SA waterbulletin

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WATER AND SANITATION
Researchers evaluate cost - effectiveness of new projects

METEOROLOGIE
Daaglikse reënvalmodel dek nou hele Suider-Afrika

GRONDWATER
Geophysical techniques applied to determine pollution

INTRODUCTORY COURSE IN WATER MICROBIOLOGY

9 - 12 May 1995

Organised by the Health Programme of the Division of Water Technology, CSIR, Pretoria.

PURPOSE

The purpose of this course is to provide a practical approach where participants will be trained in the basic concepts of health-related water microbiology. The course will include practical (60%) and theoretical (40%) aspects.

WHO SHOULD ATTEND

The course is aimed at people working in the water industry who require knowledge about basic techniques for the microbiological analysis of water. Industry, municipalities, government departments, water boards are among the bodies who may find such a course useful.

ATTENDANTS

A maximum number of 12 attendants will be allowed to ensure personal attention.

COURSE CONTENTS

Attendants will be trained in the basics of water microbiology.

- Detection and analyses of faecal indicators of pollution: Standard plate count; Total coliform; Faecal coliform; Faecal streptococci / Enterococci; Coliphage and the confirmation of Escherichia coli.
- Interpretation and reporting of results.
- Demonstrations on the detection of other pathogens in water: Viruses; Parasites; Legionella; Bio-assays for toxicity and Ames mutagenicity test.
- Quality control.
- Laboratory safety.

COST

R1 500 per person. All teas and lunches included.

COURSE MANUAL

A course manual will be supplied to all participants.

ACCOMMODATION

Accommodation as well as the travelling to and from the CSIR are not included in the price.

CONTACT PERSON

Mr Gerrit Idema
Tel (012) 841 3948
Fax (012) 841 4785

CSIR
WNNR

NOTE

- A detailed programme will be sent on request.
- A minimum of six participants is required for the course to be presented but additional courses will be presented depending on the interests of candidates.

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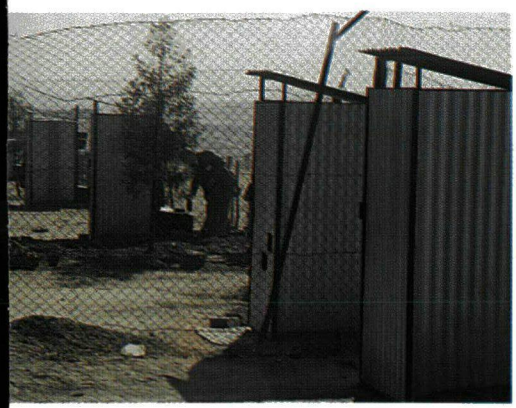

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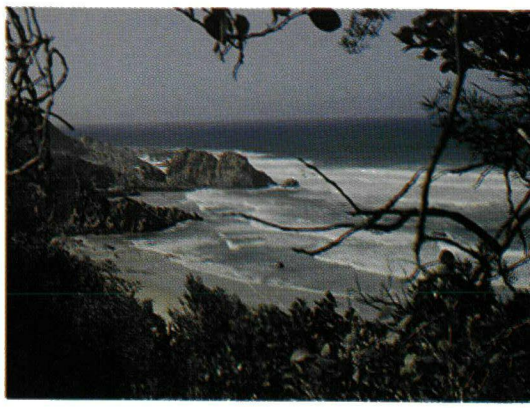

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Cover photo: Helene Joubert

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New appointment at WRC ...

Dr Nozibele Mjoli has recently been appointed as a Research Manager at the Water Research Commission (WRC). She will be responsible for the management of research projects relating to the provision of water and sanitation for unserved communities.

The WRC's activities in this area have expanded considerably in recent times. Some 40 extensive research projects relating to water supply and sanitation, as well as environmental management in developing communities, are currently being financed and managed by the WRC.

According to Dr Mjoli this WRC position offers her a unique opportunity to make a tangible contribution to the community.
"I grew up in an underdeveloped rural area in Transkei where there was insufficient water. I understand the difficulties faced by the people in such deprived communities and hope that this first-hand knowledge will assist me in making a positive contribution towards alleviating existing problems."

Dr Nozi Mjoli

Dr Mjoli grew up in the Umzimkulu district. She matriculated at the Marianhill High School in 1973. After obtaining a B.Sc Honours degree and teaching diploma at the University of Fort Hare, she lectured at the University of Bophuthatswana before being awarded a Fullbright scholarship. As a Fullbright scholar she studied (1982-87) at the University of Notre Dame in Indiana, USA, completing a Masters degree and Doctorate in Microbiology.

Upon returning to South Africa she worked as a researcher at the University of Cape Town and at Watertek, CSIR. Dr Mjoli was a senior lecturer (1992-94) in Microbiology at the University of Durban Westville prior to her appointment at the WRC.

She is the mother of three daughters; the eldest is studying at the University of the Western Cape, the middle daughter is at high school and the youngest is three years of age. Dr Mjoli says that she enjoys reading, gardening and knitting in her free moments.

STANDER LECTURE EVENING

The 1994 Stander Lecture Evening was jointly presented by Watertek, CSIR, and the Water Research Commission in Pretoria. Two prominent young researchers and two well known researchers in the water field were invited to deliver papers at this auspicious occasion.

Below, from left to right: James Meyer (University of Pretoria) Rebecca Tharme (University of Cape Town), Dr Heather MacKay (CSIR) and Dr Piet Meiring (Wates, Meiring & Barnard).

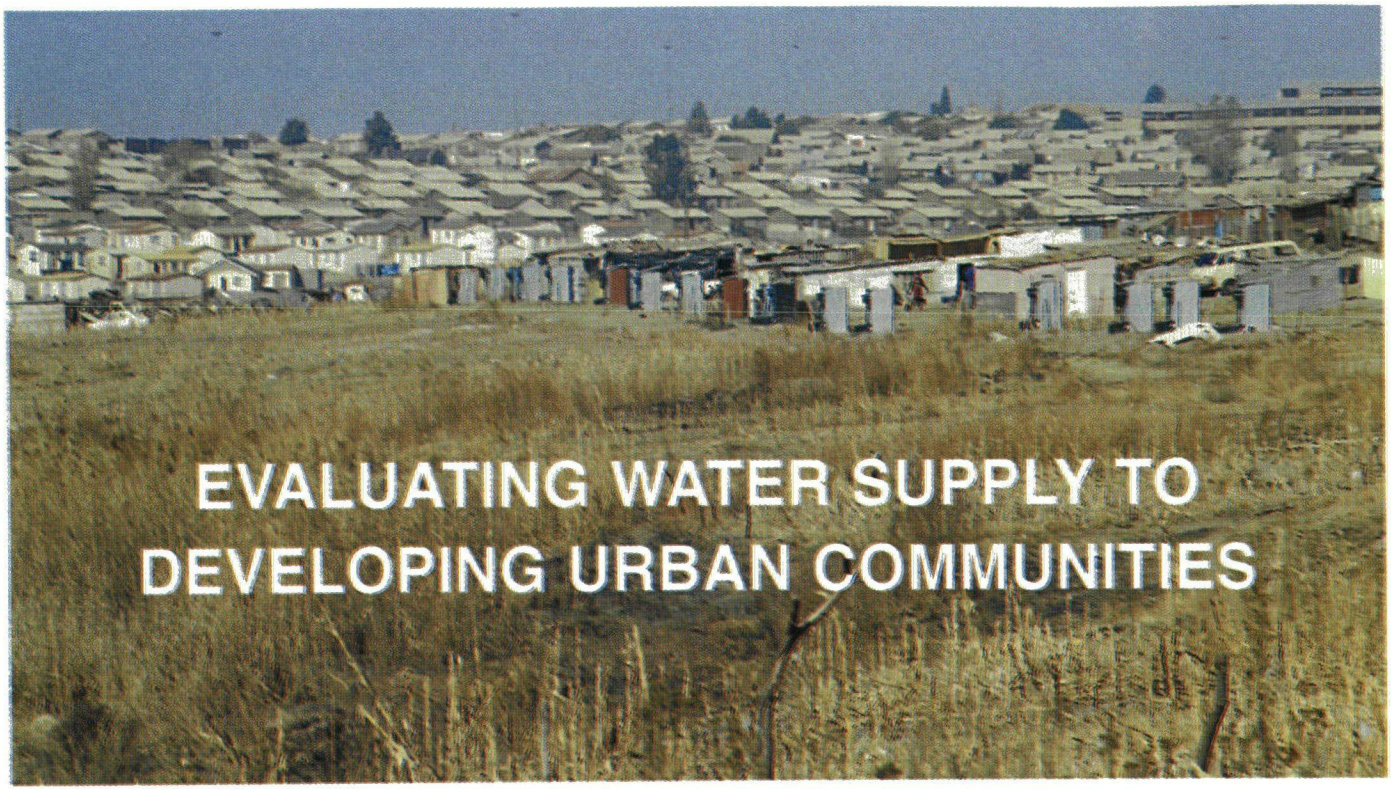
Dr Piet Meiring (right) presented Dr Daan Toerien (Executive Vice President, CSIR) with the prestigious President's Award at the Stander Lecture Evening, on behalf of Dr Gerrie Stander who was originally honoured with this award for his meritorious service in the water field.

Geïntegreerde stroomgebiedbestuur van die Olifants bespreek

'n Simposium is verlede jaar by Loskopdam Aventura gehou waartydens afgevaardigdes die beginsels bespreek het hoe die Olifantsrivierstroomgebied op 'n geïntegreerde wyse bestuur kan word ten einde die volgehoue gebruik van die rivier te verseker en die rivier as waterbron te bewaar. Die simposium is aangebied deur die Waterinstituut van Suider-Afrika (WISA) se tegniese divisie vir stroomgebiedbestuur van riviere, in samewerking met die Olifants-rivierforum. Die simposium was 'n voorloper tot die internasionale kongres met die tema: Stroomgebiedbestuur van Riviere vir Volhoubare Ontwikkeling wat later vanjaar in die Nasionale Krugerwildtuin plaasvind.

Die openingsprekers. Professor Kader Asmal, Minister van Waterwese en van Bosbou (middel), saam met mnr Len Abrams (DWWB) (links) en dr André van Niekerk (Wates, Meiring & Barnard) voorsitter en 'n organiseerder van die simposium.

Voordragte by die simposium is oa gelewer deur die volgende persone. Van links: mnr HC van Zyl (Amcoal) (Mynbou en waterbron- en watergehaltebestuur); dr ADP Botha (Instituut vir Grond, Klimaat & Water) (Boerdery en waterbron- en watergehaltebestuur); mnr AWJ Jooste (Palabora Mynmaatskappy) (Nywerheidsperspektief op stroomgebiedbestuursopsies vir riviere); me M Uys (NKW-navorsingsprogram) (Wetlike perspektief op stroomgebiedbestuur van riviere); mnr F van Zyl (DWWB) (Watergehaltebestuur in die Olifantsrivierstroomgebied); mnr B Pullen (Consultburo) (Die Olifantsrivierstroomgebied in perspektief); mnr N Van Wyk (DWWB) (Waterbronontwikkeling in die Olifantsrivier-stroomgebied) en dr A Deacon (NKW) (Bewaring van waterlewe in 'n rivier onder druk).



EVALUATING WATER SUPPLY TO DEVELOPING URBAN COMMUNITIES

The Water Research Commission in May 1992 appointed the Palmer Development Group in association with the University of Cape Town's Water Research Group to carry out a strategic evaluation of water supply to developing urban communities in South Africa.

The broad objective of the research was to investigate the present status of domestic water supply to developing communities in urban areas and to provide relevant and up to date information and analysis upon which rational policy and practice may be based so that the large and increasing demand for basic water supply services in low-income developing urban communities may be met in an economically efficient and equitable manner.

THREE PHASES

The project was conceptually divided into the following three phases:

Phase 1: Overview

- A review of the current status of water supply to developing areas internationally.
- Execution of a survey of water supply to the urban areas of South Africa, based on questionnaires and interviews, to determine who has access to adequate water supply, what type of systems are being used, and to obtain as much operating and costinformation as possible.

Phase 2: Evaluation

Evaluation of water supply systems from the point of view of acceptance by communities, health impact, cost, ease of construction and operation and environmental impact.

Phase 3: Strategies

- Development of a strategy for dealing with water in developing urban areas over the next decade.
- Preparation of guidelines for the selection, implementation and operation and maintenance of water supply systems.

REPORT

A report presenting the results of the work carried out under Phase 1 of the project has now been released by the Water Research Commission. The report entitled **An evaluation of water supply to developing urban communities in South Africa** (WRC report KV 49/94) was compiled by I Palmer and R Eberhardt and copies are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: $25).

