

S4 waterbulletin

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DESEMBER/JANUARIE 1989

M du P.

AFVALVERWERKING

Ontwaterde rioolslyk hou talle
voordele in vir
baksteenvervaardigers

WATER SUPPLY

Report forecasts water demands in
Vaal River supply area to year 2025

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Anaerobic digestion

Second Symposium

VENUE AND DATE OF SYMPOSIUM

The two and a half day Symposium on Anaerobic Digestion will be held at the CR Swart complex of the University of the Orange Free State, Bloemfontein, South Africa, on 18 to 20 September 1989.

Anaerobic Digestion

Anaerobic digestion is one of the major biological waste treatment processes in use today. Broad-scale application of the process has been largely in the treatment of municipal sewage sludge and, more recently, in the treatment of strong and medium strength industrial wastes. Advances in the basic understanding of the microbiology and biochemistry of the process, along with advances in hardware technology, have helped to overcome many of the problems associated with anaerobic digestion.

Organised by:

Department of Microbiology
University of the Orange Free State
Bloemfontein and
Division of Water Technology CSIR
with the Symposium Secretariat at the
University of the Orange Free State
BLOEMFONTEIN

ENQUIRIES

All correspondence concerning the symposium and the reply forms, should be addressed to:
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OBJECTIVES OF SYMPOSIUM

The first Symposium on Anaerobic Digestion was held at the University of the Orange Free State during 18 to 20 September 1986.

This symposium can be considered the beginning of a new era in the development and application of anaerobic digestion in South Africa. The need was expressed for ongoing communication and exchange of ideas between engineers, scientists and operators. The objective of the second symposium is to discuss laboratory, pilot and fullscale experiences, current developments and research trends on processes.

CALL FOR EXHIBITORS AND SPONSORS

Companies who have an involvement in the water industry will be able to participate in the Symposium by advertising in the brochure, renting an exhibition stand, sponsoring of socials and by donations.

ENROLMENT

Payment of the full enrolment fee of R180 will entitle a delegate to:

- Symposium programme and the volume of pre-print papers in advance
 - Lunches and teas
 - Attend the evening socials on 17, 18 and 19 September.
- The enrolment fee will exclude accommodation and breakfast. Depending on the response, a full programme of visits to places of interest will be arranged for accompanying persons (Ladies Programme).

TRANSPORT AND ACCOMMODATION

Transport will be available for the social programme and also from and to the airport. Accommodation will be available in several categories of hotels or other accommodation. Early reservations are urged in order to avoid disappointment. Full details of the social events will be given in the Second Circular.

OUTLINE OF PROGRAMME

The Symposium will include plenary papers, poster papers, panel discussions and exhibits.

Possible topics to be covered include:

- General outline of the process
- Engineering aspects of digestion
 - Control of the process
 - Industrial effluent treatment
- Sewage treatment using anaerobic digestion
 - Economic and commercial aspects
 - Digestion of agricultural wastes
 - Microbiology of anaerobic digestion
 - Biochemical aspects of the process
 - Storage and use of biogas

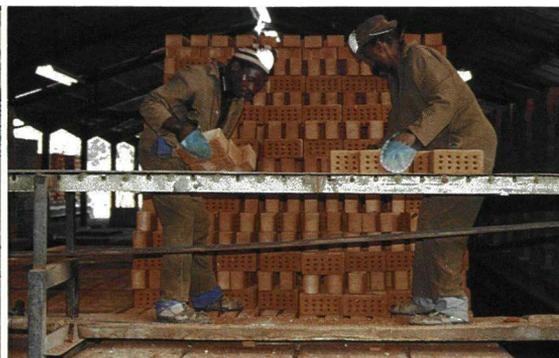
The organising committee is negotiating with a number of prominent national and international researchers to attend the symposium.



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Inhoud

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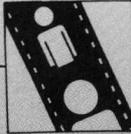
Cover: Open sluice gates at the Vaal Dam.

SA Waterbulletin is a two-monthly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organization established in 1971 by Act of Parliament.

Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source.

Editorial offices: WRC, P O Box 824, Pretoria 0001, Republic of South Africa. Tel. (012) 33-00340. Fax: (012) 70-5925

Editor Jan du Plessis. Ed. Secretary Rina Human, Colour separations Litho Technik, Typography and design Nicola van Nikkelen Kuyper, Printing Creda Press, Cape Town.



Symposium on Phosphorus Removal

A technology transfer symposium to discuss advances in biological phosphorus removal by the activated sludge process was held at the Indaba Hotel in Sandton last year.

At the symposium the University of Cape Town officially handed over to the Water Research Commission the final report on their research into biological excess phosphate removal.

The principle objective of the UCT research, which was carried out in conjunction with the Johannesburg City Council, was to develop a kinetic model for biological excess phosphate removal in biological nutrient removal plants with a view to improving the technology concerned. Four separate sub-projects were completed in the study, viz. biological excess phosphate removal system performance, substrate description, modelling of biological excess phosphate removal and non-polyphosphate activated sludge modelling.

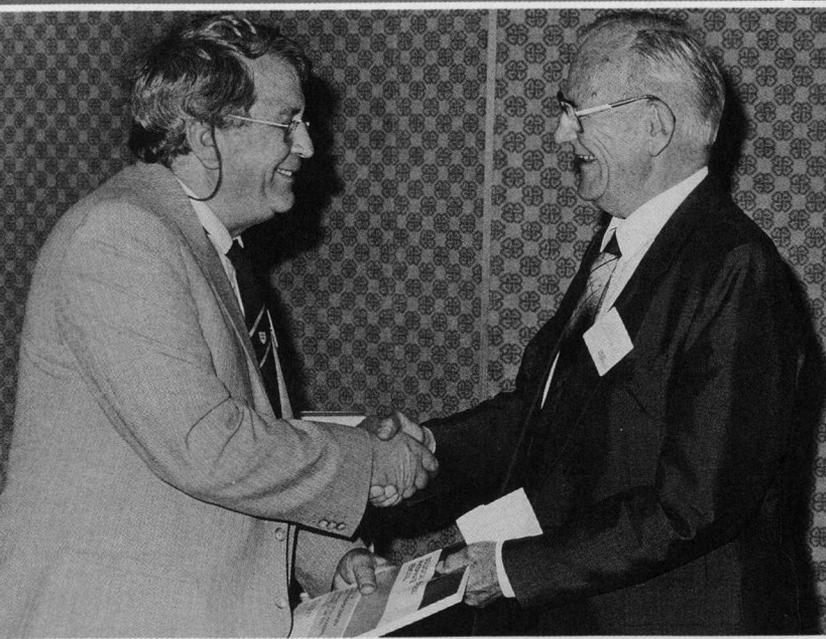
In his presentation speech Prof Marais, of the Department of Civil Engineering, UCT, lauded the WRC's role as catalyst for promoting research.

He said that the WRC's financial support of the wastewater research programme transformed it from a cash strapped to a financially secure programme.

Some 83 papers and four design manuals emanated from the WRC sponsored work.

Nine doctorates and 32 master's degrees have also been attained from the research work in this field. This is the most number of master's and doctorates awarded to the students of one professor at UCT, Prof Marais said.

Copies of the final report are available from the Water Research Commission, Po Box 824, Pretoria 0001. Tel (012) 330-0340. 



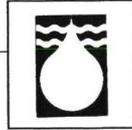
TOP: Dr JP Kriel, Chairman of the Water Research Commission accepts the report, *Biological excess Phosphate Removal* from Prof G vR Marais of the Department of Civil Engineering, University of Cape Town.

RIGHT: From left: Mr PJ van Schalkwyk (Nigel City Council) and Mr EE Weston (Sasol 2).



TOP: From left: Mr JE Glibbery (Glibbery and Associates), Mr L Marais (Germiston City Council) and Mr CA Geddie (Bradford, Conning and Partners).





Dien navorsings- voorstelle nou by WNK in

Ten einde die WNK in staat te stel om sy begroting vir 1990 vroegtydig en na wense te beplan, sal dit waardeer word indien enige waternavorsingsvoorstelle wat u organisasie (vir finansiering gedurende 1990) aan die WNK wil voorlê, die WNK voor 31 Mei 1989 sal bereik.

Sodanige voorstelle sal as voorlopige navorsingsvoorleggings beskou word en gevolglik word slegs die volgende inligting verlang:

- Titel van die voorgestelde navorsingsprojek.
- 'n Kort samevatting van die motivering vir die navorsing en die werkwyse wat beoog word (ongeveer twee bladsye).
- Voorgestelde termyn van die beoogde navorsing.
- Vir elke jaar van die voorgestelde termyn 'n begroting waarin bedrae vir onder andere die volgende uitgawes aangetoon word:

- Salarisse van navorsingspersoneel wat uit projekfondse besoldig sal word.
- Ander lopende uitgawes.
- Uitgawes ten opsigte van kapitaalgoedere.

Indien u enige raad of leiding rakende die opstelling van hierdie voorlopige voorlegging verlang, staan dit u vry om met die WNK se navorsingsbestuurders in hierdie verband te skakel.

Neem asseblief kennis dat die meriete en prioriteit van alle voorleggings wat die WNK ontvang, gesamentlik oorweeg sal word. U sal so gou doenlik daarna in kennis gestel word of u navorsingsvoorlegging(s) aanvaar is met die oog op die voorbereiding van 'n gedetailleerde navorsingsvoorstel en onderhandelinge in verband met 'n uiteindelijke ooreenkoms. Tydens hierdie fase sal daar uit die aard van die saak noue skakeling tussen die betrokke WNK-navorsingsbestuurders en die indiener van die voorstel moet wees. Uiteindelik word die voorstel tydens 'n vergadering van die WNK oorweeg en 'n aanbeveling oor die finansiering daarvan aan die Minister van Waterwese gemaak.

Submit research proposals to WRC now

In order to enable the WRC to properly and timely plan its budget for 1990, it would be appreciated if any water research proposal which your organisation may be planning for submission to the WRC for funding during 1990, could reach the WRC before 31 May 1989.

These proposals will be seen as preliminary proposals and consequently only the following information is required:

- Title of the proposed research project.
- A short resume of the motivation for the research and the intended modus operandi (approximately two pages).
- Proposed duration of the planned research.
- A budget for each year of the proposed duration in which inter alia the following are indicated:
 - Salaries of research personnel to be remunerated from the project funds.
 - Other running expenses.
 - Costs of capital equipment to be purchased for the project.

Should you require any advice or assistance in the preparation of this preliminary proposal, you are invited to consult with the WRC's research managers in this regard.

For your information please note that the merits and priority of all submissions received by the WRC will be considered jointly. You will be informed as soon as possible whether your submission(s) have been accepted for development into detailed research proposals. We will then initiate the negotiations regarding the agreement eventually to be entered into with the WRC. During this development phase close cooperation between the WRC's research manager and the proposer of the research is essential.

Finally the proposal will be considered at a meeting of the Commission with a view to a recommendation to the Minister of Water Affairs regarding the funding of the project.

'n Steenmaker van Port Elizabeth gebruik reeds sedert 1980 ontwaterde rioolslyk suksesvol vir die vervaardiging van bakstene vir die boubedryf. Die slyk word vanaf die Fishwater Flats-waterherwinningswerke verkry waar dit deur middel van die Zimpro-proses behandel word. Tot op datum is reeds meer as 120 miljoen biostene gemaak. Die meng van slyk en klei vir baksteenvervaardiging hou talle voordele in vir beide die steenmaker en die plaaslike owerheid.

Vir laasgenoemde is dit 'n maklike en goedkoop manier van afvalverwydering.

Vir die steenmaker beteken die slyk 'n besparing van brandstof, water en vervoerkoste (omdat die stene soveel ligter is). Daar kan ook heelwat meer stene op 'n slag in die oonde geprosesseer word aangesien die slyk die brandingsgebied in die oond aansienlik vergroot.

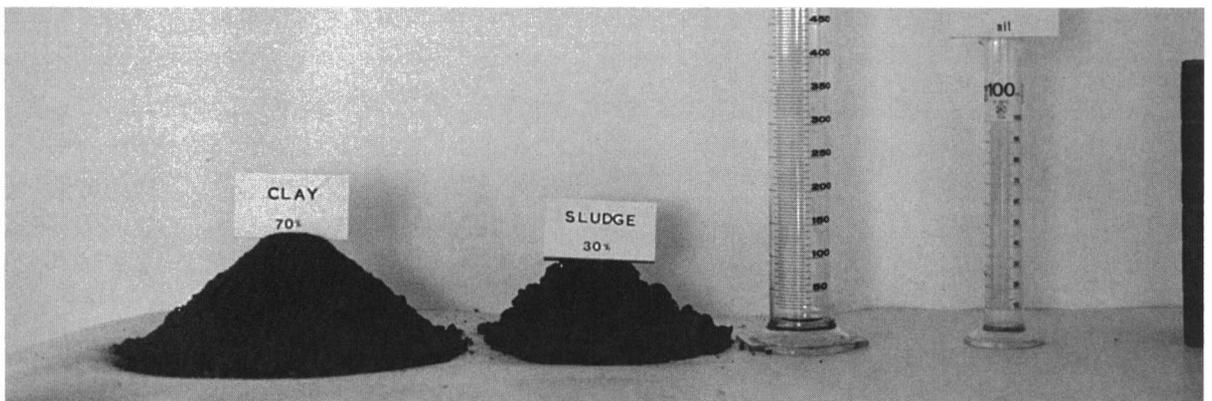
SA Waterbulletin gee in die artikel 'n kort oorsig van dié interessante en nuttige manier van afvalverwerking.

