SA waterbulletin

ISSN 0258-2244 Volume 21 No 5 September / Oktober 1995

GROUNDWATER
New tool developed for waste site selection.

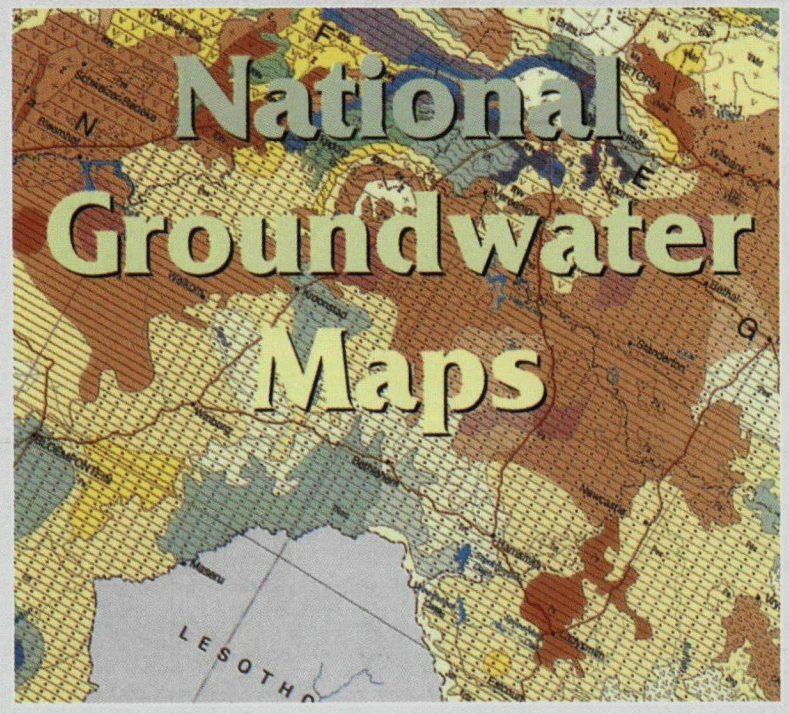
LANDBOUWATER
Opgaring van reënwater in grond vir droëlandboerdery.

WATER SUPPLY
Report released on the long-term use of plastic piping.

NATIONAL GROUNDWATER MAPS

The first attempt at providing synoptic and visual information on South Africa's groundwater resources

Prepared for the Water Research Commission by JR Vegter



The set of hydrogeological maps has been produced on two A0 sheets as follows:

- **Sheet 1:**
  Borehole prospects in colours superimposed on a background of lithostrati-graphy indicated by different hachuring and letter symbols (scale 1:2.5 million).

- **Sheet 2**
  - ❑ Saturated interstices providing a qualitative indication of groundwater storage (scale 1:4 million)
  - ❑ Depth of groundwater level (scale 1:7.5 million)
  - ❑ Mean annual groundwater recharge (scale 1:7.5 million)
  - ❑ Groundwater component of river flow (base flow) (scale 1:7.5 million)
  - ❑ Groundwater quality (scale 1:7.5 million)
  - ❑ Hydrochemical types (scale 1:7.5 million)

A Guide on how to read and understand the maps is included. The Guide also gives a short exposition of hydrogeological principles on which the maps are based and how they were compiled.

Note: It should be emphasised that these maps depict groundwater conditions on a regional scale. They are not site-specific and cannot be used for borehole siting or for deducing any other site-specific condition. Such an exercise requires local investigations and larger scale maps.

Price: R114,00 (VAT, postage and packing incl.) for a set of two maps together with the Guide. Please send payment with your order. Proforma invoices will be issued on request.

Orders: The maps are obtainable from
The Librarian,
Mrs Tineke van der Schyff,
The Water Research Commission,
PO Box 824, Pretoria 0001.

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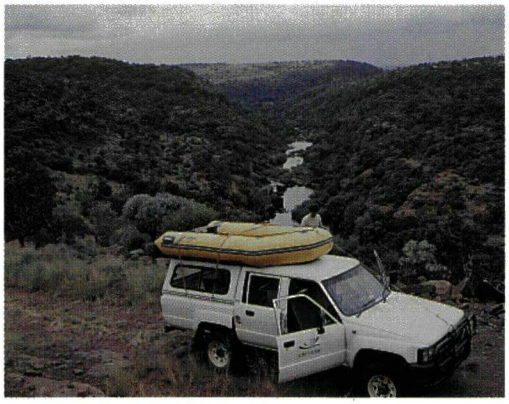

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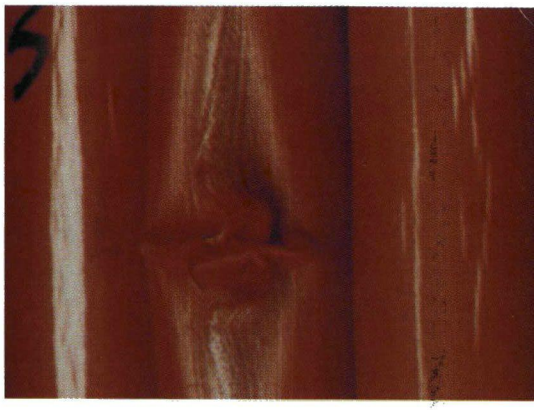

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Voorblad: Droëlandboerdery - 'n land naby Brits word gereed gemaak vir die nuwe plantseisoen. Sien artikel op bladsy ses. (Foto: Jan du Plessis)

SA Waterbulletin is a two monthly magazine on water and water research published by the South African Water Research Commission (WRC), a statutory organisation established in 1971 by Act of Parliament. Subscription is free. Material in this publication does not necessarily reflect the considered opinions of the members of the WRC, and may be copied with acknowledgement of source. Editorial offices: Water Research Commission, PO Box 824, Pretoria 0001, Republic of South Africa. Tel (012) 330-0340. Fax (012) 331-2565. Editor: Jan du Plessis. Asst Editor: Helene Joubert. Ed Secretary: Rina Human. Layout: Prepress Images, Pretoria. Colour Separations: Lithotechnik. Printing: Beria Printers.

IWSA Congress *'sans frontiers'*

Dignitaries at the opening of the IWSA Congress and Exhibition (from left): Mr Vincent Bath, Chief Executive of Rand Water, the Mayor of Durban, Councillor SS Ngwenya, the Minister of Water Affairs and Forestry, Prof Kader Asmal with Dr Bob Laburn, President of the IWSA Congress and Mr Pierre Giacasso, President-Elect of the International Water Supply Association (IWSA).

Recently the 20th International Water Supply Association (IWSA) Congress and Exhibition was held in Durban. Some 2000 delegates and exhibitors from 33 different countries convened for this event. The congress theme was "Water supply - the essential service: working for excellence". According to Dr Bob Laburn, President of the Congress, this representative gathering of the world's leading water scientists, engineers and technicians underlines the importance of water supplies in today's world.

The actual congress proceedings was preceded by a very generous opening ceremony at which President Nelson Mandela spoke a word of welcome to the delegates by way of a video presentation. The Minister of Water Affairs and Forestry, Professor Kader Asmal, gave a picture of the South African water scene in his opening address, and IWSA President-Elect, Mr Pierre Giacasso, presented his inaugural address.

REPORTS AND PAPERS

Nine international reports and sixteen special subject papers were presented to the congress. These reports and papers took the form of a brief introductory international overview followed by a number of short national reports on that particular subject. Special contributors and national rapporteurs were responsible for the national reports that were collated to form international reports or special subject papers. This afforded all member countries the opportunity to participate and contribute to the congress, and gave delegates up-to-date reports of what is happening world wide with regard to each subject presented.

The International Report topics were: water quality standards; planning and design for continuity and reliability in distribution systems; network management; elements influencing the price of water; monitoring efficiency; service provisions and capital investment; how to reduce conflict in water management: employ new resources or change existing habits; the environmental imperative; and state-of-the-art techniques in reverse osmosis, nanofiltration and electrodialysis in drinking water supply.

The special subjects included the influence of water metering on water consumption; customer relations and service; disinfection and disinfection by-products; evaluation and actions in case of accidental pollution; pathogenic protozoa in raw and drinking water; eutrophication and development of algae in surface water; water treatment in small water systems; interaction of microbiological processes, water, biofilm and pipe materials in water distribution networks; micro- and ultrafiltration in drinking water treatment; advances in the economics of leakage control and unaccounted-for water.

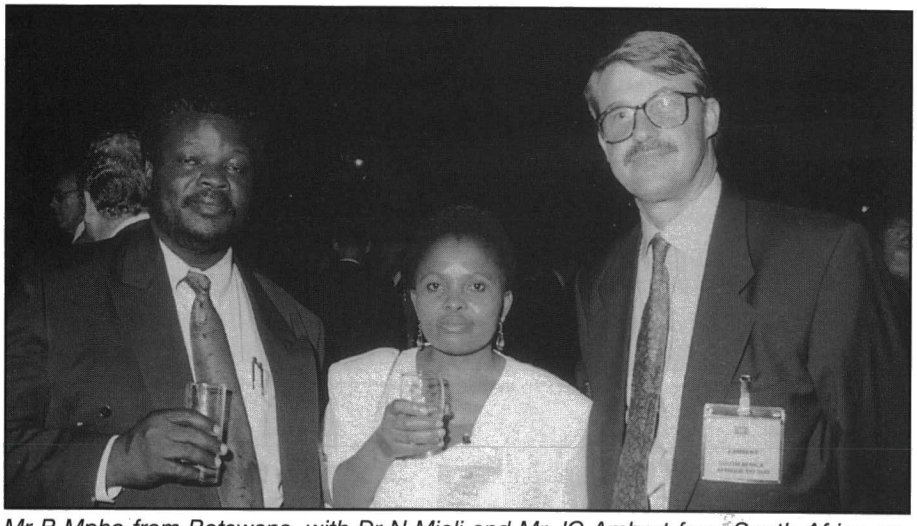
SA CONTRIBUTERS

South African water managers and researchers contributed to the congress reports and papers from their experience and vantage point. In the national report on water pricing, Mr HJ Best of the Department of Water Affairs indicated that the price of water in South Africa can be expected to increase steadily in future, as demand was growing fast while availability remained the same.

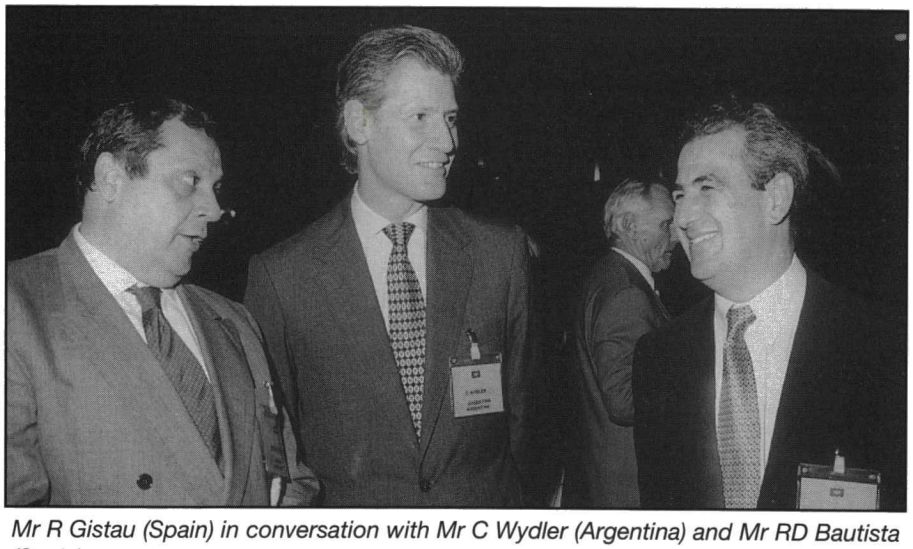
Regarding network management sytems Mr Graham Ward, Director of Operations at Umgeni Water, said that South Africa is a mix of the developed and the developing, and pointed out the importance of reviewing social changes that are influencing decisionmaking in the water industry. He said that the present population growth rate of three per cent and an expected rate of urbanisation of five per cent is presenting a formidable challenge to South African water supply agencies

The focus on the quality of drinking water as reflected in the new World Health Organisation (WHO) Guidelines was brought to the fore in the international report on water quality standards, which was presented by Mr SW van der Merwe of Rand Water. In concluding this report, he did point out that in developing national drinking water standards based on these new guideline values, it will be necessary to take into account a variety of geographic, socio-economic and other factors "and this may lead to national standards that differ appreciably from the WHO guideline values".

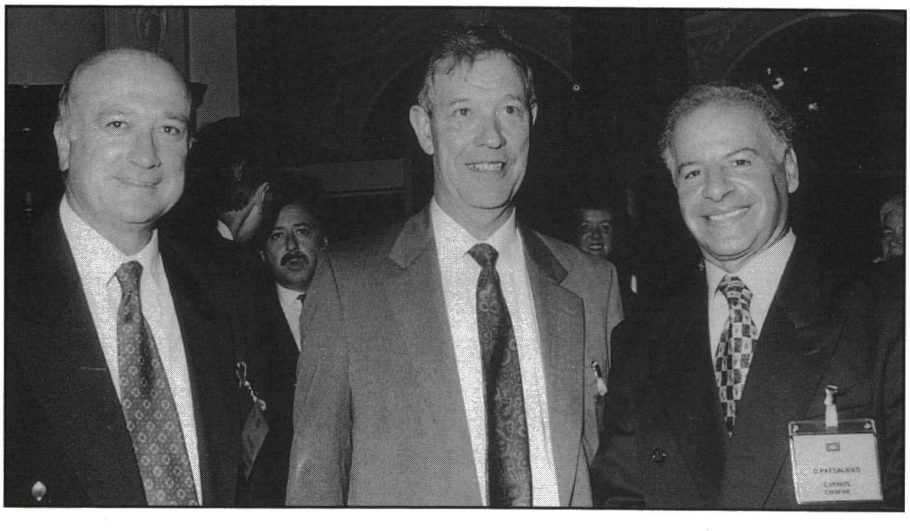
Forty poster presentations by researchers brought various fields of research in the drinking water industry worldwide to the fore. South African authors presented posters about research on unit treatment processes and the morphological characteristics of algae; an algal toxin monitoring protocol, and "On-line monitors - the Rand Water experience".