INFORMATION

According to the authors the report on Phase 1 provides the following base information and analysis:

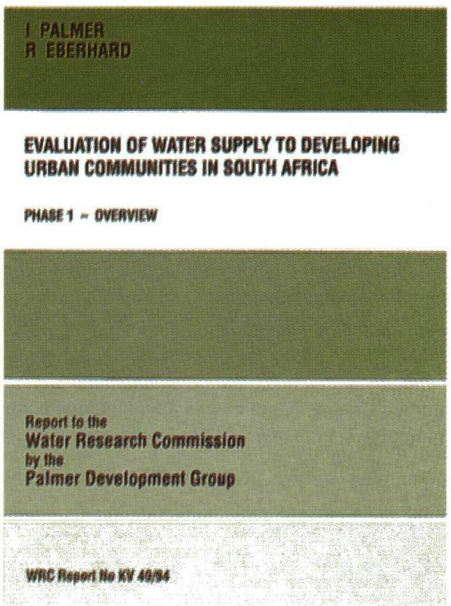
- A summary of the lessons that have been learnt from international experience in the provision of water supply to lower income communities. Recent world-wide initiatives to improve water supply to poorer communities are reviewed and the way these have been related to South Africa by international agencies are discussed.

- A quantitative analysis is given of the need for basic water supply services in the urban areas of South Africa. The report presents the results of a survey conducted in all the urban areas to determine the number and distribution of people without adequate access to safe water supplies and the levels of service currently available.

- A qualitative description (at a macro and institutional level) is included of the current water supply arrangements in the urban areas. The report provides an overview of the institutions involved in the manament of water supply, bulk water supply in the main metropolitan areas, domestic water consumption patterns, tariff and tariff policy and ope-r rating and maintenance problems typicallyexperienced.

- An overview is given of the current and future domestic water demand in South Africa. A summary is presented of the current water demand in the major urban areas and the demand projections reviewed, including the relationship of domestic demand to water demand for other uses.

- A forecast is presented of the demand for water supply services in the future. An estimate is given of the demand for water supply services up to the year 2000, calculated on the basis of the existing need with the use of a demographic projection model and an income distribution model.

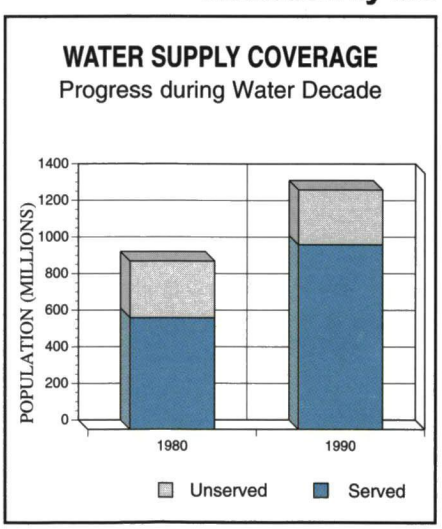


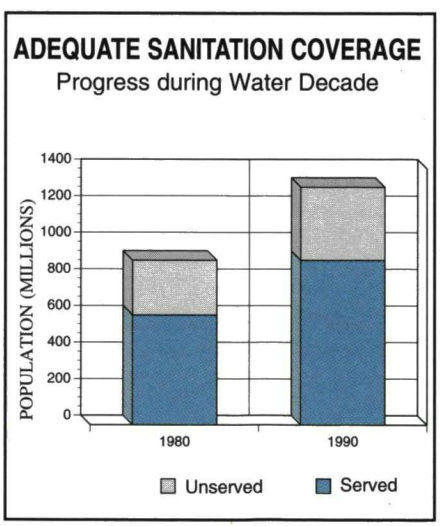
- The report gives an initial assessment of the cost of providing adequate water supply to all people living in the urban areas of South Africa. The calculation of the capital cost of providing the basic infrastructure required is based on initial cost estimates.

- The report reviews the current water supply design standards in urban areas and compares it with international practice.The current standards affecting service level and functioning of water delivery arrangements are reviewed in the light of a literature survey and the relative merits of various standards are dicussed.

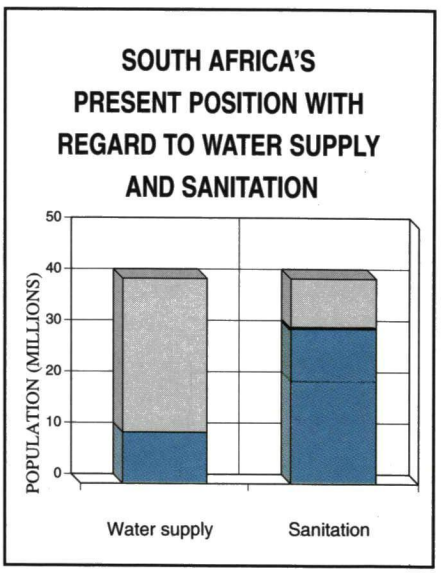
- Lastly, the report also discusses the role of water conservation in the context of water scarcity and the socio-economic and political imperative to extend and upgrade water supply networks.

The United Nations declared the 1980s as the International Water Supply and Sanitation Decade with the goal of providing everyone in the world with a supply of safe water and adequate sanitation by the end of the Decade.





Progress in water & sanitation coverage during the UN's 1980s waterdecade:The figures show that although advances were made in providing many more people with water supply and sanitation services during the Decade, population growth meant that little headway was made in reducing the total number of people without water and sanitation services.



In South Africa it has been estimated that one in every four people (10 million) lack access to a safe water supply and one in every two people (20 million) lack access to adequate sanitation.

Guidelines published on the cost-effectiveness of rural water supply and sanitation projects

In March 1987 the Water Research Commission (WRC) arranged a workshop to co-ordinate the efforts of people and organisations involved in rural water development.

The workshop highlighted the need for national guidelines on how to ensure the cost-effectiveness and appropriateness of the work undertaken in this field and the WRC consequently contracted the Division of Water Technology at the CSIR to establish procedures and guidelines for future projects on rural water supply and sanitation.

The results of this investigation are now available in the form of a WRC final report consisting of two parts, namely:

- ***Part 1: Guidelines on the cost-effectiveness of rural water supply and sanitation projects*** *and*
- ***Part 2: Guidelines on the technology for and management of rural water supply and sanitation projects.***

Copies of the report (WRC Report 231/1/93) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: $25).

It is believed that this report offers the reader a useful though not exhaustive handbook on the processes and technologies for rural water supply and sanitation projects.

It summarises the technologies most commonly being used in small-scale rural water supply schemes and discusses the steps which should be taken into consideration when undertaking such projects.

The report says lessons from development projects in the water supply and sanitation fields have emphasised the need for two main components to enhance the success of these projects. These are:

- The vital necessity of community involvement in all phases of the pro ject, including the planning and decision making processes; and
- The importance of the use of appropriate technology solutions for the provision of water and the disposal of human wastes to ensure the long-term sustainability of such systems.

An important finding, both locally and in other developing countries, was that the community does not always choose the lowest-cost option, but rather an affordable option which they feel will provide them with a service they are satisfied with and are capable of maintaining. Thus when the cost-effectiveness of schemes is evaluated, such schemes which satisfy the aspirations of the community, yet are affordable, but not necessarily the cheapest, are the schemes which will be the most cost-effective.

The first guideline document contained in the report focuses primarily on the methodologies for the selection of technologies for rural water supply and sanitation projects. The important factors of sustainability, cost recovery and community participation are stressed. The related costs and benefits of various water supply systems are dealt with and a table of the general service level is provided. This

The report discusses various aspects of small-scale rural water supply schemes

table indicates the costs and benefits of service levels from traditional sources, through the steps of improved traditional sources, hand pumps, standpipes, yardtaps and finally house connections. Estimates of capital and operation costs are given for the various components of water supply schemes. Finally the steps recommended in the selection of suitable technology for a particular application are given as follows:

- ❑ Discussion with the community on their needs and aspirations.
- ❑ Feasibility study: technical and social.
- ❑ Assessment of support finances available.
- ❑ Consultation with community to select preferred option.
- ❑ Detailed design.
- ❑ Training of personnel.
- ❑ Setting up of administrative and technical support functions.
- ❑ Implementation of system with community support at various levels.
- ❑ Commissioning of system.
- ❑ Post monitoring and evaluation.

The second guideline document focuses on technologies and management aspects of rural water supply and sanitation projects which have been successfully applied in southern Africa and in some cases in other parts of the world, but which would be applicable for local use. The main topics covered in this document are:

- ❑ General survey of the existing situation in the rural areas of South Africa.
- ❑ Water resources.
- ❑ Water quality.
- ❑ Water treatment.
- ❑ Pumps and pumping.
- ❑ Storage and distribution.
- ❑ Sanitation options.
- ❑ Management aspects.

The report says most organisations and authorities are now aware of the need for community involvement in rural projects.

However, the problems of maintenance, appropriate technologies and cost recovery still require much attention. These are dealt with to some extent in the guideline document.

CONCLUSIONS

Some of the more appropriate water supply systems being employed in rural areas are as follows:

- ❑ Spring protection, storage and limited distribution, where favourable springs exist. These systems offer

the benefits of good quality water which can substantially reduce the water collection time for rural dwellers. The associated costs are also relatively low and maintenance requirements are rudimentary.

- ❑ Handpump fitted onto a well or borehole. As with protected springs, in most cases a good quality of water is available. Associated costs are low to medium and maintenance requirements can be low with village level technician training.

- ❑ Wind, solar, diesel or electric pumps fitted to boreholes are significantly more costly than handpumps, but may prove to be a more cost-effective solution in many circumstances. Trained caretakers and operators would be required. The groundwater quality will generally be high, although additional treatment may be required in cases of high fluoride, nitrate or salinity.

- ❑ Surface water treatment through slow sand filtration, followed by storage and limited distribution. Such systems are appropriate where surface water is the only or preferred source. A pumping stage may be necessary. Final water quality is usually acceptable and maintenance requirements are relatively low, although trained personnel would be required on a semi-continuous basis.The report says promising sanitation technologies for use in rural areas are:

- ❑ VIP (ventilated improved pit) and SanPlat latrines. These latrines can be erected at a low cost by individual households. They can provide virtually odour and fly free on-site disposal of human wastes. Under most circumstances the effect on the underground water is minimal. Caution needs to be exer-cised with regard to a longer term nitrate build-up. Maintenance is in terms of general hygiene and clealiness.

- ❑ Low flush pedestal connected to a digester or septic tank and on-site soakaway. These latrines may be preferred by certain households, as well as for use at rural institutions (schools, clinics, etc.). A number of systems are available, but these are all more costly and require a higher level of maintenance than VIP latrines.

In more dense rural settlements, low or medium flush pedestals connected to digesters and then to some sewerage system. The transported effluent may be treated in ponds or in wetland systems. Pond and wetland systems offer

the possibility of low maintenance and the potential for agricultural or aquacultural exploitation.

The report says despite the progress made, these methods are not being widely utilised and successfully employed in South Africa. In certain areas where dedicated support is available, some of these methods have been adopted. However, in other rural areas, regional or large schemes which are extremely costly and require skilled technical inputs on an ongoing basis, are still being installed.

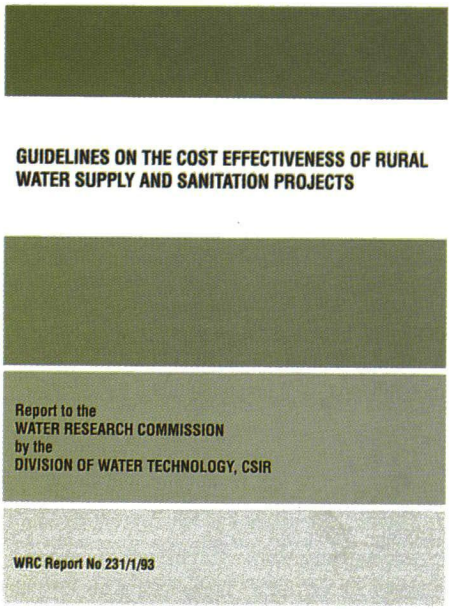
RECOMMENDATIONS

Recommendations in the report on aspects which require particular attention at the present time with respect to the provision of water supply and sanitation services in rural areas, include the following:

- There is a need for more attention to be paid to the education and training aspects of these schemes. Regional centres, or preferably regional training teams who can move from district to district, need to be established to provide the training and follow-up support needed. Education should focus on sanitation and domestic health and hygiene, as well as creating an awareness of ways of achieving development successfully. Training needs include the following:
  - ❑ Committee functions, management and the building of administrative capacity;
  - ❑ Maintenance of water supplying infrastructure;
  - ❑ Construction of simple water supply features (e.g. springprotection);
  - ❑ Construction of VIP latrines;
  - ❑ Sanitary surveillance.
- Appropriate technologies which have been successful in other rural areas need to be tested and evaluated, and where necessary, modified for local conditions. Thereport says the following technologies are among those which should be followed up:

A VIP latrine

  - ❑ Rainwater harvesting and storage;
  - ❑ Small dams (especially sand dams) for semi-arid areas;



  - ❑ Disinfection methods for small water supplies;
  - ❑ Desalination for remote areas;
  - ❑ Water dispensers for distribution terminals;
  - ❑ Water storage tanks (ferro- cement and other low cost, on-site, construction techniques; and
  - ❑ Village level operation and maintenance (VLOM) hand pumps.
- Finally, the report recommends that the privatisation of many of the functions related to water supply in rural areas should be promoted. In particular the support framework for entrepreneurs to participate in the construction and implementation of schemes, as well as to set up semi-commercial activities in:
  - ❑ Manufacturing components for or the complete construction of VIP latrines;
  - ❑ Selling water and maintaining the system;
  - ❑ Operating and monitoring the system.

