

S4 waterbulletin

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RAINFALL RESEARCH

Mechanisms causing wet and dry spells over Southern Africa investigated

BESPROEIJING

Twee nuwe rekenaarprogramme met WNK befondsing ontwikkel

RIVER RESEARCH

New technique could improve river discharge measurement

00020054



SANCIAHS/SAICE CONFERENCE '97



17 - 19 November 1997 ▼ Conference Centre ▼ University of Pretoria.

Theme

Integrated hydrological sciences for sustainable water resources management in Africa.

Objectives

The need to recognize the holism of the hydrological cycle and to achieve sustainable development of water resources through integrated management (quantity and quality, all water, the water environment, catchments etc.) have become key principles in the South African water law review. This poses major challenges to hydrologists in terms of a more integrated approach towards their science in research and application.

The Conference will focus on improved understanding of the hydrological cycle and the application of this understanding towards sustainable development of our limited water resources. Of particular interest will be:

- the hydrological regime in different geographical settings (understanding and quantification);
- geographical and spatial characterization of water resources;
- hydrological networks (design, adequacy, integration, results);

- methods of water resources assessment;
- approaches to deal with uncertainty and heterogeneity;
- integration of research and decision making;
- international river basins; information requirements.

We need to refocus our research and development on the range of knowledge and information requirements for sustainable development, eg. for:

- resource assessment at different scales;
- water allocation for competing uses;
- water use control;
- catchment management;
- community water supply;
- water resource protection;
- water resource enhancement;
- environmental impact assessment; and
- conjunctive use.

Water supply and sustainable development of scarce water resources are at the top of the political agenda of many African countries. It is essential that the hydrological sciences are focused on this need and that African countries share their expertise in this regard.

Organisers

The Eighth Biennial SANCIAHS Conference will be organized jointly by SANCIAHS and the Water Division of the South African Institute of Civil Engineers. Mr Hugo Maaren of SANCIAHS and Prof Faan van Vuuren of SAICE will be on the organising committee.

Conference format

The Conference will only have plenary sessions (no parallel sessions) to allow for integration across disciplinary fields. Presentation of posters will be strongly encouraged in order to cover the full spectrum of the hydrological sciences.

A series of courses will be run back to back with the Conference. Ideas are invited from SANCIAHS or SAICE members who would like to present a course.

A single key note address and about 40 papers will be presented during 2½ days (Monday - Wednesday morning).

Paper deadlines

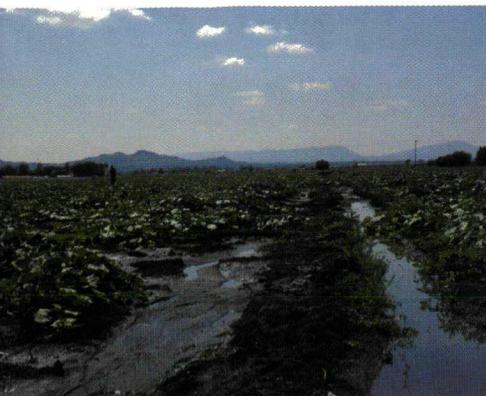
- Deadline for abstracts:
30 April 1997
- Final papers (in electronic format):
15 September 1997

Cost

- Registration fee:
Approximately R500.00
(excluding accommodation)

Enquiries to:

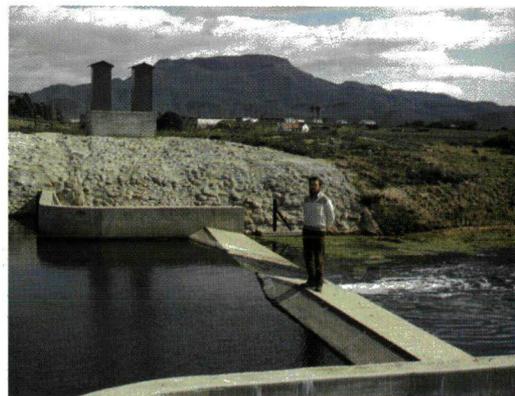
Ms Gerda Kruger or Mr Hugo Maaren
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p 12



p 16



p 22

Contents

WEERVOORSPELLING	6	Langtermyn reënvalvoorspellings in SA - tegnieke ondersoek
RAINFALL	8	Identifying the mechanisms that give rise to wet and dry spells over Southern Africa
WATER AND SANITATION	11	Overview presented of water supply to developing urban communities
IRRIGATION	12	New PC program could replace the "Green Book" in South Africa
RAINFALL	16	Development of a real-time rainfall mapping system for South Africa
IRRIGATION	18	Viability of irrigation farming investigated
RIVER RESEARCH	22	Calibrating sharp-crested and crump weirs
RIVER RESEARCH	24	Improved technique developed for measuring river discharge
FEATURES	4	Waterfront
	26	SANCIAHS News
	27	News Snippets
	29	Conferences and Symposia

Cover: Mountain stream in Kogelberg (Dr. William Harding)

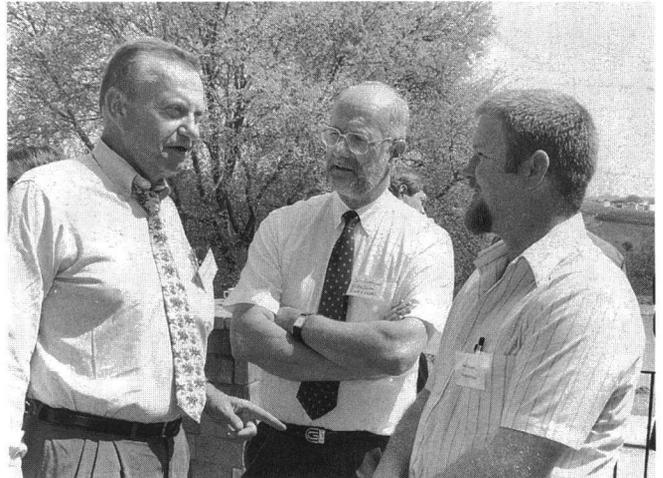
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WRC and US wastewater expert team up to transfer technology

The Water Research Commission in co-sponsorship with the American Citizen Ambassador program recently held a one-day technology transfer seminar on activated sludge treatment of industrial wastewaters. The course was presented by the well-known Professor Wesley Eckenfelder, one of the worlds foremost authorities on waste water treatment. Over a hundred delegates from all over South Africa attended the seminar.



Participants in the US Citizen Ambassador Program: Dr Nirimala N Khandan from New Mexico State University (USA), Mr Rex W Murphy, Construction Manager and Inspector (USA) and Mr Rodney T Williams, Engineer : CMPS & F Environmental (Australia).



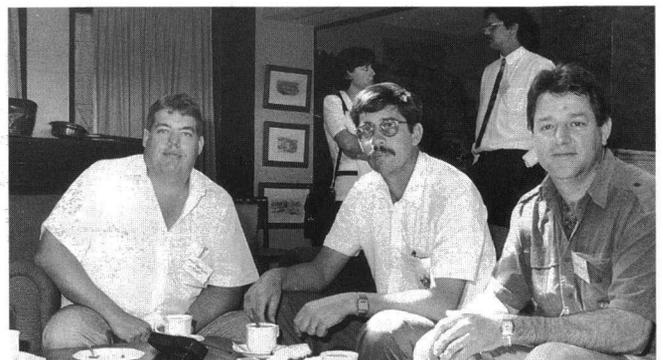
Professor Wesley Eckenfelder in conversation with Mr Paul Gaydon (Umgeni Water) and Mr Colin Appleyard (Eckenfelder Black & Veatch, USA).



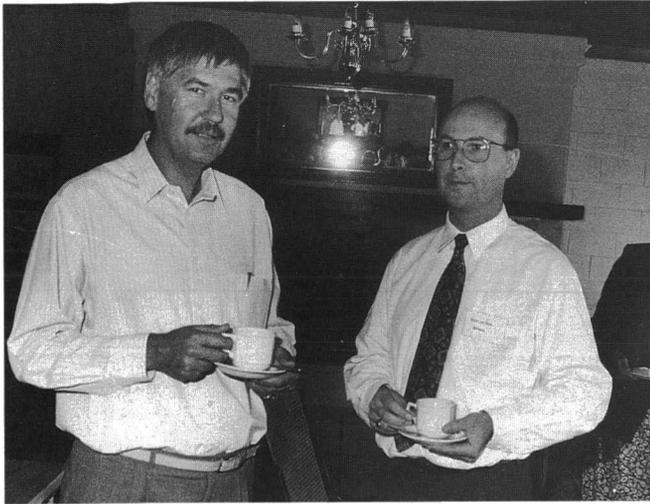
Professor Eckenfelder explaining the principal wastewater quality determinants to delegates.



Dr Steve Mitchell(WRC) opening the seminar, and Professor Eckenfelder in the back.



Mr Eddie Deetlefs (ERWAT), Mr Pierre Smit and Mr Albert van Vuuren (both from the CSIR).

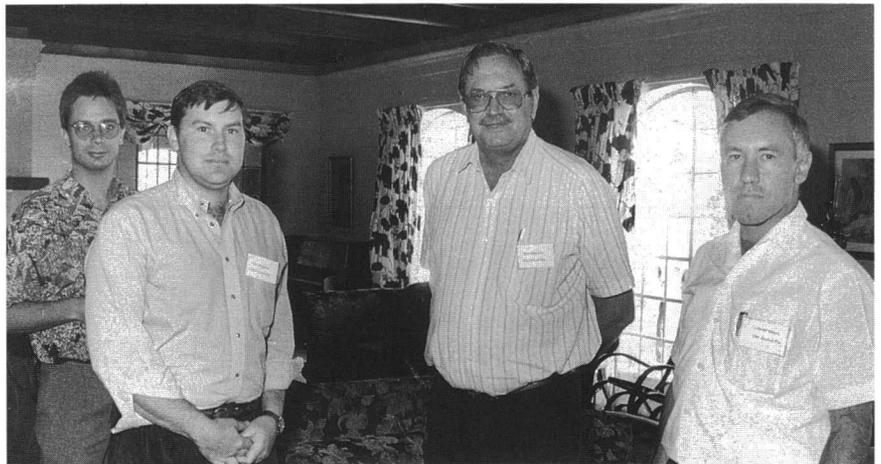


Above: Mr Roney Hoffmann (BN Kirk Inc) and Mr Sarel van der Walt (Biwater).



Above: Me Ronel Augustyn and Mr Peter Wille (both from SASTECH) with Mr Gideon de Villiers (Biwater).

Right: Mr Stephen van der Merwe, Mr Tom Houghton, Mr Gert Saayman and Mr Derek Wilson, all from the City Council of Pretoria.



Conference highlights French water technologies



The opening speakers at the French Water Technologies for Africa conference recently held in Midrand were (from left): Mr Jean-François Talec (French International Office for Water), Mr Boutellier (French Embassy in South Africa), Mr Mike Muller (Deputy Director-General, Department of Water Affairs and Forestry) and Mr Bernard Kaczmarek (French Ministry of the Environment). The Conference was organised by the French Embassy and ACTIM - a French government agency in charge of promoting technical and industrial cooperation between French and foreign professionals.

LANGTERMYN REËNVAL- VOORSPELLINGS IN SA

– tegnieke ondersoek

'n Tegniek wat belofte toon vir die voorspelling van reënval oor 'n langer termyn, is tydens 'n navorsingsprojek, wat finansiël deur die Waternavorsingskommissie ondersteun is, aan die Universiteit van Pretoria ontwikkel. Die tegniek maak dit moontlik om tussen die vyfde en die tiende van elke maand 'n voorspelling oor seisoenale reënval te doen.

Navorsers aan die Departement Siviele Ingenieurswese se Leerstoel in Weerkunde by die Universiteit sê in 'n verslag aan die Waternavorsingskommissie die voorspellingstegniek is by uitstek geskik vir die periode Junie tot November elke jaar, veral wanneer daar redelike sekerheid bestaan oor water fase die El Nino suidelike ossilasie gaan aanneem.

Afskrifte van die verslag getiteld **Tegnieke vir seisoenale en langtermyn-reënvalvoorspelling in Suid-Afrika (WNK-verslag 306/1/95)** kan gratis bestel word vanaf die Waternavorsingskommissie, Posbus 824, Pretoria 0001.

Hierdie navorsingsprojek, wat die besonder ambisieuse doelwit gehad het om tegnieke te ontwikkel vir langtermyn reënvalvoorspelling, het in 1990 'n aanvang geneem ingevolge 'n kontrak tussen die Waternavorsingskommissie (WNK) en die Universiteit van Pretoria. Die Suid-Afrikaanse Weerburo was deurentyd 'n nie-kontraktuele vennoot en het die projek aktief ondersteun.

Om die doelwit te kan bereik, is verskeie metodes gebruik waar toepaslike inligting uit die nasionale en internasionale weerkundige databasis benut is. Daar is gelet op sekere weerkundige verskynsels en benaderings wat uiteindelik gevorder het tot die gebruik van gesofistikeerde numeriese algemene sirkulasie modelle.

Die navorsingspan, bestaande uit J van Heerden, CJ de W Rautenbach en MM Truter, sê in hul finale verslag aan die

WNK die navorsingspoging is georden deur die projek in vier komponente in te deel.

“Veral die komponente wat te make het met die sogenaamde El Nino suidelike ossilasie sowel as klimaatmodellering het baie aandag geniet. Al was daar nie positiewe resultate uit al die komponente nie het ondersteuning vanuit die Weerburo, ander universiteite en navorsingsinstellings baie bygedra en verseker dat navorsing op al die komponente gedoen is.”