Mr B Mpho from Botswana, with Dr N Mjoli and Mr JC Ambert from South Africa, as delegates to the IWSA Congress.



Mr R Gistau (Spain) in conversation with Mr C Wydler (Argentina) and Mr RD Bautista (Spain).



Right: Mr J McGown and Mr JR Browning were delegates from the UK, and Mr D Patsalides represented Cyprus.

Opgaring van reënwater in grond ondersoek by droëlandboerdery

Allerweë word aanvaar dat besproeiing die enigste wyse is waarop plantproduksie in droë en halfdroë klimaatstreke gestabiliseer kan word. Maar die toenemende beperking op die voorraad besproeiingswater, die geweldige koste om nuwe besproeiingskemas te ontwikkel en die hoë instandhouding en operasionele koste van bestaande besproeiingskemas, veroorsaak dat besproeiingsboerdery al hoe moeiliker in droë gebiede beoefen kan word. Die alternatief is om droëland en reënafhanklike boerderystelsels te ontwikkel wat op volhoubare beginsels gegrond is.

So sê navorsers van die Departement Grondkunde aan die Universiteit van die Oranje-Vrystaat in 'n verslag oor die opgaring van reënwater in grond vir die stabilisering van plantproduksie in halfdroë gebiede. Die navorsers, ATP Bennie, JE Hoffman, MJ Coetzee en HS Vrey, sê in die verslag die doelstellings van die navorsingsprojek wat deur die Water-navorsingskommissie gefinansier is, was soos volg:

- Die bepaling van die impak van verskillende grondbenuttings- en bewerkingspraktyke op die grondwaterbalans met die mees effektiewe reënvalopgaring binne die wortelsone as doel.

- Die bepaling van die doeltreffendheid van gebruik van opgegaarde plantopneembare water deur verskillende wyses van grondbenutting. Dit behels natuurlike weiding in verskillende suksessiestadiums, kontantgewasse soos koring, mielies en graansorghum gekombineer met verskillende bewerkingspraktyke en lengte van wateropgaringsperiodes.

- Die vergelyking van die ekonomiese implikasies van die verskillende wyses van reënvalbenutting.

- Verskaffing van bestuursriglyne vir optimale droëlandwateropgaring en gebruik van reënval vir plantproduksie in halfdroë klimaatstreke.

Die navorsers sê om die eerste doelstelling te bereik is 'n intensiewe studie van die grondwaterbalans onder droëlandtoestande gemaak om te bepaal hoe dit deur verskillende wyses van grond- en waterbestuur beïnvloed word. Dit sluit in drie grondbewerkingspraktyke, naamlik:

- **Konvensionele bewerking** wat 'n skoon, onbedekte grondoppervlak laat.

- **Deklaagbewerking** wat sodanig uitgevoer word dat die maksimum hoeveelheid plantreste op die oppervlak gelaat word om waterinfiltrasie te verbeter en grondoppervlakverdamping te verminder.

- **Geenbewerking** waar die grondoppervlak slegs met die plantproses versteur word en chemiese onkruidbeheer toegepas word.

PLANTPRODUKSIE

Verskillende wyses van plantproduksie is vergelyk om te bepaal hoe doeltreffend die reënwater in die grond opgegaar is en hoë reënval gedurende die groeiseisoen benut word. Dit het die volgende gewasverbouingspraktyke ingesluit: jaar na jaar verbouing van 'n wintergewas (koring) wat hoofsaaklik op opgegaarde water in 'n somerreënstreek groei. Jaar na jaar verbouing van 'n somergewas (mielies, graansorghum, sonneblom) wat gedurende die reënseisoen groei. 'n Wisselboustelsel waar somer- en wintergewasse afgewissel word om sodoende die tydperk vir wateropgaring van vyf na tien tot twaalf maande te verleng. 'n Stelsel met 'n bestuursopsie waar 'n gewas geplant word wanneer die plantbeskikbare water in die potensiële wortelsone meer as 120 mm is. Hierdie gewasverbouingspraktyke is met die produksie van aangeplante weidings en klimaks en subklimaksveld vergelyk.

Die vergelykende studies is op proefterreine in die Vrystaat te Bloemfontein, Petrusburg, Hoopstad en Tweespruit herhaal en metings het oor vier jaar vanaf 1989 tot 1993 gestrek, dus vier winter- en vier somergroeiseisoene. Die 1990-91 somer- en 1991 wintergroeiseisoene het bogemiddelde reën ontvang. Die 1988-89 en 1989-90 somerseisoene was gemiddeld en die res van die groeiseisoene het 'n ondergemiddelde reënval gehad.

Daar is onderskei tussen die waterbalans van die reënopgaringsperiode, wat vanaf die oes van die vorige gewas tot plant van die huidige gewas strek, en die waterbalans gedurende die groeiseisoen. Gedurende die reënopgaringsperiode het die gemiddelde afloop, afhangende van die hoeveelheid reën en tipe reënbuie, gewissel tussen ses en dertien persent van die totale reënval gedurende die opgaringsperiode by Bloemfontein en Tweespruit waar afloop gemeet is. Die afloop was, anders as wat verwag sou word, hoër by geenbewerking en kan verminder word deur die grond met bewerking te versteur. In die afwesigheid van 'n vlak watertafel het die grondoppervlakverdamping tussen 62 en 70 persent van die reënval beloop. By Hoopstad waar 'n vlak watertafel teenwoordig was, was die gemiddelde verdampingsverliese gedurende die reënopgaringsperiode 92

persent van die reënval. Diep perkolasie het hoofsaaklik gedurende die periodes van bogemiddelde reënval voorgekom en het gemiddeld tussen 8 en 15 persent gewissel. By Petrusburg, met 'n diep sanderige grond sonder 'n diepliggende kleilaag wat perkolasie beperk, is diep perkolasiewaardes van tot 36 persent van die reënval gemeet. By Tweespruit waar meer kleierige grond aangetref word, was die diep perkolasie minder as agt persent en meestal laer as twee persent van die reënval.

Die navorsers sê die persentasie van die reënval gedurende die opgaringsperiode wat binne die grondprofiel gestoor is, naamlik die reënopgaringsdoeltreffendheid, het toegeneem hoe droër die gronde na die verwydering van die oes was. Dit het tussen 15 en 30 persent gevarieer. Die toepassing van deklaag- of geenbewerking het geen positiewe uitwerking op die reënopgaringsdoeltreffendheid gehad nie. Die mate van grondbedekking deur die plantreste, wat meestal laer as 50 persent was, was onvoldoende om verdamping en afloop te verminder.

Gedurende die groeiseisoen het die minste afloop vanaf klimaksveld plaasgevind, naamlik gemiddeld drie persent van die jaarlikse reënval. Met bewerking van die grond het die afloop verhoog na tien tot 12,5 persent. Diep perkolasie was negatief gedurende die wintergroeiseisoen, dit wil sê water het opwaarts vanaf die natter grondlae in die wortelsone inbeweeg. Gedurende die somergroeiseisoene met bogemiddelde reënval, het diep perkolasie wel voorgekom. Die hoogste waarde wat gemeet is, was 16 persent van die groeiseisoen se reënval by Petrusburg. Volgens die navorsers is 'n gemiddelde langtermyn diep perkolasiewaarde van een tot twee persent van die reënval meer realisties.

By die veld is dit weglaatbaar klein, maar gewasproduksie bevorder die aanvulling van die ondergrondse waterbronne. Daar is nie gepoog om 'n onderskeid tussen grondoppervlakverdamping en transpirasie gedurende die groeiseisoen te tref nie.

Doelstelling twee van die projek: die bydrae van die voor plant opgegaarde water tot die totale evapotranspirasie gedurende die groeiseisoen was gemiddeld 37 persent vir koring, 12 persent vir die somergewasse en 28 persent by die wisselboustelsel. Die mate waarin die grond gedurende die groeiseisoen uitgedroog is, het volgens die hoeveelheid en verspreiding van die reën gewissel tussen gemiddeld 60 to 100 persent.

SWAKKER OESTE

Volgens die navorsingsresultate het die toepassing van deklaag- en geenbewerking op die sanderiger gronde, veral by koring en graansorghum, swakker oesopbrengste as konvensionele bewerking tot gevolg gehad. Die swakker oesopbrengste was nie die gevolg van swakker watervoorsiening nie en die redes was moontlik wortelsiektes of fitotoksisiteit. Die swakker produksie het die interpretasie van die waterbalansresultate bemoeilik omdat dit met laer evapotranspirasie gepaard gegaan het. By koring en graansorghum het 'n toenemende hoeveelheid profielbeskikbare water met planttyd tot dienooreenkomstige verhogings in oesopbrengs aanleiding gegee en kan in droeë seisoene tot 58 persent van die totale evapotranspirasie van koring uitmaak.

By al die gewasse is daar goeie regressieverwantskappe tussen die oesopbrengs en die groeiseisoenreënval bepaal. Die mate waarin die grondprofiel uitgedroog is, (uitgedruk as 'n persentasie van die profielbeskikbare water met planttyd) het afgeneem met 'n toename in die groeiseisoenreënval. Die navorsers sê die uitwerking van die reënvalverspreiding op hierdie bepaalde verwantskappe moet nog verder ondersoek word. By Hoopstad is daar bereken dat die vlak watertafel in droë jare 'n bydrae van so hoog as 70 persent tot die gewaswaterverbruik kan maak. By die veld en aangeplante weidings was die produksie afhanklik van die groeiseisoenreënval behalwe in een seisoen toe goeie lentereëns deur 'n droë somer opgevolg is. Die veld het daardie somer ten spyte van die lae reënval 'n goeie produksie gelewer weens die bydrae van die opgegaarde water van die vorige lente. Goeie, bruikbare verwantskappe tussen produksie en evapotranspirasie is vir al die gewasse en veldtipes bepaal.

PRODUKSIEKOSTES

Rekord is gehou van die produksiekostes vir al die behandelings en gevolglik was dit moontlik om die doeltreffendheid waarmee reën na produksie omgeskakel word op 'n massa- en geldwaarde basis te bereken. Die waterverbruiksdoeltreffendheid wat 'n indeks van die produksie per hektaar per millimeter evapotranspirasie is, is in bogrondse plantmassa (kilogram per hektaar per millimeter), bruto inkomste (rand per hektaar per millimeter) en inkomste na produksiekoste (rand per hektaar per millimeter) bereken. Die syfers wat verkry is, maak dit nou moontlik om die koste van waterverliese deur afloop, verdamping of diep perkolasie te kwantifiseer. Die reënverbruiksdoeltreffendheid wat 'n indeks van die produksie per hektaar per millimeter reën plus die verandering in die profielwaterinhoud is, is op dieselfde wyse as die waterverbruiksdoeltreffendheid gekwantifiseer. Die navorsers sê dit het aangedui dat 'n wisselbou gewasproduksiestelsel, wat met konvensionele bewerking uitgevoer word, die mees volhoubare en ekonomiese stelsel is. Die hoë koste van chemiese onkruidbeheer en laer produksie met die bewaringsbewerkingspraktyke, veroorsaak dat dit nie by boere aanbeveel kan word nie. By Hoopstad waar deklaagbewerking winderosie doeltreffend beheer, geskied dit teen 'n inkomsteverlies van 61c per hektaar per millimeter reën. Die omskakeling van veld na aangeplante weiding verdubbel die reënverbruiksdoeltreffendheid en wanneer veld na gewasproduksie omgeskakel word, verhoog die reënverbruiksdoeltreffendheid drie tot viervoudig, aldus die verslag.

Afskrifte van die verslag getiteld **"Opgaring en benutting van reënwater in grond vir die stabilisering van plantproduksie in halfdroë gebiede" (WNK-verslag 227/1/94**) is gratis verkrygbaar by die Waternavorsi-ngskommissie, Posbus 824, Pretoria 0001. (Buitelandse prys: VSA$ 2.

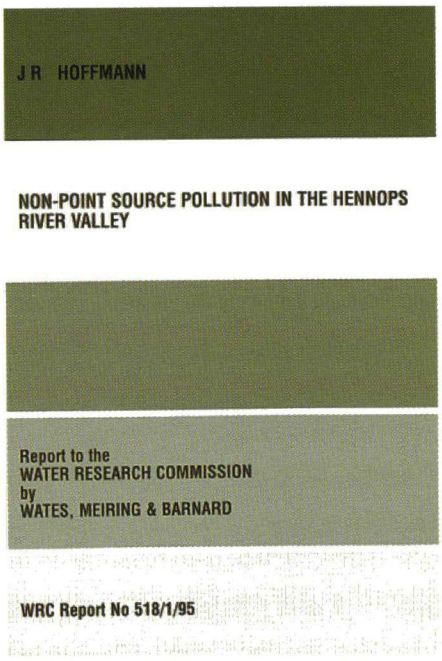
Non-point source pollution in the Hennops Valley

Sources and causes of pollution can be classified either as point or non-point contributors. Point sources of pollution are defined as pollution that enters transport routes at specific, defined individual points and can usually be measured. Major point sources under this definition include sewered municipal and industrial effluents.