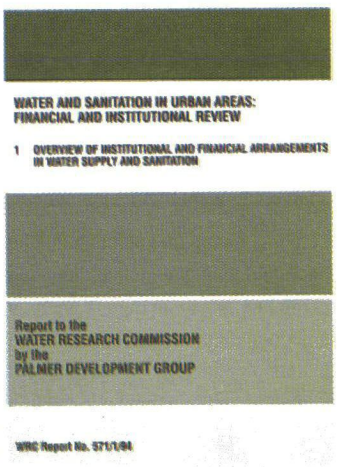
Researchers review water supply and sanitation services in South Africa's urban areas

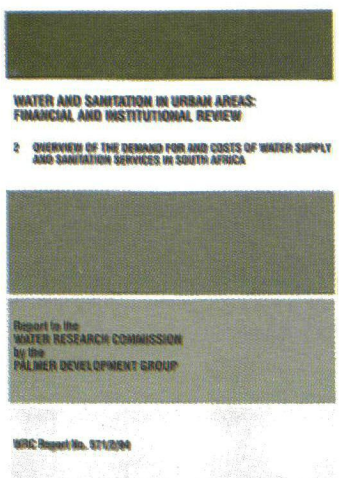
A series of reports summarising the results of an institutional and financial review of water supply and sanitation services in the urban areas of South Africa are now available from the Water Research Commission (WRC). The review was undertaken by the Palmer Development Group and addresses the need for unified and concerted action in the water and sanitation sector to meet the large and increasing need for adequate services in both urban and rural areas.

The overall objective of the project was to present and analyse information and an analysis that can help relevant community leaders and decisionmakers to:

- Guide and promote the extension of services and the reshaping of organisations to enable all people living in urban areas of South Africa to have adequate and appropriate water supply and sanitation; and
- Facilitate the related processes of financial, institutional, legislative and other changes that the adoption and implementation of the above objective will require.The project outputs consist of a series of six reports and seven working papers. Each report covers one of the specific project objectives, while the working papers were written to provide background material for the main project reports. The reports are:

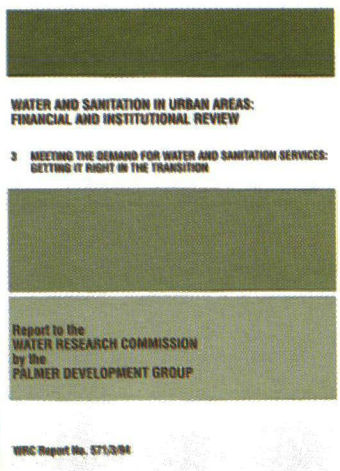
- **Report 1** (WRC report 571/1/94) (Overview) provides an overview of current institutional and financial arrangements in the South African water and sanitation sector, with a focus on the urban areas. (Overseas price: $25).

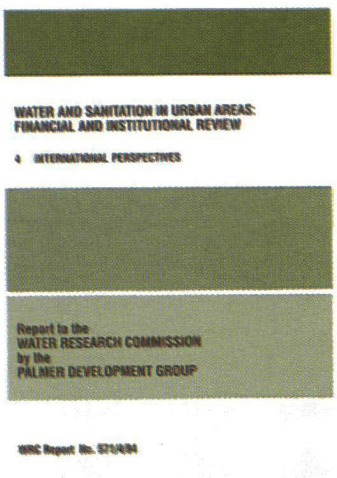




- **Report 2** (WRC report 571/2/94) (Demand and costs) estimates the total future demand and costs for water and sanitation services in the urban areas of South Africa. (Overseas price: $15).

- **Report 3** (WRC report 571/3/94) (Getting it right in the transition) focuses on the key issues facing the urban water and sanitation sector and suggests policy and implementation approaches that, in the opinion of the researchers, will best enable the sector to meet the significant challenges facing it. (Overseas price: $15).

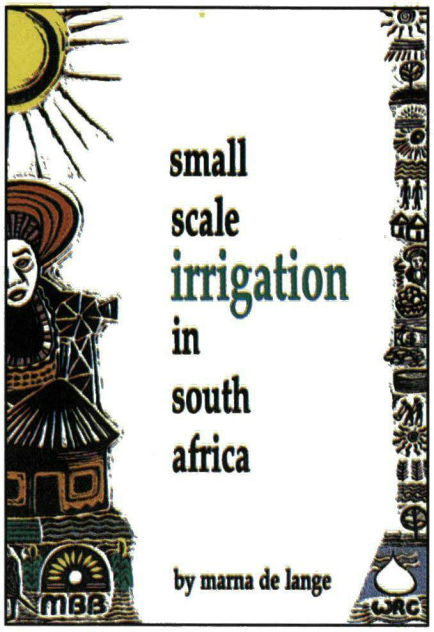




- **Report 4** (WRC Report 571/4/94) (International perspectives) provides a summary of the more detailed working papers on management experiences in the urban water and sanitation sector in Britain, France, Italy,Brazil and Botswana. (Overseas price: $5).

Publication will support the development of sound small-scale irrigation projects

Small-scale farmers want access to technical support as much as large producers do. This support should be supplied in a facilitative and consultative manner. Unfortunately, irrigation projects are still being planned and implemented by "specialists", who "sort out all the technical problems" before participants are "selected".



This is said in a booklet on **Small-scale irrigation in South Africa** recently published by the Water Research Commission (WRC). The publication is based on research done by a firm of consulting engineers, Murray, Biesenbach & Badenhorst Inc under contract to the WRC, and was compiled by Marna de Lange with contributions by LP Mohajane, CT Crosby, CM Stimie, JW Badenhorst and Professor MC Laker.

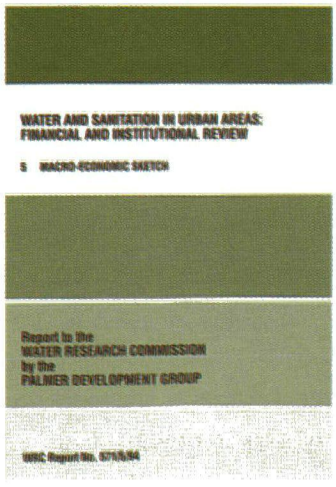
The author says that the publication is not intended to be a comprehensive final document, but only an interim information paper. The steering committee of the WRC project "Evaluation of the irrigation techniques used by small farmers" (on which the publication is based) requested that such an interim document be prepared and distributed as widely as possible in view of the possible spate of development that is expected to occur in South Africa in the near future.

"Of particular importance is that politicians, planners and technicians realise the contribution that small and microscale irrigation makes to household food security in South Africa."This is especially true of the vegetables grown on community garden plots, which often provide an important additional income to housewives and pensioners who are otherwise fully dependent on outside sources of income, yet responsible for nourishment of large families. In contrast, a large impressive modern irrigation scheme often burdens its participants with high overhead costs and restrictive management.

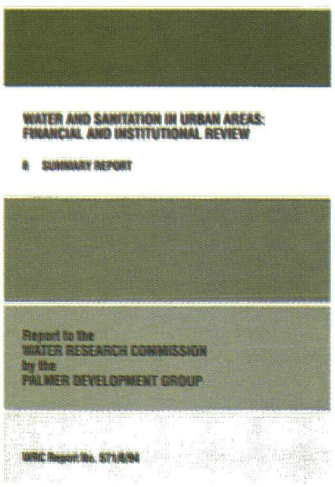
Contents: **Overview of small-scale irrigation farming in South Africa:** Irrigation schemes, Vegetable gardens, Independent farmers; **Irrigation technology in small-scale agriculture:** Flood beds, Furrow irrigation, Sprinkler irrigation, Centre pivot, Micro irrigation, Drip and trickle irrigation; **Issues around small-scale irrigation:** Appropriate technology - need for consultation and facilitation, Limited irrigation and crop water requirements, Sharing of infrastructure and equipment - need for organisation of farmers, Management of irrigation schemes and empowerment of farmers, Training needs.

REQUEST

The author says readers of this document are requested to assist the research team in their further investigations into research technologies for small-scale irrigation farming in South Africa by responding to this interim document. Responses can be in the form of comments on certain aspects in the document, sending the author copies of relevant published or unpublished papers or reports and referring the research team to specific papers or persons (giving their addresses) whom the reader believe should be contacted.Copies of the booklet Small-scale irrigation in South Africa are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: $5).



❑ **Report 5** (WRC report 571/5/94) (Macro-economic sketch) outlines some of the macro-economic implications and linkages of major investments in water and sanitation. (Overseas price: $10)



❑ **Report 6** (WRC report 571/6/94) is a summary report and fulfils the function of an extended executive summary, documenting the primary conclusions and recommendations of there search. (Overseas price: $10).

KHAYELITSHA'S STORMWATER POLLUTION ASSESSED.

Khayelitsha stormwater quality differs from First World type catchments in three basic ways, namely: consistently high microbiological contamination; high salt concentrations; and low trace metal concentrations. Except for salinity the Khayelitsha stormwater quality is similar to other Third World type urban catchments.

These results emanate from a research project funded by the Water Research Commission, in which researchers from Watertek, CSIR (Stellenbosch), investigated stormwater runoff from Third World type urban catchments. The researchers selected Khayelitsha as study area, as presently it contains all the features typical of Third World urbanisation taking place in South Africa.

The researchers A Wright, W Kloppers and A Fricke say in their report that Third World type urbanisation, with its informal housing and "shanty towns" is very much part of South Africa today, and will continue to play a major role in this country for many years to come. They say furthermore that well proven engineering solutions from First World communities are not always applicable to Third World urban areas

The report entitled *A hydrological investigation of the stormwater runoff from the Khayelitsha urban catchment in the False Bay area, South Western Cape* (WRC Report No 323/1/93) is available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. Please note: Foreign orders will be charged a list price of US $25 per copy.

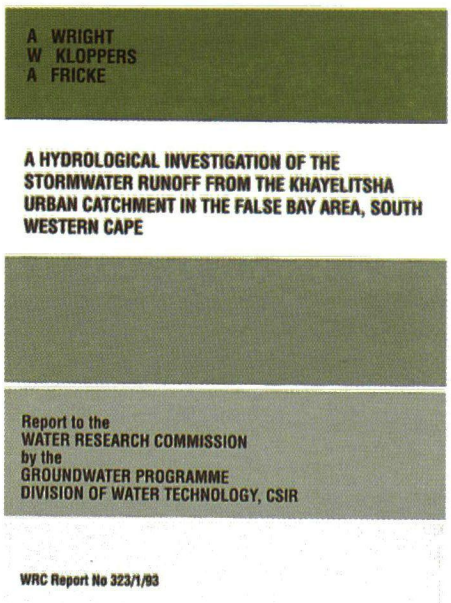
South Africa has not escaped the demographic phenomenon of rapid urbanisation experienced by developing countries. The rapid acceleration in urbanisation over the last decade is largely attributed to the abolition of influx control. The urban Black population is expected to treble within the next twenty years and much of the urbanisation will be in the form of informal settlements around existing metropolitan areas. Many of these people live in overcrowded tin shanties with no running water or ablution facilities. In an effort to combat this problem, the authorities are attempting to upgrade the existing settlements and to establish site-and-service schemes. Unfortunately even these semi-controlled areas become overcrowded and the basic services provided inevitably prove inadequate. It is thus highly probable that any stormwater runoff originating in these catchments will be polluted. Many studies have been done in the First World type urban catchments but the findings from these are not necessarily applicable in the Third World type catchments in Africa, especially considering the African culture and way of life.

The objective of this project was to assess the magnitude of the stormwater contamination, identify pollution sources and assess its resultant effect on the receiving water body. The three specific aims of this study was:

- to identify the hydrological processes taking place within the urban catchments and the role of each process in contributing to the contamination of the stormwater runoff with special emphasis on the microbiological contaminants;
- to investigate the gradual accumulation effect versus shockloading impact of chemical and microbiological pollutants on the marine environment around Monwabisi Resort;
- to evaluate the WITWAT hydrological simulation model in a Third World urban catchment in the winter rainfall zone.