Vir meer inligting en tegniese besonderhede kontak mnr JA Slim of mnr RW Wakefield van die Stadsingenieursafdeling, Posbus 7, Port Elizabeth. 6000. Tel : (041) 52-2080.

Deurbraak met biobakstene in Port Elizabeth



1. Fishwater Flats-waterherwinningswerke. Toe rioolslyk in 1979 vir opvullingswerk by die rioolwerke in Port Elizabeth gebruik is, het die slyk soms aan die brand geraak. Die eienaar van die plaaslike steenwerke het besef dat die slyk dieselfde verbrandingsmoontlikhede kon hê as die steenkoolstof wat in die Transvaal gebruik word om brandstofkoste in die bakproses te besnoei. Hy het toe 'n hoeveelheid van die rioolslyk bekom vir eksperimentering.



2. Aanvanklik is hoeveelhede van ongeveer vyf persent slyk met die klei gemeng en die normale proses is gebruik om die bakstene te maak. Die persentasie slyk is mettertyd vermeerder en daar is gevind dat meer as 45 persent slyk in die mengsel, misvormde en gekraakte bakstene veroorsaak en die oondtemperatuur moeilik beheer word. Met 'n slykinhoud van ongeveer 30 persent was die bakstene egter van 'n hoë gehalte met 'n goeie voorkoms. Temperature kon doeltreffend beheer word en 'n aansienlike besparing van brandstof is behaal.



3. By die rioolwerke word die ontwaterde slyk deur 'n vervoerband na 'n stoorplek geneem waar dit op vragmotors gelaai word. Die slyk is voldoende ontwater en dit was dus nie nodig om die vragmotors se bakke aan te pas vir die doel nie.



4. Die klei wat vir die stene gebruik word, is 'n grys marine neerslag van die Sondagsrivierformasie.

5. Die slyk en die klei word vermeng vanaf kasvoeders met 'n veranderlike spoed, toegerus met roterende tande en word dan op 'n vervoerband leeggemaak. Tans word 30 persent slyk bygevoeg vir die vervaardiging van pleisterstene en tussen vyf en agt persent vir sierstene.

6. Die mengsel van slyk en klei word na 'n vergruisingsaanleg geneem waar 'n kerwer die klonte klei in stukke van minder as 12 mm in deursnit sny. Daarna word die stukke verder verklein deur 'n hoë spoed rolmeule tot 'n korrelgrootte van nagenoeg 2,5 mm.





7. Hierna gaan die mengsel na 'n menger wat dit knie tot 'n egalig gemengde massa nadat water bygevoeg is. By die vervaardiging van pleisterstene, skakel die slyk die noodsaaklikheid vir ekstra water heeltemal uit.

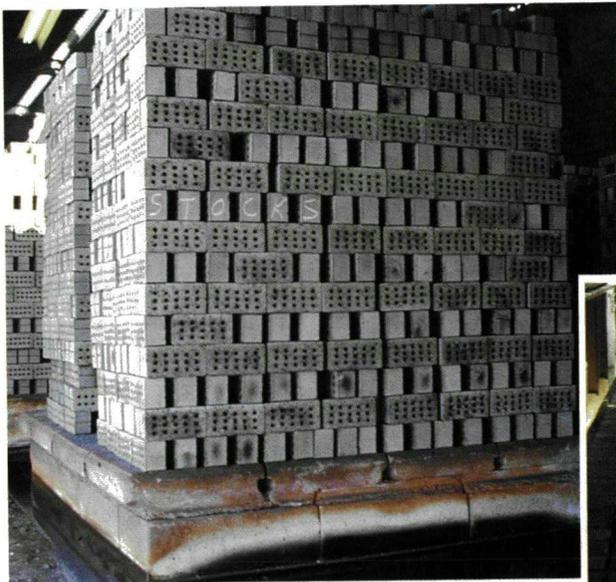
8. Die kleimengsel word deur 'n metaalvorm uitgepers om 'n kontinue kolom van spesifieke deursnee en patroon te vorm.



9. Die klei- en slyk-kolom word in 1,15 meter stawe gesny wat dan met draadsnyers in 15 dele verdeel word om bakstene van konvensionele grootte, te vorm.

10. Die ongedroogde "groen" bakstene word op 'n latwerk gepak, opmekaar gestapel en op trollies vervoer na 'n area waar dit toegelaat word om te lugdroog. Lugdroging vind onderdak plaas teen die omringende temperatuur vir 'n tydperk van ongeveer twee weke of in verhitte kamers waar die bakstene vir 48 uur teen 'n gemiddelde temperatuur van tussen 60 en 65°C bly.





11. Die droë ongebakte bakstene word dan van die trollie verwyder en met 'n vervoerband na die verhardingsafdeling geneem waar dit gestapel word, gereed vir branding in die oond.

12. Die oondtrollies gaan eers 'n voorverhittingsone binne met 'n temperatuur van ongeveer 100°C. Van die vog wat nog in die stene is word dan verwyder.



13. Wanneer die stene net van klei gemaak word, beweeg die trollie 1,3 m vorentoe elke uur. Teen hierdie spoed neem dit die trollie 76 ure om deur die oond te beweeg. Met die byvoeging van die slyk, kan die proses egter twee keer vinniger plaasvind vanweë die brandstofwaarde van die slyk.

14. In die verhittingsone word die oorblywende vog in die bakstene verwyder en teen 'n temperatuur van ongeveer 150°C begin die organiese stowwe in die slyk brand. Dit veroorsaak 'n vinnige styging in temperatuur tot 800°C wat op ongeveer 1,8 m in die oond bereik word. Teen dié tyd is die slyk opgebrand en die temperatuur neem af oor die volgende 35 meter tot by die brandingsarea. Brandstof word deur oorhoofse nossels oor 'n afstand van 5 m in die oond ingespuut om die temperatuur te verhoog tot 960°C wat nodig is vir die verglasing van die klei. Sonder die byvoeging van die slyk, word 80 liters brandstof benodig om genoeg hitte vir 1000 stene te verskaf. Die byvoeging van slyk het dié hoeveelheid verminder tot 25 liters vir 1000 bakstene en daar word verwag dat 'n geringe verhoging in die hoeveelheid slyk, die brandstof verder sal verlaag tot slegs 10 liters per 1000 stene.

15. Die pleisterstene en sierstene wat van die klei en slykmengsel gemaak word, lyk baie goed. Die stene lyk eenders van kleur en tekstuur en het nie baie krake nie. Die stene kan nie onderskei word van konvensionele kleistene wat betref voorkoms of reuk nie. **W**

IWSA STANDING COMMITTEES

IWSA international biennial congresses are often looked upon as the brightest stars in the IWSA galaxy, but they are certainly not the only ones. Although they may not shine quite so brightly and attract quite so much attention, much valuable work is carried out by the various International Standing Committees of the IWSA. In this issue of the newsletter we have reports on the activities of two standing committees and preliminary details on Wasser Berlin '89 where two conferences will be organized by two more standing committees.

Standing Committee on Water Quality and Treatment

Dr Piet Aucamp of the Department of National Health and Population Development took part in a Workshop on Water Treatment and Drinking Water Regulations in Vienna last year and sent us this report.

Drinking Water Regulations, Water Treatment and Protection of Water Resources

At its International Workshop 'Water Treatment and Drinking Water Regulations' on June 30/July 1st, 1988, in Vienna the IWSA Standing Committee on Water Quality and Treatment dealt with the possibilities and limits of water treatment technology. On



Dr PJ Aucamp.

this occasion the following conclusions were stated on an international basis.

Among the huge numbers of organic and inorganic substances affecting the quality of the water resources, numerous substances exist which cannot be removed by the treatment procedures applied nowadays. Thus they may contaminate drinking water. This means, that the fulfilment of the more rigorous drinking water requirements cannot be achieved only by water treatment measures, since

- the treatment procedures are already approaching technical limits
- economically reasonable relations between treatment costs and effectiveness surpass a justifiable limit, also from the point of view of the consumer
- a non-justifiable environmental impact may be triggered by the more sophisticated treatment measures
- the huge number of smaller water supply authorities are not able to apply such sophisticated treatment technology.

Above all this concerns agrochemicals,

low limit concentrations, e.g. a number of pesticides with 0,1 ug/l and halogenated organic compounds with a guideline value of 1 ug/l. Other parameters have very low limits for aesthetic or organoleptic reasons.

If such substances are present in the raw water, the water works often have difficulties to comply with the limits.

Additionally, it is very difficult to detect some of these substances analytically. For many substances analytical procedures do not exist.

The increasing number of chemicals and their wide application are alarming for the water supply authorities.

During its panel discussion the Workshop stated the following conclusions:

- Emissions of toxic substances not removable by treatment procedures should not occur.
- The discharge of such substances to surface waters should be practically omitted by changing process conditions or by internal safety precautions.



The gardens of the Schönbrunn (beautiful fountain) Palace just outside

fertilizers and organic substances, which are hardly or even not biodegradable.

For that reason it is necessary that more extensive water resources protection measures be taken in order to guarantee a safe drinking water supply for the whole population.

The requirements put on drinking water quality as mentioned in national and international regulations and in the WHO guidelines are partly based on health requirements. Some of the quality requirements are based on a preventive policy to protect the consumer. Among the parameters involved, some are concerned with very

- If such measures are not practicable, unobjectionable substitute substances should be developed.
- These requirements are valid for diffuse sources too.
- Substances not objectionable for health reasons, which however are not removable by treatment technology as practised today (water work relevant substances) should not be present in water resources, or only in very low concentrations. This is valid especially for certain halogen, sulphur and nitrogen compounds, e.g. for certain pesticides.

- Principally, pesticides should be biodegradable under the conditions of the site of application during a time period judged to be reasonable from the point of view of water quality. A low mobility of such substances is also a prerequisite for protecting the water resources. The intermediary degradation products should be known, analytically detectable and not toxic. The users of such products should apply them in consideration of the water protection goals (time of application, dosage). In drinking water protection zones the application restrictions have to be respected.

For all these reasons the Standing Committee on Water Quality and Treatment states that the intensified protection of water resources has to be set as first priority. Nevertheless the further improvement of water treatment technology is necessary.

Standing Committee on Public Relations

South Africa's representative on the Standing Committee on Public Relations is Graham Atkinson, Chief Executive, Umgeni Water. In October 1988 he attended a two-day Workshop in Brussels to consider in depth a number of case studies arising from water supply problems. These demonstrated the value of effective Public Relations activities and communication efforts in dealing with the public.

At the Workshop in Brussels the following six cases were presented:



Mr G Atkinson

- Study No 1: 'INTRODUCING WATER METERS'
- G Thoelen (Belgium)
- Study No 2: 'CONTACTS WITH CONSUMERS ON-THE-SPOT'
- R Norberg (Sweden)
- Study No 3: 'THE NATAL FLOOD DISASTER, SEPTEMBER 1987'
- GDJ Atkinson (South Africa)
- Study No 4: 'SCHOOL LIAISON'
- A Kassel (West Germany)
- Study No 5: 'INTRODUCING WATER METERS'
- F Vos (Netherlands)
- Study No 6: 'THE SANDOZ ACCIDENT - ECOLOGICAL DISASTER OR POLITICAL EVENT'
- H Seegers (West Germany)
- Study No 7: 'NATIONAL CAMPAIGN TO ENHANCE THE IMAGE OF WATER QUALITY'
- M Peasey (Great Britain)

· Paper actually presented by Mr J Bray, Deputy to Mr R Odell of the Water Research Council in the UK.

Some of the points which arose from these studies were of importance to South Africa, e.g. we tend to think of Western Europe as an advanced, very much first world environment. It is therefore a shock to learn that the water supply to consumers and particularly to domestic consumers is coming under increasing attack and is being viewed with suspicion as to acceptability. In fact the lunatic fringe of the environmental lobbies are starting to have success in convincing the public that it is positively dangerous to drink water from the tap. To illustrate this point, in a survey undertaken in Cologne recently, 61 per cent of the respondents were not prepared to drink water from the tap!