Non-point sources (NPS) are simply 'everything else' which include sources of pollution that are diffuse and difficult to identify and/or quantify. It can result from any activity which produces pollutants that enter the receiving water body in an intermittent and diffuse manner, mostly through rainwater run-off.

Generally domestic and/or industrial waste water is collected in a municipal sewer system and treated at the endpoint to set specified standards. However, where dealing with diffuse non-point sources, the term "management" is used instead of treatment and removal. The solutions proposed for non-point source (NPS) pollution are defined as Best Management Practices (BMP's). Best Management Practices (BMP) as employed in the USA commonly imply non-structural or low-structural, typically on-site measures. These are effective in controlling non-point source pollution from the various land use activities.

There are no clear abatement strategies for non-point source pollution control in South Africa. The result is that, in many instances where cost effective methods could have been used for combatting non-point source pollution, nothing is done, says the researcher JR Hoffmann (Wates Meiring & Barnard) in a report to the Water Research Commission.



There are two approaches to this type of pollution problem. The first being the quantitative approach, requiring detailed studies over long periods of time. The second approach is qualitative and identifies the worst cases of pollution. These cases are by eliminating 80 % of the pollution load at 20 % of the cost and thus referred to as the 80/20 approach.

Wates Meiring & Barnard recognised the need to evaluate the 80/20 approach as a method of initiating prescriptive measures for non-point source pollution in a representative valley and proposed a research project to the Water Research Commission.

OBJECTIVES

The objectives of the project were as follows:

- ❍ to monitor point source and non-point source pollution in the Hennops River Valley during base flow and stormwater flow conditions for 12 months.
- ❍ to assess the pollution mass loads from the various land users.
- ❍ to identify pollution sources and their effects on the receiving water quality.
- ❍ to prepare pollution control strategies based on the 80/20 approach for improving the quality of polluted water from industries, informal and formal settlements in the Hennops River Valley.
- ❍ to present general abatement strategies for controlling non-point source pollution.

STUDY AREA

The Hennops River Valley was selected for this study as it represents a variety of

land users, such as formal and informal housing, commercial and industrial development, point sources and agriculture. The catchment extends from its source at Kempton Park/ Chloorkop in the south to the outlet of the Centurion Lake (Verwoerdburg Lake) in the north.

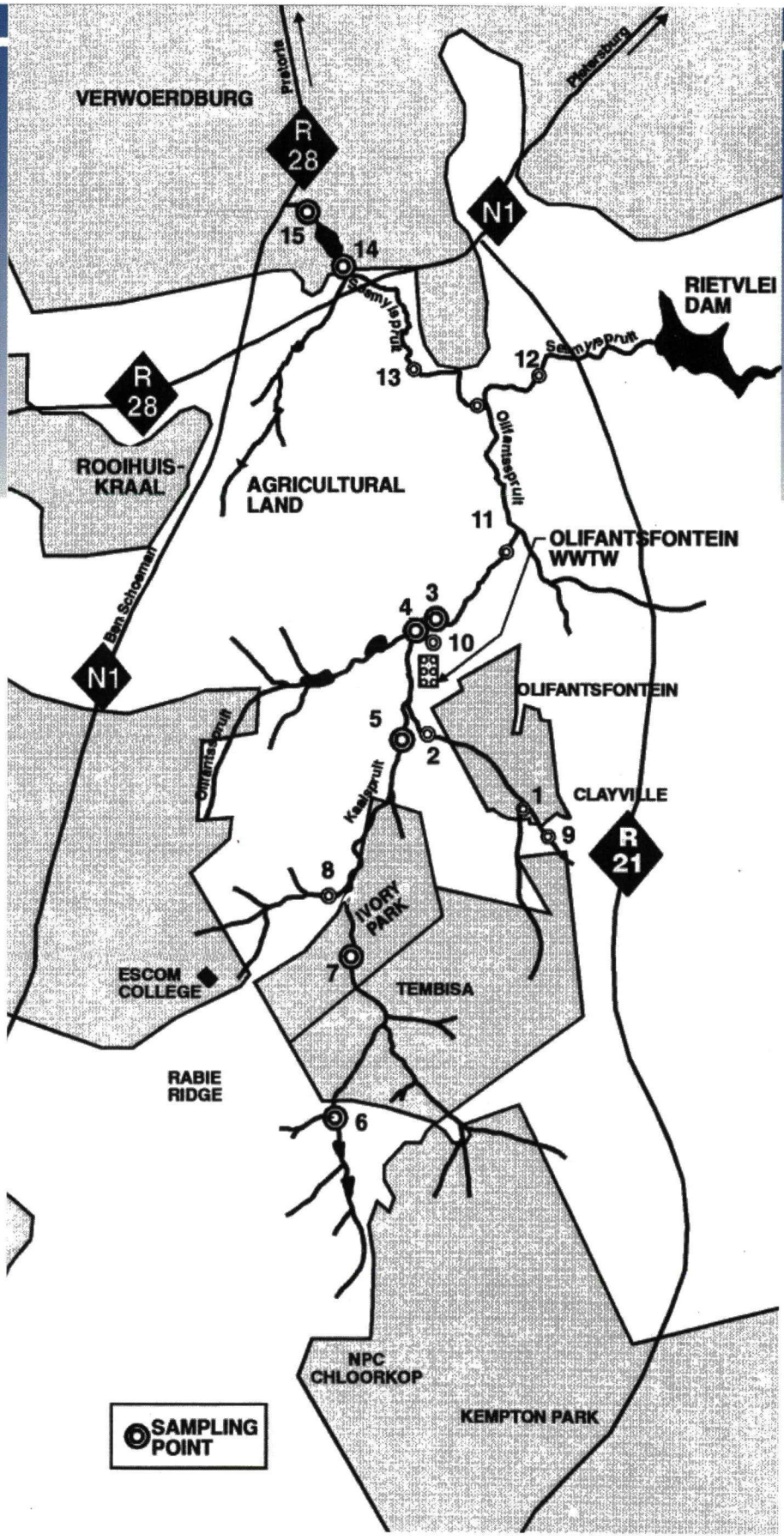
The upper reaches of the catchment is mainly of residential nature and drained by the Kaalspruit which runs through Tembisa and Ivory Park. These areas contain formal housing with waterborne sanitation and informal housing (shacks) with minimal services and on-site sanitation, (LOFLOS - low flush on-site anaerobic digester). The Olifantsfontein/ Clayville part of this catchment is a mixture of residential, commercial and industrial development with waterborne sanitation. Stormwater from the industrial development drains into a concrete lined drainage channel which passes through the middle of Clayville. This channel is a major tributary of the Kaalspruit during storm events, but a minor contributor under dry weather conditions.

Beyond the confluence of the Kaalspruit and the Clayville tributary, the Olifantspruit catchment consists mainly of agricultural holdings with on-site sanitation (septic tanks and/or french drains). Stormwater runoff is from agricultural and undeveloped land.

Downstream of the Kaalspruit and Olifantspruit confluence, the effluent from the Olifantsfontein Waste Water Treatment Works discharges as a major point source into the Olifantspruit. The catchment between the Olifantsfontein Treatment Works and the Centurion Lake is mainly an agricultural area. There are residential and some office developments at Irene and Centurion (Verwoerdburg) CBD using waterborne sanitation.

MONITORING NETWORK

An initial field reconnaissance showed that the monitoring network would have to be on a macro scale. Both the nature of the catchment and the poor security situ-



Hennops Valley study area

ation discouraged the establishment of any monitoring structures. The different sub-catchments were investigated with respect to the stormwater runoff, different types of land users and activities. This was done so as to site the water quality monitoring points and rudimentary flow measurements.

The sampling were done manually during daylight hours as the security situation did not allow for the installation of automatic samplers. Routine sampling consisted of "grab" samples at the selected sites. Sampling frequency was bi-weekly during the dry season (April - September) and weekly during the wet season (October - March).

Stormwater sampling consisted of "grab" samples at five selected sites after a storm event in the catchment. Whenever possible in-situ flow measurements were conducted at the sites, but this was not always possible due to the high flows in the stream and the security situation in Tembisa and Ivory Park.

RESULTS

- Non-point source runoff originating in the upper reaches of the Hennops River Valley catchment is polluted throughout the year. The base flow and storm event pollution is predominantly of a microbiological nature with corresponding high concentrations to studies elsewhere in South Africa. The trace metal concentration compares well with the values observed in other similar studies.

- The major source of pollution is solid waste and faecal contaminants. These are as a result of deliberate pipe blockages in Tembisa, the high population density, ineffective on-site sanitation facilities in Ivory Park, leachate from accumulated solid waste, inadequate maintenance of sewers and a general lack of environmental awareness.

- In this study it has been found that the pollution load emanating from Tembisa formal housing and serviced stands is considerably higher than from informal and unserviced stands. The provision of waterborne sanitation does not necessarily reduce the pollution problem.

- The point source contribution from the Olifantsfontein Waste Water Treatment Works actually dilutes the highly polluted base flow in the river.

- The pollution contribution from the Clayville Industrial development is insignificant. Its impact on the receiving water cannot be detected due to the high base flow in the river.

- The Centurion Lake functions as a pollution reduction facility during base flow conditions but was not as effective during storm events. The microbiological contamination during storm events is considerably higher than during base flow conditions. This can be attributed mainly to the shorter exposure of water in the lake and river system to sunlight.

- The Lake contains fifty per cent silt which can be largely attributed to the soil runoff from urban development in the upper reaches of the catchment, i.e. Ivory Park and Tembisa.

- The results indicate that the microbiological contamination of the water is the main source of pollution and that the river water quality is unfit for use when compared to the selected water quality guidelines of the various user groups (domestic, recreation, industry, irrigation, live stock, aquatic life).

BPM's

Best Management Practices (BMP) should be implemented to reduce and control non-point pollution from the formal and informal housing sector in the catchment. These practices were based on the 80/20 approach, where 80% of the pollution is eliminated at 20% of the cost. These guidelines as discussed in the report, are basic and can be used in other similar developments.
Certain Best Management Practices given in the report, however, are site-specific measures to control non-point source pollution and to improve the water quality in the Hennops River Valley for the various land users. According to the report abatement strategies should actually form a part of Integrated Catchment Management planning.

CONCLUSION

This study was undertaken on a more macro-scale than other studies conducted

in South Africa and focused on an area representative of several land uses, such as formal and informal housing, industrial activities, point sources, commercial and high income residential developments as well as agricultural activities and undeveloped land. The type of urbanisation that has taken place in the of the Hennops River Valley is not unique in South Africa and can be compared to several other catchments.

The results of this study confirmed that the severe diffuse pollution is occurring as a result of the runoff from formal and informal settlements. The researcher says it is essential that source control should be a priority in combatting pollution as part of the RDP's long term strategy. Further studies, which entail intensive monitoring in similar catchments, will serve no purpose unless pollution sources control measures are implemented on a catchment scale under appropriate institutional arrangements.

The report entitled ***Non-point source pollution in the Hennops River Valley*** (WRC report no 518/1/95) is available, free of charge, from the Water Research Commission, PO Box 824, Pretoria 0001. Foreign order price: US$ 20.

Planting a Drought Insurance

There are more drought-tolerant fodder shrubs (DTFS) planted in South Africa than in any other country of the world (approximately 0.8 million ha). However, still more remains to be done in order to develop a full-fledged "drought insurance" policy at a national level. Ideally some five per cent of the arid and semi-arid land surface should be under DTFS, says Henry N le Houérou in a report to the Water Research Commission. He suggests that a policy encouraging the planting of DTFS would be cheaper and more efficient than the "drought subsidy" policy applied in the past, saying that it seems more efficient to anticipate the impact of drought than belatedly trying to cure it at an unproductive higher cost.

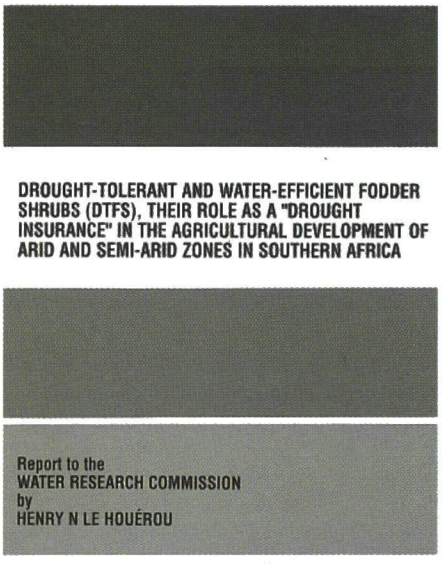
In the report entitled "Drought-tolerant and water-efficient fodder shrubs (DTFS), their role as a 'drought insurance' in the agricultural development of arid and semi- arid zones in Southern Africa", Le Houérou discusses the three main groups of species presently utilised in South Africa. These are saltbush, spineless cacti (more commonly known as prickly pear), and Agave. These three groups of plants are highly rain- and water-use efficient, even under annual rainfall as low as 120-150 mm.

Saltbush and cacti can produce 1 kg of dry matter (DM) fodder with only 250 and 300 kg of water respectively and Agave can produce 1 kg DM using less than 100 kg of water, whereas fodder crops such as barley and lucerne need 500 and 1 000 kg of water to produce 1 kg DM fodder.