STUDY AREA

Khayelitsha, a new township of some 0.3 million people on the northern shores of False Bay in the South Western Cape, was selected as a study area. Designed as a high intensity black township, Khayelitsha serves as a typical example of present low income type urban development in South Africa. Although development was still in the initial stages, the stormwater runoff was already contaminated and considered a major source of pollution to False Bay. The urban development has taken place on an unconfined sandy aquifer that forms part of the Cape Flats Aquifer. The catchment may be divided into a number of sub-catchments with a dual stormwater drainage system down the centre of the catchment.The catchment is of an entirely residential nature and contains organised squatter housing with minimal services (shacks with communal water supply points), serviced sites (shacks with waterborne sewerage and stormwater drainage), and formal housing (permanent structures).



DATA AND SAMPLING

The researchers acquired all available data on the catchment from the relevant government departments and the project engineers, and also did an extensive review of existing urban stormwater literature. An initial field reconnaissance showed that the hydrological monitoring network would have to be on a macro scale. Both the nature of the catchment and the poor security situation discouraged the establishing of any permanent monitoring equipment within Khayelitsha. The constantly changing state of the urban development with its deviations from the masterplan meant that the network had to be modified from time to time. The highly volatile security situation continually disrupted field work and resulted in the exclusion of certain sub-catchments from the study.

However, the main sampling programme consisted of both storm event sampling and the sampling of 11 selected sites during specific weather conditions, e.g. dry summer periods, dry winter periods and wet winter periods. Sampling involved the taking of a grab sample. Storm event sampling was done on the main stormwater outfall upstream of the final detention basin. The sampling had to be done manually during daylight hours as the security situation did not allow the installation of automatic samplers. The sampling interval was initially brief to ensure maximum data acquisition during the early stages of the storm in order to monitor the first flush effect.

Two of the sub-catchments monitored underwent urbanisation during the study period and provided a "before" and "after" scenario. The sub-catchments represent the two major types of controlled Third World urban development, namely, formal housing and serviced sites.

A laboratory mixing experiment and inner surfzone sampling was undertaken at the stormwater outlet east of Monwabisi Resortin order to assess the effects on the receiving water body. The surf samples were taken at doubling intervals up to 200 meter on either side of the outfall on a receding surf. Samples were analysed for trace metals, nutrients and microbiological indicator organisms.

RESULTS

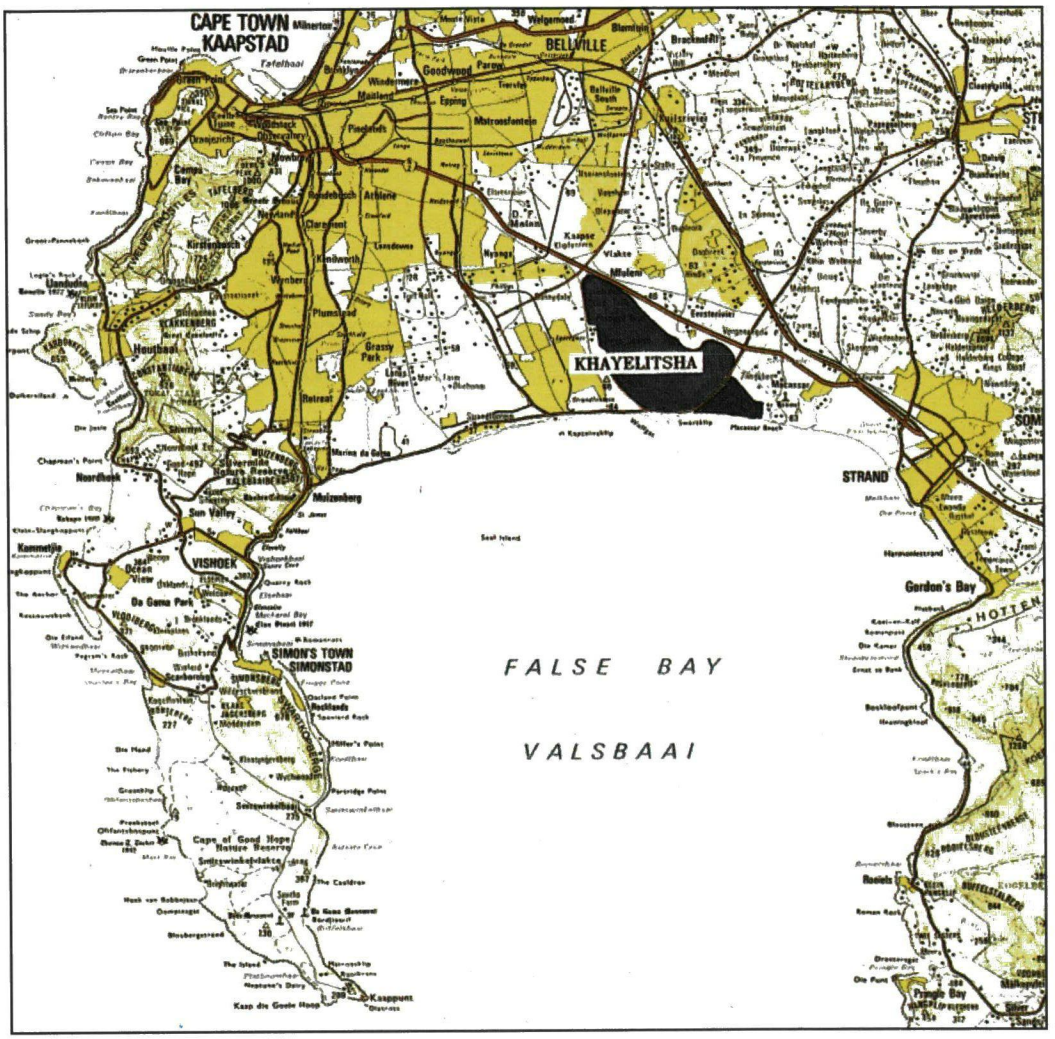
The urban stormwater runoff originating in Khayelitsha was found to be polluted throughout the year. The pollution was predominantly of a microbiological nature with correspondingly high concentrations of nutrient and organics. Trace metal pollutant loads were low in comparison with most First World type urban catchments, thus reflecting a lack of industry andmotor vehicles. The salinity values being a result of saline groundwater. The best quality stormwater originated in the sub-catchments with formal housing, although these sub-catchments had slightly higher trace metal loads. The serviced site sub-catchments consistently produced the worst quality stormwater.

The sandy nature of the catchments, small effective impervious surface area and low intensity rains experienced, resulted in very little overland flow. Interflow and groundwater flow were the predominant runoff processes and resulted in a large baseflow component throughout the year.

Rapid interflow being the major contributor to stormflow, hence the lack of a first flush effect. The highly porous nature of the sands enables pollutants to be carried down by infiltrating water to produce contaminated subsurface flow. The effect of this is seen in the high pollutant concentration of the baseflow and sub-catchments with no stormwater runoff system. The reduced concentrations during stormflow are due to rapid interflow. The pollutant loads, however are greatest during stormflow due to the increased discharge volumes.

The major source of pollution was litter and faecal contaminants that abound throughout the catchment. The high population density, poor living conditions and general lack of environmental awareness ensure ongoing pollution generation far in excess of that experienced in First World type urban catchments. The ongoing violence and periodic strikes in Khayelitsha adversely affect the basic services that are provided. Extended periods of unrest result in the complete collapse of services and the accumulation of garbage, blocking of drains and local dumping of bucket latrines. The worst pollution recorded during the study occurred during times of unrest. The provision of additional infrastructure, as in the serviced site sub-catchments did not necessarily reduce the pollution problem. In fact, the installation of water-borne sewerage and stormwater systems facilitated the removal of pollutants from the catchment and increased the contamination resulting from the sub-catchments. Where parks, playing fields and open spaces are provided these have been inundated with shacks, with a resultant increase in pollution. All forms of urbanisation involving shacks result in contamination of the water leaving the catchment, either as surface or subsurface flow. The magnitude of the contamination appears to depend more on the population density than degree of infrastructure provided.

The final stormwater detention basin northeast of Monwabisi Resort functioned as a pollution reduction mechanism during baseflow conditions, but was not as effective during storm events due to the short retention time. Microbiologically the stormwater runoff entering the sea during winter was unacceptable even after initial dilution. During base flow condi-



Location of Khayelitsha relative to False Bay and Cape Town

tions the levels were lower, but even so, direct contact recreation should not take place within at least 100 metres of the stormwater outfall. The inner surfzone sampling showed that in most cases the concentration of dissolved nutrient sand trace metals during baseflow conditions are within specified limits. During storm conditions, however, the limits are regularly exceeded. Dilution studies indicated that through mixing with seawater the trace metals posed no serious problem with regard to the short term impact on the marine environment. However, the longterm impact from lead could be substantial, due to accumulation in sediments and aquatic organisms.

The constant unrest and Third World nature of the urban area resulted in conditions that made hydrological research extremely difficult. Hydrological equipment normally used for taking field measurements was found to be unsuitable for Khayelitsha conditions. With the result that the accuracy and coarse scale of much of the hydrological data made simulation with a sophisticated computer model like WITSKM of limited value, especially with regard to model evaluation. This component of the study was therefore not pursued.

CONCLUSION

Although the study had to be undertaken on a macro-scale, more so than initially envisaged, the main issues could still be investigated. The study was the first of its type in South Africa and produced valuable information on stormwater quality and hydrological processes in a sandy Third World urban catchment. This was the first major attempt at investigating the source area of contaminated water entering False Bay.

The results will, however, not only benefit authorities in the South Western Cape, but throughout the coastal area. Many results are also applicable to the townships on the Highveld, even though these catchments receive summer rain and have different geological settings.

LOOKING FOR A LINK BETWEEN SOUTH AFRICAN SUMMER RAINFALL AND SEA SURFACE TEMPERATURES

The results of a project researching the links between South African summer rainfall and ocean surface temperature can now be obtained from the Water Research Commission in Pretoria.The results are summarised in a final report entitled *South African summer rainfall variability and its association with the marine environment.* The report was compiled by BMR Pathack, MR Jury, FA Shillington and S Courtney, all from the Department of Oceanography at the University of Cape Town. Copies of the report (WRC report 278/1/94) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price $25).

Oceanic and continental climate systems are intricately linked via various feedback mechanisms involving the transfer of heat and moisture at the air sea interface.

Although research in other parts of the world has linked rainfall variability with ocean surface temperatures, very little research on this topic has been done in the South African region.

The project reported on here was initiated by Dr ND Walker, previously from the University of Cape Town, after she had reported on links between the South African summer rainfall and temperature variability of the Agulhas and Benguela Current systems. Her research concentrated on the simultaneous correlations between sea surface temperature and summer rainfall at seasonal (i.e. three month) time scales and excluded the effects due to the Pacific El Niño phenomenon and concentrated on the effects that oceanic regions adjacent to South Africa had on summer rainfall variability.

It was clear at the end of Dr Walker's initial investigations that more detailed research work should be done on understanding the mechanisms responsible for enhancing or reducing South African summer rainfall in association with sea surface temperature anomalies. Once such mechanisms are properly identified and understood, it is then possible to consider the process of building models for forecasting or predicting the tendency of the summer rainfall anomalies.

OBJECTIVES

The main objectives of the project were:

- To identify areas within the summer rainfall region where links between ocean temperature variability and rainfall behaviour are strong enough and exhibit sufficient time lags to provide potential rainfall anomaly predictability.
- To design a methodology by which sea surface temperatures can be monitored within key ocean areas in quasi-real time. This monitoring system should involve both ship and satellite derived products.
- To develop a scheme utilising sea surface temperature data in quasi-real time for establishing the stability of relationships between sea surface temperature anomaly patterns in key ocean areas and rainfall variability in summer months (October through March) over South Africa.

METHODOLOGY

Rainfall data for this project were obtained from the Computing Centre for Water Resources (CCWR) in Pietermaritzburg, for the period 1950 to 1986. The sea surface temperature data were obtained from the Comprehensive Ocean and Atmosphere Dataset (COADS) provided by the Climate Analysis Centre, Washington DC. Wind data at six standard levels were obtained from the Climate Analysis Centre, NOAA, USA, while the outgoing long wave radiation (ORL) data was obtained from the same Institute for the period 1974 to 1987.

Earlier research by Dr Walker had concentrated on correlations of summer rainfall areas with sea surface temperatures in the South Indian and South Atlantic Oceans at seasonal time scales. The first task of this project was to examine similar concepts and ideas, but at monthly time scales. An important objective for the prediction of summer rainfall anomalies was to examine the data for lagged correlations between sea surface temperatures and summer rainfall.