'n Verdere intermedieë doelwit ter bereiking van die sentrale doel was die opstel van sekere databasisse. Hieronder val die berekening van die Weerburo se distriksreënval, waarmee die projekspan die Weerburo se klimaatafdeling bygestaan het. Die verwerking van hierdie datastel deur die Weerburo en die verdere streeksindekking wat deur die navorsers opgestel is,

vorm deel van die projek se databasis. Hiermee saam gaan 'n rekenaarpakket wat die distriksreënval analiseer en grafies voorstel op 'n rekenaarskerm of laserdrukker. Verwantskappe met EL Nino is by die pakket ingesluit.

As deel van die projek is die daaglikse 12h00 UT Weerbuletin wat deur die SAWB uitgegee word, versyfer vir die ses somermaande en vir die periode van 1960 tot 1992. Hierdie daaglikse weerbuletin is een van die beste grafiese produkte wat die Weerburo publiseer en besondere waarde word aan die gehalte van die analise geheg juis omdat die analise van hierdie kaart deur die jare altyd toevertrou was aan 'n weervoorspeller met lang ondervinding. Afgesien van die navorsingsresultate wat uit die analise van hierdie datastel kom, vorm die datastel en die rekenaarpakket wat daarmee saamgaan een van die produkte van hierdie projek.

'n Verdere doelstelling, was om 'n stelsel te ontwikkel wat 'n gekoördineerde nasionale langtermyn tendensvoorspelling moontlik kon maak. Hiermee is slegs gedeeltelik geslaag.

ENSO

Die navorsers sê ten spyte van die relatief lae betroubaarheidsgraad van die reënvalvoorspellings wat daarop gebaseer word, is die vooruitskatting van die fase van die El Nino suidelike ossilasie (ENSO) en die klimatologiese gevolge daarvan nog die enigste bewese seisoenale voorspellingstegniek.

“Dit was min of meer die situasie reeds voor die aanvang van hierdie projek. Die navorsing wat tydens hierdie projek uitgevoer was, het hierdie stelling verder onderskraag. So ook uit die ondervinding wat opgedoen is met die aanbieding van 'n tentatiewe langtermyn voor-

spellingsadviesdiens wat gedurende die laaste paar jaar ontwikkel het.

“Dat die ENSO 'n baie belangrike verskynsel is word verder ook bevestig uit die talle groot internasionale navorsingsgroepe wat in die laaste jare gevorm is om hierdie verskynsel te ondersoek, waar te neem en te probeer voorspel.”

SIRKULASIE

Die navorsing oor maandgemiddelde sirkulasie en voorspelling vir tot 60 dae vooruit (komponente 2 en 3) het geen bruikbare voorspellingstegniek opgelewer nie. Die navorsingswerk oor groepanalises toon wel belofte vir voorspellings van sowat 'n maand vooruit.

LANGGOLWE

Navorsing oor die rol wat langgolwe speel in die voorkoms van nat- en droëperiodes oor Suid-Afrika word in die verslag opgesom. Resultate toon aan dat wanneer 'n langgolf-rug suidwes, suid of suidoos van die land teenwoordig is, die straalstroom suidwaarts verplaas word tydens nat periodes. In droë periodes kom daar 'n langgolf-trog oor hierdie areas voor en is die bolug westewind sterker oor die land. 'n Geslote bolug hoogdrukstelsel en 'n oppervlak laagdrukstelsel in die Mosambiekkanaal onderdruk reënval sterk.

Volgens die verslag is daar sedert 1993, in samewerking met die Universiteit van Wisconsin-Madison, statistiese seisoenale reënvalvoorspellingstegnieke in ondermeer 'n neurale netwerkmodel (NNM) ontwikkel. Die mees suksesvolle NNM maak gebruik van die Suidelike Oosiliasie indeks (SOI) en die 50 hPa sonale wind by Singapoer tydens die vorige somer as voorspellers (invoer). Die model oefenperiode was vir 1954-1978 en die onafhanklike verifikasieperiode van 1979 tot 1993. Die NNM het daarin geslaag om 62 persent van die veranderlikheid in die onafhanklike datastel (1979-1993) te verklaar. Operasionele voorspellings met onder andere die NNM vir die hoëveld somer-reën (Desember tot Februarie) vir die periode 1993-1994 was egter misleidend. Die reënval anomalie voorspel vir 1994-1995 was -46mm. In werklikheid is 'n reënvalanomalie van -88mm in hierdie tydperk aangeteken. Verdere ontwikkeling van hierdie tegniek is daarom geregtig.

SALFF

Die navorsers sê die stigting van die “South African Long-lead Forecast Forum (SALFF)” met lede uit die Weerburo en die onderskeie universiteite is 'n positiewe stap. Seisoenale reënvaltendense kan nou op 'n gekoördineerde wyse geskied. Dit is net so belangrik dat die SALFF funksioneer sonder owerheidsvoorskrifte of inmenging en aantasting van die deelnemers.

Globale algemene sirkulasie-klimaatmodelle het volgens die navorsers tans nie die vermoë om seisoen-reënvalvoorspellings te maak op dieselfde wyse as wat numeriese weervoorspellingmodelle dit doen nie.

J VAN HEERDEN
CJ DeW RAUTENBACH
MM TRUTER

TEGNIKE VIR SEISOENALE EN LANGTERMYN-REËNVAL
VOORSPELLING IN SUID-AFRIKA

Verslag aan die
WATERNAVORSINGSKOMMISSIE
deur die
LEERSTOEL IN WEERKUNDE
DEPARTEMENT SIVIELE INGENIEURSWESE
UNIVERSITEIT VAN PRETORIA

WNK Verslag No 306/1/95

“Klimaatmodelle is belangrik om die sirkulasieverandering as gevolg van randwaarde- of beginwaarde verandering na te vors.”

Die rol wat see-oppervlak temperatuur (SOT) anomalie in sirkulasieverandering speel, is deeglik nagevors. SST anomalie oor veral die Indiese Oseaan het baie aandag geniet. Gedurende die warm fase ENSO kom daar groot areas met positiewe SOT anomalie voor. Die atmosferiese sirkulasie verandering soos gesimuleer deur klimaatmodelle en wat intree as gevolg van die konvektiewe opstroming en verhitting (latente hitte vrystelling) bo hierdie warm gebiede kan as volg saamgevat word:

□ Daar is 'n toename in westewind sirkulasie oor Suid-Afrika met 'n gevolglike ooswaartse uitbreiding en subsidensie.

□ Die oppervlaksirkulasie oor die Mosambiekkanaal ontvang 'n suidelike komponent met die gevolg dat baie minder van hierdie vogtige marine lug anti-syklonaal kan draai oor Mosambiek om uiteindelik suidwaarts oor Suid-Afrika te penetreer.

□ Sinoptiese skaal atmosferiese versteurings kom wêreldwyd voor in model sirkulasie in reaksie op die sterk konvektiewe- en temperatuur pertubasie wat ontstaan bokant die positiewe SOT anomalie.

□ Die sirkulasieverandering wat oor Suid-Afrika intree is 'n nie-liniêre gevolg van die primêre konvektiewe versteuring en daarom baie minder voorspelbaar.

Klimaatmodelresultate soos hierbo opgesom, is van fundamentele belang as die waarde van voorspellings gebaseer op indirekte voorspellingsmetodes geëvalueer word. Gemoduleerde atmosferiese sirkulasieverandering is gesimuleer deur die CSIRO-4, 'n 4-vlak Algemene Sirkulasiemodel (ASM) met 'n R21 spektrale resolusie. Gedurende 1995 was hierdie resultate bevestig met die meer gevorderde CSIRO-9 ASM. Hierdie model is beskikbaar gestel aan Suid-Afrikaanse navorsers deur die CSIRO (Division of Atmospheric Research, (DAR) met samewerking van die Universiteit van Pretoria.

Navorsing met die Britse 15-vlak voorspellingsmodel (UKMO GCM) het getoon dat die Suid-Afrikaanse plato 'n fundamentele rol speel in die ontwikkeling van afsny laagdruk-stelsels. Hierdie stelsels is verantwoordelik vir die meeste oorstromings in Suid-Afrika. Verandering in SST rondom Suid-Afrika speel nie 'n deurslaggewende rol in die ontwikkeling van reënval oor die land in die korttermyn (5 dae) nie.

Ten spyte van die vordering wat plaaslik en elders gemaak is met navorsing oor seisoenale voorspellingstegnieke, lê hierdie veld nog braak. Maar die navorsers sê die voordele, vir die Suid-Afrikaanse volkshuishouding, wat kan voortspruit uit die min wat reeds bereik is, is enorm.

*Identifying
the mechanisms
giving rise to*

**WET AND DRY SPELLS
OVER SOUTHERN
AFRICA**

A report which summarises the results of an investigation into the mechanisms of short term rainfall variability over southern Africa is now available from the Water Research Commission in Pretoria.

The purpose of this WRC-sponsored research project was to develop a foundation of knowledge on the antecedent conditions, causes and structure of wet and dry spells, through analysis of meteorological data. These include surface observations, numerical weather analyses and satellite data sets. It was postulated that common features would emerge through statistical analysis and enable 1 - 2 week lead-time weather forecasts with application to seasonal agricultural and water resource management strategies.

The researchers, MR Jury, KM Levey and A Makarau from the Climate and Weather Research Lab in the Oceanography Department at the University of Cape Town, say the water balance over southern Africa is affected by convective weather systems which link the tropical heat and moisture sources with mid-latitude dynamical features. The rainfall is non-homogeneous in time and space, and is organised into multi-day events by atmospheric waves with cycles of 15-40 days. At present weather prediction models provide reasonable forecast guidance up to 5 days, and efforts have recently been made to understand year-to-year oscillations in climate. This leaves intermediate scale weather phenomena for improved understanding.

RESULTS

Area-averaged pentad (discrete 5-day mean) rainfall indices were analysed to identify 15-40 day cycles in summer convection over southern Africa. The most commonly observed convective cycle was around 25 days in almost 75% of cases. Analysis of convective indices at sub-monthly scale demonstrated a peculiar seasonal distribution. The major wet spells tend to occur around 17-21 November, 21-25 January, and 12-16 March; interrupted by a mid-summer dry spell at the end of December. A change from apparent water deficits before mid-January to water balance in the second half of summer is noted in data collected over the highveld and central plateau of South Africa.

Following identification of intra-seasonal oscillations (ISO) over South Africa, it was necessary to determine underlying causative factors. ECMF (European Centre for Medium Range Weather

Forecasts) weather data were obtained in the period 1986-1992 and ISO life cycles were grouped into various phases, namely dry, onset, wet and decay. Cases chosen on the basis of various rainfall indices, whether for the western Transvaal, Zimbabwe or the Drakensberg, revealed consistent patterns of evolution and structure. Thus interpretations of intra-seasonal weather dynamics could be generalised for southern Africa.

Evidence presented in the research findings demonstrates that intra-seasonal oscillations are influenced by slow, eastward moving 'waves' in both the tropics and mid-latitudes. The contribution from either source is variable and results in a wide range of characteristics. About half of all summer wet spells develop internally and are quasi-stationary over southern Africa. They derive from tropical export of warm humid air. About one-third of identified cases shifted eastward during their lifespan in sympathy with the eastward progression of convective waves in the lower and higher latitudes either side. A smaller number of in-season wet spells shifted westward from the Indian Ocean, whilst even fewer appear to be a result of variations in Hadley overturning. These results apply to areas south of 25°S. Further north in Zimbabwe, shifts in the position and intensity of the inter-tropical convergence zone (ITCZ) often result in faster developing intra-seasonal oscillations which are influenced by westward moving waves. It is likely that global warming will cause a poleward shift of weather characteristics. Thus knowledge of historical conditions over Zimbabwe could benefit our future knowledge of weather over the northeastern third of South Africa.

Mechanisms underlying intra-seasonal oscillations were brought out in composite analyses of numerical weather data. Factors which contribute to the development of summer wet spells include:

- moisture brought in from the tropical Indian Ocean some 5 - 15 days in advance, owing to a relaxation of the monsoon there;
- an upper trough shifts eastward in the mid-latitudes towards southern Africa in the onset phase, followed by a ridging anti-cyclone;
- uplift during the wet phase is wide-

spread over southern Africa and compensated by sinking in the tropics and mid-latitudes;

□ the local intra-seasonal oscillations are embedded within a half cycle of the tropical wave.

The researchers say intra-seasonal oscillations develop differently in early and late summer. In general water vapour transport over the Atlantic Ocean is seaward and uninfluential, except over Angola. In early summer there is little evidence of monsoon effects and convection from tropical troughs is absent. Conditions are relatively warm and dry leading to high evaporative water losses. Westerly flow in the upper levels is a prevailing feature, and anomalies therein determine the phase and character of in-season wet spells.

In late summer, upper westerly winds retreat polewards and the lower atmosphere is moist as a result of confluence of flow from the Congo basin and the Mozambique Channel. During wet spells, two troughs usually lie across southern Africa. The first is oriented zonally in the 15-20°S band and the second extends southward along 20-25°E. An 'anchor-point' is found over Angola.

During dry spells the Botswana high suppresses convection in association with anti-cyclonic spin (vorticity) and mid-level sinking motions. Anomalies of upper convergence and lower divergence (mass flux) are then present. Vertical sections indicate that mid-level heating, and upper easterly flow are important features of late summer wet spells, whereas upper westerlies and decreased mid-level temperatures are common in dry spells.

Conclusions

Intra-seasonal oscillations of summer convective rainfall and their underlying mechanisms have been identified. This discovery is of practical use in developing 10-30 day weather forecasts. The research has elevated the intra-season-

al scale to its rightful position of fundamental importance in respect of rainfall-producing weather systems of southern Africa. A number of data sets were obtained and 'readied' for analysis, which will facilitate on-going studies in WRC and related projects.