Saltbush is very hardy and "forgiving" in water-use management, however it is very sensitive to over-grazing and continuous grazing, says Le Houérou, pointing out that a vigorous stand may be destroyed in less than 12 months of abuse.

Spineless cacti are indicated in the report as having a high drought tolerance. However cacti are poor in protein as a fodder, and therefore need to be complemented with fodder such as saltbush as a stock feed. Spineless cacti are also prone to destruction through overgrazing by wandering livestock or game.

Agave is said to be comparable to cacti in ecological adaptation and yield, but richer in fiber and therefore constitutes the ideal complement to saltbush in stock feeds. Furthermore Agave is also excellent for erosion control and as a silt-trap hedge.



CONTENTS

In the report an introductory history of drought tolerant fodder shrubs in arid and semi-arid countries are given and the bioclimatology of Southern Africa along with climatic limitations and constraints are outlined as a background. The report discusses saltbush, spineless cacti and Agave with regard to the following aspects:

- drought tolerance;
- cold and frost tolerance;
- soil requirements, tolerance to salinity, sodicity, alkalinity, waterlogging and response to fertilisation;
- multiple use of water-efficient fodder shrubs in rain-fed and irrigated production systems;
- productivity, rain-use efficiency and water-use efficiency under rain-fed and irrigated conditions;
- use of saline seep effluents, drainage waters and other effluents;
- invasiveness and other environment hazards;
- establishment, management and utilisation methods and strategies;
- fodder and nutritive value, ecological competition and nutritional complementarity with indigenous species, feeding strategies;
- other benefits;
- economic aspects under various strategies, yields and profit per unit of water used;
- development policies, areas and systems amenable to DTFS,
- integration into various production systems including game farming,
- drought subsidies versus DTFS development, and DTFS as a "drought insurance";
- miscellaneous remarks on arid land management and desertification in South Africa.

Le Houérou concludes with some recommendations and briefly points out research needs with regard to DTFS. The report includes references to, and acknowledgement of, a considerable number of people with whom he consulted in this research project.

The report ***Drought-tolerant and water-efficient fodder shrubs (DTFS), their role as a "drought insurance" in the agricultural development of arid and semi-arid zones in Southern Africa*** (WRC Report no KV 65/94) is available, free of charge, from the Water Research Commission, PO Box 824, Pretoria 0001. Overseas price: US$ 25.

Towards successful small-farmer irrigation

By Marna de Lange* and Charles Crosby**

The Water Research Commission is funding a study of existing small-farmer irrigation to establish design methods and norms that will facilitate effective planning and development of small-farmer irrigation.

The information document *Small-scale irrigation in South Africa* (De Lange, 1994), was produced after the first year of study, exploring reasons for the failure of so many small-farmer irrigation projects, while noting factors common to successful projects.

The main purpose of the second interim report (1995), reviewed here, is to indicate the direction in which established planning and design approaches should be adapted to be appropriate for small-farmer irrigation.

Special attention is given to the requirements for farmer-managed small-farmer schemes, as this is seen as a main area for potential irrigation development in South Africa with significant contribution to rural development.

The challenge is to break with the past and establish planning approaches and design norms that are appropriate, cost effective and realistic for farmer-managed small-farmer irrigation development. These approaches should be technically sound, without requiring unrealistically detailed investigations, and should provide clear decision-making parameters to avoid paralysing delays in project approval.

CURRENT AGRICULTURAL POLICY

The vision of the White Paper on Agriculture 1995, calls for:

"A highly efficient and economically viable market-directed farming sector, *characterised by a wide range of farm sizes*, which will be regarded as the economic and social pivot of rural South Africa and which will influence the rest of the economy and society."

Among the previously disadvantaged communities, a wide range of irrigation farm sizes are found - from community garden plots of 100m^2 (= 10m x 10m) to 600m^2 (= 20m x 30m), up to farms of 100 to 150 hectare.

The White Paper highlights the importance of small-scale farming:

"In the past, ensuring food self-sufficiency was a goal of agricultural policy and the development of *small-scale farming* was seen as detrimental to this goal. Within the context of food production, but more in line with food security at national and household level, the potential and role of *small-holder farming* become important. However, appropriate research will have to be undertaken to develop this potential."

SCOPE OF THE WRC STUDY

Fieldwork for this WRC study on small-farmer irrigation included some large-scale black farmers, some of whom employ up to 300 workers at a time, thus making an important contribution to their local economies.

Significantly, it was found that all irrigation farmers are essentially commercial farmers - producing more than they consume and selling or trading the surplus - regardless of the size of their farm, and this includes farmers on plots in community gardens as well. Small-farmers are generally considered as operating on 10 hectare or less.

Because the scale of operation was found to have so little to do with the nature of the farming enterprise, irrigation farmers were categorised, for the purposes of this study, in terms of the *nature of their water supply* as follows:

- ❑ farmers who share water supply infrastructure, including schemes and community gardens; and
- ❑ farmers with access to a private water source - termed "independent farmers".

Another important distinction is the level of risk at which the farmer prefers to operate. Large scale, intensive, highly commercial irrigation is high risk farming. In contrast, small-farmers often seek to reduce risk so that, for them, optimal production is often (but not always) at lower input and yield levels than those recommended for high risk irrigation farming.

SMALL-FARMER IRRIGATION SCHEMES

The term "small-scale" does not adequately describe the typical situation where large numbers of small-farmers are grouped together on large (or small) -scale schemes.

While these are generally refered to as "small-holder schemes" in the rest of Africa, the term causes some confusion in South Africa, where the term small-holding has become familiar for the residential properties found around our towns and cities. Therefore we'll simply refer to small-farmer schemes.

Far more important than the scale of these schemes, or the scale of the farms

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in them, is the nature of the scheme management.

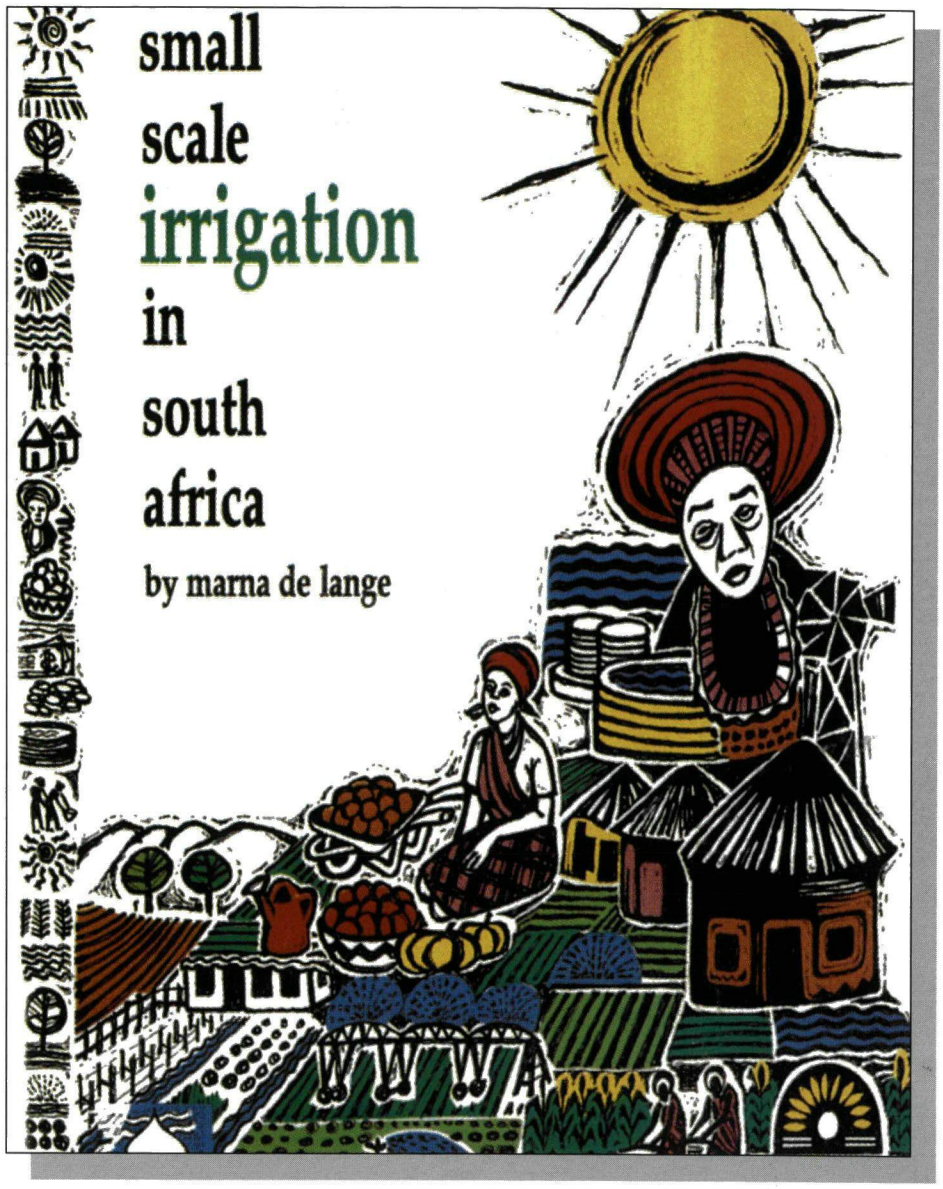
The term "farmer-managed schemes" is used here to emphasise that, to be successful, schemes should be structured for independent management-by-the-users (as opposed to schemes requiring management by external agencies). With this approach, the scale of the scheme (and the choice of infrastructure) depends on what is manageable for the users, instead of the infrastructure dictating the management structure.

THE PROPOSED STRATEGY

The proposed strategy for future small-farmer irrigation development in South Africa therefore envisages concentrating on rehabilitation, improvement and also construction of farmer-managed schemes.

An integrated approach should be applied which strives for complementarity of infrastructure (including water supply, access roads, storage facilities, soil conservation structures, etc.).

Technological options should include phased developments (not only in-scheme, but also on-farm), utilisation and improvement of traditional schemes and methods, labour-intensive construction methods, and training of users in the management, operation and maintenance of their systems.



THE STATE'S ROLE

The research emphasised the important role the state has to play in creating an "enabling environment" within which successful projects can develop. While the emphasis remains on farmers taking the initiative and responsibility for the development of their projects, there are a number of ways in which the state can contribute to the process.

Financial assistance is normally required for various aspects of a project, from the investigation through implementation and beyond. The administrative process through which farmers can apply for financial assistance, must be very clear and accessible and should provide quick answers. The criteria for project approval should be well-known and supported by the national strategy, yet allow for particular local circumstances.

At the operational level, the national strategy should recommend policy on support services to be supplied by the state, which may include facilitation, extension, research, short-, medium- and long-term finance, transport, marketing and technical advisory services. The delivery mechanisms for these services should be developed through a consultative process and evaluated regularly, by the users.

PARTICIPATIVE PLANNING

"Top-down planning" is nowadays often cited as the main reason for failure of irrigation development. However, while there is general agreement on the need for a "bottom-up approach" and "farmer participation", there is inadequate understanding of just what this process entails and what is needed to ensure its success.

Some think that the appropriate degree of participation depends on the type and scale of the project. They argue that, for some projects it may be sufficient merely to inform the community or obtain their agreement for planned projects, while, for others, it will be necessary to consult community leaders or other key people in the community for input into the planning process and, for yet other types of projects, full participation is needed.

However, experience has shown that, for agricultural development projects to have the best chances of success, different aspects of the project development warrant varying levels of participation by a variety of role players.

An example of effective small-farmer irrigation in Lebowa.

The one element common to successful irrigation schemes, farms or projects is that they are all farmer-managed. Therefore, it is essential that prospective participants in the project should have full participation in the planning process and in the choice of technology, as they will eventually be using the infrastructure on a daily basis and will be faced with the task of making it succeed despite its (inevitable) limitations.

An integrated and holistic approach is essential to ensure sustainable irrigation development within the rural community development context. Therefore it is important that irrigation farmers consult and cooperate with other water users in their community to explore possibilities for the development of infrastructure with complementary uses.

PARTICIPATORY MAPPING

The participative process involves comprehensive and meaningful information exchange between the farmers and their technical advisor, with the farmers taking the lead and the advisor playing a facilitative role. The plans are the farmers' and they consult the facilitator to ensure that their plans are technically feasible. While the thrust is primarily towards self-help, the community is assisted to form links with potential sources of outside assistance, where necessary. Organisations and individuals with the capacity and understanding to make meaningful input (and listen) at grassroots level, can play an important role in this regard. While technical input comes mainly from consultants and technical government staff, NGOs are well positioned to assist with institutional capacity building.

The participative process does not end with the implementation of infrastructure, but continues in the active participation of the community interest group (often through an elected committee), in managing, operating and maintaining the infrastructure. Further, users should regularly evaluate their actual utilisation of the infrastructure and the operational arrangements around it, to refine and improve these as their experience grows. The identification of training needs is an important product of these evaluations.

Farmer-managed projects can only be established through participative planning. However, internationally accepted techniques which enable the community to achieve the proper level of participation and control of projects in the rural development context, are as yet relatively unknown in South Africa.

INITIAL ASSESSMENT OF PROJECTS

The initial assessment of a proposal for an irrigation scheme is highly critical, as the seeds of the vast majority of future problems are already present and must be identified. It is extremely difficult to withdraw from an unsound project once commitments have been made.
Assessment of an irrigation scheme proposal can be complex, because of the

range of factors that must be considered, such as:

- socio-economic conditions;
- farmers' aspirations, abilities and involvement;
- soils;
- topography;
- hydrology and water supply;
- climate; and
- crops and markets.