The researchers say that with a view towards achieving these goals, the rainfall and sea surface temperature data sets were stratified on a monthly basis and their standardised departures from their respective long-term monthly means (called standardised indices) were computed for the period 1950 to 1986. Rainfall indices for the four individual homogeneous rainfall zones defined in the report, were cross-correlated with monthly sea surface temperatures indices specified at the gridpoints of 2° x 2° areas over the ocean. From a large number of these correlation maps, twelve key "area boxes"

were identified from the sea surface temperature domain which encompassed the globe within the belt from 20°N to 40°S. The sea surface temperature boxes were selected on the basis of a number of subjective criteria, for example, sea surface temperature data density, spatial coherence of the rainfall-grid point sea surface temperature correlation results, as well as the results of previous relevant studies. The main lagged correlation studies were performed using the twelve "box" sea surface temperature indices and the rainfall indices of the four summer rainfall zones. The "all area" rainfall index time series was also lag-cross-correlated with those of the key-box sea surface temperature series.

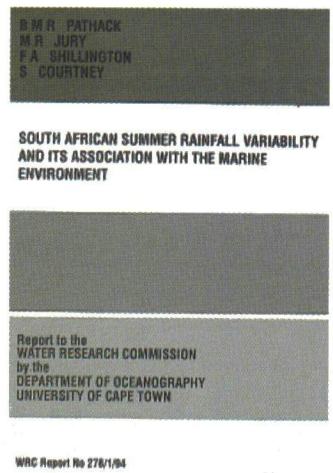
RESULTS

A summarised list of key sea surface temperature boxes which show high correlations at appreciable lags of sea surface temperature effects before the occurrence of summer rainfall, is provided in the report. The researchers say it is anticipated that these key sea surface temperature boxes would be used in the development of empirical predictive summer rainfall anomaly models. Further analyses are required to confirm the validity and stability of the relationships over time and, more importantly, the physical links causing the correlations.The correlations of summer rainfall with sea surface temperature in different areas is discussed month by month in the report, starting with October.

- October: October rainfall variations do not show any apparent correlation with sea surface temperature variations and it is the driest of the six summer months considered.

- November: November rainfall (important because it is associated with the start of the summer growing season) was positively correlated with sea surface temperature in the Central South Atlantic at lags of -2 to -4 months.

- December: Whereas October and November rainfall variations show generally positive, albeit weak, links with sea surface temperature variations over most ocean areas, in December the correlations become negative and more significant, particularly with those sea surface temperature boxes which are situated further away from the subcontinent. The negative sign of the correlations was then generally maintained until at least the following March. Among the sea surface temperature regions which represent potential for prediction of December rainfall include the Arabian Sea Area and the Western and Eastern Equatorial Pacific area. The sea surface temperature variations within these regions (especially the Pacific areas) are associated with a significant portion of December rainfall variance across almost the entire summer rainfall area of South Africa.



- January: There is a general drop in the degree of association between January rainfall and sea surface temperatures in comparison with December and February. The coastal sea surface temperature show little correlation.

- February: February rainfall modulations were observed to be strongly associated with variations in sea surface temperatures. The ocean areas showing the most significant correlations were the Central Equatorial Indian Ocean and the Western and Eastern Equatorial Pacific areas, with correlations negative throughout.

- March: March rainfall variations were found to be correlated with sea surface temperatures. Central Equatorial Indian Ocean sea surface temperature was consistently associated with the rainfall indices of all four summer rainfall zones in South Africa, individually as well as when all the stations werk grouped into the "all-area" region

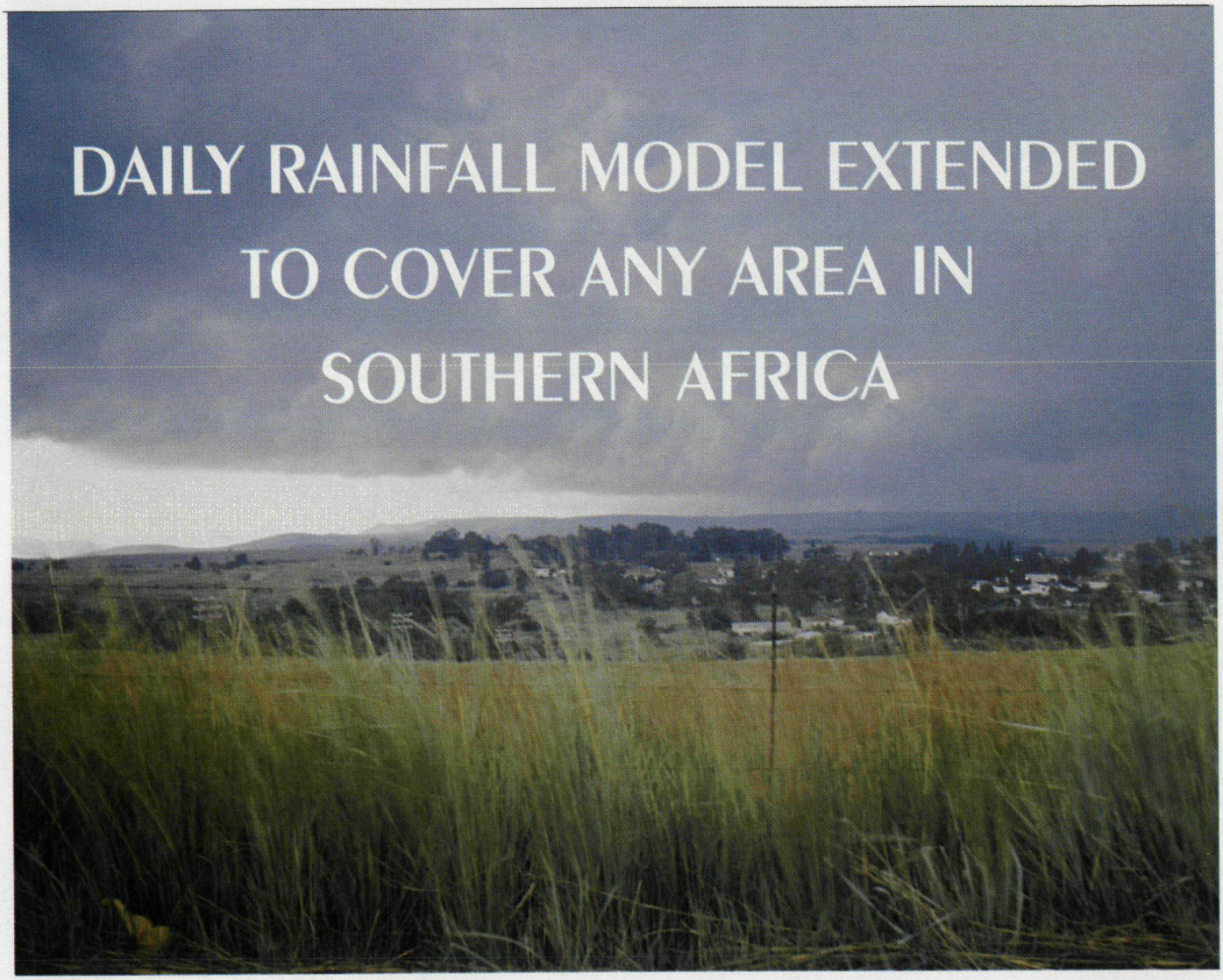
The researchers say that where as rainfall variability across the central and eastern interiors of South Africa are spatially coherent, the time variation at a monthly scale is remarkable. Statistical analyses have shown that there is an abrupt change (from November to December) in the behaviour of the simultaneous, as well as lagged, associations between rainfall and sea surface temperature variations. In this context it can be said that December to March rainfall across the summer rainfall region of South Africa were more frequently produced from warm systems where convergence and east-west Walker celltype circulations were most important. On the other hand, October and November precipitation were more frequent from cold systems which might benefit from surface heat inputs to the south-west or west of the Southern African subcontinent through a re-orientation of standing subtropical wave patterns.

TROPICAL CYCLONES

The researchers say it has been confirmed in this study that there is a significant negative correlation between the equatorial South Indian Ocean sea surface temperature and South African summer rainfall. It is suggested that there are physical grounds to justify the negative association. The researchers proposed the following mechanism: when the South Indian Ocean sea surface temperature is above average, there is a tendency for intense tropical cyclones to be more frequent during the austral summer. In this scenario, moisture convergence and convective activity become anomalously intense over these oceanic areas, and at the same time depriving the southern African subcontinent of moisture flux. In a preliminary analysis, it has been found that there is a statistically significant positive association between the September to November sea surface temperature within the major tropical cyclogenesis zone of the South-West Indian Ocean and the total number of intense tropical cyclones forming in the following summer months (December to March). The correlation between central Indian Ocean sea surface temperature and the number of tropical cyclones is discussed in detail in the report.

Considerable attention is also given to assessing the usefulness of satellite derived outgoing long wave radiation data and its associations with rainfall over the subcontinent and adjacent oceans.

DAILY RAINFALL MODEL EXTENDED TO COVER ANY AREA IN SOUTHERN AFRICA



In a Water Research Commission project on the occurrence and severity of drought in South Africa, completed in 1984, researchers W Zucchini and PT Adamson described a daily rainfall model for South Africa.

The model, which was calibrated at 2 550 sites across the country, captures all the probabilistic properties of the daily rainfall process at those sites and can be used to quantify the daily, monthly and annual statistics of rainfall, its seasonality, the risk of storms as well as the probabilities of droughts of various durations and intensity. In fact, it can be used to estimate the probability of any rainfall event or sequence of events with a resolution of one day or longer. Thus the model provides a versatile decision support tool enabling hydrologists, water resource managers, natural resource planners and other decision makers to assess the probable consequences of decisions whose outcome depends on the amounts and timing of rainfall. Although the model was calibrated at a large number of sites, the sites having sufficiently long records to allow for accurate calibration are concentrated in and around urban centres. Many parts of the country, notably the north-western Cape, the north-eastern Transvaal and Lesotho, are poorly covered, due to the shortage of rainfall records. Consequently users of the rainfall model have been obliged to base their estimates and conclusions on the rainfall properties of calibrated sites, which are often quite distant from the location of interest. Thus, whereas the usefulness of the model has been established, its application has been limited to those sites for which it has been calibrated.

NEW PROJECT

In a follow-up project, funded by the Water Research Commission and carried out by the Department of Statistical Sciences at the University of Cape Town, the main objective has been to produce estimates of the parameters of Zucchini and Adamson's daily rainfall model for sites throughout South Africa at which there is little or no rainfall data available, thereby making it possible to use the model to generate artificial rainfall sequences and study rainfall characteristics at any given location or over any given area in South Africa.

In order to fit a reasonably accurate model of daily rainfallat any location, it is necessary to have a fairly long record of daily rainfall at that site. Zucchini and Adamson fitted their daily rainfall model to some 2 550 stations throughout southern Africa, which in 1981, had at least 30 years of dailydata available.

In 1992 there were some 3 397 stations with at least 30 years of data in southern

Africa (including Lesotho and Swaziland). However, for this project the researchers decided also to include all stations with between 20 and 30 years of data. The first phase of the project was thus to re-fit the rainfall model at each of these stations.

It is clear from the maps in the report that there are a number of areas with a very low density of data points, in particular the western, north-western and central Cape, Lesotho and an area in the north-east of the country around the Kruger National Park. For these areas, it was decided to include those stations having at least five years of data, giving an additional 512 stations. While models fitted at such sites might not be very accurate in themselves, they would contribute useful information to the estimation process described in the report. The accuracy of the fitted model was incorporated into the final estimation process in such a way that stations where the fitted model had low accuracy would be appropriately down-weighted. In all, there were 5 070 stations finally selected.

INTERPOLATION

Having re-calibrated the model at the 5070 sites, the major objective of the research project was to interpolate the model parameters (16 at each site), to a grid of 1 minute of a degree of latitude and longitude throughout southern Africa, or some 500 000 points in all.

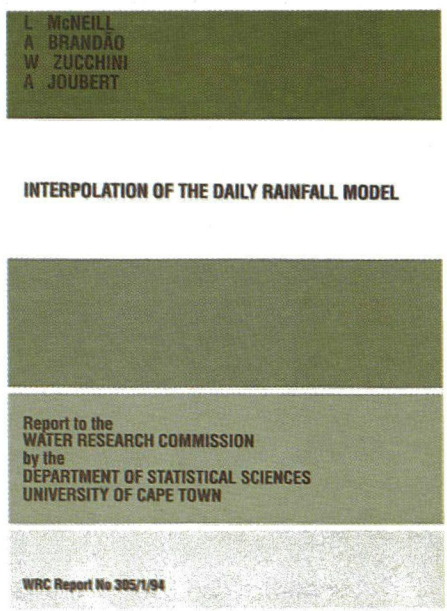
The key theoretical issue was to identify the most appropriate method of interpolating the calibrated parameter values. All existing methods of interpolation in the literature were considered and the main ones are briefly reviewed in the report. For a variety of reasons the researchers decided to make use of the method known as kriging. However, the standard kriging techniques (and software) are not directly applicable to the problem the researchers faced and so it was necessary to develop new variations on the kriging methodology and to write the corresponding software.