The importance of ongoing liaison with, and education of the public is necessary and an honest and trusting relationship must be built up and maintained with the media. It is no use trying to sort out problems on an ad hoc basis at the moment. This will not succeed unless a long term relationship has been built up with the media.

The paper presented by Mr Atkinson, 'The Natal Flood Disaster: September 1987', was well received, as was the audio-visual that accompanied it. The exhibition that he used (on loan from the Department of Geology at the University of Natal) attracted a great deal of interest.

Apart from the obvious interest of the gathering in viewing scenes of South Africa

(none of the delegates had ever been here), they saw the potential for turning what could have been a public relations disaster, into something positive. This was achieved by effective communications with the public during the time of the flood and the immediate aftermath, as well as the acknowledgement of thanks and public information campaigns that followed the event.

Wasser Berlin '89

This year's Congress Wasser Berlin '89 takes place from 10 to 14 April and has as its overriding theme environmental protection. Amongst the wide range of subjects to be discussed are water management and planning, groundwater protection, surface water protection and the safeguarding of water quality.

The IWSA contribution to Wasser Berlin '89 takes the form of two specialized conferences. The first is organized by the recently formed IWSA Standing Committee on Management and Training and is entitled 'The Development of Water Industry Managers'. It covers a wide area, focussing on successful management techniques and skills, keeping abreast of technological change, as well as changes in political and economic climates; an overview of the responsibilities of management will also be included.

The second conference is organized by the IWSA Standing Committee on Water Transport and Distribution and is entitled 'The Rehabilitation of Mains and Pipelines'. It begins with an overview of performance relating to legal and consumer obligations. Survey and inspection methods will be reviewed, together with efficient data storage retrieval procedures and effective use of the information and non-structural rehabilitation methods will be discussed and particular problems identified. The conference ends with a look into the future, which takes the form of a panel discussion.

Further details on Wasser Berlin '89 can be obtained from Phil Coombs, Secretary, SA National Committee, IWSA, P O Box 395, Pretoria, 0001. Telephone (012) 841-2231.

P COOMBS
SECRETARY



South African National Committee for the International Association of Hydrological Sciences

SANCIAHS COMMITTEE CHANGES

Through a number of resignations, because of changing work environments the SANCIAHS Committee has a number of new faces. The persons who have left us are:

- Dr Peter Roberts - now Director of the Institute for Commercial Forestry Research at the University of Natal.
- Mr Dave Cousens - now Managing Director of CG Smith Sugar Estate.
- Dr Paul Roberts - now Managing Engineer: Development in the Department of Water Affairs.
- Mr Johan Vegter - not available for another four year term with SANCIAHS.

We are very grateful for their long service to SANCIAHS. Peter Roberts, with his eight years' experience as SANCIAHS chairman, will be particularly missed. His major inputs, leading to the establishment of our South African arm of the International Association of Hydrological Sciences, are highly appreciated.

The new committee brought about by either election of new Commission representatives after the completion of the four year term or through co-option after resignation of members between elections looks as follows:

OFFICE BEARERS OF SANCIAHS (1988 TO 1991)

CHAIRMAN:

Mr E Braune
Director: Hydrological
Research Institute
Department of Water Affairs
Private Bag X313
0001 PRETORIA

National Representative for
the International Committee
on Remote Sensing and Data
Transmission



H Maaren

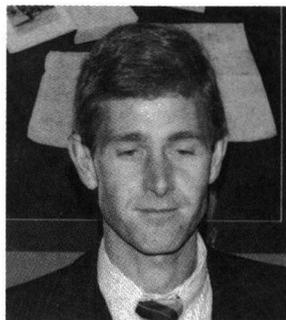
VICE CHAIRMAN AND SECRETARY:

Mr H Maaren
Research Manager
Water Research Commission

Committee representative for
the International Committee
on Remote Sensing and Data

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Transmission



D Hughes

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the International Commission
on Continental Erosion

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Commission representative for
the International Commission
on Snow and Ice



E Braune

The new faces on the committee are briefly introduced to you.

Hugo Maaren

Hugo is presently Research Manager at the Water Research Commission in Pretoria. He qualified as an Agricultural Engineer at the University of Wageningen in the Netherlands and came to South Africa in 1967. His special interests are land use hydrology and the application of remote sensing.

Dennis Hughes

Dennis Hughes is the senior member of the Rhodes University Hydrological Research Unit and Associate Professor in the Department of Geography. He has wide experience in the hydrological field with a special interest in modelling hydrological systems. Dennis came to South Africa from the United Kingdom in 1980. He has a PhD from the University of Wales in the field of flood plain hydrology and hydraulics.

Dave Bredenkamp

Dave is presently Deputy Director of the Directorate of Geohydrology of the Department of Water Affairs in Pretoria. Dave has a special interest in modelling groundwater recharge and dolomitic systems in general. He received a PhD from Bloemfontein University.

PUBLICATION IN THE JOURNAL OF THE IAHS, THE HYDROLOGICAL SCIENCES JOURNAL

There is as yet no better way of communicating scientific findings than publication in reputed international journals. An important function of SANCIAHS is to promote communication of South African hydrologists with the international hydrological community. We strongly encourage our registered members to present papers at IAHS gatherings and to use the Hydrological Sciences Journal for publications of wider interest.

In this regard we would like to draw your attention to the annual IAHS Tison Award to promote excellence in research by young hydrologists.

Tison Award

The Tison Fund was established in 1982 to provide an annual prize of \$750 (US). The Tison Award will be granted for an outstanding paper published by IAHS in a period of two years previous to the deadline for nominations. Nominations should be received by the Secretary General not later than 31 December each year. Candidates must be under 41 years of age at the time their paper was published.

Nominations may be submitted by the National Committee (SANCIAHS) and also by any individual or group of persons. Nominations should contain a reasoned argumentation.

SOUTH AFRICAN ATTENDANCE OF 1989 IAHS BALTIMORE CONFERENCE

I would be glad if everybody attending the Baltimore conference this year could inform me, or Hugo Maaren at the WRC, with a quick note or telephone call. (Telephone (012) 82-1415 or (012) 330-0340).

Please mention in what sessions you are presenting a paper.

We will draw a bit on experience from previous IAHS conference attendants and will come back to you with suggestions on possible co-ordination of the South African effort in Baltimore.



CHAIRMAN: SANCIAHS

EBERHARD BRAUNE

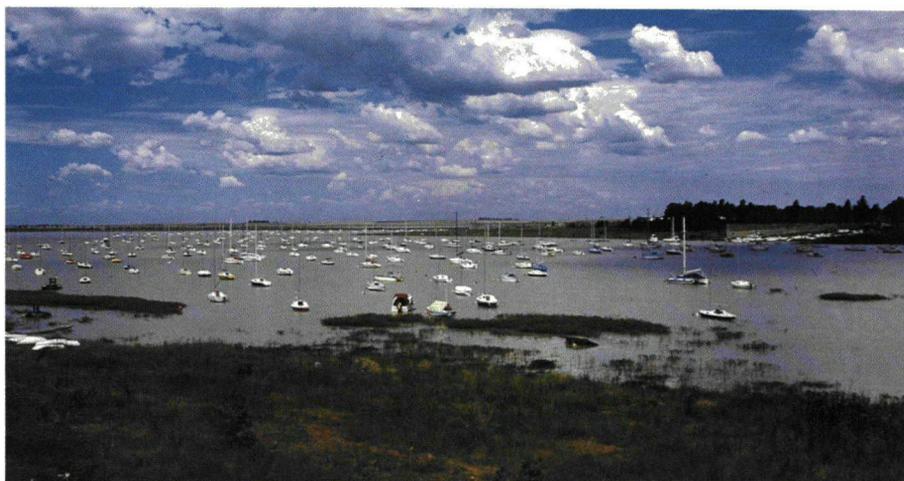
Water demands in the Vaal River supply area forecasted to year 2025

In December 1982 the Director-General of the Department of Water Affairs invited several experts from the private sector to form a steering committee under the chairmanship of the then Managing Engineer, Water Resources, Mr TPC van Robbroeck to direct a study of the future water demands of all users of water from the Vaal River Catchment. The Committee's final report has recently been published and forecasts a water demand by the end of the study period to about five times that which can be met from the Vaal River's own resources.

The Committee states that although water is being recycled and re-used throughout the system, and will continue to an increased scale in the future, further major importations of water will be needed, even beyond those envisaged in the Lesotho Highlands water scheme.

The Vaal River supply area extends beyond the Vaal catchment boundaries. Readily exploitable water resources within the catchment are fully committed and water has had to be imported to the supply area from neighbouring catchments, for example, from the Komati in 1962, the Usutu in 1967 and the Tugela in 1976. Concentration of economic activity in this region was to be expected in view of its vast mineral wealth. It is dominated by the Pretoria-Witwatersrand-Vaal Triangle (PWV) complex which with its surrounding areas embraces the world's richest gold and platinum mines as well as the coalfields that provide the feedstock for South Africa's synfuel and carbo-chemical complexes and fuel its giant power-stations. These and other features have made the region the economic hub of the subcontinent.

Government policy is to offer incentives to industry to develop at growth points away from the central area. At the same time it is recognised that, to create the wealth with which to sustain the decentralization pro-



gramme, the reasonable needs of the principal prosperity-generating region must continue to be met. Water consumption in the Vaal Supply area has increased exponentially over the past half-century or more and to keep up with demands future augmentation schemes must proceed in steps of increasing magnitude and frequency. In view of the long lead times involved in planning and constructing major water schemes, and the time to be allowed for filling the necessary storages, it is essential that water requirements be forecast well

into the future and that every effort be made to achieve reliability of data on which to base such forecasts. Periodic droughts necessitating the imposition of water restrictions have further highlighted the need to reliable water demand forecasts. To this end the Director-General of the Department of Water Affairs (DWA) in 1982 appointed this Committee to examine possible future water demands in the areas dependent on the Vaal River Supply system.

Chapter 1 of the report provides the back-

ground against which the study was undertaken, defines the terminology, the terms of reference, the study area, supporting studies and introduces the members of the Committee.

Chapter 2 broadens the perspective of the study area in both the South African and the subcontinental setting. Embracing 78 magisterial districts, the study area accommodates 29 per cent of the Republic's population and accounts for 56 per cent of the gross domestic product. The mean annual runoff of the Vaal at its confluence with the Orange River is 4 300 million m³, which is but 8 per cent of that of all the country's rivers. Because of high evaporation, the nature of storage sites and frequent prolonged droughts, interspersed with extreme floods, less than half the average runoff can be beneficially exploited.

Although the sources of water to meet the needs of the study area were not the concern of this Committee, the historical review would be incomplete without mention of the interbasin importation schemes (Tugela-Vaal and Usutu-Vaal) as also the background to the proposed Lesotho Highlands augmentation project. The importance of re-use as a supplementary source of water is also stressed. (Currently up to 35 per cent of the Rand Water Board sales constitutes treated effluents returned to the Barrage.) Problems arising from increased levels of salinity through recycling of used water are noted. Irrigation areas within the Vaal River Supply Area are still greater than in any other river basin in South Africa, but having been overtaken by urban water use, irrigation no longer represents the major water user.

CATEGORIES

A comprehensive survey of various categories of water use throughout the supply area from the early 1960's to 1984 formed the basic input to much of the demand forecasting effort. The results are grouped under nine subcatchments of the Vaal system in a data bank in Appendix A. Other demands such as Escom, Sasol, irrigation, minor users and riverbed transmission losses are dealt with separately. Records dating back in some cases to the past century for major consumers in various parts of the country were examined. Long records of water use by major consumers, representing 85 per cent of the total water consumption for the study area, proved invaluable for identifying trends.

In Chapter 3 the many factors that influence water demands are considered. Population growth rates were identified as highly significant but attention is drawn to the fallibility of population censuses and growth forecasts, both locally and worldwide. Among the other factors discussed are: economic development, social conditions, climate, housing, land use, water restrictions, public attitudes, pricing policies, metering, recycling and re-use, quality of water, distribution losses, water legislation, management and efficiency of water use.

WATER CONSUMPTION

An extensive literature survey was undertaken to assist in choosing appropriate methods of forecasting water demands. In Chapter 4, reference is made to the huge volume of data collected from scores of water supply undertakings worldwide. Plotted time series of water consumption, with growth trends, for undertakings in many parts of the world are assembled in Appendix B. These were carefully analysed to extract trends and to seek the reasons for disruptions in the trends. Numerous factors that influence the growth or decline of water demands were identified, and these provided a basis for formulating future scenarios that might be relevant to the Vaal Supply area. Wide fluctuations in unaccounted-for water and introduction of universal metering can mask or modify trends determined by other factors, such as water restrictions during drought.