There is a danger that procedures will be followed slavishly and overly comprehensive reports (which can be time-consuming and expensive) produced. In the case of small-farmer irrigation schemes, working from a rough first estimate and progressively gathering and analysing more detailed information is considered to be more efficient. Further investigations should be carried out only if required. In South Africa, examples of irrigation under conditions similar to those being assessed can usually be found, and these can often substitute for the detailed investigations of soils and hydrology, and the full agricultural year of on-site observation normally specified by international agencies.

The information becomes more meaningful to decision-makers if it is presented as notes and diagrams on a topographic map or aerial photograph. Community members can draw up very meaningful maps of their own, showing all the relevant local information.

TECHNOLOGICAL OPTIONS FOR SMALL-FARMER SCHEMES

Technological options should include phased development, utilisation and improvement of traditional schemes and methods, labour-intensive construction methods, and training of users in the management, operation and maintenance of their systems.

Selection of irrigation method

In South Africa, mainly sprinkler and mechanised irrigation schemes were developed over the last twenty years, particularly with the advent of large development schemes in the ex-bantustans. New surface (or flood) irrigation projects were the exception, although early small-farmer irrigation schemes in South Africa were based on "wild flooding". Sprinkler irrigation requires water under pressure, which implies pumps and piping and a fairly high level of management. All too often, the farmers had little experience or knowledge of irrigation or even of arable farming. To achieve reasonable production levels and efficiency, the authorities administering the projects tended to manage them as large estates rather than as independent individual farms. Inevitably, this approach took much of the initiative out of the hands of the farmers.

To facilitate management and operation of these schemes, water was supplied to the individual farmers in pipelines under sufficient pressure to operate the sprinkler systems and this water was sometimes available "on demand". The latter is a capital-intensive approach and placed an unrealistically high burden of overhead cost onto the schemes.

Lessons of experience provide the basis of a methodical procedure for assessing which irrigation methods are likely to be most appropriate for the circumstances prevailing. This procedure will be incorporated in the envisaged guidelines, which will be the final product of this research.

Estimation of crop water requirements

Crop water requirement estimates are important and must be in harmony with farmers' practices and requirements. Over-conservativeness leads to over-design, which can result in viable projects being turned down on the grounds of inadequate water resources or excessive cost. Field investigation has shown that many small-farmers are expert at making effective use of limited water resources and achieving worthwhile and cost-effective production. Therefore, more accurate (and often reduced) predictions for crop water requirements may be expected in future.

It is important that planners and engineers be positioned to take the possible lower water requirements of small-farmers into account so that, when warranted, they can design more modest and affordable systems.

Water supply considerations

The water supply on any irrigation farm must be sufficient to "get through" all the lands in rotation during peak season before crops are damaged by water stress.

Shared water supply is usual when independent supply to each farm is too expensive or impractical, as is normal in small-farmer applications and irrigation board schemes. Planning and designing shared water supply adds a new dimension to the analysis required, because a shared system involves a number of individuals, each with different crops, which each has varying water requirements throughout the season! Merely designing on the basis of rotational supply to the scheme area as a whole (as if for an independent farmer or centrally managed estate), makes efficient on-farm water management very difficult.

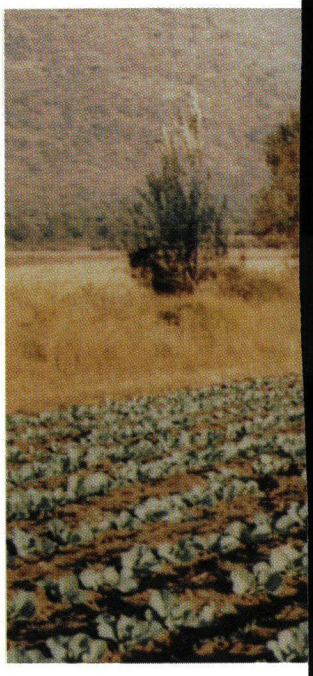
Experience shows that the management of small-farmer schemes, must be based on consensus between farmers on the rules for the scheme – including the principle of payment for water supply and special allocation arrangements during periods of drought. Much of the success of community gardens is attributed to the independence of the farmers' group in managing their own affairs – including water supply. This is not a new concept, as the established irrigation boards in South Africa, which are legal entities, have been functioning along these principles for many decades.

Irrigation systems in practice

The requirements for design of small-farmer irrigation often differ from conventional irrigation design.

To meet the needs of the small-farmer cost effectively, requires new and more flexible standards based on discussion of the specific circumstances between the designer and his client, the farmer. More initiative and innovation, based on a better understanding of small-farmers and their requirements, will be expected of designers.

There is a need to build more versatility into designs: for instance, a pump that can efficiently handle a larger range of flow rates could be selected to accommodate variations in use. Higher variations in discharge than are usually accepted along a lateral may be more than justified, if there is a significant cost saving.



Researchers looking at short furrow irrigation systems.

A major advantage of **sprinkler systems** is that a farmer can start in a small way and expand the system as he learns how to use it and can afford it. If the farmer plans to do this, provision should be made at the planning stage. However, sprinkler irrigation is not always the best method for all small-farmer applications. Ready access to equipment dealers and technical support is vital to achieve sustained efficiency. Design requirements may differ from the conventional if the irrigation management is to fit into the life pattern of a part-time farmer, and may result in a more expensive system. For instance, shorter or varied sprinkler stand times may have to be used.

Centre pivots are designed to irrigate relatively large areas. Circles generally range in size from 30 up to 100 hectares in area, because the equipment cost per hectare becomes very high for smaller pivots. Therefore, small-farmers using centre pivots usually have to share the equipment, which invariably leads to management and operational problems. In addition, centre pivots are mechanically complex and require skilled maintenance therefore they are not recommended for small-farmer schemes.

With **micro and drip (trickle) irrigation**, it is more difficult to spot blockages than with sprinkler irrigation, because there are so many small emitters. The application rate may double or halve without a farmer's noticing, if he doesn't monitor his system carefully. This places a high demand on the farmer's time – an additional chore which may be kept up if the farmer thoroughly understands his system and the principles of irrigation, and can afford the time.
Interesting applications of micro and drip irrigation are found in the field, such as an unexpected willingness on the part of small-farmers to move dripper lines between irrigations, almost as though they were conventional sprinkler laterals. Another example is of micro sprayers on long spaghetti tubing, initially installed to irrigate fruit trees, but which are also being moved around for intercropping vegetables between the fruit trees – a miniature dragline system.

The possibility of such laborious irrigation practices has hitherto been discounted on larger farms, where they are impractical – but this is a good example of how, under special circumstances, practices which seem unacceptable or ineffective can, in fact, make a significant contribution to both management and production.

Micro irrigation, which has only been used to a limited extent by small-farmers, therefore warrants further investigation. However, unless the vulnerability of the system can be reduced, its applicability remains limited for farmers without adequate access to technical support, training services and equipment dealers.

Flood irrigation is not suitable for all soil conditions, but has major advantages over other types of irrigation for small-farmer irrigation (or any situation where access to support services is limited). The entire system can usually be designed to operate at very low running costs with gravity feed, without pumping or any mechanical equipment. While the maintenance of infrastructure like weirs, canals and diversion structures is important, this can be handled in a regular, programmed and largely preventative manner – emergency breakdowns requiring urgent access to support services are rare in gravity systems.

Flood irrigation is regarded as more labour-intensive than mechanised systems. However, it is often more suitable where small-farmers live a considerable distance from their fields, as they can travel to the fields only once, complete the irrigation in three to four hours, and then return home. A farmer-housewife may find it impractical to travel to her fields a number of times per day to move sprinkler lines.

Short-furrow or furrow-basin flood irrigation has the additional advantage that weeding and insect control are done simultaneously with the irrigation.

Another advantage of furrow-basin irrigation is the very uniform distribution of water across the whole field, even in

The challenge is to establish design norms for farmer-managed small-farm irrigation development.

cases where the gradient varies or where the flow rate is inconsistent; for example, when another farmer suddenly starts irrigating between the first farmer and the water source. These variations in gradient or flow rate would make other methods of flood irrigation difficult or even impossible.

Where feasible, new schemes or developments requiring significant official funding should possibly be based on variations of furrow-basin irrigation.

Irrigation method should be subject to close study and motivation during the participative planning for the scheme and the selection should be dependent on the particular circumstances.

TECHNICAL TRAINING AND SUPPORT

The following were highlighted during the study:

❑ the need for the orientation of engineers, planners and agricultural professionals in the realities and requirements for appropriate small-farmer irrigation technology;

❑ the need for appropriate practical technical (engineering) training for farmers, extensionists and pump operators; and

❑ the need for well-trained support technicians.

There is a need for a pragmatic approach, aimed at getting a job done, rather than theoretical or academic learning – farmers have expressed their frustration with wasting their time on irrelevant lectures or demonstration plots. Unfortunately, many lectures and videos are a rehash of classic theory, with little practical relevance to the realities of the specific situation. Farmers and extension staff emphasised their need for more knowledge about their own situation and systems, rather than overall knowledge of the subject. The type of training farmers value most is on-the-job training, such as they had while working for other farmers, or from their own experience.

The farmers, working together with their extension officers and technical advisor, should thoroughly analyse their actual situation and identify the training requirements of them all. It is recommended that this precedes any training programme or extension activity.

Training methodology should recognise that adults "learn by doing". Critical analysis of their own situation is in itself a powerful learning experience for farmers, and often automatically lead to solutions.

Although lectures are generally believed to have very limited success, it is often the presentation method rather than the content which is unsuccessful. When material and demonstrations have been presented in well-thought-out "parables", the audience understood very well and enjoyed them tremendously. Continuous evaluation by trainees of training content and presentation is important to ensure that the process keeps on track, and provides a useful tool for the training facilitator.

Pump attendants need training as much as farmers do, and support technicians are sorely needed, particularly by independent farmers and community gardens. Possibly, selected extension officers or existing technicians could be trained to fulfil this role. The approach should be to assess what knowledge is necessary to make a person useful in this role and to give precisely the training needed to impart that knowledge, such as:

❑ elementary design and surveying;

❑ the essential, but probably elementary, mechanical aspects of pump installation and maintenance; and

❑ the basic principles involved in spacing sprinklers and judging the correctness of their operational pressures.

CONCLUSION

The final product of the small-farmer irrigation study will be technical guidelines and procedures for the development of small-farmer irrigation projects. These will contain detailed recommendations for use by planners and designers and is expected to be released towards the end of 1996.

Oewerplantegroei van die Olifantsrivier in Transvaal se funksie ondersoek

W.J. Myburgh* & H.J. Vermeulen*

Fig.2. Die Olifantsrivier in die Vandyksdrif-Witbank omgewing.

In Suid-Afrika is daar beperkte bronne met staande water en riviere is met die uitsondering van enkele opgaardamme, die enigste water beskikbaar vir ontginning deur die mens (O'Keeffe 1986).

Daar was 'n geweldige toename in wateraanvraag oor die afgelope paar jaar. Landbou, bosbou, nywerhede en mynbou plaas toenemend druk op hierdie waardevolle en beperkte hulpbron. Water sal binnekort, die huidige bevolkingsaanwas in ag geneem, dié enkel faktor wees wat die ekonomiese groei en lewensstandaard van die bevolking sal beperk.

O'Keeffe (1986) beskryf 'n riviersisteem as die natuurlike dreinering van 'n gegewe gebied. Die sisteem word beskou as 'n hoogs ingewikkelde ekosisteem. Hierdie ekosisteme is dinamies en weerspieël die tipe en die toestand van die land wat gedreineer word. Indien enige deel van die sisteem versteur word, word die sisteem in geheel daardeur beïnvloed.

Riviersisteme met geassosieerde oewerplantegroei is ekologies uiters sensitief (FRD 1990). Hierdie plantegroei vorm 'n integrale deel van enige riviersisteem en kan beskou word as 'n buffersone tussen die opvanggebied en die rivier.

Die ver-nietiging van hierdie plantegroei lei tot 'n destabilisering van die rivierbanke en veroorsaak 'n groter afloop, 'n versnelde erosie-tempo en 'n swakker infiltrering van water (O'Keeffe 1986). Die behoeftes en funksionering van oewerplantegroei moet deeglik verstaan word alvorens doeltreffende bestuursriglyne voorgestel kan word (Van Coller 1992).

Veld en Weidingsinstituut , Privaatsak X05, Lynn East, 0039. Republiek van Suid-Afrika.

DIE STUDIEGEBIED

Die oewerplantegroei van die Olifantsrivier word ekologies ondersoek vanaf Breyten waar die rivier ontspring tot by die grens van die Nasionale Krugerwildtuin naby Phalaborwa (Figuur 1). Die gedeelte van die Olifantsrivier binne die Nasionale Krugerwildtuin is reeds ekologies ondersoek (Bredenkamp & Van Rooyen 1993).

Die bo-lope van die riviersisteem dreineer 'n gedeelte van die Oos-Transvaalse Hoëveld in die omgewing van Witbank en Middelburg, die middelgedeelte kronkel deur die Springbokvlakte, terwyl die laaste gedeelte deur die Transvaalse Laeveld vloei.

Die riviersisteem strek oor 'n area wat beide grasveld (Figuur 2) en savanna bioom (Figuur 3) insluit (Rutherford & Westfall 1986). Dié plantegroei word onderverdeel in vier veldtipes (Acocks 1988) naamlik die Bankenveld (Veldtipe 61), Suuragtige Gemengde Bosveld (Veldtipe 19), Gemengde Bosveld (Veldtipe 18) en die Dorre Laeveld (Veldtipe 11).