VALIDATION

The rainfall model itself was extensively tested and validated by Zucchini and Adamson and therefore in this project the research team focused on the validation of the interpolated parameter estimates. This was carried out by "hiding" a number of available data points, using the remaining data points to obtain interpolated estimates at the locations of the hidden points and then comparing the interpolates to the "true" values. The agreement was found to be within the limits of accuracy indicated by the so-called bootstrap variance calculations.

Another way to validate the results is to calculate derived characteristics, such as the mean annual precipitation, based on simulated data generated by the model. This enables the researchers to test the model as a whole in the form in which it will be used in practice, and also allows comparison with the same statistics derived from other sources. They therefore calculated a mean annual precipitation at the location of each of 373 selected test sites using four different methods:

- Using a 100 year simulation based on the daily rainfall model parameters estimated for that station.
- Using a 100 year simulation based on the daily rainfall model parameters estimated by the kriging procedure at the grid point with the same latitude and longitude as the station.
- Using the mean annual precipitation calculated directly from the daily rainfall data for that station held by the Computing Centre for Water Research (CCWR) in Pietermaritzburg.
- Taking the value of the mean annual precipitation from the CCWR data base of gridded mean annual precipitation values.



MODEL APPLICATION

The daily rainfall model is routinely used by researchers and decision makers in a wide variety of applications. It is hoped, now that the model is applicable at practically any site in southern Africa, that it will find even wider application.

It needs to be emphasised that although the theory behind the model is rather technical, the model is easy to use for anybody who can operate a micro-computer. No statistical or other specialist knowledge is required to apply the model. The feedback during the last eight or nine years from users with very different mathematical backgrounds, has been encouraging: no one has indicated that they found the model difficult to apply. According to the researchers they are not aware of any user who has misunderstood what it is that the model provides or who has misinterpreted the estimates derived from the model.

Copies of the report entitled **Interpolation of the daily rainfall model** (WRC report 305/1/94) by L McNeill, A Brandao,W Zucchini and A Joubert are freely available in the form of an executive summary together with a PC compatible disk containing a small data set and sample programs. (Overseas price: $25).

Geophysical Techniques tested for Characterising Groundwater Pollution

Contamination of groundwater by diffuse and point sources is causing increasing concern in South Africa. "Although contamination is mostly detected and monitored with the aid of boreholes sunk for this specific purpose, electrical and geophysical techniques are now increasingly being applied world wide as an aid in the detection and monitoring of groundwater and soil contamination. These techniques are also employed in the location of pollution plumes in groundwater, and for the judicious siting of monitoring boreholes", says Mr Tony Reynders, research manager at the Water Research Commission.

However, the overseas experience in this regard is almost exclusively limited to aquifers in unconsolidated sediments, while South Africa has mainly secondary or so called "hard rock" aquifers.

Recently the Water Research Commission funded a project aimed at the testing of various geophysical techniques under different South African geological conditions, in order to evaluate their effectiveness as tools for the rapid, cheap and efficient delineation of the extent of groundwater contamination at a pollution site, and in the preparation of guidelines for the use of these techniques in the groundwater pollution field.

The research was executed by R Meyer, AWA Duvenhage and V de A Coetsee of EMATEK, CSIR (Pretoria) and JMC Weaver of Watertek, CSIR (Stellenbosch). The initial investigations covered alluvial type (unconsolidated) aquifers to establish techniques and interpretation procedures under known and well understood geohydrological conditions, while the remainder of the study concentrated on the secondary aquifers common to South Africa.

The project report entitled *The evaluation and development of geophysical techniques for characterising the extent and degree of groundwater pollution* (WRC Report no 267/1/94) is now available, free of charge, from the Water Research Commission, PO Box 824, Pretoria 0001. Please note: Foreign orders will be charged a list price of US $25 per copy.

The main purpose of the project was, firstly, to test the various geophysical techniques under different geohydrological conditions in order to evaluate their effectiveness as a tool for the efficient delineation of the extent of groundwater contamination of polluted aquifers, and secondly, to compile a set of guidelines for delineating contamination plumes, using geophysical techniques.

The project encompassed the following specific aims:

- the determination of the degree and areal extent of contamination at each of the selected test sites;
- conducting geophysical methods in terms of their correlation with the observed contamination;
- and, finally, drawing up guidelines for investigators in the groundwater contamination field for different hydrogeological settings.

Surface geophysical techniques developed by the minerals and petroleum prospecting industries are applicable to groundwater investigations. Through measurements taken at the earth's surface, these techniques detect subsurface physical property changes which are related to hydrogeologic conditions.

The nature of the hydrogeologic setting determine the applicability of a particular geophysical method. In many groundwater studies, several different geophysical methods are applied to the same survey area. Although each method in these integrated surveys responds to different property changes, the results of each data set often support a single interpretation. In general, the selection of a geophysical technique depends on the physical nature of the survey area, the desired depth of penetration, the data resolution requirements and the available resources.

The researchers' approach in this project was:

- to review the application of geo-physical methods to groundwater contamination studies through a study of selected international literature;
- analyse the effect of groundwater quality on the electrical properties of geological formations;
- apply and evaluate different geophys ical techniques to a variety of South African aquifers where contamination is known or has a potential to occur; and finally,
- to develop a set of guidelines for the application of geophysical techniques at waste disposal sites to evaluate potential new sites and to design geophysical monitoring pro-grammes to monitor possible future development of pollution around dis-posal sites.

The first two aspects mainly involved a

review of literature on the subject and, based on the review information, geophysical techniques were selected and surveys designed for polluted aquifers, as well as aquifers with a potential for future pollution. This was done to evaluate the applicability of these techniques under South African conditions.

Both primary and secondary aquifers were selected for this study. These sites, together with a short description of the type of aquifer were:

♦ Site 1

A municipal solid waste disposal site situated on an alluvial sand aquifer where the water table is close to the ground surface.

♦ Site 2

A coastal alluvial aquifer involving artificial recharge basins where treated industrial effluent and saline effluent generated by a water softening plant is disposed of. Contamination of this aquifer is at a fairly low level. It was selected for investigation to test the electromagnetic method on areas of low level contamination.

♦ Site 3

A series of unlined evaporation ponds on granitic terrain. The effluent disposed of in the evaporation ponds is extremely saline.

♦ Site 4

Contamination caused by slimes and evaporation dams from a gold mine where ore from the Witwatersrand Sequence under a cover of Karoo Sequence sedimentary formations is extracted. The slimes dams and tailings are located on sedimentary rocks of the Karoo Sequence intruded by numerous dolerite dykes and sills.

♦ Site 5

A toxic waste disposal site developed in a worked-out clay quarry of Karoo Sequence age. The Karoo rocks form inliers on an eroded and karstic dolomite surface of the Malmani Group, which hosts one of the major aquifers in South Africa.

LITERATURE REVIEW

According to the literature review geophysical techniques used to investigate the occurrence of groundwater contamination have thus far concentrated on the detection and delineation of the extent of contamination within aquifers. Lately, attempts are also being made to assess the concentrations of pollutants and their patterns of movement. In all these investigations, electrical or electromagnetic geophysical techniques are applied.

As groundwater contamination is usually associated with an increase in the salt concentration, and consequently with an associated increase in the electrical conductivity of the water, electrical techniques are an obvious choice. The methods most frequently applied are some form of resistivity profiling (Schlumberger or Wenner configuration and dipole-dipole) and electromagnetic profiling. The most widely used electromagnetic instrument is the Geonics EM-34 ground conductivity instrument.

The case studies of groundwater pollution reported in the literature, where geophysical methods have been applied to investigate the extent of contamination, describe cases where geohydrological conditions are reasonably homogeneous and well understood. Anomalous geoelectrical conditions found around those waste disposal sites were therefore invariably related to the source of pollution.

Little attention has been given to the use of geophysical techniques to investigate geological conditions, and especially the geological structure, around disposal sites that may influence the geohydrological conditions and, in turn, will dictate the pattern of pollutant migration to a large degree. The effect of clay layers present in the geological succession on the geoelectrical field and the difficulty in distinguishing whether anomalous electrical resistivity results observed near disposal sites can be ascribed to the presence of clay layers or contaminated water, has been highlighted in several of the reported case studies.

The effect of groundwater quality on the electrical properties of geological formations is discussed. The importance of salt concentration and the chemical composition of groundwater in influencing the formation resistivities in relation to the variations in porosity within an aquifer is also addressed. Again, the change in formation resistivity, due to the presence of contaminants, can be reasonably predicted when homogeneous (usually alluvial) geohydrological conditions are present. In the absence of matrix conduction, slight variations in the porosity have a large influence on the formation resistivity. When matrix conduction is, however, present, it will be difficult to distinguish whether resistivity anomalies are caused by the presence of contaminants or due to increased levels of matrix conduction.

According to the researchers a relatively new approach in analysing a combination of geophysical and chemical data and which in future will definitely receive more attention, is the application of geostatistical techniques to these combined data sets. These methods have the potential to be developed into "tools" to predict the future degree and areal distribution of contaminants in an aquifer, given the local geohydrological constraints.

SA RESULTS

From case studies done in South Africa under different geological conditions, the minimum apparent resistivity values obtained from the inflection points on sounding curves were successfully used in shallow alluvial aquifers where no clay lenses were present. This method is restricted to areas where the underlying formation has a higher resistivity than the aquifer and where the aquifer is geophysically viewed as a relatively isotropic medium. Under these conditions, the use of the transverse resistance of the first geoelectrical unit proved to be an effect tool for a rapid reconnaissance study. This technique was not reported in any of the literature studied. It is recommended that this technique be used more often under similar geohydrological conditions, and that it should also be tested under hard rock aquifer conditions where a shallow potentiometric level is present.

The electromagnetic technique was applied extensively during the study of the different sites. Although the method is very well suited for tracing groundwater contamination, it was found that great care should be exercised in the interpretation of the results. The main disadvantage is the qualitative nature of the data, and the difficulty in obtaining reliable depth control. Particular care should be exercised when working in low resistivity conditions not directly related to contamination. In this regard, the study or delineation of contamination in shale or clay rich environments, like aquifers in Karoo sediments, should include the use

of geophysical methods other than the electromagnetic methods. Under these conditions, he application of resistivity techniques, where more control over the depth of investigation can he exercised, should be included.

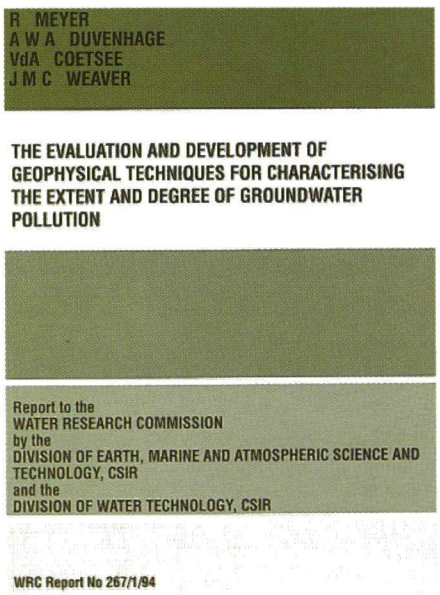
WATER QUALITY INFO

When mapping an area where contamination occurs, it is essential to have information on the water quality present in the area. Without water quality information, it is difficult to distinguish whether the conductivity recorded is due to increased salt content in the groundwater, or whether the conductive nature of the aquifer is inherent to the geological formation. Once the contaminated zone has been delineated of mapped, monitoring the movement of the contaminant can be achieved with less frequent sampling of the water quality.

In general, the electromagnetic methods should preferably be used to delineate areas of shallow groundwater contamination, whereas the direct current resistivity technique (sounding and profiling) should be applied to obtain quantitative information of deeper groundwater contamination.

For a conductive geological terrain, like weathered Karoo sedimentary successions, the electrical methods were unable to define the contamination plume. However, in the absence of clay, i.e. the more sandstone rich horizons, the resistivity sounding- and resistivity profiling methods were able to define the contaminated zones. Dolerite dykes in Karoo sedimentary successions often occur close to the surface and are then prone to intense weathering. Dolerite weathers to a clay and contributes to an already difficult problem of distinguishing whether the conductivity anomalies are due to contaminated water or to geological features.