Many features were recognised that would bring about steep increases in water demands, such as rapid urbanization, increased attraction of population to the Vaal Supply Area with the lifting of influx control (despite incentives to industry to decentralize) and improvement of living standards of the less privileged. These, the Committee considered, would outweigh factors tending to lower demands, such as improved technology in water use and re-use, public conservation consciousness, and the expected decline in population growth rates that usually accompanies urbanisation and enhancement of living standards.

In Chapter 5, methods of forecasting water demand are reviewed. Those considered are extrapolation methods, where analytical, phenomenological and vectorial extrapolation are distinguished, and trend correlation methods, included in

which are econometric modelling techniques. No single generally acceptable method of water demand forecasting could be found and this seems to be the case worldwide. Length and reliability of records of water use, together with concurrent records of relevant parameters, such as population and economic indicators relating to equivalent areas, are crucial to successful forecasting.

Chapter 6 is concerned with population forecasting. Having identified population growth as possibly the most important parameter in water demand forecasting, the Committee carefully examined reports of past censuses and projections of future population growth. The results were disturbing in that they revealed wide differences. In the absence of any satisfactory authentic forecast, the Committee was obliged to make its own. A preliminary projection based on aggregation of forecasts for each of the magisterial districts in the study area was subsequently revised on the basis of recently acquired information on under-counts in the official censuses of 1980 and 1985, and on the rate of urbanization.

MODELLING

Chapter 7 is devoted entirely to econometric modelling as a means of forecasting water demand. First attempts, employing a wide range of explanatory variables, produced some illogical results largely because of incompatibility of variables with the geographical areas to which they were applied. The 78 magisterial districts forming the study area were then grouped, under seven regions having generally common characteristics. In the finally accepted model all explanatory variables except population and real gross geographic product (RGGP) were eliminated. Despite problems initially experienced with the availability of sufficiently detailed and reliable input data, the Committee is satisfied that eventually the best information available in the country at this time in regard to population and economic growth data was used in the model. The most probable region-by-region forecast generated by the econometric modelling technique is summarized with totals and the control. The full year-by-year time series of all the econometric forecasts and their controls are reproduced in Appendix C.

In Chapter 8 forecasts were made by exponential and unit consumption extrapolation

of various kinds. It was appreciated that extrapolation of water demand at current growth rates, which are roughly double the population growth rate, would relatively soon generate per capita demands exceeding plausible values. One approach was, therefore, to generate as a time series the product of population and unit demand - the unit demand rising gradually to a plausible ceiling value of $700 \text{ l}\cdot\text{c}^{-1}\cdot\text{d}^{-1}$. The other approach was to assume that past constant exponential trends would persist (a) with and (b) without the time shift brought about by the current drought disruption until a $600 \text{ l}\cdot\text{c}^{-1}\cdot\text{d}^{-1}$ unit demand was reached, whereupon demand growth would continue to rise but at a lower rate, viz. about 1 per cent above population growth rate.

The second approach is referred to in the report as a forecasting method based on trend analysis. Given in Appendix B for water supply undertakings throughout the world are time series of water consumption, showing primary and secondary trends and disruptions of various types - along with reasons, where identified, for departures from the primary trends and characteristics of trends common to most water supplies are discussed.

In Chapter 9 demands other than urban/industrial/mining are considered. Irrigation, which represented the greatest component of demand on the Vaal supply system prior to the 1980's, has a comparatively slow growth rate and is expected by the year 2025 to constitute only about 12 per cent of the total demand. Distribution losses are

allowed for in the demand projections but, where water has to be transmitted over long distances by river channel, the losses are estimated separately. Riverbed losses are expected to remain constant at about 226 million m^3 per annum.

The Sasol demand, presently standing at about 97 million m^3 per annum, is expected to remain constant until the end of the century whereafter a fourth Sasol will probably raise the demand to 130 million m^3 per annum. The Sasol demand, originally excised, was subsequently incorporated in the urban/industrial/mining projections.

Because of uncertainties about dry-cooling and sources of cooling water, three scenarios are considered for the growth of the



WATER SUPPLY

Eskom water demand which at present stands at somewhat less than 300 million m³ per annum. If dry cooling proves entirely successful, the demand will not be even double the present consumption by the end of the forecast period but if all future stations have to be wet cooled there would have to be a fourfold increase of water supply. The most probable forecast put the future Eskom demand at 750 million m³ per annum, or about 9 per cent of the total demand on the system in year 2025.

been allowed for, along with stockwatering and other minor water demands, and amount to a constant total of 150 million m³ per annum.

All demand forecasts to year 2025 are aggregated in Table 9.5. As may be seen, the most probable forecast is bracketed by upper and lower envelopes.

Chapter 10 contains concluding observations which summarize much of the content of the report followed by recommendations of which the main ones are: that the upper estimate be adopted for planning future augmentation systems and the "most prob-

able" forecast for examining the economic benefits of proposed schemes and for fixing future water tariffs; that the data and the forecasts should be regularly updated and that research should be promoted into methods of forecasting. 

This report TR 134 (Volume A and B) is available from The Department of Water Affairs, Private Bag X313, Pretoria, 0001. Contact person: Mrs P Hoffman, tel No: (012) 808-0377.

Demand forecast to year 2025 in Vaal River supply area.

Demands (million m ³)	1989	1990	1995	2000	2005	2010	2015	2020	2025
Urban\industrial mining									
Upper estimate	1 290	1 407	2 359	3 022	3 590	4 263	5 063	6 013	7 143
Most probable	1 290	1 378	1 868	2 594	3 038	3 759	4 469	5 788	6 247
Lower estimate	1 290	1 378	1 724	2 083	2 492	2 973	3 537	4 207	4 998
Irrigation									
Probable	895	900	925	946	957	968	975	982	997
Eskom									
Upper estimate	-	-	319	395	527	670	850	1 065	1 210
Probable	287	282	319	370	420	483	564	684	750
Lower estimate			319	357	370	390	416	452	485
Minor users									
Probable	150	150	150	150	150	150	150	150	150
Riverbed losses									
Probable	226	226	226	226	226	226	226	226	226
Totals									
Upper estimate	-	-	3 979	4 739	5 450	6 277	7 264	8 436	9 726
Most Probable	2 848	2 936	3 478	4 006	4 791	5 586	6 384	7 330	8 370
Lower estimate	-	-	3 344	3 762	4 195	4 707	5 304	6 017	6 856

New report reviews marine disposal practice in South Africa

The marine discharge of municipal sewage and industrial effluents is currently receiving considerable attention in South Africa.

To ensure safe and judicious design and operating procedures for future marine outfall systems, the WRC commissioned the CSIR in Stellenbosch to document technical details of existing marine pipelines and experience in operating these pipelines.

This review report by APM Fijen of the Marine Pollution Programme, Division for Earth, Marine and Atmospheric Science and Technology, CSIR, is now available on request from the Water Research Commission, P O Box 824, Pretoria 0001. Free of charge.

South Africa is fast approaching a critical stage in meeting the challenge of catering for alarming increases in population (and attendant development) along the coast while maintaining conservation objectives.

The recent lifting of influx control measures has highlighted this problem, especially in the Natal area and along the False Bay coastline.

More and more agencies are also looking at the marine disposal option for discharging the domestic and industrial effluents that result from increased coastal development, not only because of the often limited space available for treatment of these effluents on land but also because of the economic attractions of a marine discharge system.

At present, marine disposal practices in South Africa vary widely, from surf zone discharges of raw municipal sewage or industrial effluents to discharges of effluent through well designed offshore pipelines, fitted with hydraulically efficient diffusers operating in water depths of more than 20 metres.

Because of stricter control practices imposed by the controlling authority, the Department of Water Affairs, attention has recently been given to the construction of more efficient marine disposal systems. The water quality aspects of the present discharges of effluent into the marine environment and their compliance with the water quality criteria laid down in the permit specifications are closely scrutinized. Fu-

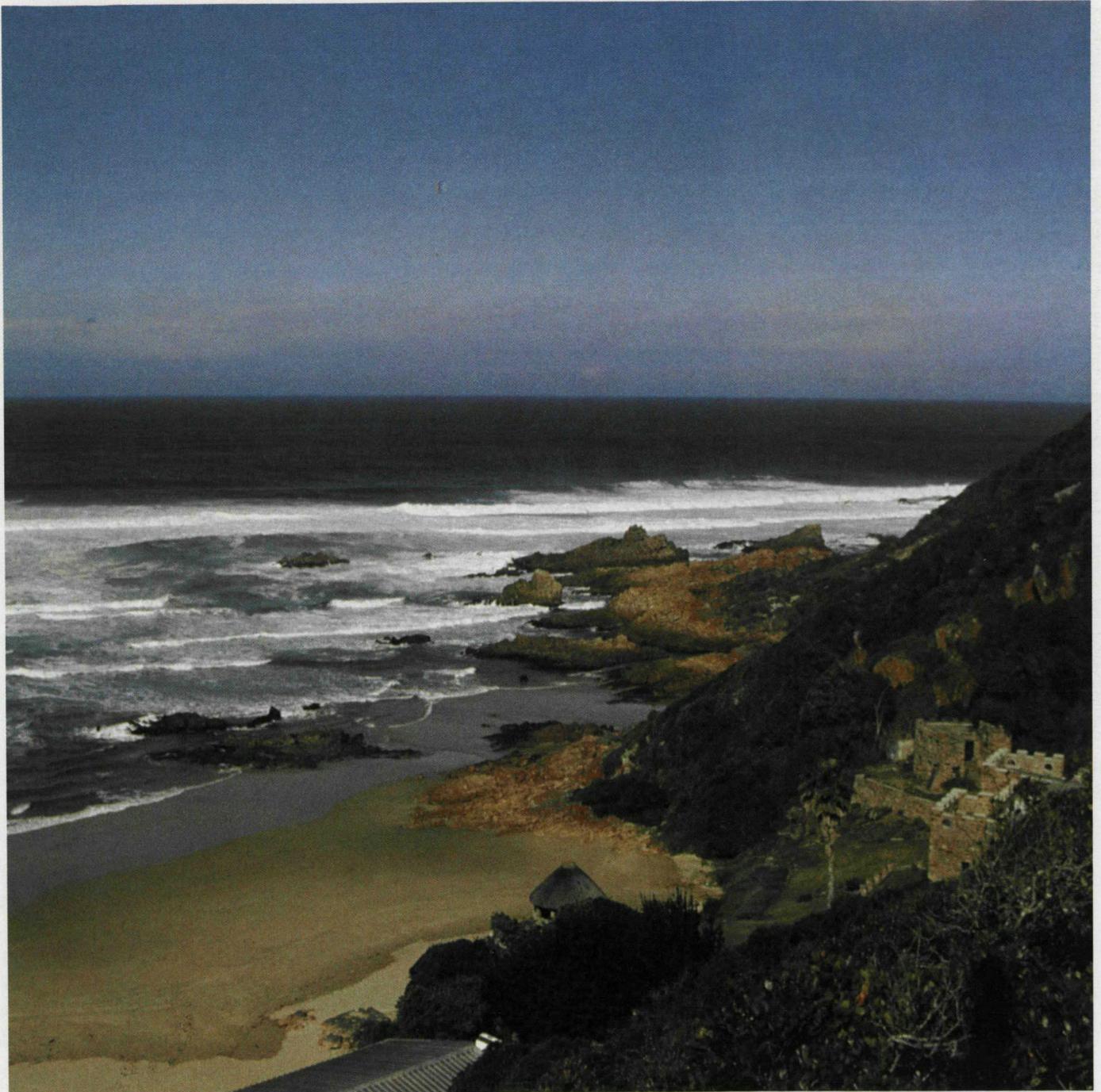
ture dischargers (if not present dischargers) will certainly be forced more and more to adopt the best possible design approach in order to comply with these water quality criteria. This was emphasized in the recent publication on specific water quality criteria for marine discharges, edited by Dr JA Lusher of the Department of Water Affairs (1984).

The compilation of a Guide for Marine Disposal of Effluents through Pipelines, by the CSIR on behalf of the Water Research Commission (1988), will provide further assistance to planners and designers.

Against this background the Water Research Commission commissioned the CSIR to compile a further publication to document technical details of and operation procedures for existing marine outfalls by way of a supplement to the above Guide. Information on negative as well as positive aspects gained of pipelines operating in South Africa at present with regard to port design, pre-treatment of effluent prior to discharge, scaling, clogging cleaning etc has been collected.

The aim of this report is therefore to document this information in such a way that prospective dischargers (i.e. planners, municipalities, consulting engineers etc) can review existing operating practices to ensure that safe and judicious design and operating procedures are adopted in future and avoid repetition of problems experienced in the past.

A marine discharge is defined as: Any discharge directly into the sea below low-water level by means of a pipeline.



“Safe and judicious design and operating procedures for marine disposal must be adopted in future to avoid repetition of problems experienced in the past.”