A major finding of the project is that in-season oscillations are of significant amplitude over southern Africa. In the tropical band to 20°S the major wet spells are pulsed by the monsoon and occur at preferred times during summer. By contrast over South Africa, the wet spells occur more randomly owing to forcing by chaotic mid-latitude weather patterns. A conspiracy of forcing factors combine to enhance wet spells, including Easterly waves in the sub-tropics, Rossby waves in the mid-latitudes, the tropical Madden Julian Oscillation, etc. These various contributors to the mechanisms of short term rainfall variability over southern Africa are outlined in the research report.

M R JURY
K N LEVEY
A MAKARAU

MECHANISMS OF SHORT TERM RAINFALL VARIABILITY OVER
SOUTHERN AFRICA

Report to the
WATER RESEARCH COMMISSION
by the
OCEANOGRAPHY DEPARTMENT
UNIVERSITY OF CAPE TOWN

WRC report No 436/1/96

Recommendations

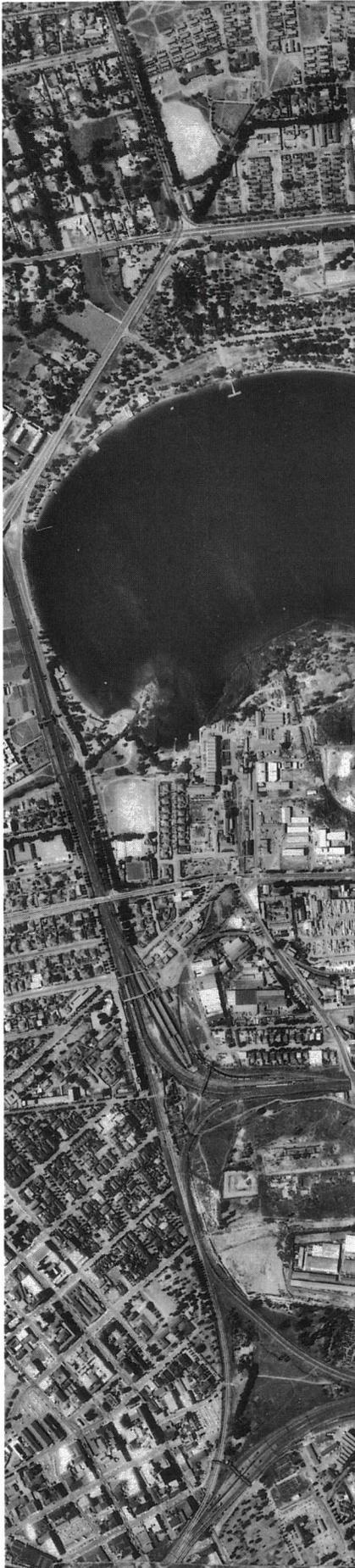
National weather services in southern Africa should develop the capability to

combine daily weather data into 5-day averages, expressed as departures from historical mean conditions for the period under consideration. Real-time diagnostic trends could then be tracked to establish the development, evolution and intensity of dry and wet spells. Ten to 30 day forecasts need to be communicated to farmers, etc to assist decisions regarding irrigation demand, planting, fertilising, etc. Most weather services currently predict short term rainfall variability on the basis of total meteorological values without the advantage of time filtering and removal of the background mean. This increases the risk of 'missing' important signals which lead wet and dry spells over southern Africa.

Development and utilisation of dynamically extended range numerical models should move ahead with the recognition of the importance of slowly evolving ISO cycles. Interaction between year-to-year and week-to-week scales of weather variability should be assessed in simulation exercises.

Further observational work on ISO phenomena should be pursued. Relationships between ISO over South Africa and events elsewhere in the region could be assessed. Distinctions between ISO operating during El Nino years, La Nina years, and in-between years could be made. This may offer useful insights to changes in the seasonal distribution of rainfall, to spatial focusing of drought and flood events and to impacts therefrom. Principal components analysis of pentad OLR data could provide additional insights to the various modes of intra-seasonal behaviour, and this work is on-going at UCT. ISO impacts could be investigated through the use of pentad soil moisture and satellite vegetation data.

Copies of the report titled **Mechanisms of short term rainfall variability over southern Africa** (WRC Report 436/1/96) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US\$ 10).



Overview presented on water supply to developing urban communities

A report evaluating the status of water supply to developing urban communities in South Africa is now available from the Water Research Commission in Pretoria. The report, emanating from a research project carried out by I Palmer and R Eberhard of the Palmer Development Group, identifies some of the more important problem areas and the researchers put forward general proposals for making improvements.

The report summarises all the important findings of the project "in a way which will be useful and informative to people who do not wish to look into the more detailed reporting contained in the project's 23 separate reports."

CONCLUSIONS

The researchers say that to draw conclusions relating to such a complex topic is difficult. "However, there are certain broad conclusions which can be made."

There are 4,7 million people in urban areas without access to adequate water supplies, which is 18 per cent of the urban population. While this is not a satisfactory situation, it is also not one which is catastrophic.

"In facing this situation, it is evident that there is the capacity in South Africa to deal with this problem and to give everyone an adequate supply within a five year period," the researchers say. However, this is dependent on the following:

- The restructuring of local authorities based on sound economic and administrative principles.
- The availability of housing subsidies which can be used to provide presently unserved people with water supply reticulation.
- The promotion of financially strong water supply agencies which will be able to raise capital for bulk and con-

ductor infrastructure.

- Acceptance by consumers that they must pay for water.
- The availability of properly trained personnel to design, construct, operate and maintain water supply systems.

The researchers say all these factors can be addressed and, therefore, the water supply situation can be dramatically improved.

"Perhaps the area where most of the effort needs to be concentrated is on human resources development as it is only properly qualified and motivated people who will provide the drive to improve water supply services."

I PALMER
R EBERHARD

EVALUATION OF WATER SUPPLY TO DEVELOPING URBAN
COMMUNITIES

SUMMARY REPORT

Report to the
WATER RESEARCH COMMISSION
by the
PALMER DEVELOPMENT GROUP

WRC report KV 73/95

Copies of the report entitled **Evaluation of water supply to developing urban communities** (WRC Report KV 73/95) are available from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US\$ 15.00)

New PC program could replace the “Green Book” in South Africa



One of the main products of a research project funded by the Water Research Commission, the computer based program called SAP-WAT 1.0, could in future be used by irrigation engineers, planners and agriculturalists as a decision making procedure for the estimation of crop water requirements. This is stated in a final report to the Water Research Commission compiled by CT Crosby of the consulting engineers, Murray, Biesenbach & Badenhorst Inc.

The report says the estimation of crop water requirements is an essential starting point when both farm scale and major irrigation projects are planned or upgraded. Inappropriate estimates can have a major impact on both policy and design decisions and on the eventual economic viability and operational efficiency of projects.

In South Africa the well-known “Green Book” or more correctly: “Estimated irrigation requirements of crops in South Africa”, published by the then Department of Agriculture and Water Supply in 1985, has been the comprehensive source document available to planners and designers. The procedures for estimating irrigation requirements currently used in design in South Africa are endorsed by the Institute of Agricultural Engineering of the Agricultural Research Council, the SA Irrigation institute, University Departments and most practitioners.

“However, as far as is known, no critical confirmation studies have been undertaken on the procedures. It also appears that research results published in the RSA and overseas during the past

decade have had little or no impact on estimation procedures used for design purposes in South Africa.”

OBJECTIVES

According to the report the primary objective of this pilot project was to assess the feasibility of establishing a personal computer (PC) based decision support system for the estimation of crop water requirements under irrigation. The intention was that the procedures should be:

- suitable for use by practitioners with limited computer experience and training,
- be in line with current international practice,
- and incorporate both interpreted research results and the practical experience of specialists.

An implied secondary objective was to incorporate in the procedure the results of Water Research Commission (WRC) supported research projects dealing directly, or indirectly, with water requirements of irrigated crops.

SAPWAT

A PC based program, SAPWAT, is the main product of this pilot project. SAPWAT (Southern African Procedure for estimating irrigation WATER requirements), is a computerised procedure for estimating crop irrigation requirements, which demonstrates that by linking existing data, procedures and programs, and by incorporating recent international recommendations, it is possible to provide an updated and effective successor to the "Green Book".

SAPWAT is a self standing program with menus and graphics to facilitate calculations and to cater for users with limited computer literacy.

RESEARCH APPROACH

■ Inter-disciplinary co-ordination

A wide range of disciplines are concerned with irrigation and crop water requirements. The designer must extract the specific data and processes that he needs from knowledge and information originally developed for other purposes. In the course of developing SAPWAT, there was close contact with a wide spectrum of disciplines and it is felt that this networking was mutually beneficial.

■ Incorporation of international recommendations

This study has taken note of the current internationally accepted approaches to the estimation of crop water requirements.

SAPWAT, in common with similar procedures, is an aid to estimation, not a calibrated simulation model. Each element in the procedure is, however, an improvement on what is currently available, even in the accepted Food and Agriculture Organisation (FAO) procedures.

■ Incorporation of existing WRC research results

In addition to the incorporation of international recommendations, SAPWAT leans on research supported by the

One of the important achievements of the pilot project has been to clarify the decision making process involved in estimating crop irrigation requirements.

WRC, particularly by the researchers Dent, Schulze and Bennie. It has been possible to use the FAO procedures as a foundation and incorporate the information generated by South African research. Notable examples of this are the detailed climatic zones with ZONEFINDER and their extensive data bases, long term daily rainfall data, surrogate methods for developing potential evaporation estimates and ACRU, PAWC, PMBWAT and BEWAB models at the heart of the calculations.

The computerised procedure SAPWAT is, therefore, a synthesis of international trends and local research.

■ Considerations during software development

To be acceptable to the ordinary practitioner any new procedure must present advantages that go beyond mere technical excellence. It must also be more convenient to use than present methods. Considerable attention has been given to programming style, and it is believed that a satisfactory approach has been achieved. Extensive use has been made of menus and graphics, and none of the procedures have to be "learned". Input data is "packaged" and immediately available. It is possible to move around in all the linking programs incorporated in SAPWAT, encouraging "what-iffing".

SAPWAT is suitable for use on PCs with a graphics card.

ACHIEVEMENTS

□ A study was made of the factors that influence crop water use. The objective was to bridge the gap between the engineer, designer and planner on the one hand, and the agriculturist and scientist on the other, and to ensure that there was agreement in interpretation.

□ One of the important achievements of the pilot project has been to clarify the decision making process involved in estimating crop irrigation requirements. Clarity has been reached on the structure of a procedure for the estimation of irrigation requirements for design purposes.

□ Progress has been made in developing software for key elements of the procedure for the estimation of irrigation requirements. Existing programs and databases have been incorporated where applicable.

□ "Non-standard" situations: SAPWAT, in common with most methods of estimating irrigation requirements, is based on "maximum" crop water use. That is when there is no shortage of water in the profile and the crop is well adapted and healthy. This assumption is adequate for normal commercial irrigation. There are situations where this assumption does not apply, and these are beyond the scope of SAPWAT.

□ Deficit irrigation: Deficit irrigation comes into its own when irrigable land is not the limiting factor, and it is possible to increase total production by utilising the water and inputs available on a larger area. The implication is that the percentage decrease in yield is significantly less than the percentage water deficit and that the cost of irrigating the larger area is minimal. It is feasible to reduce water requirements by over 25 per cent with yield decreases of only about 10 per cent. While it is possible for a practitioner to develop a deficit irrigation strategy, the application of crop growth models by a specialist is indicated.

□ Limited irrigation: The situation arises in the case of some commercial and emerging farmers where irrigation is

used to ensure good 'dry land' yields when precipitation is below average or badly timed. Inputs such as seed and fertiliser are considerably less than would have been the case had 'full irrigation' been the objective. This approach differs from the conventional approach to "supplementary irrigation", where irrigation augments precipitation up to full irrigation levels. SAPWAT is appropriate for supplementary irrigation but not for limited irrigation; here crop growth models and simulations can provide valuable guidelines.

□ Crop growth models: All irrigation farming is, to a greater or lesser extent, non-standard. The decision-making criteria developed by successful irrigation farmers as a result of years of past experience and intimate contact with crop, soil and climate, are mostly applicable to one set of farming circumstances only. Crop growth models can play an important role in developing irrigation guidelines for specific areas and situations.

It cannot be left to planners or designers to use crop growth models, nor should it be the task of the modeller or the researcher, because their interests and abilities are focused on developing and calibrating better models. It is important that there be practitioners from a variety of disciplines who are crop growth model literate. Models promote interdisciplinary co-operation and a better understanding of the fundamentals.

Crop growth models can play an important part in augmenting the SAPWAT type procedure in arriving at comprehensive regional guidelines.

□ Regional guidelines: The water requirement of crops is only one aspect of irrigation and must be seen in the context of irrigation farming as a whole. A computerised approach such as SAPWAT represents progress, in that it enables the ordinary practitioner to make better estimates than is presently possible, but its overall place in the scheme of things should not be overrated.