Daar is tans vier opgaardamme in die Olifantsriviersisteem waarvan Witbankdam, Doringpoortdam en veral Loskop-dam, 'n deurslaggewende rol speel by die hoë-intensiteit besproeiingsarea vanaf Loskop tot by die Marble Hall distrik.

METODES EN BENADERING

Tydens die verkennigsfase is 40 opnamepunte regoor die riviersisteem besoek. Fotografiese en habitatsdata is ingewin by die onderskeie lokaliteite. Hierdie data, tesame met die geologiese variasie verkry vanaf 1:250 000 geologiese kaarte (Geologiese opname 1978a, 1978b, 1986a, 1986b), is intensief bestudeer. Die onderskeie hoogtes bo seespieël is verkry vanaf die 1:250 000 Topografiese kaarte (Opmetings en kartering 1986a, 1986b, 1988a, 1988b).

Hierdie data is gebruik om 'n profiel van die riviersisteem te plot met behulp van ARC/INFO (1989) (Figuur 4). Die

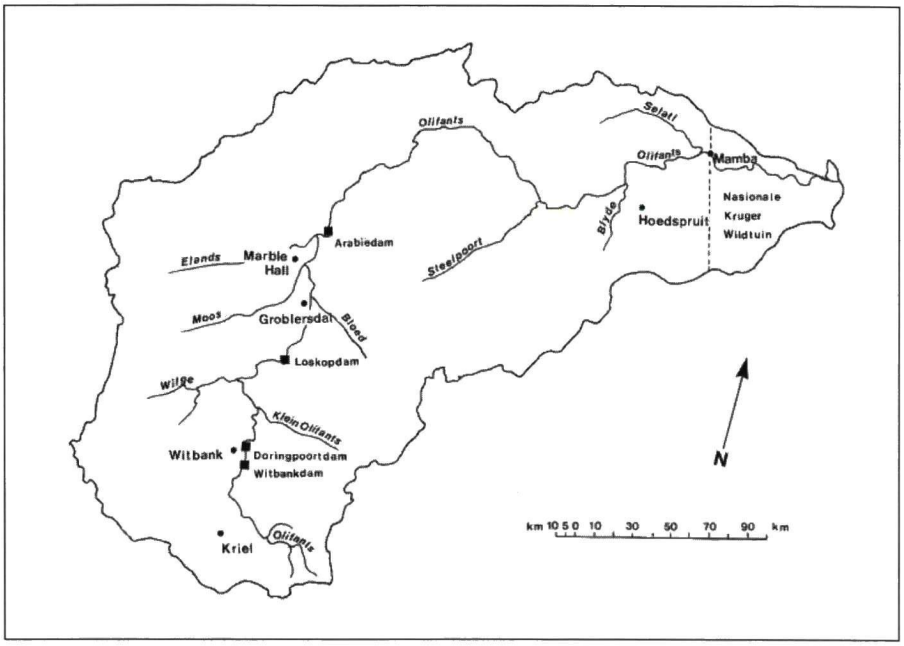


Fig.1. Die ligging van die Olifants en ander belangrike riviere binne die opvanggebied.

Fig.3. Die rivier kronkel deur bergagtige terrein voordat dit Loskopdam bereik.

gestratifiseerde eenhede is gebaseer op geologiese eenvormigheid, maar waar die geologiese formasies herhaal met 'n opmerkbare verskil in hoogte bo seespieël, is die eenhede beskou as verskillend.

Opnamepunte met 'n oppervlak van 200 m^2 is ewekansig uitgeplaas binne hierdie gestratifiseerde eenhede. Elke opname-punt verteenwoordig 'n minimum van twee relevés (persele), een relevé op elkeen van die rivierbanke. Indien daar verskillende sones aanwesig is, word daar 'n relevé in elke sone uitgeplaas om te verseker dat die maksimale floristiese variasie binne dié betrokke oewerplantegroei gemonster is.

By elke relevé word al die plantspesies teenwoordig met behulp van 'n Psion data-skandeerder aangeteken. Die plantnommerskaal (Westfall & Panagos 1988) word gebruik vir die bepaling van die kroonbedekkings van die spesies binne die onderskeie struktuurklasse (Edwards 1983).

Omgewingsparameters wat aangeteken word, sluit onder andere in die helling van die oewers, die breedte van die oewerplantegroei, die breedte van die rivier, die rigting waarin die rivier vloei, gronddiepte, grondtekstuur, grondkonsistensie, bo-grondse klipbedekking en klipgrootte. Die ruitverwysing en hoogte bo seespieël word by elke opnamepunt bepaal met behulp van 'n G.P.S. navigasiesisteem. Die data sal geklassifiseer word deur middel van die PHYTOTAB-PC-rekenaarprogrampakket (Westfall 1990). Vanweë die omvang van die data-insameling en die moeilik toeganklike terrein, strek die studie oor drie jaar.

BEDANKINGS

Dr. R.H. Westfall word bedank vir sy ondersteuning en insette tydens die beplanningsfase van die projek, mev. J. Schaap vir die natrek van figure en die Waternavorsingskommissie vir finansiële steun.

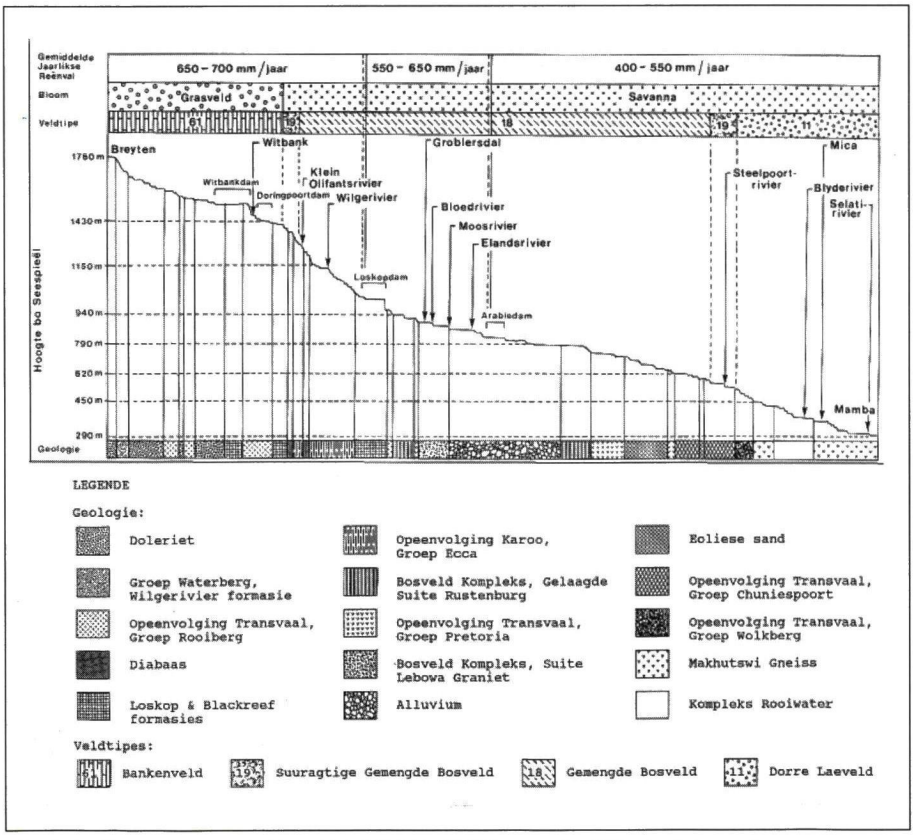


Fig.4. 'n Grafiese voorstelling (ARC/INFO 1989) van die Olifantsrivier gebaseer op hoogte bo seespieël.

BRONNELYS

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Exploring a new membrane extraction technique for the demineralisation of industrial effluents

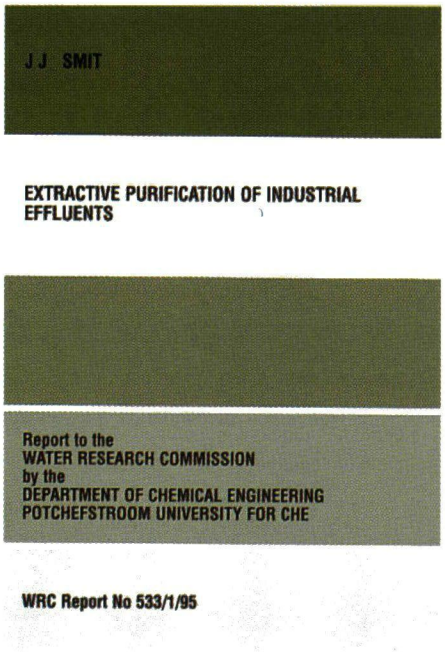
The requirements for environmentally sustainable development and the adverse economics of water recovery demand a new approach to the contaminants contained in industrial effluents says a researcher from the Department of Chemical Engineering at the Potchefstroom University for CHE. The researcher, Professor JJ Smit, says in a report to the Water Research Commission, "these contaminants are, more often than not, chemical species with either a nuisance value or otherwise with widely variable economic value". The report summarises the results of an investigation into the extractive purification of industrial effluents. The researcher says that in the metallurgical industries, especially electroplating processes, effluents are generated containing a variety of nuisance and valuable dissolved metals. The dual challenge is therefore to treat these effluents without causing additional deleterious pollution and trying to recover valuable metals to off-set treatment costs, with subsequent water recycle.

LIQUID MEMBRANES

One of the most recent techniques using membranes for the extraction, or separation, of chemical species is called SLM (Supported Liquid Membranes).

Liquid membrane extraction refers to all extraction processes where a specific extractant, normally dissolved in an organic diluent (lixiviant) extracts chemical species from an aqueous solution (feed), transfers it to another aqueous solution (strip) where it is released. It is obvious that the contact between the organic solution and the two aqueous solutions could be configured in various ways, but only two different principal contacting modes can be characterised, namely the supported liquid membrane (SLM) and the emulsion liquid membrane (ELM). The only difference lies in the way the immobilisation of the actual liquid membrane (viz organic diluent with dissolved extractant) is effected between the two aqueous phases.

The researcher says in this exploratory investigation, funded by the Water Research Commission, that the technical feasibility of demineralisation with supported liquid membranes (SLM) was established and the performance of SLM was investigated on nickel and its associated chemicals in an electroless plating electrolyte effluent.



RESULTS

The results of the investigation may be summarised as follows:

❑ Several specially designed contactors were conceptualised, constructed and successfully tested. One configuration was selected for subsequent system analysis and testing.

❑ The extraction protocol regarding extractant, diluent and aqueous conditions were selected from various experiments and previous experience.

❑ The extraction of nickel from an electroless plating effluent was effected and the researcher found that the extraction is technically feasible.

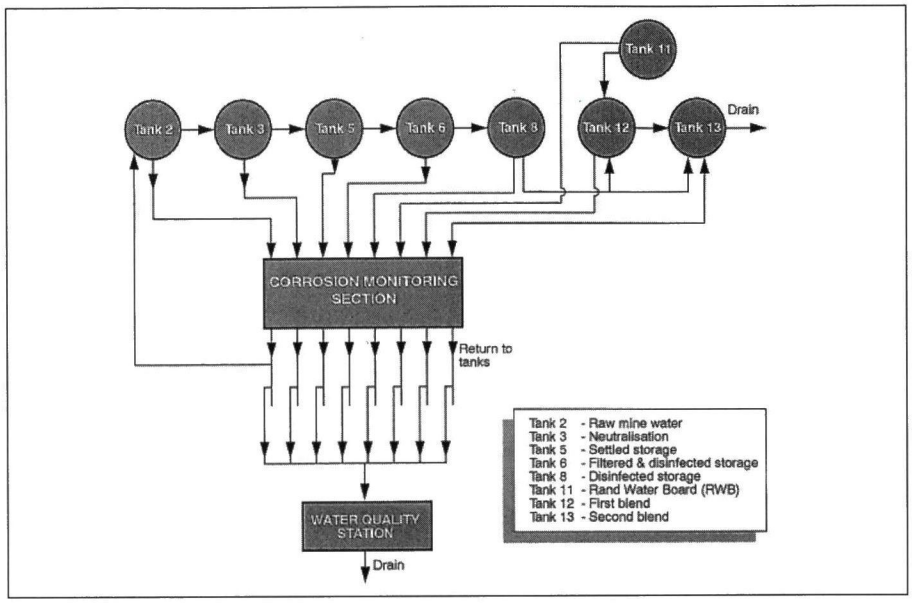
❑ The extraction of nickel could not, as yet, be shown to effect a concentration (viz "up-hill" concentration) from a low feed concentration into a higher strip concentration. It was, however, shown that this is possible for copper (as an example) and should, with correct selection of extraction variables, also be a possibility for nickel.

❑ The extraction of the degradation products (contaminants) resulting from electroless plating (for example orthophosphite) was also demonstrated in a SLM configuration. This result was, however, not selective for orthophosphite but could be manipulated and adapted to be of industrial use. A possible protocol is proposed by which the detrimental orthophosphite could be continuously removed from an operating electroless nickel plating bath.

❑ Specific proposals for the reconditioning of the extracted chemicals (pollutants) is discussed in the report and qualitative indications are given to effect their recirculation. This implies the possibility of a zero discharge concept for further research.

Copies of the report entitled ***"Extractive purification of industrial effluents"*** **(WRC Report 533/1/95)** are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 20).

Influence of water treatment processes on metal corrosion studied



Schematic presentation of the mine water reclamation plant.