This review therefore does not include:

- discharges into estuaries, rivers etc.
- discharges through pipelines that release effluent onto the beach or onto a rocky foreshore, or through pipelines that release effluent above high water level.
- discharges through an open furrow or canal.
- stormwater discharges.

LOCATION OF PIPELINES

In South Africa, the Minister of Water Affairs issues permits for the discharge of effluent to the marine environment.

There are only 33 dischargers releasing effluent into the marine environment that fall within the definition mentioned above. Only 12 of these are outfall systems that release effluent beyond the surf zone.

WASTE WATER

The number of offshore and surf zone pipelines according to the location of the pipeline and the operating agency

LOCATION		OPERATING AGENCY				
		Municipality	Industry	Fish-proces.	Other*	Total
Natal	- offshore	2	3	-	2	7
	- surf zone	3	3	-	1	7
Eastern Cape	- offshore	1	-	-	-	1
	- surf zone	3	-	-	1	4
Cape	- offshore	2	2	-	-	4
	- surf zone	1	3	2	1	7
Western Cape	- offshore	-	-	-	-	-
	- surf zone	-	-	3	-	3
Total	- offshore	5	5	-	2	12
	- surf zone	7	6	5	3	21

* In Natal 2 offshore pipelines are operated by the Mhlatuze Water Board in Richards Bay and a surf zone one by the South African Police holiday resort in Port Edward. In the Eastern Cape the Department of Environment Affairs operates a surf zone pipeline in East London and one surf zone pipeline is operated in the Cape by the Western Cape Regional Services Council in Llandudno.

According to this table the offshore pipelines, which represent only 35 per cent of the outfalls studied in this survey, are discharging 589 700 m³/day or 86 per cent of the total discharge rate. In actual fact there are only 3 dischargers that release more than 10 000 m³/day that do not discharge beyond the surf zone (2 fish-processing factories and 1 municipality). The table also shows that Natal has the biggest discharge by far, namely 73 per cent.

The Western Cape coast is only a minor contributor to the total discharge volume in the above table because most of the pipelines there either discharge onto the beach or above high water level and as such were not included in the report. Relatively low population densities along the Western Cape coastline and the absence of a strong coastal current are the reasons for this.

Fish processing factories that operate marine discharges in the context of this report are exclusively located along the Cape and Western Cape coasts. The

various types of fish processing that takes place at the factories (processing of fish into fishmeal, oils, canned products etc) obviously generate different types of effluent. However, the effluents always have a high organic content and typically consists of a mixture of sea-water, blood water, scum, oil, etc. The fishmeal and cannery factories produce effluent throughout the year, while processing factories for abalone, rock lobster, snoek etc are in operation for certain months of the year only. The effluent quantity varies enormously depending on the type of processing but can be surprisingly high, up to 18 000 m³/day. Pretreatment of the effluent prior to discharge generally consists of screening and settling tanks. The effluent from fish processing factories amounts to 6 per cent of the total marine discharge rate of 686 900 m³/day.

Municipal sewage constitutes 44 per cent of the total discharge rate. Municipal discharges vary from macerated raw sewage and septic tank overflow to almost fully

treated sewage. Fortunately the practice of discharging almost raw sewage in the surf zone occurs in only a few cases, in all of which the discharge is being upgraded. Generally some type of treatment is carried out on the effluent. The presence of bathing beaches or shellfish collection areas in the vicinity are important factors to be taken into account.

The greatest variation is to be found in the type and quality of industrial effluents. The general practice is that no extensive pretreatment is carried out on industrial effluents. Pretreatment consists mainly of the settling of solids in settling dams and of screening prior to discharge. Because of strict control, public pressure and the more toxic nature of the industrial effluents, discharge of these effluents takes place in most cases through long sea outfalls. The total industrial effluent discharge rate constitutes the major part of the total discharge rate, namely 50 per cent, therefore it is slightly higher than the municipal discharge rate.

WASTE WATER

PIPELINE DISCHARGES

The pipeline discharges can be conveniently categorized into three types:

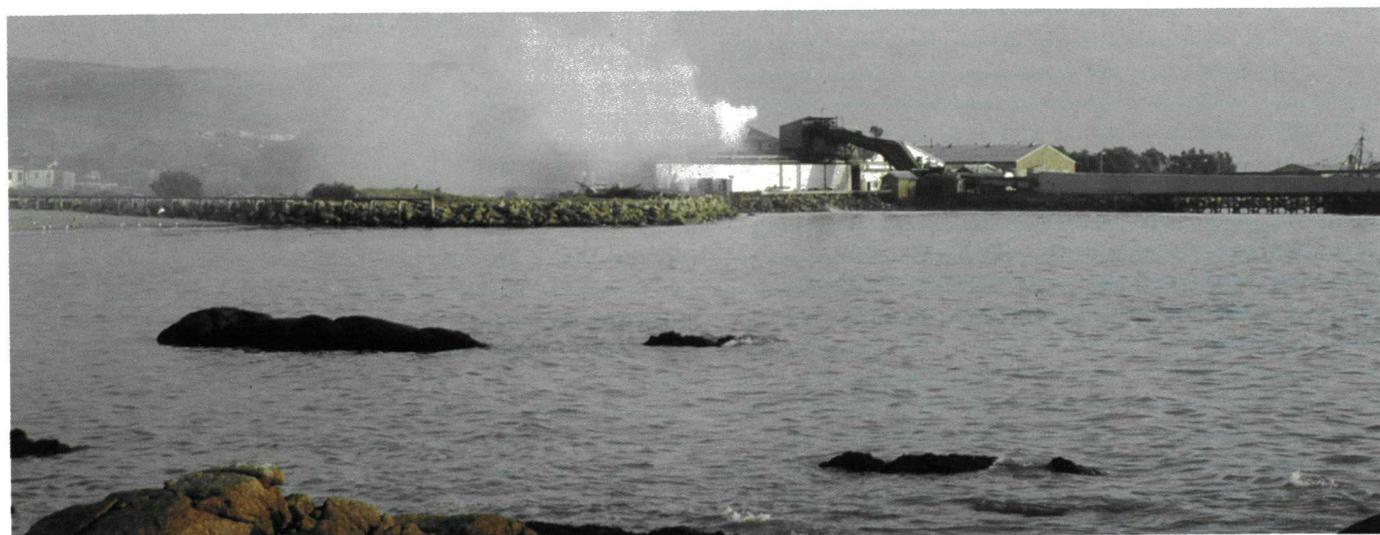
- municipal sewage
- industrial effluents
- discharges from fish processing

Discharge quantities according to the location of the pipeline and type of discharge in m³/day

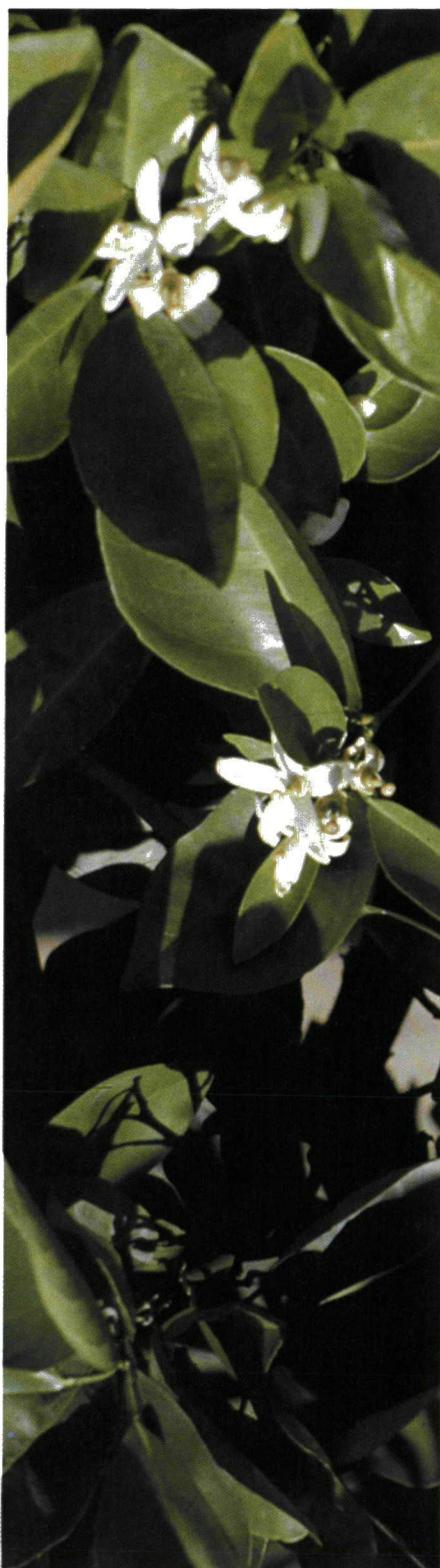
LOCATION		DISCHARGE TYPE				
		Municipal	Industrial	Fish-proc.	Total	%
Natal	- offshore	175 000	315 900	0	490 900	71
	- surf zone	2 100	12 000	0	14 100	2
Eastern Cape	- offshore	60 000	0	0	60 000	9
	- surf zone	32 000	4 800	0	36 800	5
Cape	- offshore	35 800	3 000	0	38 800	6
	- surf zone	1 400	3 000	22 100	26 500	4
Western Cape	- offshore	0	0	0	0	0
	- surf zone	0	0	19 800	19 800	3
Total	- offshore	270 800	318 900	0	589 700	86
	- surf zone	35 500	19 800	41 900	97 200	14
Grand total		306 300	338 700	41 900	686 900	100

Note that in the case of the Richards Bay, Durban and East London pipelines, the discharge quantities are split up into municipal and industrial components.

The total volume discharged through the 33 pipelines is 686 900 m³/day or 8.0 m³/sec. By way of comparison, the average flow of the Orange River is 238 m³/sec, that of the Umgeni River 19 m³/sec and that of the Berg River 9.5 m³/sec.



Irrigation scheduling of citrus: research results



A world congress on citrus research was held in Tel Aviv, Israel, last year. This symposium is held every four years under the auspices of the International Society for Citriculture.

At the symposium, Dr Sarel du Plessis from the Citrus and Subtropical Fruit Research Institute at Nelspruit, delivered a paper on the irrigation scheduling of citrus. The paper was based on research done at the Sunday's River Agricultural Research Station, Addo.

Irrigation scheduling by means of lysimeter water usage, crop factors and tensiometers were evaluated in a field trial. Since a good knowledge of evapotranspiration is essential for irrigation scheduling, this investigation was undertaken to compare evapotranspiration values obtained by means of a weighing lysimeter to the actual water use under field conditions.

METHOD

Lysimeter experiment

The lysimeters were situated in a Valencia orchard (old clones on rough lemon rootstocks) with a planting distance of 6,1 x 6,1 m. The trees were planted in 1963. Each lysimeter had a surface area of 13,4 m² and contained 50 tons of soil. Evapotranspiration (Et) data for five consecutive seasons were determined in this investigation. Et was measured on a daily basis and expressed as mm/tree/day (monthly averages). A water depletion of 75 mm (1000 l/lysimeter) was allowed between irrigations.

Field experiment

A nearby orchard planted in 1961 with Olinda Valencias on rough lemon rootstocks with a planting distance of 5,8 x 6,7 m was used for this investigation. The treatments used are shown in Table 1. Five treatments replicated 4 times with 3 trees per plot were used. Two micro jets per tree were used giving a wetted area of 19,75 m² per tree. Treatments 1 to 3 were irrigated when 600 l of water had been used according to the lysimeter. Treatment 4 used crop factors varying monthly as shown in Figure 3. For treatment 5 tensiometers were used at depths of 30 and 60 cm.

Water was applied when a soil moisture potential of -50 kPa was approached in the top soil and/or -30 kPa in the subsoil. To replenish the available water in the top soil to field capacity (-10 kPa) 690 l per tree was applied. Water applied was measured for each treatment. Yield and fruit size distribution were determined annually, while fruit growth measurements (mean diameter of 50 marked fruit per treatment) were done bi-weekly from January to July for the

TABLE 1 Treatments: Field experiment (wetted area 19,75 m²/tree)

Scheduling by means of	Irrigate when:	Amount applied (l/tree)
1. Lysimeter	600 l used	900
2. Lysimeter	600 l used	450
3. Lysimeter	600 l used	675
4. Evaporation pan	50 mm needed	990
5. Tensiometers	-50 kPa	690

1985/86 season. Weather data was obtained from a weather station located about 200 m from the lysimeter and field trial.

Crop factor (f)

The crop factor was calculated on a monthly basis from long term class A pan evaporation (E_o) data and 5 years' evapotranspiration (E_t) data as follows:



$$f = \frac{E_t}{E_o}$$

where E_t = average monthly water use in mm/day obtained from the lysimeter as follows:

$$E_t = \frac{w}{13,4}$$

where w = lysimeter water use in liter/day and 13,4 is the surface area of the lysimeter in m^2 .