SAPWAT is a computerised procedure

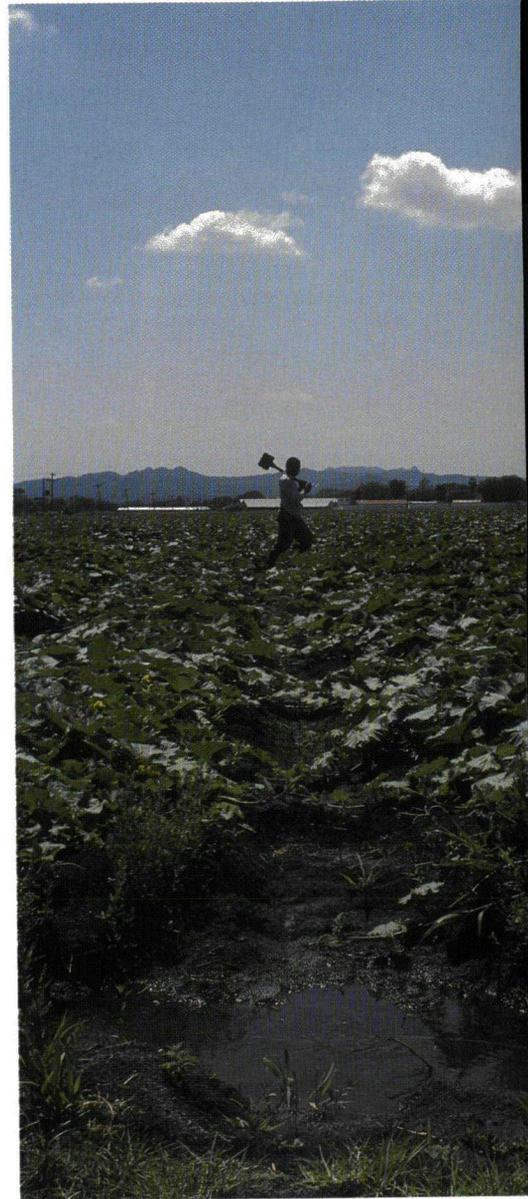
for estimating crop irrigation requirements, as such it is only a component of a decision support system. A computerised approach to irrigation planning must be supplemented by guidelines developed on a multidisciplinary basis, by people dedicated to irrigation and farmers' needs. Presently, each irrigator has the unenviable task to decide whether to adopt or reject recommended technologies, taking into account his own specific circumstances and the hidden interest of the advisors or researchers. There should be guidelines available that at least ensure that "hidden interests" are not a factor, and that all involved are concentrating on the realities of farming circumstances. The Soil Conservation Service in the USA has for many years published such guidelines, developed by permanent interdisciplinary teams. Guidelines are of immediate importance to farmers, but are equally useful to planners and designers.

□ "Packaged" PC based regional guidelines - WATER, ROBERTS - There is merit in packaging guidelines for a specific region which has characteristics peculiar to it, in the form of PC programs which can supplement printed material. A prototype program was developed that illustrates this approach.

The objective was to draw designers' attention to the soils, crops and management practices applicable to the area, and to prompt their decisions by providing appropriately "packaged" input data and even crop water requirements.

This concept was applied to wine grape production in the Robertson area. This is a well-researched crop, so that the program can be regarded as being based on valid inputs. This program, ROBERTS, includes the facility to combine the requirements of a number of vineyards.

SAPWAT estimates should be augmented by zone specific guidelines developed on an inter-disciplinary basis. In a sophisticated form, if adequate information is available, this process can be computerised as has been done on a preliminary basis with ROBERTS.



ESTIMATING CROP WATER REQUIREMENTS - SAPWAT

■ SAPWAT - General

The report says the current procedures for the estimation of crop water requirements used in South Africa are well defined, and the norms employed have, through usage, become generally accepted. However, while there is sufficient depth of experience in the RSA to ensure good irrigation design, there are latent vulnerabilities in existing procedures which should be addressed. This

is particularly true of 'non-standard' situations.

To be acceptable, a new approach must have common ground with present procedures and be well packaged, have a "built-in" infrastructure and require only a limited level of computer literacy.

SAPWAT is conventional in that it uses monthly reference evaporation (ET_o) and crop coefficients (K_c) to calculate crop water requirements. Irrigation requirements are then derived by taking into account effective precipitation and soil water balances. SAPWAT is a synthesis of a number of existing data bases and computer programs. These are linked by Turbo Pascal programs which rely on menus and graphic presentations to facilitate the exercise of judgement while developing estimates.

■ ZONER - Climatic zones

The first step in the SAPWAT procedure is to establish the zone in which the irrigation scheme is located by entering the latitude and longitude into the PC program ACRU ZONEFINDER 1.01. The output is initially in the form of a map of the country, showing the number and location of the zone, followed by a map of the zone and its position relative to surrounding zones. SAPWAT uses the 712 climatic zones developed by the Department of Agricultural Engineering, University of Natal to calculate the irrigation requirements of crops.

■ RAIN - Long-term precipitation

A graphic and tabular presentation of precipitation for the zone, by month and year, is then called onto screen, utilising the program RAIN, which was written for this project. The historical rainfall pattern can be reviewed at a glance, so that vulnerabilities can be identified and an irrigation strategy developed. This makes it possible to select, by month, a "normal" season, or a one in five, or one in ten "dry" season.

■ MONTHKC - Crop coefficients

Crop coefficients for each month of the crop growing season are then developed by another program written for this project, MONTHKC. Default values are provided for a wide range of crops and

the generic crop coefficient curve appears on screen. Planting dates and the lengths of crop growth stages can be edited. The output is the integrated crop co-efficient for each month.

■ NATAL/PMBWAT - Crop irrigation and total water requirements

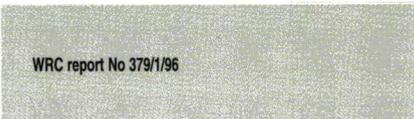
The monthly crop coefficients, zone and climatic circumstances are transferred by a linking program, NATAL to the modified output files developed for the zone by PMBWAT. This is a major advance in that an extensive data base and powerful model are utilised to provide a "packaged" infrastructure which becomes part of SAPWAT.



SAPWAT 1.0 - A COMPUTER PROGRAM FOR ESTIMATING IRRIGATION REQUIREMENTS IN SOUTHERN AFRICA



Report to the
WATER RESEARCH COMMISSION
by
MURRAY BIESENBACH & BADENHORST INC



The PMBWAT outputs consisting of monthly irrigation and total water requirements, have been developed from the ACRU irrigation routine based on daily weather inputs and soil water balances.

■ OFS/BEWAB - Incorporating pre-programmed irrigation scheduling and PAWC

The final linking PC program, OFS, is a reprogramming in Turbo Pascal, with graphic menus, of BEWAB. The principles are used to extend the application

of BEWAB to include all the crops and zones covered by SAPWAT.

Models are included for estimating profile available water capacity (PAWC) and the effect of the water content of the profile at the start of the season on scheduling at seasonal peaks.

■ SCHEME - Scheme water requirements

No standard procedures are available to facilitate the estimation of monthly water requirements on a scheme, where the mix of crops, areas planted and planting dates can be varied. Some planners have developed spreadsheets for this purpose, but SAPWAT caters for this requirement as part of the comprehensive procedure.

■ GROSS - Converting net to gross water requirements

The net irrigation outputs developed by SAPWAT are corrected for the clothesline and island effects of advection, and are checked against crop water: yield curves, to assess if there is a realistic relationship between estimated water requirements and expected yields. Procedures for estimating crop irrigation requirements, concentrate on establishing net requirements. However, the gross requirement is required in planning and design. The normal procedure is to convert net values to gross by applying an application efficiency factor which takes losses into account.

SAPWAT IN PRACTICE

The report says SAPWAT is currently still in demonstration form. Modifications are necessary to some component programs, the data bases need further expansion and the overall program requires packaging before distribution. Limited exposure has been favourable and comments constructive.

Copies of the final report titled **SAPWAT 1.0 - A computer program for estimating irrigation requirements in Southern Africa** (WRC Report 379/1/96) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001 (Overseas price: US\$ 20.00).

Developing a real-time **RAINFALL MAPPING S** for South Africa



The results of a pilot study to develop a system for the real-time measurement of daily rainfall over the Wilge and upper Vaal River catchments have been released by the Water Research Commission in the form of a final report.

The system incorporates:

- Radar coverage from Bethlehem in the Free State.
- Data from the Weather Bureau surface rain gauge network.
- Meteosat satellite image data and locally developed image to cloud algorithms.
- Integrated rainfall gauge, radar and satellite data.

The study was carried out by researchers from the Department of

Civil Engineering at the University of Pretoria and the approach developed, "although completely new, contains elements which have not been used operationally elsewhere as far as could be determined".

The researchers, J van Heerden, MM Truter and CJ de W Rautenbach, say in the report that the need to improve water resources management in South Africa, makes it imperative to obtain the best possible rainfall record over the country on a daily basis.

SYSTEM

data in real time also poses serious problems. Most of the rainfall stations report only on a monthly basis. During the last few years the Weather Bureau upgraded the daily reporting gauge network to some 500 stations. This is still inadequate for the kind of information required for water management, flood advisory services as well as short term agricultural and industrial planning.

The researchers say the only viable solution for improving knowledge of the rainfall distribution and duration is the development of remote sensing techniques. Fortunately, South Africa has adequate satellite data coverage. Thermal infrared (IR) images at the rate of 48 per day (half hourly intervals) and visible waveband images (VIS) at the rate of 24 per day are received in real time by the South African Weather Bureau from the European geostationary satellite METEOSAT.

According to the report previous research indicated that threshold techniques (cold cloud top temperatures), although lacking in sophistication, may prove to be among the best techniques available. It was found that cloud top temperature colder than -30°C has a high probability of producing rainfall. The TAMSAT (Tropical Applications of Meteorology using Satellite Data) group at the University of Reading in Britain uses a cold cloud statistics technique. Satellite measured infra-red radiation from the earth, referred to as a pixel (5 x 5 km resolution) is converted to radiation temperature by means of calibration data supplied by the European Space Agency (ESA). Pixels below a given temperature threshold are identified on hourly or half-hourly imagery from METEOSAT. The number of pixels classified are accumulated over a period of ten days to provide a measure of the duration of active rain clouds over any pixel, which is then converted into a rainfall estimate using empirically determined regressions. This method is used operationally for drought monitoring and in hydrological research.

In South Africa the research team collected satellite, radar and rainfall gauge data and prepared it for analysis.

Rainfall and radar data were collected at Bethlehem while the South African Weather Bureau archived Meteosat image data.

To compare the satellite computed and observed rainfall data, rainfall maps for three days during the '93/'94 rainfall season were developed with the new system, called the RASRAIN system.

Over most of the country the two maps compared well with each other, except over the coastal regions where the satellite-derived rainfall underestimated the observed rainfall. Over the continental areas of South Africa the satellite map over-estimated rainfall. But the researchers say it is expected that further research and analysis will improve this. The map nevertheless gives a very good distribution of rainfall and provides detail never before achieved.

J VAN HEERDEN
MM TRUTER
CJ DE W RAUTENBACH

DEVELOPMENT OF A REAL-TIME, NON-CONVENTIONAL
RAINFALL MAPPING SYSTEM

Report to the
WATER RESEARCH COMMISSION
by the
DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF PRETORIA

WRC Report No 438/1/95

Copies of the report entitled **The development of a real-time, non-conventional rainfall mapping system** (WRC Report 438/1/95) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US\$ 20).

The Weather Bureau currently supports a rainfall gauge network of some 2 100 stations. These are supplemented by localised gauge networks operated by the Department of Water Affairs and Forestry as well as the Agricultural Research Council. Some automated recording stations that report rainfall are also available.

In spite of this, the distribution of this network over the country is far too sparse for a reliable rainfall distribution map. The collection of all this gauge

Viability of IRRIGATION FARMING investigated



The results of a study on the interdependent factors which determine the viability of irrigation farming has been published by the Water Research Commission in the form of a final report.

The report titled "SAPFACT 1.0 - a computer program for qualitative evaluation of irrigation farming" was compiled by CT Crosby of the consulting engineers firm Murray Biesenbach & Badenhorst Inc, with contributions by A Vaughan and I Schmidt.

Copies of the report (WRC Report 382/1/96) are available free of charge from the Water Research Commission, PO Box 824, Pretoria, 0001. (Overseas price: US\$ 25).

When the research proposal for this project was originally submitted to the Water Research Commission, it was felt that case studies of individual irrigation farmers could provide an important understanding of the complexities of irrigation farming and assist policy-makers and practitioners "in visualising and relating to the realities of the situation."

"The results should show, in particular, how there could still be many apparently successful irrigation farmers at a time when financial and economic evaluations for new and rehabilitated irrigation projects were predominately negative."

The basis of the study was to be the undertaking of in-depth surveys on farms in three irrigation regions. The data obtained were to be utilised to synthesize stratified profiles of representative farms which would be incorporated in case studies.

The survey was, however, to include social and economic facets and the inputs of specialists in undertaking open-ended investigations of this nature were to be obtained.

An inferred objective was to compile a reference manual that would provide policy-makers and practitioners with the information that is normally only available through first-hand contact with farming relatives or friends i.e. "an in-law in each irrigation area!"

It soon became clear, however, that the dream of a reference manual of this nature was not only unattainable, but also undesirable. There was, consequently, some revision to the research objectives.

REVISED OBJECTIVES

The social scientist supporting the team proposed that qualitative research (which was a new field to the research team), based on taped, semi-structured open-ended farmer interviews, be employed in preference to questionnaire surveys. It soon became apparent from the interviews that the "missing link" that the decision-makers had been instinctively seeking, was the farmer as individual and entrepreneur.

The technique of developing representative farms as originally proposed, has

been successfully applied in technical and economic studies. However, individuality is submerged in the "representative farm" or "reference manual" approach and the objective of a better understanding of people and their motivations thus defeated.

It was found that a technical specialist can apply qualitative methods, provided he has the necessary aptitude and training to conduct a sympathetic and objective interview with the emphasis on listening. An open-ended discussion lasting an hour can reveal a great deal. Analysing and presenting the data are more difficult but the application of qualitative methods to technical problems and situations by people not specifically qualified in the social sciences, is an exciting and viable innovation.