Layers rich in graphite are frequently encountered in South African dolomitic rock formations. These layers are extremely conductive and great care should be taken when using any electrical methods in dolomitic terrain. Other conductive features occurring in the dolomites, and which must not be confused with groundwater contamination, are: wad, palaeo-karst features filled with deposits of Karoo age and deep weathering of dolomite. The deposits of Karoo sediments are often mined for their good quality clay for brick-making, and once mined out, these pits are often used as waste disposal sites. These pits usually still have a lining or floor of unmined clay which is electrically conductive. Great care therefore has to be exercised when applying any electrical geophysical techniques under these conditions, because the anomalous conductive conditions recorded are not necessarily related to groundwater contamination.



One of the main conclusions the researchers reached after completing the different case studies, is that, before any meaningful and realistic conditions can be made form the geophysical data, the geohydrological regime of the area where groundwater contamination occurs must be wel understood. Only when these conditions are met, can a meaningful conceptual geohydrological model be constructed.

Once such a model is in place, the most likely areas where contamination are expect to occur can be developed. The geophysical results should then also be corroborated with data from chemical analyses of water samples from selected observation points. Only then can definite conclusions regarding the existence, degree and extent of the pollution, be made.

The researchers say it is in applying this "recipe" that the value and importance of geophysical methods like seismic refraction, magnetics and gravity, which do not respond to changes in the physical properties related to groundwater contamination, are recognised and appreciated. These methods often supply vital information for understanding the mechanism of groundwater flow in the region, especially in structurally complex geological terrains.

GUIDELINES

According to the researchers, from the waste disposal sites investigated in South Africa, as well as information gained from references found in the international literature, it is evident that a sound knowledge of the geological structure, in addition to the geohydrological information, is of primary importance in understanding and predicting the future movement of contaminated fluids around a disposal site. At the disposal sites studied during this project, the geophysical investigations revealed several important geological features that had a direct bearing on the geohydrological regime of the area surrounding the site. Had some of this geological information been available at the permit application stage, different requirements for the development, operation and management of the site may have been laid down.

PERMITS

With regard to granting permission for the development of a new waste disposal site, the researchers recommend that guidelines on geological studies and the application of geophysical techniques, as set out in the report, be considered. The results of the suggested geological studies and geophysical techniques should be considered in conjunction with all the other investigations required for the approval and licensing of a new disposal site.

This recommended approach should form part of the intensive geohydrological investigations required, before any new waste disposal facility should be granted a permit to be developed. Although the initial cost for the recommended investigations may be high, the damage and long-term effect to an aquifer system caused by irresponsible waste disposal practices, are far greater.

About droughts and conferences ...

"The droughts have definitely attracted attention on a fairly wide front and it appears that a drought conference is a scientific must. Please keep on sending us your comments. I am sure there are more angles to this issue worth highlighting!" says Hugo Maaren, Secretary of Sanciahs. The following comments were sent through in response to ideas about a drought information centre, a drought research institute and a possible drought conference as discussed in the previous Sanciahs News column (SA Waterbulletin Nov/Dec '94):

♦ PETER ALCOCK is presently collecting a very large bibliography on drought in South Africa and especially Natal. This information will be available to interested parties in about six months time.

♦ ANDREW DEACON from the Kruger National Park informed us that they are presently working on an extensive report entitled: "The 1991/92 drought in the Kruger National Park: Some notes on its intensity and effects". The report will have the following chapters:

- General global weather patterns associated with El Niño. (F Venter & N Zambatis)
- Relevant climate records for the KNP. (N Zambatis)
- Changes in the water table depth: boreholes in general. (L van Rooyen)
- Changes in the water table depth: Luvuvhu River floodplain. (S Ronaldson)
- Erosion tendencies associated with the drought . (F Venter & F Nel)
- The occurrence of sinkholes and pipe erosion on the Luvuvhu flood plain and other areas. (M Bench, F Gerber & F Venter)

People interested in this report can contact Andrew Deacon at tel. (01311)-65611.

♦ MARK DENT (CCWR) provided the following comments: Thank you for the idea regarding a SANCIAHS Conference on drought. You also expressed the wish to canvas our thoughts on Ms Whitmore's idea of a drought research institute.

The issue of drought is of great importance, however, I do not believe that the best way to address it is through a drought research institute as proposed by Ms Whitmore. I believe that a workshop on the subject would however be very useful. The workshop should concentrate on what institutional and organisational arrangements are best suited to cope with the issue.

My views on the subject may seem a little strange at first but I believe they have merit and I would therefore welcome the opportunity to air them at a workshop. In brief I believe that it would be counter productive to attempt to set up a **separate** institute.

I had a longer letter in mind but on reflection I have condensed it by thinking of an analogous example to illustrate my view. If one considers civil defence organisations, the layperson's initial perception of their structures is that they are just a group of volunteers which do everything required during the "disaster". However, on closer examination one sees that the skills that make up the organisation are given "teeth" because the persons work through established structures. For example, the firemen in the civil defence organisation do the fire fighting with and through the local fire brigade. Essentially when they mobilise they have to use the existing infrastructure to achieve the required action. In the same way the Institute for Drought Research would have to mobilise (on the ground action) across disciplines and organisations. The chances of an organisation (Drought Institute) achieving this from the outsider status (as it were) are very small. Furthermore, to have any chance they would have to have developed exceptionally close working relationships with the organisations who have to implement the actions. In fact, ideally the relationship should be so close that they should be one and the same organisation. In other words I believe that the solution lies in developing ways to work on the drought issue within and through **exsting** organisations.

All the organisational and inter-human psychology is against a separate drought institute getting real support from already existing organisations during a crisis. The temptation may be present to accord the Drought Institute a kind of "SUPER ORGANISATION" status. This latter course of action would, in my view further exacerbate the "them & us" syndrome. Organisations would be reluctant to throw their weight and resources behind the Drought Institute whom they will probably see as having poached some of their precious resources and staff.

I believe it is essential to find a way to tackle the problem of research and crisis action coordination within the context of the existing organisations. By setting up a separate outside body to do this, one is just creating another body to coordinate. In addition the negative psychological factors mentioned above will come into play.

I look forward to contributing to a workshop on this issue. My contribution would be in line with the views expressed above.

♦ ARTHUR CHAPMAN provided the following: The article in the SANCIAHS column in the SA Waterbulletin on the establishment of a drought research institute has spurred some comment. We should aim our science at the core of the problem.

So far, the consensus is that we need one. However the multidisciplinary nature of such an animal causes some difficulty over the establishment of facilities and staffing. Like all institutes, one needs the best per-

sonnel possible for one of our most pressing problems. The best personnel in the country would then need to be lured away from their current positions.An approach would be to get involved slowly. Perhaps by:

- establishing a southern African drought conference, or
- building a focus in the WRC and directing drought research from there.

The advantages of this approach is that most people who would undertake drought related research are already established in other positions and have extensive networks into other disciplines.

The route by which research outputs are established as policy or applied in the field (ie technology transfer) must also be considered carefully before any action takes place.

♦ PAT REAVELL says: "I completely support the launching of a Drought Research Institute. In my opinion it is an idea at least a decade overdue.

I entirely agree with your criticism of the local mentality, with the "ostrich like" avoidance psychology. In my opinion there seems to be a bland assumption that the recent 1991 to 1995 drought is due to global climate change, a fact recognised by the North Americans and western European nations who estimate a 10-40 per cent effect on rainfall patterns. In Tyson's book on the climate of Southern Africa there is no mention of anthropogenic effects, deforestation, carbon dioxide accumulation, hole in the ozone layer, etc.

One wonders why there is such a different attitude amongst climatologists over here? You correctly say that drought is endemic, but why is it only recently that there has been the worst continuous coastal drought in Zululand since 1931? This drought has never before been continuous in the sense it has been since 1991.

Finally there are two serious omissions in your list of interested parties: ecologists and Limnologists. Terrestrial forest communities and inland aquatic ecosystems are seriously effected by cyclic and permanent rainfall change. So may I suggest that you or Ms Whitmore contact the following organisations to attend a workshop:

- South African Institute of Ecology.
- Biochemistry Unit, Zoology Dept, Natal University, PMB.
- South African Association of Botanists.
- Wildlife Society Southern Africa.
- Southern African Society Aquatic Sciences (SASAQS).

SA WATERKALENDER

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

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

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

Legend:

- ❍ An SA Water Event arranged for these dates.
- ❑ 2nd SA Water Event scheduled for these dates.
- ✗ 3rd SA Water Event scheduled for these dates.

See conferences and symposia pages for events.

Die Waternavorsingskommissie plaas hierdie kalender om te help met die koördinering van watergebeurtenisse in Suid-Afrika.

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

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

Gids:

- ❍ Een SA Watergeleentheid vir hierdie dae.
- ❑ 'n Tweede SA Watergeleentheid gereël vir dié datums.
- ✗ 'n Derde SA Watergeleentheid gereël vir dié datums.

Sien Konferensies-en Simposiumbladsy vir aangeduide geleenthede.

1995

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JUNE 1995

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SOUTHERN AFRICA

1995

BESPROEIING
MEI 10 - 12

Die tweejaarlikse kongres van die Suid-Afrikaanse Besproeiingsinstituut sal in Port Elizabeth gehou word. Navrae: Die Suid-Afrikaanse Besproeiingsinstituut, Oos-Kaaptak,Privaatsak X27592, Greenacres 6057. Tel (041) 33 1284. Faks (041) 331 583.

RIVER MANAGEMENT
MAY 14 - 19 1995

The IAWQ conference on river basin management for sustainable development will be held in the Kruger National Park.
Enquiries: Dr Ben van Vliet, Watertech, CSIR. Tel (012) 841-2237 Fax (012) 841-4785.

RESOURCE MODELLING
JULY 5 - 10

The '95 world conference on natural resource modelling will be held at the University of Natal in Pietermaritzburg.
Enquiries: Professor John Hearne, Department of Applied Mathematics, University of Natal, Private Bag X01, Pietermaritzburg 3209. Fax: (0331) 260 5599 Tel: (0331) 260 5626.

HYDROLOGY
SEPTEMBER 4 - 6

The 7th national southern African hydrological symposium will be held in Grahamstown.
Enquiries: Prof Denis Hughes, Institute for Water Research, Rhodes University, Grahamstown 6140. Tel (0461) 24014 Fax (0461) 25049. E-mail: Denis @ iwr.ru.ac.za.

IWSA
SEPTEMBER 9 - 15

The 20th biennial congress and exhibition of IWSA will be held in Durban.
Enquiries: Mrs Ginny Eslick, IWSA Congress International, 18 Rapson Road, Morningside, Durban 4001. Tel (031) 233 494. Fax (031) 232 405.

GROUNDWATER
SEPTEMBER 25 - 27

A conference and exposition on groundwater recharge and rural water supply - Groundwater '95 - will be held at the Volkswagen Conference Centre in Midrand.
Enquiries: Conference Co-ordinator, Groundwater Division, GSSA, PO Box 75728, Lynnwood Ridge 0040.

1996

WISA '
MAY 20 - 23

The WISA '96 conference will be held at the Feather Market Centre in Port Elizabeth. Enquiries: Conference Planners, PO Box 82, Irene 1675. Tel (012) 63-1681. Fax (012) 63-1680.

AQUATIC SYSTEMS
JULY 15 - 19

A conference on aquatic systems will be held at the Vic Falls Hotel in Zimbabwe. Call for papers. See page 32 of this Bulletin.

OVERSEAS

1995

WATER TREATMENT
MAY 15 - 17

An IWSA specialised conference on advanced water treatment and integrated water system management into the 21st century will be held in Osaka, Japan.
Enquiries: Water Osaka '95, c/o Osaka Municipal Water Works Bureau, 6-28 Minami-ogimachi, Kita-ku, Osaka 530, Japan. Tel 06 (363) 7301. Fax 06 (363) 7362.

GROUNDWATER QUALITY
MAY 15 - 18

An international conference on groundwater quality: remediation and protection (GQ 95) will be held in Prague, Czech Republic.
Enquiries: Conference Secretariat GQ 95, c/o Guarant, Opletalova 15, 110 00 Prague 1, Czech Republic. Tel +42 2 2421 0650 or 2421 0735 Fax +42 2 260 130.

OZONE
MAY 15 - 19

The 12th Ozone World congress will be held in Lille, France.
Enquiries: Mme Michele Rizet, IOA International Coordinator, c/o Societe des Eaux du Nord, 217 blvd. de la Liberte Lille, B.P. 329, 59020 Lille CEDEX, France. Tel 33-2049 4000. Fax 33-2049 4052.