RESULTS

Lysimeter data

Figure 1 illustrates the long-term class A pan evaporation (E_o) for the Addo area and five year mean water use (w) pattern for a fully grown lysimeter tree, induced onto the fruit development stages as weeks after full bloom, for the 1985/86 season. From this figure it follows that maximum water use occurred during phase I of the cell enlargement stage i.e. from about 14 to 28 weeks, after full bloom. Peak evaporation occurred a few weeks earlier, from 10 to 22 weeks after full bloom. From these results crop factors (f) have been calculated as described.

Figure 2 shows the average f values on a monthly basis over an entire season. The maximum and minimum lines demonstrate the variation between seasons for the same month over the 5 year period of the study. This variation can be as high as 0,4, illustrating the limited value of the crop factor concept for scheduling citrus trees.

Relationship between water use (w) and crop factor (f)

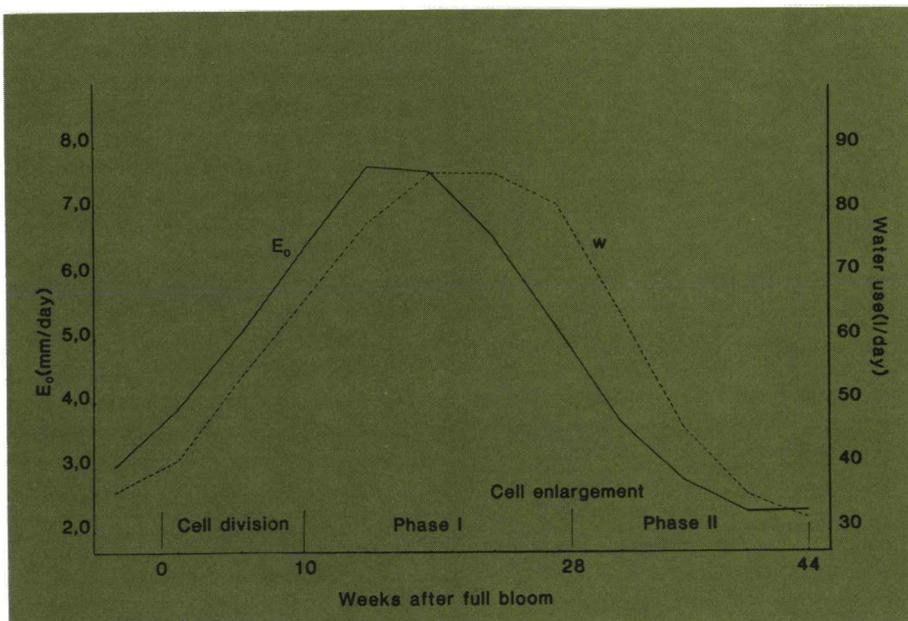
Figure 3 demonstrates the difference existing between water use of mature trees and the crop factor, with f reaching a maximum in autumn and w in mid summer. This can be expected since f is dependent on both w and E_o , which are also out of phase (see

Figure 1). Therefore, the highest f does not necessarily correspond with the period of maximum atmospheric demand.

Variation in crop factor f for different areas

From the previous discussion it follows that f will differ between different areas, depending mainly on E_o for a particular area. Assuming that w will remain fairly constant between areas the f values for three different areas have been calculated. A comparison of some climatic data between the three areas is given in Table 2.

From Fig 4 it follows that f differs largely between these areas, reaching a relatively



Variation in crop factor

Fig 1
Relationship between class A pan evaporation (E_o) and water use (w) of mature citrus trees as related to fruit development from full bloom to yield.

low value in summer for Citrusdal which is a winter rainfall area, as compared to the high values for Nelspruit, a summer rainfall area, with relatively low E_o values in summer (Table 2).

Comparing fruit growth rate and water use

A very close relationship ($r = 0,96$) was found between the fruit growth rate (diam. in mm/month) and the water used (liters/day) for the period January to July. Both decreased from a high in January to a low in July.

TABLE 2: Comparison of some climatic data between the three different areas.

Area	E_o in January (mm)	Average Maximum temperature (°C)	
		January	June
Nelspruit	6,4	29,1	23,2
Marble Hall	8,0	32,3	22,5
Citrusdal	12,4	32,3	19,4

treatment five was 5911 m³/ha. Rainfall amounted to 1670 m³/ha and if 50 per cent can be taken as effective, the total volume of water used amounted to 6750 m³/ha/year to produce 53,7 tons of fruit. The lysimeter tree used 23,4 m³/year or 6014 m³/ha extrapolated to the same planting density mentioned above, for this season. The field trees, therefore, used about 12 per cent more water with tensiometer scheduling, than the lysimeter tree. This can be attributed to the larger wetted area in the field trial (19,75 m² as compared to the lysimeter 13,4 m²) resulting in more surface evaporation.

Dr Sarel du Plessis from the Citrus and Subtropical Fruit Research Institute at Nelspruit.

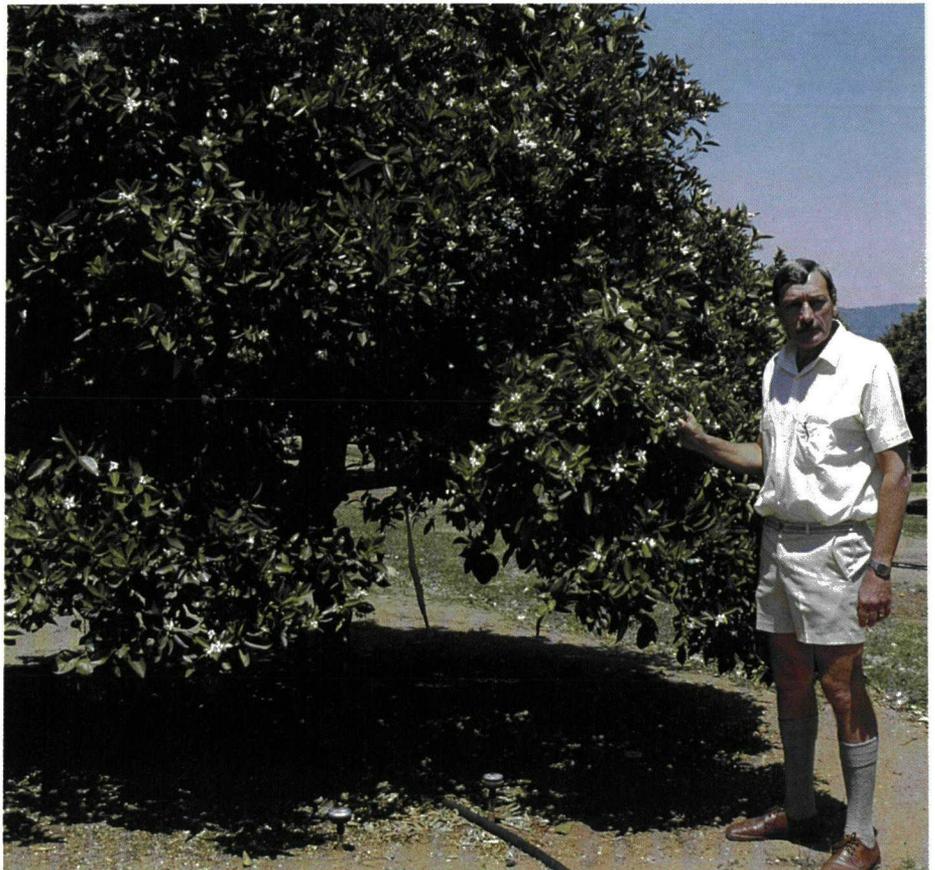
Field data

The treatments for the field experiment are shown in Table 1 and the results in Table 3.

The highest yield was obtained with treatment five (tensiometer scheduling) although this was not significantly better than three and four. The poorest yield and fruit size were obtained from treatment two, which also received the least amount of water. Scheduling by means of a varying crop factor (treatment four) gave results similar to treatment five and one, but much more water was used than for treatment five.

Treatment five gave the highest net income and received a relatively small amount of water (23 m³/tree/season). Therefore, by using tensiometer scheduling instead of an evaporation pan almost 8 m³ of water per tree or 2000 m³/ha/year could be saved, together with a slight improvement in net income. This corresponds with the data shown in Figure 2 that the crop factor can vary a lot between seasons and that over (or under) irrigation will be the rule rather than the exception.

With a planting density of 257 trees/ha (5,8 x 6,7 m) the volume of water applied with



IRRIGATION

TABLE 3: Treatment effects# on yield, fruit size and net income per tree for the 1986/87 season (rainfall 329 mm or 6,5 m³/tree).

Treatment	Yield (kg/tree)	Fruit size (>63 mm diam.)	Net income	Water applied	
			Rc	m ³	%
1*	166 bc	147 a	42,10	34,6	151
2	143 c	97 b	26,66	17,7	77
3	195 ab	182 a	51,36	26,4	115
4	179 abc	161 a	45,77	30,7	133
5	209 a	175 a	56,45	23,0	100

#Values between treatments followed by the same letter do not differ significantly at P 0,05 according to Duncan's multiple range test.

* The lysimeter tree used 23,4 m³ during this season (rainfall included).

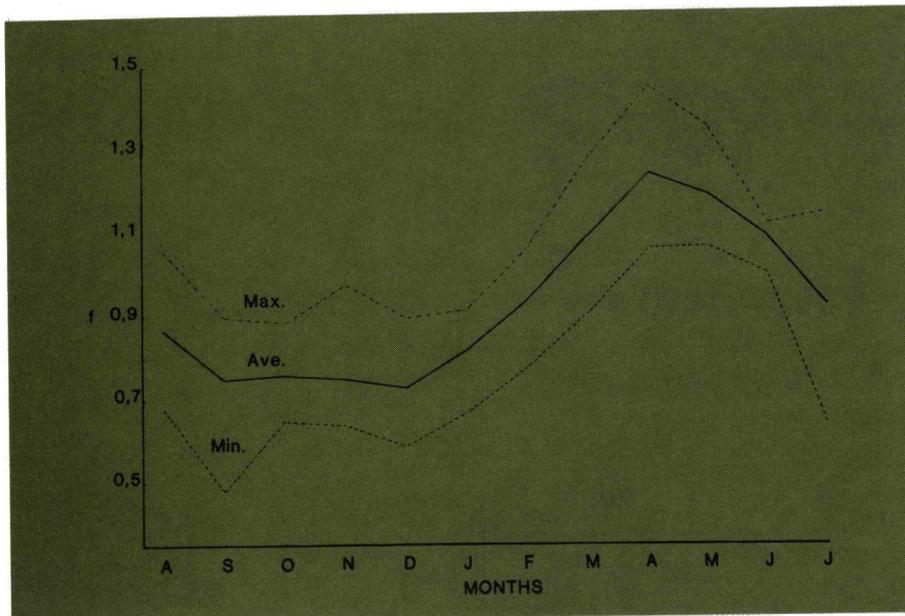
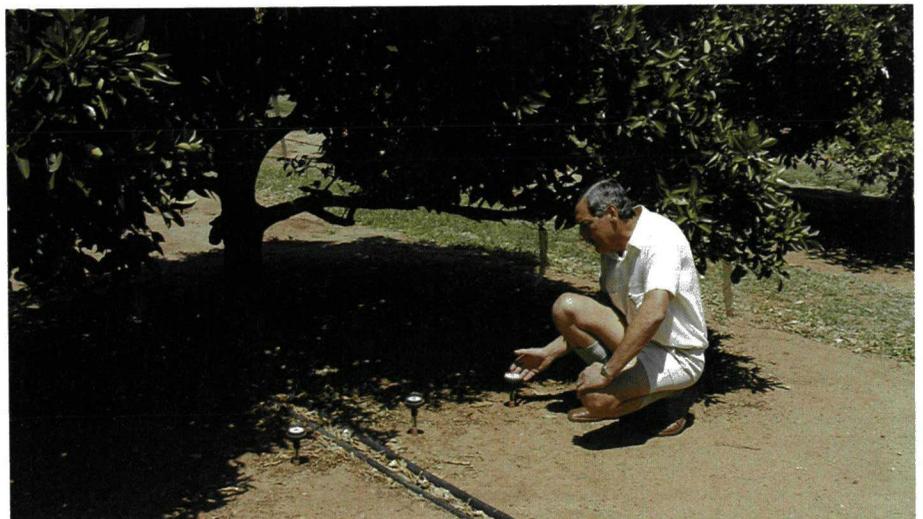


Fig 2 Monthly and seasonal variation in the crop factor over a period of 5 seasons.

The field experiment showed that by using tensiometer scheduling, almost 8m³ of water per tree per year could be saved.