An important facet of the revised research objectives was the assessment of ways of incorporating qualitative research techniques into the portfolio of technical specialists. The project aimed to develop a practical system for analysing and presenting the data applicable to irrigation farmers. This would facilitate the proposed establishment of an extended information base for irrigation planning and development.

METHODOLOGY

■ Semi-structured interviews

The bulk of data gathering was by semi-structured interviews. Although qualitative research may not be statistical, it is still systematic and strives for internal validity. Therefore, before the interviews could be embarked on, a number of preliminary steps had to be taken. The first step was to achieve a degree of consensus about the form and content of the proposed interviews. The second step was to draw up guidelines for the semi-structured interviews. The third step was to train the interviewers.

Interviews were conducted on the farm and took the form of a freeflowing general discussion, with the starting point normally being determined by the farmer. The interviewers did not dominate and allowed the farmer to determine the general direction of the discussion. Gentle prompting and probing when necessary ensured that most of the information required was covered.

The objective was to gain broad insights

into the attitudes of irrigation farmers, and the environment in which they were operating. "Upper third" farmers, who could be expected to be well informed, were, therefore, interviewed. The usable interviews transcribed were eight in Natal, eight along the Orange River below the Van der Kloof Dam, eight in the former Transvaal Province, five in the Western Cape and one in the Orange Free State.

The semi-structured open-ended taped interview is a powerful method, but has its limitations as a research tool. The recording of interviews is essential, but not always easy or successful. The transcription of the interviews and organising of the data are time-consuming and require skill and experience. The method appears to be particularly suited to situations where a relatively limited number of in-depth interviews can make a major contribution to the knowledge base. The planning of the research and the training of the interviewers is important, because of the intensive nature of the technique.

A sample interview transcript is presented in the report.

■ Sondeo

A recognised procedure developed to cater for situations where coordinated inter-disciplinary inputs are essential in order to solve specific problems, or produce development plans for an area, is the Sondeo approach.

The Sondeo technique is as applicable today in South Africa as it has been for the past ten years in Guatemala (where it was developed) and in other parts of the world. Like the semi-structured taped interviews, it is based on open-ended discussions with farmers and makes use of a multi-disciplinary team which concentrates on an area for a week. The Sondeo discussions differ from the semistructured taped interview in that they are not recorded and subsequently transcribed. The output of the discussions is integrated and moderated in the course of team discussions.

The Sondeo approach encourages the production of a solution that meets the needs of a farmer, as seen by the farmer, and fulfils the criteria identified by the broad range of disciplines represented on the Sondeo investigating team.

Sondeo can extend the scope of the open-ended interviewing technique, while eliminating the problems with transcription and presentation. Consequently, the Sondeo's value in answering the questions raised in this pilot project, was assessed. There was some difficulty in finding sufficient and appropriate specialists who would be able and willing to participate in an experiment. The Central Branch of the SA Irrigation Institute (SABI) provided the opportunity through a Farmers' Day that was held in the Brits area at the end of August 1992 with the theme "Irrigation in the drought". The organising committee put together a team of highly qualified professionals representing a wide range of disciplines and interests for an experimental Sondeo.

Some 40 farmers were interviewed in three days, covering the Brits, Krokodil River and Beestekraal areas. Both large and small farmers were represented as were the main crops wheat, tobacco and vegetables.

The three days did not allow enough time to evolve a full development report, but the content and structure of the Farmers' Day was developed by consensus based on the interviews, and the observations made by the different specialists.

The practical application of the open-ended farmer interviews came as a revelation to the participants. The comment was made by a very experienced extension officer that it was almost unknown for farm visits to be made without a specific agenda. Usually the objective was either to "sell" a concept or a programme or to acquire specific information or statistics. Letting the farmer make the running, allowing him to talk about the questions he regarded as important, broke new ground.

Further details of the procedure and the results achieved are contained in the report.

RESULTS OF THE SURVEY

The utilisation and presentation of the information gathered during the survey created dilemmas. These were finally resolved by the development of the computer program SAPFACT, described in Chapter 5 of the report, which enables technical specialists, without specific

training in the social sciences, to utilise open-ended interviews to augment their assessments of the individual farmers and groups of farmers that they are investigating or counselling.

■ Perspectives

The perspectives gained on those aspects of irrigation farming which are of direct importance to decision-makers, equipment suppliers, scientists and counsellors are summarised in Chapter 4 of the report under the following headings:

- Irrigation water management
- Irrigation methods and equipment
- The farmer and his household
- The farm enterprise
- Management style
- Financial situation
- Labour
- Advisory services
- Markets and crops

■ Profiles

Originally the intention was to develop farmer profiles which could be incorporated in case studies. Although the research approach has been revised, the Steering Committee requested that the development of draft profiles still receive attention, "as this could assist in digesting the vast amount of data, as well as being used in viability studies."

Progress was made in drawing up profiles of individual farmers from the transcripts of the interviews, but general publication raised the problem of confidentiality. It is difficult to disguise the identity of the farmer interviewed, there are too many clues!

In addition, the development of profiles from qualitative data differs from that of the more statistically based quantitative research. SAPFACT has been used to develop ranking profiles from the qualitative data.

These profiles are presented in the form of a table and short explanatory notes for a selection of farmers evaluated. In addition, these profiles are utilised to "characterise" three of the areas in which interviews took place, namely:

- Irrigation areas below the PK le Roux (Van der Kloof) Dam (Chapter 7)
- Natal coastal areas (Chapter 8)
- General irrigation areas in the Transvaal (Chapter 9)

SAPFACT 1.0

The report says SAPFACT (Southern African Procedure for assessing farming FACTors) was developed to mobilise the information gained in the course of the pilot project, and to promote the application of interview based qualitative research techniques by practitioners with a scientific and technical background and no formal training in the social sciences.

CT CROSBY

SAPFACT 1.0 - A COMPUTER PROGRAM FOR QUALITATIVE EVALUATION OF IRRIGATION FARMING

Report to the
WATER RESEARCH COMMISSION
by
MURRAY BIESENBACH & BADENHORST INC

WRC report No 382/1/96

There are many factors that have an influence on irrigation farming and the establishment of objective priorities is not easy. Even the listing of the factors will be subjective, although there are certain clear cut items that have a major influence. SAPFACT 1.0 identifies six aspects important in assessing the situation, each aspect consisting of eight factors, giving 48 factors in total, as follows:

- Irrigation management: Operation and maintenance of equipment, design and installation of equipment, annual water supply, regularity of water delivery, understanding of irrigation, attitude to water management, appropriateness of irrigation methods, scheduling practices.
- Crop profit potential: Suitability of soils, suitability of climate, alternative crop possibilities, crop yields, production costs, gross margin potential, market

and price risks, production risks.

- General management: Supervisory support, personal supervision, seasonal planning, record keeping, counselling and advice received, training and experience of manager, management structures, longterm planning.
- Labour management: Labour organisation, labour situation, attitude to legislation, remuneration, development actions, training inputs, efficiency and supervisory contribution of labour.
- Farmer aspects : Way of life, career stage, property plans, decision-making, stress , family aspects, wife support on farm, community involvement.
- Financial situation: Accounting services, credit sources, access to income, impact of inflation, marketability of farm, bond status, scale of operation, income aspirations.

The program can be edited to modify either or both the aspects and the factors to suit the specific needs of the user. The default entries represent the conclusion derived by the researcher from the interviews undertaken in the course of the pilot project, and should be regarded as some of the results of that study.

At the conclusion of the interview with the farmer, the interviewer runs through the program and, for each factor, identifies the key word that best fits the impression he has gained during the interview. The program then converts this to a rating and, for each of the six aspects, an integrated combined rating of the factors is generated. A rating profile of the farm and farmer is presented on the screen. The whole process takes a few minutes and it is possible to identify strengths and weaknesses, bottlenecks and the likely consequences of remedial action of changing external circumstances.

To be fully effective, and to be in line with the principle of participation, the analysis should be discussed with the person being interviewed as soon as possible, and modified if necessary. This was not done with the taped interviews.

In using SAPFACT, a cascade approach can be followed. The user can eliminate possibilities progressively. Should the financial position of the farmer be seri-

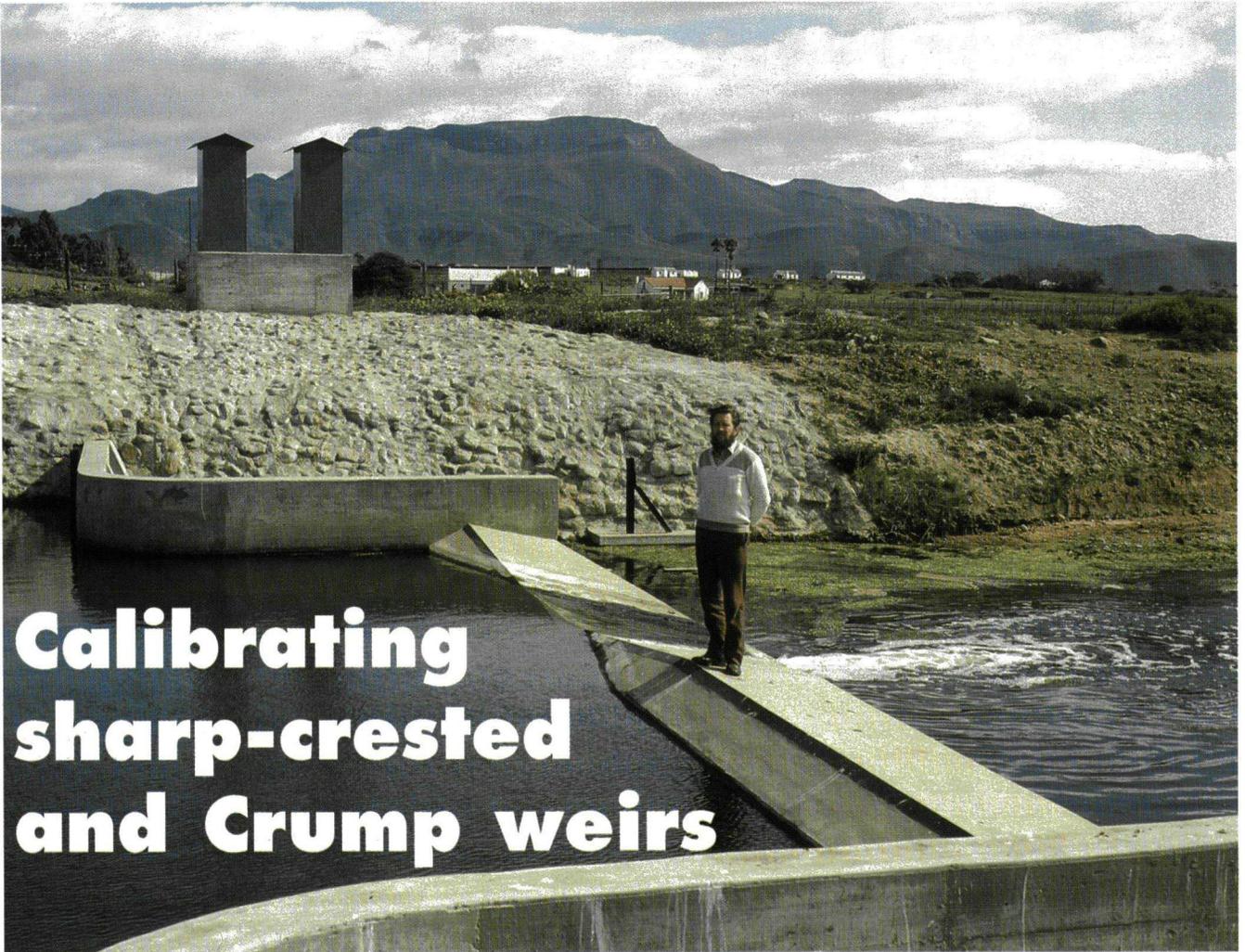
ous, there would be little point in taking other action until the necessary financial arrangements had been made. Similarly, there is little point in emphasising scheduling methods if the water supply is irregular.

The SAPFACT user is in a position, at the conclusion of the process, to assess the strengths and weaknesses of the farmers interviewed and to identify opportunities and vulnerabilities of the group as a whole.

CONCLUSIONS

- Importance of qualitative research in Agriculture and Engineering: This is an exploratory project but it has shown that there is a place for qualitative research in Agriculture and Engineering, as there is in medicine. Technical specialists with the necessary aptitude and an adequate introduction to techniques can enrich investigations, both at research and at operational level, by applying the basic principles of qualitative research. SAPFACT is an innovative attempt to facilitate the interpretation of interviews undertaken by people trained in the rigid disciplines of science and engineering.
- Important role of farmers: The project emphasises the potential role of the individual farmer, in contributing to the design of new technology and development programmes. SAPFACT is a tool that can be applied by advisory personnel, researchers and commercial concerns in their direct dealings with farmers to establish a realistic profile of resource- and people-based strengths and weaknesses.
- Perceptions: The project has disclosed that the perceptions that "We" have of "them" can be very wide off the mark. Decisions are based on the decision-maker's perception of the facts at his disposal; consequently, decision-making is not altogether mathematical or objective. The perceptions of the person carrying out the decision, in this case, the farmer, are also an important factor in the appropriateness of proposals. This research showed that the following has to be taken into account:
 - Irrigation tends to be a chore to most irrigation farmers and is nowhere near top of their priority list.
 - Water wastage is a consequence of anxiety about under-watering and not an irresponsible disregard for natural resources.
 - Irrigation increases rather than reduces the risk factor in farming.
 - Farmers may have good reason not to accept the recommendations of engineers and scientists.
 - It is not true that a farmer values equipment or services only if he pays for them.
 - The increasing attention being given to small farmers, facing circumstances unfamiliar to the specialist, has emphasised that "perceptions" of the farmer involved are just as important as "facts" available to the specialist. Internationally, there is recognition of this, particularly by agencies concerned with development funding.
- Farming practices: Semi-structured open-ended interviews proved to be particularly effective in obtaining insights into farming practices. This is of particular importance when technical aspects, such as irrigation and mechanisation, are directly related to these practices. It was noticeable that two interviews undertaken on sugar farms captured the essence of the "hows" and "whys" of irrigation in the area. The technical detail that emerged from these interviews was comprehensive and detailed and explained anomalies that had been concerning design engineers with considerable experience in this field.
- Irrigation management and training: The interviews have emphasised the relatively low priority that most farmers place on irrigation management, and the almost complete dearth of effective irrigation extension. There is, possibly, a link between the two. Effective extension is not possible if the subject is not important to the farmer! There can be no doubt that more effective management would be in the interests of both the farmer and the country but this will require a new approach based on farmer perceptions and priorities.
- Labour development: The survey emphasised the value of the support provided by employees who had developed from being labourers to being active participants in the organisation and management of the irrigation function. Irrigation farming is labour-intensive, which will have major economic consequences in the future, placing a premium on developing present labourers to be active participants in the organisation and management.