COASTAL ENVIRONMENT
JUNE 13 - 15

The Black Sea regional conference on "Environment protection technologies for coastal areas" will be held at the International House of Scientists, St Constantine Resort in Varna, Bulgaria.
Enquiries: IAWQ - Bulgarian National Committee, c/o USB - Mrs TS Angelova, Oborishte St 35, Sofia 1504, Bulgaria. Tel (+359-2) 43 01 28, 44 11 57. Fax (+359-2) 44 15 90.

ENVITEC
JUNE 19 - 23

The international trade fair for Environmental Protection and Waste Management Technologies will be held in Düsseldorf, Germany.
Enquiries: Messe Düsseldorf, Postfach 10 10 06, D-40001 Düsseldorf. Tel (0211) 45 6001. Fax: (0211) 45 60668.

RAINWATER
JUNE 19 - 25

The 7th international conference of the International Rainwater Catchment Systems Association will be held in Beijing, China.
Enquiries: Dr Mou Haisheng, Dept of Hydrology, Institute of Geography, CAS, Building 917, Datun Road, Anwai, Beijing 100101, PR China. Tel (86) 1 4914289. Fax (86) 1 4911844.

CONTAMINANTS IN WATER
JUNE 29 - 30

A conference on hazard assessment and control of environmental contaminants in water will be held in Copenhagen, Denmark.
Enquiries: Dr Niels Nyholm, Laboratory of Environmental Sciences and Ecology, Building 224, Technical University of Denmark, DK-2800 Lyngby, Denmark.

POLLUTION EVENTS
JULY 24 - 26

An inter-disciplinary symposium on uncertainty, risk and transient pollution events - Acute Risk to the Aquatic Environment will be held in Exeter, UK.
Enquiries: Dr JD Boyle, School of Engineering, University of Exeter, North Park Road, Exeter EX4 4QF, UK.

DIFFUSE POLLUTION
AUGUST 14 - 18

A symposium on diffuse (non-point) pollution will be held in Prague, Czech Republic.
Enquiries: Ing Vladimir Chour, Hydroprojekt AS, Taborska 31, CZ 140 43 Praha 4, Czech Republic.

LARGE WATER BODIES
AUGUST 22 - 25

An international conference on long-term changes of large water bodies will be held in Visby, Gotland, Sweden.
Enquiries: IHP/ IAWQ Conference Secretariat, Dept of Water and Environmental Studies, Linköping University, S-581 83 Linköping. Sweden. Tel: +46 13 282286. Fax: +46 13 133630.

BIOFILM STRUCTURE
AUGUST 30 - SEPTEMBER 1

A workshop on "biofilm structure, growth and dynamics - need for new concepts" will be held in Noordwijkerhout, the Netherlands
Enquiries: Mark van Loosdrecht, Julianalaan 67, 2826 BC Delft, the Netherlands. Tel: +31 15 781618. Fax: +31 15 782355

SEWER SOLIDS
SEPTEMBER 6 - 8

A seminar on sewer solids - characteristics, movements, effects and control will be held in Dundee, Scotland, UK.
Enquiries: Maureen Golden, WWTC, University of Abertay Dundee, Bell St, Dundee, DD1 1HG, UK.

SANITATION SYSTEMS
SEPTEMBER 18 - 19

A symposium on technology transfer - achieving high performance at low cost in environmental and sanitation control systems will be held in Salvador, Bahia, Brazil.
Enquiries: Francisco Fontes Lima, CETREL SA, Caixa Postal 011,
CEP 42.810-000 Cama_ari, Bahia, Brazil. Fax: +55 (71) 832 2562.

WATER MANAGEMENT
SEPTEMBER 26 - 30

A symposium on integrated water management in urban areas will be held in Lund, Sweden.
Enquiries: Dr Janusz Niemczynowicz, Dept of Water Resources Engineering, University of Lund, PO Box 118, S-221 00 Lund, Sweden.

WASTEWATER RECLAMATION
OCTOBER 17 - 20

The 2nd international symposium on wastewater reclamation and reuse will be held in Iraklio, Crete, Greece.
Enquiries: Mrs T Furnaraki, Municipal Enterprise for Water Supply and Sewerage of Iraklio, 1 Vironos Str., 71202 Iraklio, Greece. Tel: +30-81-229913, 225833 Fax: +30-81-22 9991

WEFTEC '95
OCTOBER 21 - 25

The Water Environment Federation's 68th annual conference and exposition will be held in Miami Beach, Florida, USA. Call for papers. Deadline for submissions December 16, 1994.
Enquiries: Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314-1994 USA. Fax 1-908-885-6417.

LAKE MANAGEMENT
OCTOBER 23 - 27

The 6th international conference on the conservation and management of lakes will be held in Tsukuba and Tsuchiura, Japan.
Enquiries: The Secretariat, Kasumigaura '95, 1-5-38 Sannnomaru, Mito, Ibaraki 310, Japan. Tel +81-292-24-6905 Fax +81-292-33-2351.

WASTEWATER PLANTS
OCTOBER 30 - NOVEMBER 1

The 3rd international specialised conference on design and operation of small wastewater treatment plants will be held in Kuala Lumpur, Malaysia.
Enquiries: Mrs Lorraine Meiring, Water Research Commission, PO Box 824, Pretoria 0001. Tel (012) 330-0340. Fax (012) 331-2565.

WASTEWATER
OCTOBER 30 - NOVEMBER 1

An IAWQ/IWSA workshop on the "Separation of microorganisms from water and wastewater: Theory and practice/ New developments and opportunities" will be held in Amsterdam, the Netherlands.
Enquiries: Amsterdam Workshop '95, International Association on Water Quality, 1 Queen Anne's Gate, LONDON SW1H 9BT UK. Tel +44-71-222-3848. Fax +44-71-233-1197.

1996

BATCH REACTOR TECHNOLOGY
MARCH 18 - 20 1996

A conference on sequencing batch reactor technology will be held in Munich, Germany.
Enquiries: Prof. Dr-Ing. Peter Wilderer, Lehrstuhl für Wassergüte und Abfallwirtshaft, Technische Universität München, Am Coulombwall, D-85748 Garching, Germany. Tel: +49 (089) 3209 3700. Fax: +49 (089) 3209 3718.

FOREST INDUSTRY WASTEWATERS
JUNE 10 - 13

The 5th IAWQ symposium on forest industry wastewaters will be held in Vancouver BC, Canada.
Enquiries: The organiser, Forest Industry Wastewaters symposium, c/o Venue West Conference Services, 645 the Landing, 375 Water Street, Vancouver BC, Canada, V6B5C6. Tel: +1 604 681 5226. Fax: +1 604 681 2503.

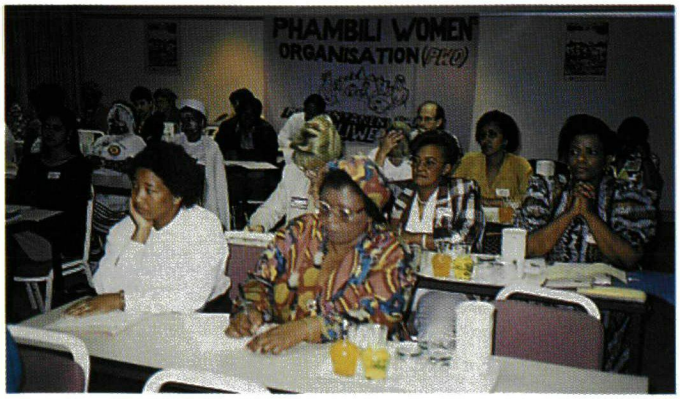
Women discuss rural water problems

The Phambili Women's Organisation held a regional project planning conference at the Karos Hotel in Sea Point on 17 - 19 November. The theme of the conference was "sharing responsibilities" with specific focus on water, sanitation and self reliance. The objective of the conference was to identify the role and commitment of the Government on the issue of rural women and water. The latter would be compiled in a working document which would be presented to the Government after the conference.

The Conference was opened by the inimitable Minister of Water Affairs and Forestry, the Honourable Kader Asmal. In his keynote address he stressed the Government's humanitarian approach to the needs of people at grass roots level. He also reassured the delegates that fairness and equity in water supply was the guiding principle on which future policy would be based. A future policy which would not perpetuate dependence.

"Water," the Minister said, "is the heart of the RDP". Therefore Parliament has passed a bill whereby local water and sanitation committees would be established on a regional basis. These committees would control the provision of water as well as the allocation of grants in the areas under their control.

The Minister also said that the University of the North had been designated to become a centre of excellence where training in water and sanitation would be provided for the whole nation as such.
From an observer's point of view the enthusiasm of the delegates and the vision of the conference was inspiring. The empowerment of rural and squatter women with knowledge, responsibility and dignity can only set the scene for great things to come.



Delegates at the Phambili Conference

S·H·O·R·T·C·O·U·R·S·E

Department of Chemical Engineering

Water Utilisation Division

Water Quality Management in Industry and Mining

8-12 May 1995

Course Contents

(Developed with the cooperation of the Department of Water Affairs and Forestry whose contribution is gratefully acknowledged)

- Water quality management policies and strategies: new approach and requirements of the Department of Water Affairs and Forestry.
- Legislation related to water pollution control
- Physical-chemical and biological aspects of water quality
- Hydrology and geohydrology
- Water quality guidelines
- Wastewater characterisation
- Waste reduction in industry and mining
- Optimal water usage
- Physical-chemical treatment processes
- Biological treatment processes
- Environmental management programmme reports (EMPR)
- Acid mine drainage
- Solid wate disposal
- Integrated environmental management: role of industry

The course is directed at managers, engineers, scientists and technicians who are involved in industry and mining.

This course will be presented in English

Enquiries: Dr CF Schuttte
Tel (012) 420-3571
Fax (012) 43-6683

If you are interested in attending this course please complete and post the application form insert in this bulletin

Vic Falls Conference on Aquatic Systems

Monitoring and Managing our Precious Resources

The Vic Falls conference on aquatic systems is organised jointly by the Southern African Society of Aquatic Scientists (SASAQS), the River Basin Management Technical Division of the Water Institute of Southern Africa (WISA), the Water Engineering Division of the South African Institute for Civil Engineers (SAICE) and the Aquatic Ecosystem Health and Management Society.

OBJECTIVES

The Vic Falls conference on aquatic systems aims to ✻ provide a multidisciplinary overview of aquatic ecosystems and resource management and utilisation, ✻ encourage the provision of quality information relevant to the African context, and ✻ help build and strengthen links to bridge the gap between managers and scientists, with their colleagues from overseas and elsewhere in Africa.

PAPER CALL

Scientists, environmental managers and professionals from appropriate disciplines are invited to submit extended abstracts (maximum 2 pages) for consideration by the selection committee. Poster papers may also be presented.

Authors whose papers are selected for oral presentation will be required to submit full manuscripts by the appropriate deadline. These will be edited by a panel of referees and will be published, along with one page abstracts of each poster, as the formal conference proceedings.

CONFERENCE THEMES

The organising committee have identified themes they feel are important for discussion at the Vic Falls conference:

- Water supply and sanitation in developing countries.
- Biomonitoring and toxicology: testing, experimentation, regulation and policy.
- Indicators and measures of ecosystem health.
- Management of lakes and fresh water supply reservoirs.
- Estuarine ecology and management.
- Sustainable management of aquatic systems.
- Information systems for water resource management.

These themes will provide the basis for presentations at the conference. Parallel sessions are planned to accommodate the anticipated number of speakers.

PAPER DEADLINES

Your two page (A4) extended abstract should be submitted by 30 June 1995. Abstracts should be typed in single space A4 format in Helvetica 12 point font. All margins should be 2,5 cm. Please indicate authors and affiliation.

EXHIBITIONS

Organisations and individuals are invited to exhibit (books, software or equipment) or advertise.

FEES

Conference fees (excluding accommodation) will be in the region of R1 500. A complete package including conference fees, airport transfers, accommodation and social programmes, is being prepared. It is estimated to cost about R2 500. Delegates are expected to make their own travel arrangements to reach Victoria Falls.

ENQUIRIES

- General & Administrative:

Ms Lesley Stephenson,
Conference Secre-tary,
PO Box 327, WITS 2050.
Tel (011) 716-5091
Fax (011) 339-7835
E-mail: Stephenson@ egoli.min.wits.ac.za.8

- Technical:

Dr Peter Ashton
Division of Water Technology, CSIR,
PO Box 395, Pretoria 0001.
Tel (012) 841-3293
Fax (012) 841-4785.

Mr Gavin Quibell
Institute for Water Quality Studies,
Dept. Water Affairs and Forestry,
Private Bag X313, Pretoria 0001.
Tel (012) 808-0377
Fax (012) 808-0338.

5-19 July 1996
Elephant Hills Hotel
Victoria Falls, Zimbabwe

First Announcement and Call for Papers