The results of a study aimed at quantifying the influence of individual water treatment processes on the corrosion of various metals have been published by the Water Research Commission. The ultimate aim was to define the most cost-effective method of minimising corrosion in mine waters of varying quality, that is, materials selection versus water treatment. The study was initiated by the Chamber of Mines Research Organisation (COMRO) which was integrated into the CSIR's Division of Mining Technology before completion of the project.

A water reclamation plant with eight parallel corrosion and water quality monitoring lines was designed, built and operated. Two water chemistries, one typical of a Witwatersrand gold mine and the other typical of a Klerksdorp gold mine were treated. After each unit process (e.g. neutralisation, filtering, disinfection, etc.) the water was passed through a water quality and corrosion monitoring line.

As major technical difficulties were experienced during the course of the study, it was not possible to achieve a constant water chemistry for each unit process. Evaluation of the data indicated that the most sensible approach would be to correlate corrosion data with measured water quality parameters rather than with the effect of each unit process as such.

RESULTS

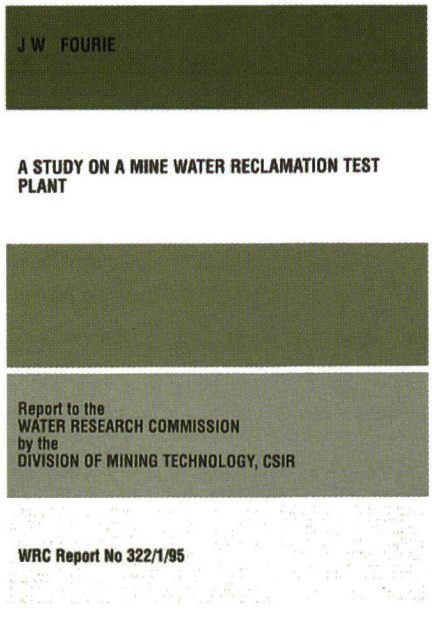
The corrosion rate of mild steel tended to increase with increasing levels of dissolved solids. The chemistries of the various waters tested were such that an increase in total dissolved solids was accompanied by an increase in the concentration of all the corrosive anions. It was therefore not possible to quantify the corrosive effect of individual anions. Galvanised steel coupons also followed the trend of increasing corrosion with increasing levels of total dissolved solids.

No correlation between Langelier or corrosivity indices and corrosion rate could be established for any of the metals tested and the indications are that the use of these indices to predict the corrosivity of mine waters has to be questioned seriously.

In this study no microbial corrosion was detected. Microbial corrosion by sulphate reducing bacteria in particular is a very common phenomenon in mine waters and the importance of controlling this form of corrosion by using biocides for instance cannot be over emphasised.

Although corrosion of copper and copper-nickel coupons did occur in many of the waters tested, no satisfactory correlation between corrosion rate and water quality parameters were found.

No corrosion was observed on any of the AISI 316 stainless steel coupons. The corrosion resistant steel 3CR12 was also immune to corrosive attack in many of the waters. Significant corrosion of 3CR12 only occurred in three waters having relatively low levels of total dissolved solids and more significantly, low chloride levels compared to other water chemistries in which no corrosion of 3CR12 occurred. This phenomenon was ascribed to the inhibiting effect that sulphate and nitrate have on the pitting of stainless steels, with the high TDS waters having a more favourable ratio of sulphates and nitrates to chlorides.



Copies of the report entitled ***"A study on a mine water reclamation test plant"*** **(WRC Report 322/1/95)** are available from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 20).

Decision support system developed for the selection of suitable landfill sites

For many municipalities in South Africa prime land available for development in urban areas is becoming scarce. This has resulted in increasing pressure for the location of sanitary (municipal solid waste) landfill sites in zones considered unsuitable or uneconomical for other kinds of development. Many such zones, however, are highly unsuitable for landfill sites. Further, even if an area is itself determined to be suitable for a landfill site, its proximity to land with an incompatible landuse or zoning may render the site unsuitable.

The above is outlined in a report on the selection of suitable sites for the disposal of municipal solid wastes, compiled by K O'H Murphy from the Division of Water Technology at the CSIR. The report was recently published by the Water Research Commission who funded the project.

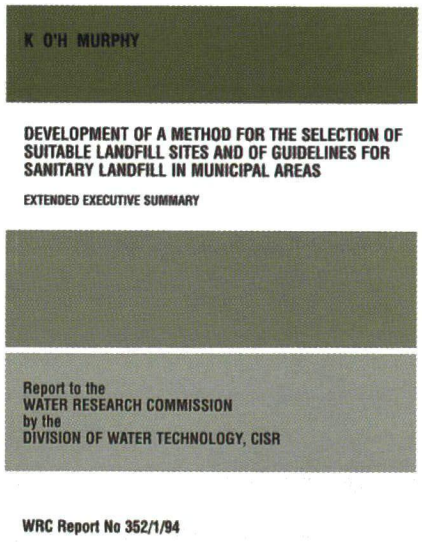
SITE SELECTION

The report states that landfill site selection and evaluation needs to be dependent on the type of waste as well as the geographical, ecological and socio-political environment. Such landfill studies typically are multidisciplinary and complex, involving decisions which are often subjective and are based on incomplete information. It is therefore considered important to identify and evaluate potentially suitable landfill sites and to determine effective options and constraints for landfill on those sites, using scientifically acceptable approaches. The Department of Water Affairs and Forestry (DWAF) have recently published the landmark document "Minimum requirements for the disposal of waste by landfill".

However, there is a definite need for a decision support system, be it the form of direct access to expertise, computer software or documented guidelines, to help regulatory bodies and consultants and to guide them in the decision-making process. This research study has developed a decision support system to guide the user through the site-selection process, which will contribute greatly toward DWAF's initiative.

MULASSAS

In this report, one such computer-based decision support system called MULASSAS (Municipal Landfill Site-Selection Advisory System) is described. The MULASSAS software system comprises various computer programs (or so-called expert-systems applications) which are designed to be utilised together within one software-development environment. The expert-systems are the following:



- **Selection-control expert system**

This system is designed to call up the other expert systems and has links to an electronic test system with some pictorial displays.

- **Text and graphics information systems**

These provide supporting information. Aspects addressed include landfill-siting minimum requirements, important definitions, display of diagrams, aquifer vulnerability indexing and IEM scoping `procedure'.

- **Landfill site-selection advisory expert systems**

These two systems use a `checklist' approach in the selection of landfill sites. For a site, they help to identify `fatal flaws', `critical factors' and applicable minimum requirements.

- **Aquifer and surface-water vulnerability index-assessment expert systems**

These expert systems are designed to help in the assessment of relative impact weightings for surface water and groundwater resources for sites with similar geographic settings. Impact weightings are often used when ranking alternative sites. The first system, called DRASTIC, is a standardised system for evaluating groundwater pollution potential used by the EPA (USA). The second, called AquiRisk, is a framework for modelling surface and groundwater pollution potential.

- **Annual waste load and waste volume estimation aid**

This expert system uses current waste/population statistics and a given growth rate to estimate future annual waste loads transported to a landfill site, as well as the volume of landfill taken up by the accumulated compacted waste. The information is presented as a table. Assuming available soil cover reserves are not a limiting factor at a site, the total air space taken up by landfill may be estimated.

- **Landfill site-cost comparison aid**

An expert system which estimates comparative costs for a site regarding soil transport, refuse transport, other annual site running costs and distributed capital costs, from data input by the user.

- **On-site soils-suitability advisor**

This expert system advises on the suitability of different types of soils for use at a landfill site, based on a sand-clay-silt content classification. The humus content and cation-exchange-capacity of soils are not addressed in the system.

The expert system is still in a development stage and will only be released once it is fully compatible with DWAF's "Minimum requirements for the disposal of waste by landfill.

Copies of the report entitled **"Development of a method for the selection of suitable landfill sites and guidelines for sanitary landfill in municipal areas" (WRC Report 352/1/94)** are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 20).

Researchers evaluate the long-term use of plastic piping

The results of a study to evaluate the long term use of polypropylene for hot and cold water piping have been released by the Water Research Commission in Pretoria. The study, which was carried out by WW Focke, M Buchinger, OG Del Fabro and O Schmid from MATTEK at the CSIR, used laboratory techniques to explore the quality of locally produced pipes in comparison to imported pipes from Germany. The objectives of the investigation were to evaluate failure mechanisms experienced in practice, to evaluate the long term thermal stability and creep properties of these pipes and to generate performance data required for quality control or acceptance tests.

A final report summarising the research results entitled **"Evaluating the long term use of polypropylene for hot and cold water piping" (WRC Report 434/1/94)** can be ordered free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 25).

Polypropylene pipes are currently used for domestic hot and cold water installations. The researchers say in the report that in South Africa the annual consumption of polypropylene raw material for this application amounts to approximately 600 tons. Raw material suppliers expect that this volume could increase to 2 000 tons per year should large scale mass housing projects get underway.

Plastic piping for the transportation of potable water potentially offers the following advantages:

- ❑ flexibility and the use of long lengths which makes installation easier and reduces the number of fittings;
- ❑ low weight with associated ease of transportation and storage, and
- ❑ relatively low cost of manufacture and installation.

Potential disadvantages include increased contraction and expansion during temperature cycling, failure modes which differ greatly from those of more conventional piping such as copper and steel, flammability, increased creep under high pressures and temperatures, etc.

The researchers say experience in Western Europe has shown that polypropylene piping can be successfully applied for under-floor heating applications. Provided that appropriate guidelines are followed in the choice and selection of the polymer grade during manufacture, acceptable service life should be attainable in practice. However, this raises the costs of manufacture which in today's competitive world leads to the temptation to take short-cuts. Enforcement of appropriate specifications will protect both the consumer and the reputable manufacturer.

Despite widespread use of polypropylene pipes, the researchers say not enough is known about the long term behaviour and ageing tendencies of such pipes, especially in hot water applications. Because of these uncertainties, many

A very bad extrusion resulting in a combination of ductile / brittle failure. An angled crack resulted ultimately in a ductile "ballooning."

This pipe showed evidence of two brittle cracks inside and an eventual ductile failure on the outside.

Brittle crack failure initiated by an indentation from a sharp rock.

authorities have expressed reservations regarding the use of polypropylene pipes. This implies a need for a sound scientific investigation for the long term performance properties of locally produced polypropylene pipes. The major objectives of this Water Research Commission study were therefore:

- ❑ the provision of relevant performance data on which criteria for a standard specification could be based, and
- ❑ to develop or select appropriate test procedures for quality control that will guarantee satisfactory performance over the required service life.

The researchers say that to achieve these goals, it was decided to focus on locally produced pipes and to conduct tests which would indicate their long term properties. It was hoped that the data generated would aid the drafting of appropriate specifications as well as routine quality control procedures to be implemented by manufacturers.

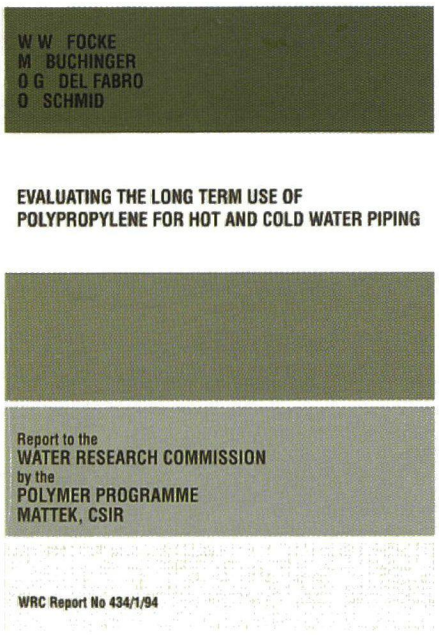
In the interest of economy, tests were limited to the most commonly used pipe diameter (outer diameter 22 mm). Products from three major suppliers were investigated. A batch of pipes from each supplier was procured from reputable retail suppliers to ensure that a representative sample was obtained and bias excluded. Each supplier subsequently confirmed in writing that the product did in fact originate from his factory. In addition, virgin raw material was obtained from Plastomark and served as a reference standard.

PROJECT

The project was executed in four separate phases:

Phase 1
Evaluation of failure mechanisms
The purpose of this phase was to identify the prevalent failure modes experienced in the field and to investigate the root causes of these failures. It was also hoped that guidelines would be generated regarding the manufacturing and installation procedures which would help to eliminate these failures.

Results: Approximately 60 samples of field failures were investigated. The major failure modes, their frequency and proposed remedial actions are given in the



report. Despite the evidence of defective raw materials being used (18 per cent), the most frequent reason for field failures was incorrect installation procedures (32 per cent). Poor quality processing or incorrect manufacturing procedures caused 21 per cent of the failures investigated. Problems were also encountered with gas or oil pollution of water inside pipes (14 per cent) and failure of fittings (8 per cent). The researchers say these results indicate that a comprehensive approach will be required to remedy the situation.

Phase 2
Material characterisation
The purpose was to quantify all major physical parameters known to affect performance of polypropylene in raw material and pipe form. Also, to develop or select appropriate analytical methods to quantify changes in raw material during processing and to determine the level of additives used.

Results: Block copolymer pipes (grades PPH 4122 and PPH 2222) are currently manufactured locally and "pipe grade" material (Tipolene) is imported from Hungary. Analysis of some pipes clearly indicated that the incorrect convertors were used and in some instances, insufficient or no stabiliser was added to the polymer. Such pipes cannot be expected to provide trouble free service over the required lifetime.