Calibrating sharp-crested and Crump weirs

A report dealing with the results of comprehensive tests and investigations into the accuracy of compound sharp-crested and Crump measuring weirs under typical South African conditions, is available from the Water Research Commission.

These tests and investigations, conducted by J Rossouw, A Rooseboom and P Wessels from SIGMA BETA consulting engineers, formed part of an extensive research project, funded by the Water Research Commission, into calibration uncertainties and maintenance problems which have been encountered at river flow gauging weirs in South Africa.

This report may be read in conjunction with WRC Report No 442/2/95 titled: "River discharge measurement in South Africa rivers: the development of improved measuring techniques" (See article on page 24 of this Bulletin.)

Sharp crested and Crump weirs are the two types of structures that are most frequently used for flow gauging in South African rivers. Over the years many of these weirs have been constructed. To improve the sensitivity during low flows and to increase the range of flow conditions that can be gauged by these structures, compound weirs are mostly used. In the compound weir the level of the crests of the weir is varied in a number of steps across the river cross-section. The low flows then pass only over the lowest section of the weir and as the flow increases flow occurs progressively over more of the crests. This ensures that as in the case of V-notch weirs, the flow can be measured relatively accurately over a wide range of flow discharges without causing an excessive increase in the water level in the river upstream of the weir during high flows.

The basic theory and calibration coefficients for both types of weirs are well established for the case when only a single crest level is used. These rela-

tionships are also applicable for compound weirs provided that dividing walls are constructed which separate the flows over the different crests of a weir. If water levels are recorded in between the dividing walls upstream of each crest, the flow over each crest can be calculated using the standard calibration relationship for a single weir.

For economical and practical reasons, dividing walls are often omitted in the construction of compound weirs in South African rivers and streams. One of the main practical reasons given for omitting the dividing walls is that floating debris such as branches and trees often become entangled by these walls, adversely affecting the calibration of the structures.

In addition to omitting the dividing walls, it is also becoming common practice in South Africa to record upstream water levels only in the vicinity of the crest with the lowest level. This practice is followed regardless of whether dividing walls are used or not.

These practices of omitting dividing walls and of recording water levels only upstream of the crest with the lowest level, have led to doubts being expressed about the accuracy with which flow can be measured by means of these structures. A need was identified to test these structures in order to determine the accuracy that can be achieved using the standard calibration formulae. If the accuracy was found to be unacceptable, means were to be sought to adjust the calibration formulae in order to improve the accuracy of flow measurement.

REPORT

This report describes the calibration tests that were performed and summarises the results of these tests. The tests were executed in the hydraulics laboratories of the University of Stellenbosch. Results from earlier tests, conducted in the hydraulic laboratories of the Department of Water Affairs and Forestry in Pretoria, are also included in the analysis. Only tests where flow took place over more than one crest are considered in this report. Non-modular flow, i.e. when the water level downstream of the weir has an influence on the water level upstream of the weir, is also not considered here. The main purpose of this investigation was therefore to cali-

brate compound weirs under modular flow conditions with flows occurring over more than one crest, using only a single water level recording, for cases with and without dividing walls.

A brief description of sharp-crested and Crump weirs as applied in South African rivers and streams is provided in the report. The basic theory used in relating the water level upstream of the weir to the discharge is described. Results of previous research and calibration tests on these types of structures are sum-

J ROSSOUW
A ROOSEBOOM
P WESSELS

LABORATORY CALIBRATION OF COMPOUND SHARP-CRESTED AND CRUMP WEIRS

Report to the
WATER RESEARCH COMMISSION
by
SIGMA BETA CONSULTING ENGINEERS

WRC Report No 442/1/95

marised. This background is then used to define the aims and objectives of the present series of calibration tests. The test facilities and testing techniques are described next and finally the results are presented and conclusions are drawn.

RESULTS

The results of the study prove conclusively that accurate flow measurements are possible with sharp-crested and Crump weirs without dividing walls. The standard method of analysis used to date leads to the slight overestimation of discharge values when the flow depths above adjacent weirs differ by more than 50 per cent. This overestimation varies from an average of 7 per cent when the flow over the higher crest commences and reduces to zero when the flow depth above the higher crest becomes more than 50 per cent of the depth above the low crest. According to

the researchers this overestimation can easily be corrected by adjusting the discharge coefficient for the weir. Adjustments whereby the discharge coefficient is expressed as a function of the ratio of the effective head and effective pool depth behind the weir, prove to give very satisfactory results. Not only did this lead to accuracies of approximately 4 per cent at the 95 per cent confidence level, but the corrections also proved to be insensitive to shallow and irregular pool conditions.

Tests with dividing walls indicated under-estimation of the flow rate under certain circumstances if the head is calculated from water levels recorded upstream of the low crest of the weir. This underestimation results from the assumption of constant energy levels upstream of different crests. The underestimation can be as high as 15 to 20 per cent in cases of a high step height in combination with a shallow pool whilst the overflow depths over adjacent weirs differ by more than 50 per cent. This under-estimation can be reduced to less than 10 per cent if the step height to pool depth ratio is kept below 0,5.

RECOMMENDATION

The results of the study have led to the recommendation that sharp-crested and Crump weirs without dividing walls can be used for flow gauging in rivers. Traditional discharge coefficients can be adapted to improve the accuracy of discharge calculations for this type of weir. Where dividing walls are not used, the step heights should be limited to ensure that the ratio of step height to pool depth does not exceed 0,5. In cases of very wide rivers with non-ideal pool conditions dividing walls should be used and water levels should be recorded upstream of a number of the crests unless specific calibration tests are undertaken. This is especially true for the more important gauging stations where a high degree of accuracy is required.

Copies of the report entitled **Laboratory calibration of compound sharp-crested and Crump weirs** (WRC Report 441/1/95) are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US\$ 20).

Improved technique developed for measuring river discharge

River discharge measurement is practised on a global scale, as the data is essential for the design of hydraulic structures, the management of water resources and water quality.

In South Africa the challenges involved in river discharge measurement are severe. Extreme variability of discharge occur, high sediment loads are transported in areas such as the Eastern Cape, Western Cape, Free State and Natal and limited financial and manpower resources are available to implement and maintain river discharge measurement networks.

The current network in South Africa consists of a large number of weirs, mostly compound weirs, supplemented by the measurement of discharge at reservoir spillways and the use of velocity area methods at a number of sites. For the measurement of extreme floods, slope area and other indirect methods are also employed.

A number of practical problems which have been experienced over the years in the measurement system have largely been overcome within the constraints placed on the system. However, two of the major questions which have remained are concerned with:

- the accuracy of measurement by means of the wide range of dimensions of compound weirs which are found locally and which mostly deviate from international standards; and
- the accurate measurement of discharge in rivers with serious sedimentation problems.

REPORT

With regard to the second question: the Water Research Commission has recently published a report which provides an improved method of discharge measurement in areas where high sedi-

ment loads are encountered.

In the report, compiled by researchers HH Lotriet and A Rooseboom from SIGMA BETA consulting engineers, a review of the fundamental theoretical principles underlying discharge measurement and the description of sediment transport processes is presented firstly.

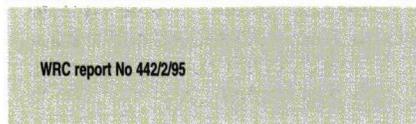
The problems which have been experienced at South African gauging stations, with the solutions that have been proposed, are summarised in order to provide some perspectives on the limitations and requirements which are associated with any improved discharge measurement system. International methods of addressing the problem of discharge measurement in rivers with sediment loads are also reviewed.



RIVER DISCHARGE MEASUREMENT IN SOUTH AFRICAN RIVERS: THE DEVELOPMENT OF IMPROVED MEASURING TECHNIQUES



Report to the WATER RESEARCH COMMISSION by SIGMA BETA CONSULTING ENGINEERS



In the light of local and international experiences, criteria and requirements for improved methods of discharge measurement are formulated. The resulting

design concepts are presented with a description of the experimental programme which was followed in order to optimise the system and determine its properties.

Finally some recommendations are made on aspects of system implementation and operation.

CRITERIA

According to the report the criteria and requirements for any improved measuring system have been identified by the researchers as:

- The extreme variability of discharge in South African rivers needs to be taken into account. The system must provide reliable continuous records, of low and medium discharges, as well as reliable estimates of flood peaks.
- The system should provide improved ways of handling sedimentation. This implies that uncertainties associated with sediment build-up upstream of weirs and the siltation of measuring equipment should be addressed.
- South African rivers cross international boundaries and the accuracy of measurement on such rivers should be internationally acceptable, in order to avoid disputes. It is therefore important to adhere to international standards of flow measurement as far as is possible.
- The improved techniques should be compatible with the existing methods of flow measurement, in order that the methods may also be applied to existing structures where problems exist.
- A maximum degree of standardisation is preferable. This would enable designers to use the system without having to take frequent recourse to extensive model studies or field calibration in order to ensure accuracy of data.

□ The accuracy of the system should be acceptable in terms of the requirements of the local users and should preferably be in line with what is generally obtainable at local gauging stations.

□ The system should be economical. Construction costs should be comparable with those of traditional structures. The maintenance of the system should compare favourably with the maintenance requirements at existing stations.

□ The system should be robust in terms of potential natural and human damage.

A design concept was formulated, tested and optimised, with the final layout being shown in Figure 1.

SYSTEM CHARACTERISTICS

The characteristics of the system proposed in the report are:

□ It is a compound structure, as this is the only way to deal with extreme variations in discharge magnitudes which occur in local rivers.

□ The lowest weir section consists of a flume type structure which forms a control by means of horizontal, rather than vertical contraction and thus allows unrestricted passage of sediment. Two symmetrical Crump weirs adjoining the flume on each side form an integral part of the system. These weirs are not separated from the flume by dividing walls, i.e. the crests of the weirs are at the same level as the top of the flume walls. By integrating the Crump weirs with the flume, a smooth transition between low notch measurements and the established methods of dealing with practices for discharge measurements over different weir sections at higher levels is possible. As soon as the water levels in the flume and above the adjacent Crump weirs are equal, the normal assumptions for the calibration of a compound weir with measurement at a single point and no dividing walls are valid. For the range of levels above the flume height and below the level at which water levels behind three adjoining weirs are equal, laboratory calibration may be required, however - if scaled versions of the recommended standardised layout are used, it may also be calibrated by means of similarity laws.

□ The flume has a trapezoidal throat, in order to be able to measure a relatively

wide range of discharges accurately. The convergence of the flume in a downstream direction, causes sediment which reaches the flume inlet to continually be accelerated and no deposition takes place within the flume. The concentrated stream with high momentum at the downstream end of the throat should ensure that no sediment build-up takes place directly downstream of the flume. In addition the risk of downstream submergence risk is decreased due to the concentrated momentum flux.

□ The flume has parallel side walls, in contrast with most international flume types which have curved side walls in order to ensure gradual contractions and expansions. The parallel side walls are necessary for the flume structure to be used in conjunction with adjacent crests in compound structures.

□ Discharges which exceed the capacity of the combined flume and adjoining sections may be calculated by means of the standard compound weir formulae.

□ The flume layout and gauging position comply with international discharge measurement requirements.

SEDIMENT

The sediment handling capability of the system was defined in terms of the minimum discharge required to keep the flume free of sediment at the inlet section.

The principle of discharge measurement by means of horizontal flow contraction was also applied to the measurement of flood peaks in natural rivers. A model study of non-uniform reaches of the Orange River downstream of the Oranjedraai weir was performed and the extreme flood peak discharges which were modelled, were the estimated flood peaks for:

□ the 1988 flood (2 150 m³/s)

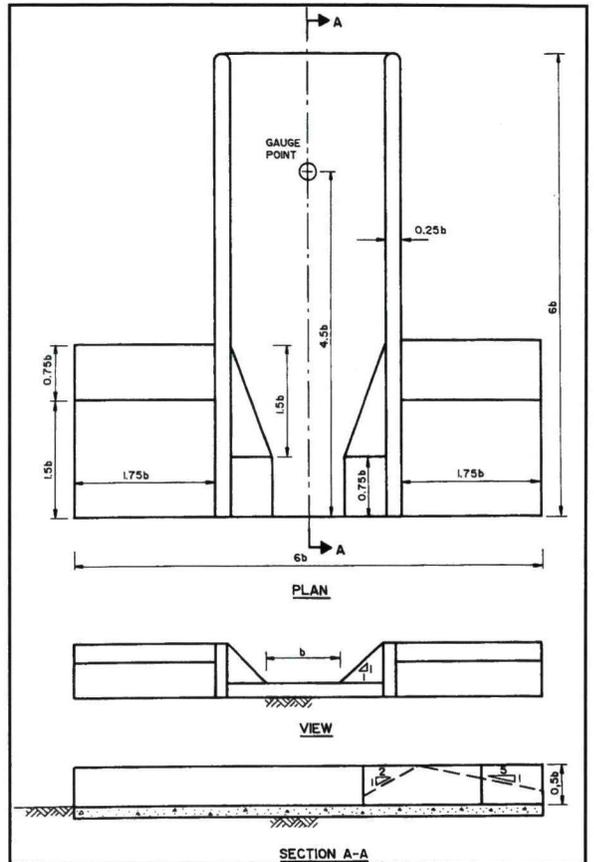


Figure 1: Recommended layout of the sluicing flume or "spoelgeut" in Afrikaans.