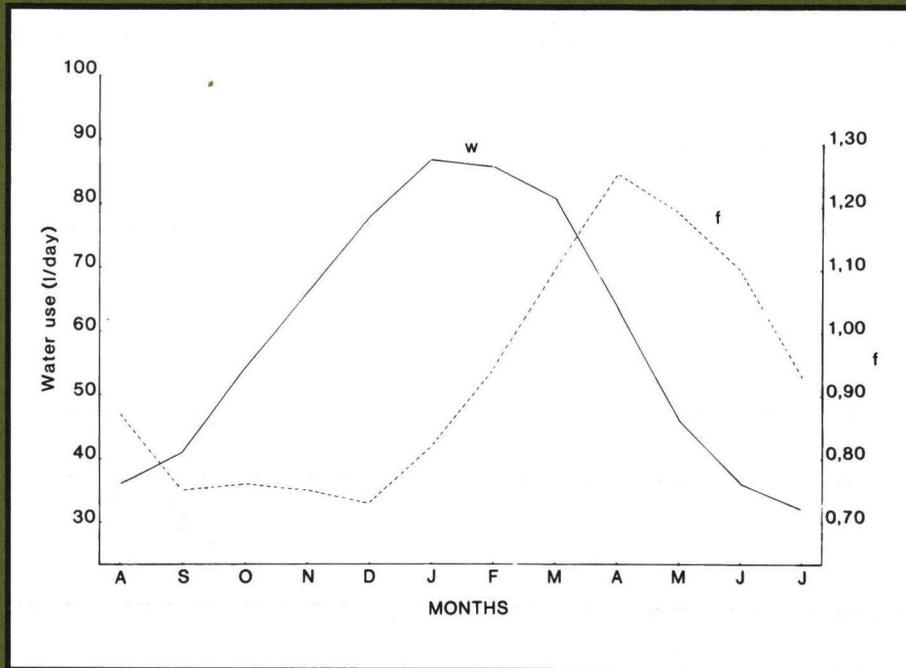


Fig 3 Relationship between average monthly water use (w) and crop factor (f) for the Addo area.

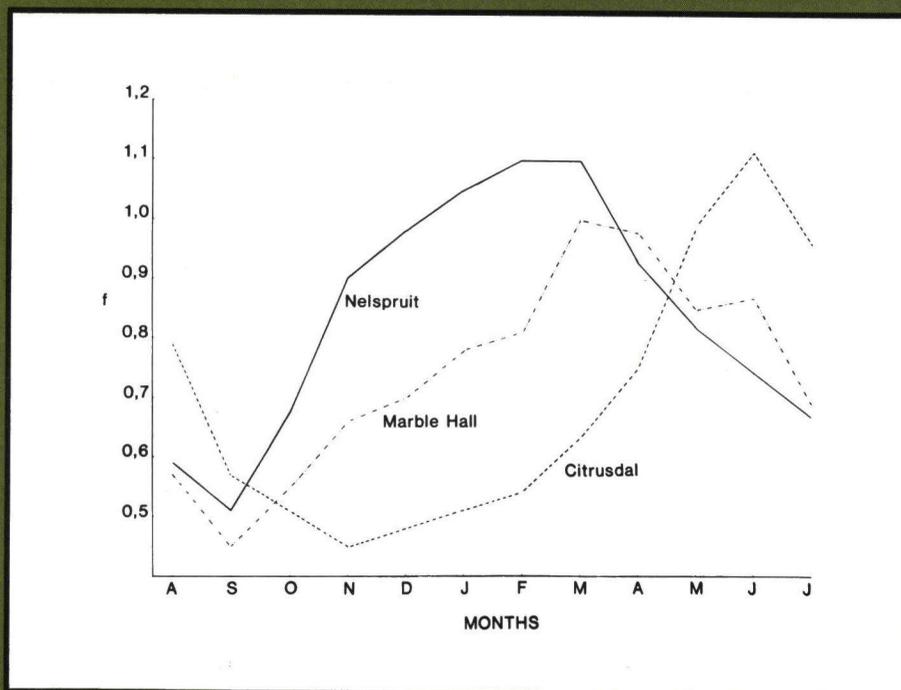


Fig 4 Crop factors (f) for mature citrus trees in different areas for different months (wetting area of 18 m²/tree).



WORKSHOP ON DOLOMITIC GROUND WATER OF THE PWV AREA

PROCEEDINGS: Seminar organised by the Ground Water Division of the Geological Society of South Africa, March 1988.

The Workshop served as a professional forum where information related to all aspects of the exploration for, and the evaluation, development and management of, dolomitic aquifers in the PWV area as sources of ground water for use as augmentative emergency urban water supply was presented, reviewed and discussed.

The proceedings contains all 21 papers presented at the workshop. These papers discuss such aspects as geohydrological considerations, development constraints, engineering feasibility, design and management criteria, and as such present new and added insights into the complexities involved in recovering ground water from the dolomite aquifer on a large scale.

1988 144 pages

Price R30,00 (inclusive of postage and packaging)

Available from Mr Bill Orpen, Directorate of Geohydrology, Department of Water Affairs, Private Bag X313, PRETORIA 0001, Tel No: (012) 299-2689.

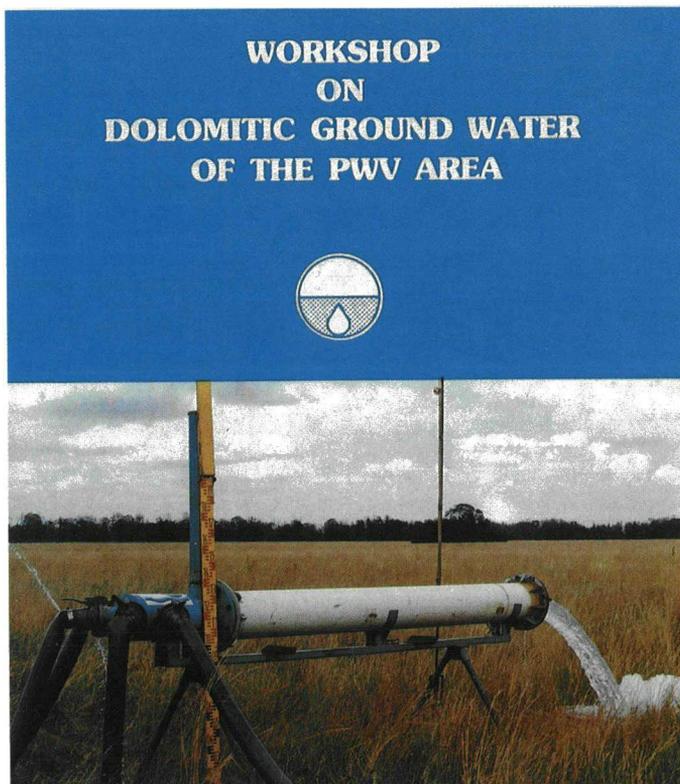
THE ATMOSPHERE AND WEATHER OF SOUTHERN AFRICA

by

RA Preston-Whyte and PD Tyson

A definitive text on the Southern African atmosphere and weather.

The atmosphere and weather of Southern Africa can be used by university students from first to final year. It applies to many disciplines including geography, meteorology, oceanography, environmental sciences and biology.



Because, traditionally, textbooks on climatology and meteorology have been written for students in the northern hemisphere, students in southern Africa have experienced enormous difficulty in adapting concepts and illustrations to suit the situation. In this textbook almost every example of a concept or phenomenon is drawn from southern Africa. Some of the many topics considered are Berg wind dust plumes, inversion layers over the Transvaal, cut-off lows over the Karoo, the latest ideas on the life-cycle of a depression to the south of Cape Town, thunderstorm models for the Highveld, local and regional winds over Natal, urban heat islands and numerical weather prediction. It also includes a much-needed chapter on the tephigram.

384 pages

Price R34 + GST

ISBN 0 19570 496 7

Available from Oxford University Press, Book Marketing Services, P O Box 10105, Caledon Square 7905.

AIRBORNE REMOTE SENSING IN WATER RESEARCH

This report results from a contract awarded by the Water Research Commission to the Division of Earth, Marine and Atmospheric Science and Technology (formerly the National Physical Research Laboratory (NPRL) of the CSIR, to perform a feasibility study and make recommendations on the utility of airborne Remote Sensing data, the most suitable techniques and necessary instrumentation, for the future programmes of water research in South Africa.

In order to keep the scope of the report within limits, those techniques which are well established and about which local expertise is generally available are not elaborated upon. In these cases emphasis is placed on the principles involved and possible pitfalls which may be encountered in setting up a research programme, based on the experience of the authors or persons they consulted.

Those aspects where local expertise is either lacking or available but probably not generally known, are discussed in more detail. Also recent technological advances are highlighted where they could influence the state-of-the-art within the near future.

As the remote determination of soil moisture is a particularly important requirement to water research, special attention is given to the very promising passive and active microwave techniques. Further motivation for elaborating on these techniques is provided by the fact that local expertise in this field is sadly lacking. One of the authors attended a Specialist Meeting on Microwave Radiometry and Remote Sensing Applications which was held in Florence, Italy, 9 to 11 March 1988. Information on the latest developments as discussed at the meeting is included in this report. A technical meeting in Edinburgh in September 1988 provides further opportunity to a South African delegate to obtain information on latest developments in this field.

1988 36 pages

Price: Free of charge

Available on request from the Water Research Commission, P O Box 824, Pretoria 0001. Telephone (012) 33-00340. Telefax (012) 70- 5925.

ESTIMATING PROBABILITIES OF EXTREME FLOODS

by the

US National Research Council

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Navorsingsbestuurder aangestel



Dr TC Erasmus is by die water-navorsingskommissie aangestel as navorsingsbestuurder. Hy was voorheen verbonde aan die WNNR se Divisie vir Energietechnologie.

OFFRINGA BY WNK

Mnr Gerhard Offringa is aangestel as navorsingsbestuurder by die Waternavorsingskommissie. Hy sal verantwoordelik wees vir waterbehandelings-tegnologie en die biologiese aspekte van munisipale uitvloei-sels. Mnr Offringa was voorheen verbonde aan die Divisie vir Watertegnologie van



die WNNR, waar hy aanvanklik hoof van die projekgroep vir die behandeling van nywerheidswaters was en later, as programbestuurder: produkontwikkeling, watergerigte produkte vir die nywerheid ontwikkel het.

Mnr Offringa is 'n Transvaler gebore en getoe". Hy is op 10 Maart 1948 op Ermelo gebore. In 1971 verwerf hy 'n graad in Chemiese Ingenieurswese aan die Universiteit van Pretoria en in 1987 die hoonersgraad in Waterbenuttingsingenieurswese. Sy eerste pos as chemiese ingenieur by SASOL I in 1971 bring hom vir die eerste keer in aanraking met wateraangeleenthede in sy hoedanigheid as projekingenieur op die water, uitvloeisel en -stikstofareas van die fabriek. In 1973 sluit hy by die Uraanverrykingskorporasie aan waar hy eers verantwoordelik is vir die inbedryfstelling en later die bedryf van gedeeltes van die uraanverrykingsaanleg te Valindaba. In 1980 sluit hy by die WNNR aan, waar hy eers hiteruilers ontwerp by die destydse Navorsingsgroep vir Chemiese Ingenieurswese, maar in 1982 aansluit by die Nasionale Instituut vir Waternavorsing (nou Divisie vir Watertegnologie).

Mnr Offringa is getroud met Dirkie Craffort, 'n navorser in kunsgeskiedenis by die RGN. Sy stokperdjies sluit voëlfotografie, wyn en die ontwerp van opgelostelugflottasie-aanlêe in.

McGlashan resigns

Mr John McGlashan, previously Research Manager at the Water Research Commission (WRC) has been appointed Manager, Operations Research of the South African Co-operative Citrus Exchange Limited from 1 February 1989. He assumed this post with the Citrus Exchange after a period of twelve and a half years at the WRC. At the time of his resignation he was responsible for research financed by the WRC in the fields of waste water treatment, sewage sludge management and marine disposal of effluents.

John McGlashan, a civil engineer and graduate of the University of Pretoria and the University of London joined the WRC in 1976 as Project Development Officer and worked under the late Mr Alex Kinmont primarily in the water reticulation and water supply field. By 1980 he was instrumental in formulating a master plan of research for sewage sludge treatment and disposal, an area which had long been a problem area for local authorities. The master plan of research made provision, inter alia, for assessing the possibility of sludge disposal to sea and for establishing norms for such disposal. The successful demonstration of sea disposal has opened up this disposal route around the South African coastline and resulted in other studies being undertaken to



assess and safeguard the South African coastal environment. Other highlights from this research programme have been the successful demonstration and subsequent construction of a full-scale forced aeration sludge composting facility and a full-scale dual digestion sludge treatment plant.

