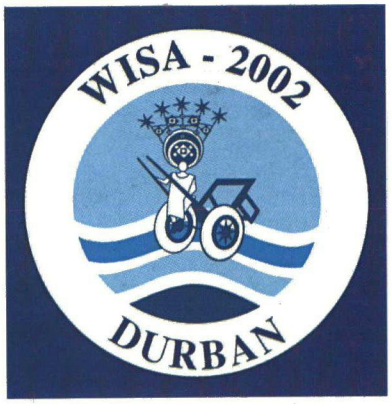
WASTEWATER TREATMENT
SEPTEMBER 23 - 25
The IWA 5th specialised conference on small water and wastewater treatment systems will be held in Istanbul, Turkey.
Enquiries: Prof Dr Izzet Ozturk, Istanbul Teknik University, Civil Engineering Faculty, Environmental Engineering Department, 80626 Maslak, Istanbul, Turkey. Tel: +90 212 2853790. Fax:+90 212 2853781. E-mail address: iozturk@srv.ins.intu.edu.tr

GROUNDWATER
OCTOBER 21 - 25
The 32nd conference of the International Association of Hydrogeologists (Argentine Chapter) will be held in Mar del Plata, Argentine
Enquiries: Sylvia Caesar Rey, Carlos Pellegrini 3775, 7600 Mar del Plata, Argentina. E-mail: scaesar@argenet.com.ar Web: http://www.mdp.edu.ar/exactas/geologia/iah2002/iah2002.html

Water Institute of Southern Africa (WISA)

Biennial Conference & Exhibition

International Convention Centre (ICC)
Durban
19 - 23 May 2002



WISA

Exhibition

An exhibition - a showcase for all water and environmentally orientated organisations and companies will be held concurrently with the conference. The exhibition and hospitality area will be significantly expanded to cater for the increasing demand, but will be limited to a maximum of one hundred units. Exhibitors are assured of ample opportunities to interact with the conference delegates. Exhibitors are advised to make their reservations as soon as possible in order to secure preferred positions. Details of the full exhibition package and costs are available from the WISA offices.

Enquiries

All enquiries in regard to this conference should be directed to -

Cilla Taylor
Conference Planners
Tel: (012) 667 3681 • Fax: (012) 667 3680
E-mail: confplan@iafrica.com