- the 1967 flood (highest observed - 7 099 m³/s)
- the estimated Regional Maximum Flood (15 730 m³/s)

For each of the flows, the theoretical discharge was calculated and compared with measured values.

The accuracy of these values compares favourably with the accuracy obtainable with the current system. It will be possible to calibrate other converging river reaches in order to extend the range of traditional gauging stations for maximum discharges, which are beyond the normal reliable ranges of such stations.

Copies of the report entitled **River discharge measurement in South African rivers: the development of improved measuring techniques** (WRC Report 442/2/95) can be obtained free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US\$ 25).

Opportunities for international co-operation in the water research and management environment

"Africa will have to rely more and more on its own strength. It is to be hoped that this situation will finally open its eyes and enable it to take its own destiny in hand, to be persuaded that its true future lies in its children's ability to design, forge and enhance a process of renewal of liberation and progress, without which it will never participate as a credible, responsible and respected partner in international relations." (Audience Africa, UNESCO, 1995)

Our Chairman, Eberhard Braune and myself, are in the fortunate position to serve on two National Committees namely, the National Committee for IAHS and the National Committee for the International Hydrological Programme (IHP). The one is based on a scientific organisation, the other is an intergovernmental organisation. Hydrological science probably could flourish on its own in the past without the troublesome interference of policy and economy. However, since the Dublin Statement and Agenda 21 there is no doubt any more that science, development and management for a sustainable future society are linked and need to be integrated.

I see two important strategic actions that are now needing urgent attention. Firstly, we must unify our hydrology, there is no separate quiet corner anymore for surface hydrology, agrohydrology, forest hydrology, groundwater hydrology, atmospheric hydrology, environmental hydrology, etc. Dr Mark Dent nowadays emphasises: "There can not be integrated management based on disintegrated science" and he is working hard to break down barriers between historically separated disciplines!

But at the same time all scientists and others who feel they belong to the scientific community must make a concerted effort to persuade the politicians that there will be no sustainable society and sustainable water management if a sound scientific foundation is not maintained and strengthened.



Since South Africa has regained its full membership of the international community, there has been an impressive and sometimes bewildering flurry of activity and many of us are now trying to regain a clear focus. One of the new focus points is the recently established Water Sector of SADC. I understand that the SADC Water Resources sector is planning a round table process which is to mobilise and co-ordinate development assistance required for strategic and integrated water resource planning and development as part of the SADC Programme of Action. And the scientific community must seriously contemplate ways and means to make a meaningful contribution to that process.

However, especially at the international or even sub-regional level, there is such a proliferation of organisations that it is difficult to keep focus. In a time where there is a strong movement towards integrated water management it seems appropriate to strive for closer integration of relevant scientific, governmental and non-governmental organisations. Many countries clearly see a difference between global and regional or national

problems. If financial and human resources are limited, one is probably wise to concentrate on national and sub-regional issues. Not that the global context is not important but in terms of direct activity they will have to take a back seat. To have separate National Committees for WMO, IAHS, IAHR, IAH, IHP, IOC, MAB, MOST, etc simply does not seem effective. Many of these organisations have long and distinguished historical roots and it is too much to expect any one of them to give up their own identity at the global level. However, at the National and sub-regional level there seem no such impediments. Therefore, I would like to see us moving in the direction of a single National Committee on International Cooperation in Water Research.

But such a National Committee should be solidly integrated with the emerging SADC Water Sector.

I would like to hear what our SANCIAHS members think about these opportunities.

Hugo Maaren
Sanchias Secretary

DWAF appoints Environmentek to evaluate unconventional water metering and cost recovery systems

Poor cost recovery is one of the major stumbling blocks to the successful and sustainable implementation of community water supply projects. Because of this the Department of Water Affairs and Forestry (DWAF) has appointed the CSIR's Division of Water, Environment and Forestry Technology to evaluate cost recovery systems available in South Africa which are likely to be especially suitable for community water supply schemes. The emphasis of the evaluation will be on systems which incorporate prepaid meters or other unconventional water vending or metering devices.

INVITATION

As a result of this appointment companies which market such cost recovery systems or metering devices are invited to contact the CSIR's Derek Hazelton by fax at (012) 841-3954 or by telephone at (012) 841-4574.

The Department has observed that, as in other countries, people in South Africa are generally willing to pay for a convenient reliable water supply. However, implementing equitable cost effective cost recovery in a typical community is still a formidable challenge. This is because the average water consumption per household is low, the capacity of many of the institutions implementing the cost recovery at local government and village level is limited, and the majority of customers being supplied with the water are poor.

The low water consumption results in the ongoing cost of cost recovery as a percentage of total operation and maintenance costs being high when conventional meter reading and billing methods are used. In addition, in many areas access to community members for meter reading and billing is also difficult. Therefore systems which minimise the cost of cost recovery in such an environment are important.

The limited institutional capacity demands that systems requiring less administrative support structures are required for effective cost recovery.

The widespread financial distress in communities requires systems which help the consumer to budget and which prevent them from receiving surprise bills. It also requires systems which help the authorities to keep the water tariffs as low as possible for basic needs. With low water consumption, water losses as a percentage of water supplied is likely to rise significantly. Therefore, helping the local authority to monitor and control water losses becomes an essential component of the cost recovery system.

These characteristics of the environment within which the cost recovery is to be implemented require innovative technologies and systems for effective solutions. If your company has any such technologies or systems to market please be sure to contact the CSIR.

South African *Legionella* Action Group established

A conference in the USA for the American Legion in 1976, left several ex-soldiers dead. The cause was later ascribed to the presence of a then unknown bacterium which was present in the aerosol of the air-conditioning system of the hotel where the conference was held. The bacterium was isolated and named *Legionella* after this incident and has since been isolated from water systems at hospitals and dentists, industrial cooling water systems, surface water and soil.

A successful *Legionella* seminar and workshop, convened collaboratively by the CSIR and NCOH, was held on the 20th of September 1995. The main purpose was to create an awareness of the prevalence of *Legionella* in South Africa and the associated public and occupational health risks. The workshop focused on the importance of standard detection methods, guidelines for water

treatment and maintenance of water systems and the protection of public and worker health.

LAG

To address these issues, a *Legionella* Action Group (LAG) was formed, representing industry, universities, research organisations and routine laboratories. The main objectives of the LAG are to collect and disseminate information on *Legionella*, to evaluate detection methods in biofilms, bulk water and aerosols, to recommend procedures for analysis and sampling and to recommend appropriate treatment methods for water systems contaminated with *Legionella*. The LAG also intends building a data base of available information on the subject, which will be accessible to all workers in the field, and to hold regular workshops or seminars in various centres around the country. These will focus on both

industrial and medical issues.

A collaborative research project, under management of Delene Bartie (NCOH) has been initiated in an attempt to address some of these issues. The *Legionella* Action Group hopes that this study will initiate the first stages towards a better understanding of this controversial organism, and intends to report on their activities regularly through publications in appropriate newsletters and journals. Contributions and/or comments from all other interested parties are welcome.

The members of the LAG are Delene Bartie (NCOH), Pauline Coubrough (CSIR), Esmé Croucamp (SWIFT), Yvonne Bilgeri (SAIMR), Kelly Reynolds (ESKOM), Roy Roos (SABS), Audi Snyman (Polifin), Charles Bodenstein (Chematron), Hanlie Prinsloo and Fred Goede (SASTECH).

SA WATERKALENDER

The Water Research Commission is placing this calendar 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 koördinerings van watergebeurtenisse in Suid-Afrika.

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

Adres:
Die Redakteur
Posbus 824
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Tel: (012) 330-0340
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Gids:

- Een SA Watergeleentheid vir hierdie dae.
- 'n Tweede SA Watergeleentheid vir dié datums.
- × 'n Derde SA Watergeleentheid vir dié datums.

Sien Konferensies- en Simposiumbladsy vir aangeduide geleenthede.

1997

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SOUTHERN
AFRICA

1997

WATER RESOURCES
JANUARY-FEBRUARY

WR90 courses will be held at various centres in South Africa. See advertisement on page 31 in this Bulletin.

METEOROLOGY
APRIL 7 - 11

The 5th international conference on southern hemisphere meteorology and oceanography will be held at the University of Pretoria. Enquiries: Conference Planners: Amie Wissing. Tel and Fax: (012) 46-0170.

FORESTS
MAY 11 - 17

A workshop with the theme: Forests at the limit: Environmental constraints on forest function will be held at Skukuza in the Kruger National Park, Mpumalanga.

Enquiries: Ms Tisha Greyling, IUFRO Workshop Secretariat PO Box 95823, Waterkloof 0145. Tel: (012) 346-1517 Fax: (012) 46-7909 E-mail: liaison @ cis.co.za

SAICE
JUNE 2 - 4

The 2nd international mining and industrial waste conference will be held in Midrand, Gauteng. Enquiries: Lesley Stephenson, Conference Secretary, PO Box 327, Wits 2050. Tel: (011) 716-5091 Fax: (011) 339-7835.

WEDC '97
SEPTEMBER 1 - 5

The 23rd WEDC conference will be held at the International Convention Centre in Durban. Theme: Water and sanitation for all. **Call for papers.** Deadline: 31 January 1997. Suitable topics for papers include: Community management of water and sanitation supply; Hygiene, education and marketing programmes; Low-cost sanitation; Non-conventional sources of water; Environmental problems and their solution; Solid waste man-

agement; Recycling of wastes; Use of solar energy; Cost recovery techniques; Partnerships with the private sector; Local government capacity building; Groundwater use; Innovative water supply and sanitation solutions; Gender issues; Integrated community development; Balancing delivery and participation; and Management of resources for potable water.

Enquiries: Conference Secretariat, Congress International, 18 Rapson Road, Morningside 4001, Durban. Tel: (031) 233-494. Fax: (031) 232-405. E-mail: ci@neptune.infolink.co.za

ENVIRONMENTAL
MANAGEMENT
SEPTEMBER 8 - 10

A specialised conference on Chemical process industries and environmental management will be held at the new five-star Table Bay Hotel, Waterfront, Cape Town. **Call for papers:** Deadline for abstracts is 30 November 1996.

Enquiries: Conference Secretariat: Ms Cilla Taylor, Conference Planners, PO Box 82, Irene 1675. Tel: (012) 63-1681. Fax: (012) 63-1680.

HYDRAULICS
NOVEMBER 5 - 7

The third in the series of international River Flood Hydraulics conferences will be organised by HR Wallingford in partnership with the University of Stellenbosch at Stellenbosch. Topics to be covered include flood hydraulics and hydrology, management of developments on flood plains, flood control, sediment transport and river morphology, flow measurement: social, economic and environmental aspects. **Call for papers.** Deadline: December 1996. Enquiries: Prof A Rooseboom, University of Stellenbosch. Tel: (021) 808-4353. Fax: (021) 808-4361.

DAM DESIGN
NOVEMBER 3 - 4

A course on the design of smaller dams will be offered under the auspices of SANCOLD at the University of Stellenbosch. Enquiries: Prof A Rooseboom, University of Stellenbosch. Tel: (021) 808-4353. Fax: (021) 808-4361.

HYDROLOGY
NOVEMBER 17 - 19

The SANCIAS/SAICE '97 conference will be held at the University of Pretoria. See advertisement on page 2 in this Bulletin.

OVERSEAS

1997

CRYPTOSPORIDIUM
MARCH 2 - 5

An international symposium on waterborne cryptosporidium will be held in Newport Beach, California, USA. Enquiries: Brian Murphy, AWWA, 6666 W Quincy Ave., Denver, CO 80235, USA. Tel +1 303 347 6194. Fax: +1 303 794 8915.

AUSTRALIAN WATER
MARCH 16 - 21

The 17th Australian Water & Wastewater Association federal convention will be held in Melbourne, Australia. Enquiries: AWWA, PO Box 388, Artarmon, NSW 2064, Australia. Tel: +61 2 413 1288. Fax: +61 2 413 1047.

REUSE OF WATER
APRIL 1997

A WEF conference on the beneficial reuse of water and solids will be held in Marbella, Spain. Enquiries: Linda Blankenship, WEF. Tel: +1 703 684 2400. Fax: +1 703 684 2492.

GROUNDWATER
APRIL 7 - 11

An international conference and course on Analytic based modeling of groundwater flow, will take place in Nunspeet, the Netherlands. Enquiries: The Conference Secretariat, MOORGA, Buerweg 51, 1861 CH Bergen, the Netherlands. Tel: +31 7258-99062 Fax: +31 7258 99040

OXIDATION
APRIL 21 - 23

A symposium on oxidation methods for water and wastewater

treatment will be held in Berlin, Germany.

Enquiries: IOA European African Group, 83 Avenue Foch, F-75116 Paris, France.