His involvement in more recent years in the broader field of waste water treatment has seen the culmination of many years of WRC sponsored research into both chemical and biological removal of phosphates from effluents and into activated sludge bulking control.



PROJECT TO UPDATE SURFACE WATER RESOURCES INFORMATION FOR SOUTH AFRICA

The project team at Steffen, Robertson and Kirsten Inc extend thanks to all who took the time to complete the questionnaire on Surface Water Resources Information for SA. The response on the questionnaire was very encouraging.

In general, there was widespread support for a revised survey of water resources and some valuable suggestions for improvements were received. There were even pleas from neighbour countries for the survey to embrace their territories.

An analysis for the results was incorporated in the report submitted to the Water Research Commission on 25 November 1988. The report has been favourably received by the Commission and as a result a submission is to be prepared recommending work on the update to commence in 1990.



SPRINKELBESPROEING SE EFFEK OP GRONDTIPES BESTUDEER

Die Departement Bodemkunde aan die Potchefstroomse Universiteit is tans besig met 'n ondersoek om vas te stel hoe verskillende grondtipes reageer as water deur middel van sprinkelbesproeiing toegedien word.

Om te help met hierdie ondersoek, het die Departement Landbou-ingenieurswese aan die Universiteit van Pretoria, 'n prototipe besproeiingsimuleerder gebou wat sprinkelbesproeiingstelsels kan naboots en die infiltrasie-eienskappe van die grond kan bepaal. Dié simuleerder is nog net geskik vir laboratoriumondersoeke en sal die basis vorm vir 'n model wat besproeiingstelsels, soos dit in die veld gebruik word, sal kan evalueer. 67 verskillende grondsoorte vanoor die hele land word reeds by Potchefstroom getoets.

Dr DJ (Hoppie) Nel van die Departement Bodemkunde, Potchefstroom sê hulle poog om ontwerpkriteria saam te stel om voortaan vir boere of ontwerpers van besproeiingstelsels 'n spesifieke soort stelsel aan te beveel. Die hoek waarmee die water die grond tref, die druppelgrootte en die hoogte van die torings wat vir 'n sekere grondtipe geskik is, sal in aanmerking geneem word. Sodoende sal die wanbestuur van water en grond bekamp word. As water verkeerdelik toegedien word, veroorsaak dit korsvorming op die grondoppervlak wat lei tot:

- Vermorsing van water wat wegloop en verdamp.
- Gronderosie.
- Besoedeling van riviere en damme; en Swak oeste omdat die water nie die plantwortels bereik nie.

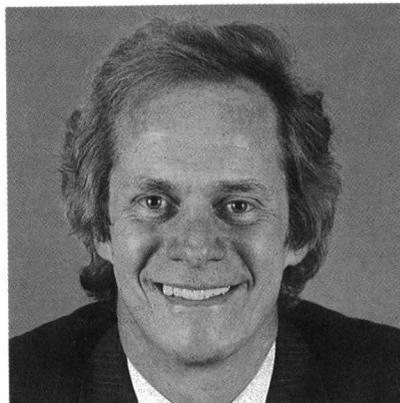


Dr Nel besig om die sterkte van 'n grondkors wat met die besproeiingsimuleerder gevorm is, te bepaal.

SA scientists attend NATO Institute



Prof RE Schulze from the University of Natal, Department of Agricultural Engineering, and Dr Denis Hughes of the Hydrological Research Institute at Rhodes University attended the two week long NATO Advanced Study Institute on "Recent Advances in the Modelling of Hydrologic Systems" in Sintra, Portugal, last year. In addition to both of them making presentations of their research work, Prof Schulze also co-presented a paper with Prof Doug James, Director of the Utah Water Research laboratory, USA, gave a computer demonstration of the ACRU Modelling System and chaired a session.



Van Leeuwen mede-professor

Dr Hans van Leeuwen is onlangs aangestel as mede-professor in Waterbenuttingsingenieurswese in die Departement Chemiese Ingenieurswese aan die Universiteit van Pretoria.

RIVIERMUGGIEPLAAG BESTRY

Boere langs die Vaalrivier stroom af van Vaaldam word die laaste tyd geteister deur 'n riviermuggieplaag wat tot groot veeverliese lei.

In die omgewing van Parys verloor boere tot 40 persent van hulle verskalwers as gevolg van die Simulium-muggie wat veral die sagte liggaamsdele van die kalwers infesteer.

Die Simulium-muggie lê sy eiers net onderkant die oppervlak van die water. Navorsing wat die afgelope paar jaar in die Benede-Oranjeriviergebied onderneem is, het getoon dat wisseling in die riviervloei een van die mees effektiewe metodes is om die muggieprobleem op te los. Wanneer die watervlak styg, versuip die larwes en papies, en wanneer die watervlak daal vrek hulle omdat hulle aan die son blootgestel word.

Die Departement van Waterwese probeer tans om so gereeld as moontlik water vanaf Vaaldam los te laat en terug te hou sodat die muggieplaag bestry kan word.



WASTE WATER

Seminars on Nutrient removal from wastewater streams, Design and operation of biological treatment plants and Industrial and hazardous waste treatment will be held from 20 to 22 March 1989 at the Mount Grace Country House Hotel near Magaliesburg, Transvaal.

Enquiries: Ms Monika Mersich, Conference Co-ordinators, CSIR, P O Box 395, Pretoria 0001. Tel: (012) 841-4615.

COMPUTERS

A conference on computers and automation in the water industry will be held from 2 to 4 April 1989 in Denver, USA.

Enquiries: Rick Harmon, AWWA, 6666 West Quincy Avenue, Denver, CO 80235, USA.

BIOFILMS

A symposium on the technological advances in biofilm reactors will be held from 4 to 6 April 1989 in Nice, France.

Enquiries: Mr J Bernard, AGHTM, 9 Rue de Phalsbourg, 75854 Paris Cedex 17, France.

GROUNDWATER

A symposium on contaminant transport in groundwater will be held from 4 to 6 April 1989 in Stuttgart, West Germany.

Enquiries: Dr W Kinzelbach, Institut für Wasserbau, Universität, Stuttgart, Pfaffenwaldring 61, D-7000 Stuttgart 80, West Germany.

ULTRAVIOLET

The 2nd International Conference on UV and Ozone in the treatment of water and other liquids will be held in Berlin FRG from 10 to 12 April 1989.

Enquiries: AMK Berlin, M2/Wasser Berlin, Postfach 191740, D-1000 Berlin 19, FRG.

CATCHMENT RUNOFF

An international conference on channel flow and catchment runoff: Centennial of Manning's formula and Kuichling's rational formula will be held from 22 to 26 May 1989 in Charlottesville, Virginia, USA.

Enquiries: Dr BC Yen, Civil Engineering Department, University of Virginia, Thornton Hall, Charlottesville, VA 22901, USA.

MEMBRANES

An international technical conference on membrane separation processes will be

held in Brighton, England, from 24 to 26 May 1989.

Enquiries: Lorraine Grove, Conference Organiser, Membrane Separation, BHRA, The Fluid Engineering Centre, Cranfield, Bedford MK 43 OA, UK.

OZONE

The 9th ozone world congress will be held in New York, USA, from 3 to 8 June 1989.

Enquiries: 9th Ozone World Congress Organiser, International Ozone Association PAC, 83 Oakwood Avenue, Norwalk, CT 06850 USA.

WATER QUALITY

An international conference on the design of water quality information systems will be held at the Colorado State University, USA, from 7 to 9 June 1989. Call for papers.

Enquiries: Thomas G Sanders, Program leader, Environmental Engineering, Department of Civil Engineering, Colorado State University, Fort Collins, CO 80523

MONITORING NETWORKS

A short course on the "Design of water quality monitoring networks" will be held from 12 to 16 June 1989 at Colorado State University, Fort Collins, Colorado.

Enquiries: TG Sanders, Environmental Engineering, Department of Civil Engineering, Colorado State University, Fort Collins, CO 80523.

COAL MINING

A symposium on the treatment and management of wastewaters industry will be held from 15 to 19 June 1989 in Warsaw.

Enquiries: Dr M Gromiec, Institute of Meteorology and Water Management, Uli-Podlesna 61, 01-673 Warsaw, Poland.

WASTEWATER PLANTS

A symposium on the design and operation of small wastewater treatment plants will be held from 26 to 29 June 1989 in Trondheim, Norway.

Enquiries: Dr P Odegaard, Institute for Vassbygging, UNIT/NTH Klæbuveien 153, N-7034 Trondheim-NTH, Norway.

SAGIS

The Southern African Geographic Information Systems conference and workshop will be held at the University of Natal, Pietermaritzburg, from 3 to 6 July 1989.

Enquiries: Dr RJ Fincham, Institute of National Resources, P O Box 375, Pietermaritzburg 3200.

WATER LAW

A mini-symposium on water: laws and management, will be held on 7 July 1989 at the University of Cape Town.

Enquiries: Dr JA Thornton, Town Planning Branch, P O Box 1694, Cape Town 8000.

RIVER BASINS

The 5th river basin management conference will be held in Rovaniemi, Finland, from 31 July to 4 August 1989.

Enquiries: The Secretary, Ms Anja Holmsten, P O Box 250, SF-00101 Helsinki, Finland.

GROUNDWATER

Groundwater '89, the 5th biennial symposium of the Ground Water Division of the Geological Society of South Africa will be held from 31 July to 5 August 1989 in Johannesburg. The theme will be "Groundwater and mining".

Enquiries: The Symposium Secretary, Groundwater '89, P O Box 8856, Johannesburg 2000.

WASTEWATER TREATMENT

A symposium will be held in Munich, FRG, in August/September 1989.

Enquiries: Dr C-H Plumer, EWPCA, Markt 71, D-5205 Sankt Augustin 1, Federal Republic of Germany.

DRAINAGE

The 28th international post-graduate course on land drainage will be held from 20 August to 1 December 1989 in Wageningen, the Netherlands.

Enquiries: The Director of the International Agricultural Centre, P O Box 88, 6700 AB Wageningen, the Netherlands.

ACID RAIN

A symposium will be held from 5 to 7 September 1989 in Amsterdam, Holland.

Enquiries: Prof R Perry, Public Health and Water Resources Engineering, Department of Civil Engineering, Imperial College, London SW7 2 BU, UK.

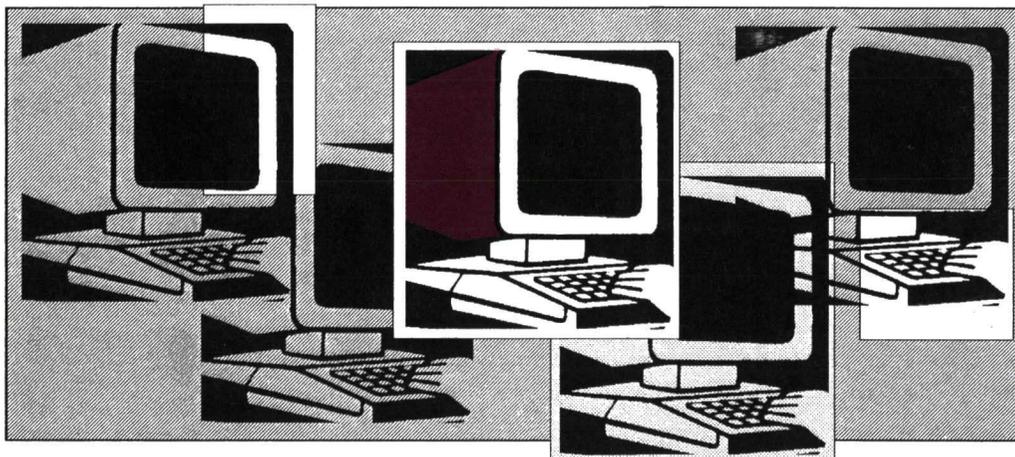
SANCIAHS

The 4th South African national hydrological symposium will be held in Pretoria from 20 to 22 November 1989. Enquiries: Mr S Kienzle, Department of Water Affairs, Hydrological Research Institute, Private Bag X313, Pretoria 0001. Tel: (012) 821100 x 207.

C·C·W·R

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- Provide the opportunity to conduct joint computer based research with colleagues at other institutions around the country
- The CCWR also provides research results, information and data to scientific consultants on a variety of electronic media.
- A small handling fee is charged.

For further information contact the Computing Centre for Water Research, c/o University of Natal, P O Box 375, Pietermaritzburg, 3200. Telephone number (0331) 63-320 ext 177/178. Telex number 64-3292.



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SAIWA '89 Symposium

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The symposium will address problems associated with industrial water systems including clarification, water treatment, fouling and corrosion.

Titles and abstracts must reach the SAIWA committee before 15 April 1989

**SAIWA COMMITTEE
P O Box 6184
Alberton North 1456**

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