RAINWATER
APRIL 21 - 25

The 8th international conference on rainwater catchment systems will be held in Tehran, Iran. Enquiries: Mr J Ghoddousi, PO Box 13445-1136, Tehran, IR Iran. Tel: +98 21 6418335 Fax: +98 21 6407214 E-mail: RAIN@NEDA.NET.IR

WATER INDUSTRY
APRIL 21 - 25

An international water industry exhibition will be held in conjunction with Wasser Berlin '97 in Berlin, Germany. Enquiries: Messe Berlin GmbH, IFW/M3, Messedamm 22, D-14055 Berlin. Tel: (030) 30380. Fax: (030) 3038-2079.

IAHS 97
APRIL 23 - MAY 3

The 5th Scientific Assembly of the International Association of Hydrological Sciences will take place in Rabat, Morocco. Enquiries: Direction Generale de l'Hydraulique, Casier Rabat, Chellah, Maroc. Tel: +212 7 769008. Fax: +212 7 778696.

SLUDGE
APRIL 30 - MAY 2

A conference on the management and fate of toxic organics in sludge applied to land will be held in Copenhagen, Denmark. Enquiries: Mia Clausen, Building 115, Technical University of Denmark, DK-2800 Lyngby, Denmark. Tel: +45 45 251613. Fax: +45 45 932850. E-mail: mc@imt.dtu.dk

DEPOLURB '97
MAY 18 - 22

Depolurb '97 - an international conference on waste pollution control and environmental management in large metropolitan areas will be held in Sao Paulo, Brazil. Enquiries: IAWQ Brazilian National Committee, Rua Conde de Irajá, 260/1 andar, 22271-020, Rio de Janeiro, Brazil. Tel: +55 21 537 4338. Fax: +55 21 537 7991. E-mail: depolurb@fageventos.com.br

WATER SUPPLY

MAY 19 - 22

A conference on reservoir management and water supply - an integrated system - will be held in Prague, Czech Republic.

Enquiries: Dr Petr Dolejs, IWSA/IWQ Conference, W&ET Team, Box 27, Pisecka 2, 370 11 Ceske Budejovice, Czech Republic. Tel/Fax: +42 38 41624.

ASIAN WATERQUAL '97

MAY 20 - 23

Asian Waterqual '97 - the 6th IAWQ Asia-Pacific regional conference will be held in Seoul, Korea.

Enquiries: The Secretariat, SL Kangnam, PO Box 305, Seoul 135-603, Korea. Tel: +82 2 3476 7700. Fax: +82 2 3476 8800. E-mail: koconex @chollian.dacom.co.kr

WATER SYSTEMS

MAY 25 - 28

An IWSA and IAWQ specialised conference on the Upgrading of water and wastewater systems will be held in Kalmar, Sweden. Enquiries: Dr Ulf Lidman, Dept of Natural Sciences, University of Kalmar, Box 905, S 391 29 Kalmar, Sweden. Tel: (46) 480-446235 Fax: 480-446262

AD-97

MAY 25 - 29

The 8th international conference on anaerobic digestion will be held in Sendai, Japan.

Enquiries (local): Prof Trevor J Britz, Department of Food Science, University of Stellenbosch, Private Bag X1, Matieland 7602. Tel: (021) 808-3578 Fax: (021) 808-3510. E-mail: voedselw@land.sun.ac.za

SEWERS

MAY 26 - 28

The 2nd international conference on The sewer as a physical, chemical and biological reactor will be held in Aalborg, Denmark.

Enquiries: Kirsten Andersen, Environmental Engineering Laboratory, Sohngaardsholmsvej 57, DK-9000 Aalborg, Denmark. Tel: +45 98 158522 ext 6522. Fax: +45 98 142555. E-mail: i5ka@civil.auc.dk

ACID DRAINAGE

MAY 31 - JUNE 6

The fourth international conference on rock acid drainage with the theme: "Application of Technology" will take place in Vancouver, British Columbia, Canada.

Enquiries: 4th ICARD, att. Peggy Shepard, Venue West Conference Services, 645 - The Landing, 375 Water Street, Vancouver, BC Canada V6B 5C6. Tel: (604) 681-5226. Fax: (604) 681-2503. E-mail: congress@venuewest.com

WATERMATEX '97

JUNE 18 - 20

Watermadox '97 - the 4th international symposium on systems analysis and computing in water quality management will be held in Quebec City, Canada.

Enquiries: Dr Paul Lessard, Department Genie Civil, Pavillion Pouliot, Universite Laval, Quebec, QC, Canada, G1K7P4. Tel: +1 418656 7293. Fax: +1 418 656 2928. E-mail: paul.lessard@gci.ulaval.ca

INSTRUMENTATION

JULY 6 - 11

The 7th IAWQ workshop on instrumentation, control and automation of water and wastewater treatment and transport systems will be held in Brighton, UK.

Enquiries: Concorde Services, 10 Wendell Road, London, W129RT, UK. Tel: +44 181 743 3106. Fax: +44 181 743 1010. E-mail: 101611.3664@copuserve.com

ENVIRONMENTAL RESTORATION

JULY 7 - 9

The first international conference on environmental restoration will be held in Ljubljana, Slovenia. Conference themes: river, soil and groundwater contamination, pesticides/PCB/oil pollution, disposal of domestic waste/industrial waste/construction industry wastes and hazardous waste management.

Enquiries: Dr Milenko Ros, Slovenian Water Pollution Control Association, Hajdrihova 19, PO Box 3430, SLO-1001 Ljubljana, Slovenia. Tel: +386 61 1760237 Fax: +386 61 125 9244 E-mail: milenko.ros@ki.si

ACTIVATED SLUDGE

JULY 21 - 23

The second international conference on Microorganisms in activated sludge and biofilm processes will be held at Berkeley in California, USA.

Enquiries: Professor David Jenkins, Microorganisms Conference, Department of Civil & Environmental Engineering, University of California at Berkeley, Berkeley CA 94720-1710, USA. Tel/Fax: 510 527-0672. E-mail: jenkins@ce.berkeley.edu

LARREN '97

AUGUST 25 - 28

An international conference on land reclamation and rehabilitation will be held in Penang, Malaysia.

Enquiries: Larren '97, School of Civil Engineering, Universiti Sains Malaysia, Perak Branch Campus, 31750 Tronoh, Perak, Malaysia. Tel: 605-3676901 ext 5412. Fax: 605-3677440.

IWRA

SEPTEMBER 1 - 6

The 9th world water congress of the International Water Resources Association (IWRA) will take place in Montreal, Canada. Theme: Water resources outlook for the 21st century - Conflicts & Opportunities.

Enquiries: Aly M Shady, Canadian International Development Agency, 200 Promenade du Portage, Hull, Quebec, Canada K1A 0G4. Tel: +1 (819) 994-4098 Fax: +1 (819) 953-3348 E-mail: aly-shady@ACDI-CIDA.GC.CA

SEDIMENTS

SEPTEMBER 7 - 11

An international conference on contaminated sediments will be held in Rotterdam, the Netherlands.

Enquiries: Van Namen & Westerlaken Congress Organisation Services, PO Box 1558, 6501 BN Nijmegen, the Netherlands. Tel: +31 24 323 44 71. Fax: +31 24360 1159.

CATCHMENT MANAGEMENT

SEPTEMBER 23 - 25

A seminar and workshop on integrated catchment and watershed management will be held at the

University of New England in Australia.

Enquiries: John Pigram, Centre for Water Policy Research, University of New England, Armidale, NSW 2351 Australia. Tel: 067 73 2420. Fax: 067 73 3237. E-mail: jpigram @metz.une.edu.au

HYDROLOGY

SEPTEMBER 25 - 27

An international symposium on emerging trends in hydrology will be held in Roorkee, India. **Call for papers.** Closing date: 31 December 1996.

Enquiries: Dr DC Singhal, Professor and Organising Secretary (ISETH), Department of Hydrology, University of Roorkee, Roorkee-247667, India. Tel: (091) 1332 72349 (ext 336). Fax: (091) 1332-73560. E-mail: hydro@rurkiu.ernet.in

LANDFILL

OCTOBER 13 - 17

The sixth International Landfill Symposium will be held in Cagliari, Sardinia, Italy.

Enquiries: Ms Anne Farmer, CISA - Environmental Sanitary Engineering Centre, Via Marengo 34 - 09123 Cagliari (Italy). Tel: +39-70-271652. Fax: +39-70-271371. E-mail: cossur @vaxca3.unica.it

WEFTEC '97

OCTOBER 18 - 22

The American Water Environment Federation's 70th annual conference and exposition will be held in Chicago, Illinois USA. **Call for papers:** Deadline: 16 December 1996.

Enquiries: WEFTEC '97 Program, 601 Wythe Street, Alexandria, Virginia 22314-1994 USA. Tel: 1-703-684-2452 Fax: 1-703-684-2471.

OZONE

OCTOBER 26 - 31

The 13th world congress of the International Ozone Association will be held in Kyoto, Japan.

Enquiries: Congress Corporation. Tel: +81 (6) 454 3740. Fax: +81 (6) 454 4711.

BESPROEING

Besproeiingsontwerphandleiding vir Suid-Afrika

Die provinsiale departemente van landbou tesame met die Instituut vir Landbou-Ingenieurswese van die Landbounavorsingsraad te Silverton het gedurende Januarie 1994 besluit om 'n besproeiingsontwerphandleiding te skryf.

Die handleiding bestaan uit 20 hoofstukke wat alle komponente van besproeiing dek, naamlik, grond, water, gewasse en besproeiingstelsels. Die interpretasie van belangrike teoretiese konsepte sowel as die verskillende ontwerpprosedures word geïllustreer deur praktiese voorbeelde.

Die voltooiingsdatum vir die handleiding is Desember 1996. Alhoewel die eerste uitgawe in Afrikaans is, sal die handleiding teen Maart 1997 ook in Engels verkrygbaar wees.

Persone wat belangstel om die handleiding teen R100 (BTW ingesluit) te koop, moet asseblief die onderstaande bestelvorm voltooi en dit saam met die geld na die betrokke adres terugstuur.

IRRIGATION

Irrigation design manual for South Africa

During January 1994, the provincial departments of agriculture together with the Institute for Agricultural Engineering of the Agricultural Research Council in Silverton, decided to compile an irrigation design manual.

The manual comprises of 20 chapters which cover all the components of irrigation, namely, soil, water, crops and irrigation systems. Interpretation of important theoretical concepts and design procedures has been illustrated with practical examples.

The completion date for the manual has been set for December 1996. Although the first edition will be in Afrikaans, the intention is to have an English version ready by March 1997.

Persons interested in purchasing the manual at R100 (VAT incl.) per copy, should please complete the order form below and return it, together with the money, to the address indicated.

BESTELVORM/ ORDER FORM

Stuur asseblief Afrikaanse kopieë @ R100 per kopie aan die volgende adres:

Please send English copies @ R100 per copy to the following address:

Titel/Title..... Voorletters/Initials..... Van/Surname.....

Adres/Address.....

Dorp/Town Kode/Code

Tel/Fax

Ingesluit my tjek vir R. /Enclosed my cheque for R

(Tjeks aan: **Direkteur:Instituut vir Landbou-Ingenieurswese**)
(Cheques are payable to: **Director: Institute of Agricultural Engineering**)

POS AAN/SEND TO:

Mnr F H Koegelenberg,
Departement Landbou: Wes-Kaap,
Direktoraat: Landbou-Ingenieurswese,
Privaatsak X1, Elsenburg 7607.
Navrae/Enquiries: Tel (021) 808-5357

Handtekening/Signature

Getting to know and use WR90

The WR90 publication *Surface Water Resources of South Africa 1990* has been available from the Water Research Commission for approximately a year. Descriptions of the Reports and Order Forms were distributed in a recent issue of the SA Waterbulletin and in some Journals. It is time now to ensure that water engineers and earth scientists are able to make the best use of the vast store of data and design aids in the Reports. The Commission has accordingly arranged for two-day courses at the main centres and mini-courses at other centres to be held during 1997.

The cost of the two-day course is R600 per participant and the mini-course R400, including lunches and refreshments. Participants may purchase a manual and one set of regional maps and appendices for R100 which is roughly half the normal price.

The two-day course will take the form of computer hands-on problem-solving sessions followed, on the afternoon of the second day, by a feed-back discussion session at which it is hoped to identify errors and elicit suggestions for additions, improvements, ideas for future updating of the Survey. The mini-courses will be presentations showing how WR90 information can be used for problem-solving.

TWO-DAY COURSES

DATE

PROBABLE VENUE

Durban/PMB	<input type="radio"/> 10 & 11 February 1997	Univ of Natal - Pietermaritzburg
Grahamstown/Port Elizabeth	<input type="radio"/> 13 & 14 February 1997	Port Elizabeth University
Pretoria/Johannesburg	<input type="radio"/> 6 & 7 February 1997	Pretoria University
Stellenbosch/Cape Town	<input type="radio"/> 28 & 29 January 1997	Stellenbosch University

MINI-COURSES

Swaziland/Nelspruit	<input type="radio"/> 18 February 1997	Drum Rock Complex
Lesotho/Bloemfontein	<input type="radio"/> 31 January 1997	GRI Bloemfontein University
Pietersburg	<input type="radio"/> 21 January 1997	Library Activity Centre
East London	<input type="radio"/> 4 February 1997	King David Hotel

APPLICATION FORM: WR90 COURSE

Name: Organisation:

Postal Address:

Tel: Fax:

I wish to attend the course at:

Registration fee: R600/R400 (inc VAT) Purchase of manuals: R100 (inc VAT)

I enclose cheque of: R made out to SRK WR90 Course.

Please complete and return to:
Brian Middleton, SRK, P O Box 55291, Northlands, 2116 before 30 November 1996.
Enquiries to Harriet at Tel.: (011) 441-1265 Fax: (011) 441-1174