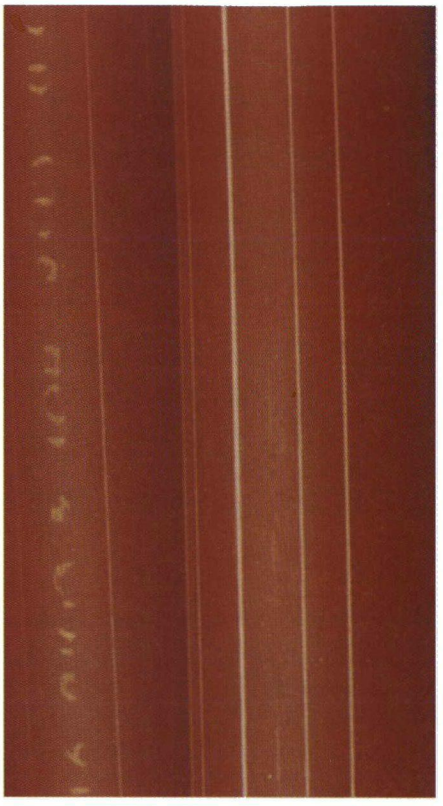
Phase 3
Thermal stability
Here the purpose was to estimate the effect of thermal oxidation on the expected service life of each pipe batch. For this a temperature life-time curve was developed using thermal scanning and oven ageing techniques. This information was to be used to evaluate the relevance of the Oxidation Induction Time requirement of the proposed SABS Standard Specification. It was also hoped to develop a routine quality control test for the stabiliser level in the manufactured pipe.

Results: Many field samples failed by embrittlement due to oxidative degradation. In all these cases it was shown that very little or no stabiliser was present. For well stabilised pipes, extrapolation of Differential Scanning Calorimetry data and oven ageing tests indicate that the pipes should have excellent dry heat stability. Predicted service life in air is much higher than specified requirements of more than 30 years at 25°C and more than three years at 80 °C.

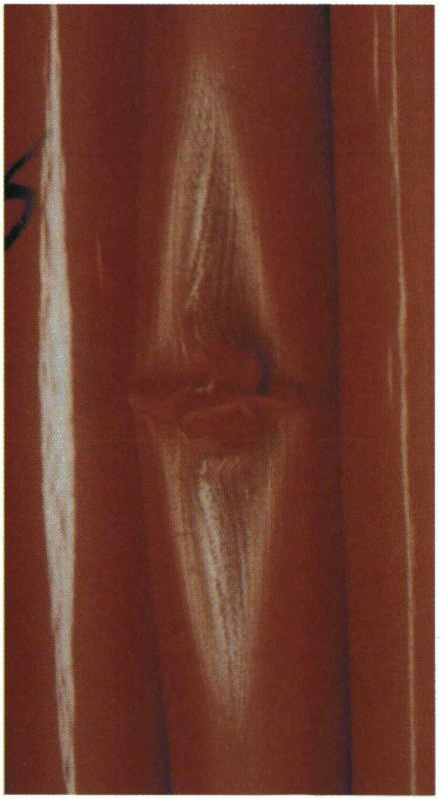
Phase 4
Long term "creep" properties
The goal of this phase was to determine the effect of mechanical stress and temperature on the service life of existing pipes.

Results: The report says the service life of polypropylene pipes is limited by two independent failure modes. Creep rupture is a ductile failure mode occurring at high stresses and short life times while "brittle" craze failure occurs at low stress levels and longer times. According to the literature, the time-to-failure for the latter mechanism is more sensitive to parameters such as molecular weight, molecular weight distribution and crystal morphology than the ductile failure mode. Quality testing should therefore test in the "brittle" fracture regime as this mode limits service life under normal operating conditions.

The requirements to be met to ensure high quality of locally produced polypropylene pipes and adequate service life are given in the report.



A typical South African "brittle" craze failure in an SABS creep test at 80°C



Examples of pipe failure modes observed in locally produced pipes tested at 80°C

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FEBRUARY 1996

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OCTOBER 1996

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NOVEMBER 1996

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DECEMBER 1996

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SOUTHERN AFRICA

1996

CROP PRODUCTION
JANUARY 23 - 25

The South African Society of Crop Production will hold its 1996 SASCP Congress at the University of the Orange Free State in Bloemfontein.
Enquiries: Mrs Annelie Barnard, Private Bag X29, Bethlehem 9700.
Tel: (058) 303-5686.
Fax: (058) 303-3952.

WATER DISTRIBUTION
FEBRUARY 8

A WISA seminar on technology and standards for water conservation will be held in the Civic Centre, Kempton Park.
Enquiries: Alta Engelbrecht.
Tel: (011) 493-2270.

GIS
MARCH 15 - 22

A conference on the application of remotely sensed data and geographic information systems (GIS) in environmental and natural resources assessment in Africa will be held in Harare, Zimbabwe.
Enquiries: The Secretariat, Conference on GIS in Africa, Environment and Remote Sensing Institute (ERSI), PO Box 6640, Harare, Zimbabwe.
Tel: 263-4-731049/5.
Fax: 263-4-733797 /731049/495628.

WATERGEHALTE
MEI 13 - 17

Die Universiteit van Pretoria bied 'n kortkursus in watergehaltebestuur aan.
Navrae: Professor WA Pretorius, Departement Chemiese Ingenieurswese, Afdeling Waterbenutting, Universiteit van Pretoria 0001. Tel: (012) 420-3566.

WISA '96
MAY 20 - 23

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

SOIL SCIENCE
JUNE 25 - 27

The 20th Congress of the Soil Science Society of South Africa will be held at the University of the Orange Free State in Bloemfontein. Theme: Sustainable soil utilisation and rural development.
Enquiries: Chris du Preez.
Tel: (051) 401-2957
Fax: (051) 401-2212.

WATER ENGINEERING
JULY 18 - 19

The young water, environmental and geotechnical engineers' festival will be held at the Rob Roy Hotel, Botha's Hill, Natal.
Enquiries: Lesley Stephenson, Conference Secretary, PO Box 327, WITS.
Tel: (011) 716-5091
Fax: (011) 339-7935.

AQUATIC SYSTEMS
JULY 15 - 19

A conference on aquatic systems will be held at the Elephant Hills Hotel, Victoria Falls, Zimbabwe.
Enquiries: Ms Lesley Stephenson, PO Box 327, WITS 2050.
Tel: (011) 716-5091
Fax: (011) 339-7835.
E-mail: Stephenson @ egoli.min.wits.ac.za

HYDRAULIC RESEARCH
AUGUST 5 - 7

The International Association for Hydraulic Research - African Division's biennial congress with the theme "From flood to drought" will take place at Sun City.
Enquiries: Miss Genevieve Stephenson, Conference Office, PO Box 327, WITS 2050.
Tel (011) 716-5091
Fax (011) 339-7835.

AFRIWATER '96
SEPTEMBER 2 - 5

The AFRIWATER Conference and Exhibition will be held at the Gallagher Estate in Midrand.
Enquiries: Nigel Walker
Tel: (011) 318-2009/1189
Fax: (011) 318 1189.
International code: (+27 11).

WATERSUIWERING
SEPTEMBER 16 - 20

'n Kortkursus in die bedryf van watersuiweringsaanlegte sal by die Universiteit van Pretoria aangebied word.
Navrae: Professor WA Pretorius, Departement Chemiese Ingenieurswese, Afdeling Waterbenutting, Universiteit van Pretoria 0001.
Tel: (012) 420-3566.

ENVIRONMENTAL MANAGEMENT
OCTOBER 7 - 8

The 2nd Environmental Management, Technology and Development Conference will be held at the Indaba Conference Centre, Fourways, Gauteng.
Enquiries: Lesley Stephenson, Conference Secretary, PO Box 327, WITS 2050. Tel: (011) 716-5091. Fax: (011) 339-7835.

WATERBEHANDELING
OKTOBER 21 - 23

'n Kortkursus oor die behandeling van nywerheids- en verkoelingswater sal by die Universiteit van Pretoria aangebied word.
Navrae: Professor WA Pretorius, Departement Chemiese Ingenieurswese, Afdeling Waterbenutting, Universiteit van Pretoria 0001. Tel: (012) 420-3566.

ISIAME '96
NOVEMBER 4 - 8

An international symposium on industrial applications of the Mössbauer effect will be held in Johannesburg.
Enquiries: Prof Herman Pollak (Chairman), Mössbauer Laboratory, Department of Physics, University of the Witwatersrand, Private Bag 3, Johannesburg 2050.
Tel: (011) 716-4053
Fax: (011) 339-8262.
E-mail: 005KLKS@WITSVMA.WITS.AC.ZA

1997

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.

OVERSEAS

1996

MICROBIAL PHYSIOLOGY
JANUARY

An advanced course on microbial physiology and fermentation technology will take place at the Delft University of Technology, the Netherlands.
Enquiries: Dr LA van der Meer-Lerk, Kluyver Laboratory, Julianalaan 67, 2628 BC Delft, the Netherlands.
Tel: 31-(0)15-785140
Fax: 31-(0)15-782355.

BATCH REACTOR TECHNOLOGY
MARCH 18 - 20 1996

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

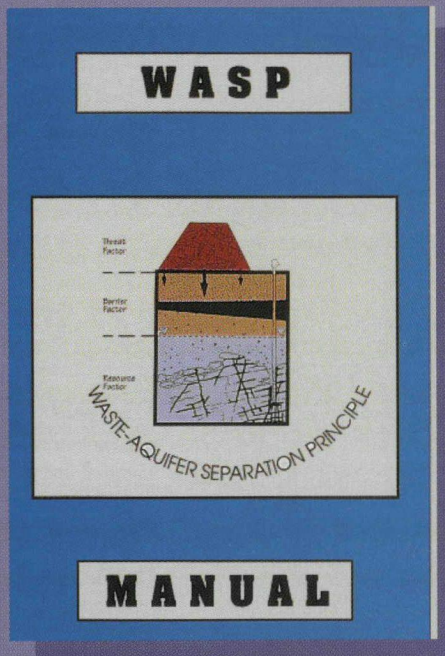
HYDROGIS '96
APRIL 16 - 19

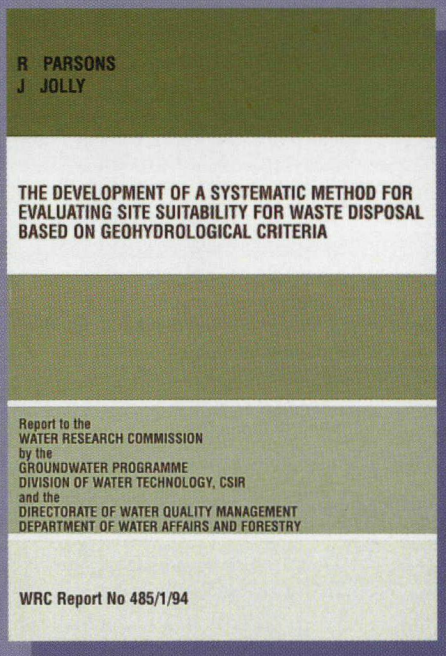
An international conference on the application of geographic information systems in hydrology and water resources management will be held in Vienna, Austria.
Enquiries: HydroGIS '96, c/o Austropa-Interconvention, PO Box 30, A-1043 Vienna.
Tel: +43(1) 588 00110
Fax: +43(1) 586 7127.

MICROPOLLUTANTS
MAY 6 - 7

A workshop on "Natural origin inorganic micropollutants: arsenic and other constituents" will take place in Vienna, Austria.
Enquiries: Mr Pierre Schulhof, Compagnie Gén´erale des Eaux, Quartier Valmy - 32, Place Ronde, 92982 Paris La Defense CEDEX.
Fax: (+33) (1) 46 35 31 50.

WASP - a new tool developed for waste site selection





Copies of the WASP Manual, the research report entitled ***"The development of a systematic method for evaluating site suitability for waste disposal based on geohydrological criteria"*** **(WRC Report 485/1/94)** as well as the WASP computer software, are available free of charge from the Water Research Commission, PO Box 824, Pretoria 0001. (Overseas price: US$ 50).

It is widely argued that most waste can be landfilled without any unacceptable detriment to the public or the environment - that is, if the sites are carefully selected. Further, if expensive and technically difficult groundwater contamination clean-up is to be avoided, waste facilities and aquifers must be kept apart.

This separation principle is central to the methodology developed in a Water Research Commission funded project which addressed the geohydrological components of waste site selection and suitability evaluation. The project was carried out by Roger Parsons of the Groundwater Programme, Watertek, CSIR and Jeff Jolly, formerly of the Directorate of Water Quality Management at the Department of Water Affairs and Forestry, and now with Groundwater Consulting Services.

The Waste - Aquifer Separation Principle, abbreviated as WASP, is a tool for assessing the suitability of both existing and proposed waste facilities in terms of geohydrological criteria. WASP considers three distinct components which play a role in defining the suitability of a particular site for waste disposal, namely:

- The threat posed by the waste pile;
- The barrier between the waste pile and groundwater resources, and
- The groundwater resource.

Each factor is independently assessed before a WASP Index is calculated. The Index is then compared with a calibrated interpretation scale to define suitability. Coupled to each factor is a data reliability rating process. The data reliability ratings of each factor are determined and then averaged. The rating is then recorded, in parenthesis, behind the WASP Index in order to provide a measure of confidence in terms of the degree of detail of information used to calculate the WASP Index.

from flood to drought

International Association for Hydaulic Research
African Division

IAHR

AIRH

BIENNIAL CONGRESS

5-7 August 1996

at

The Lost City, Sun City, South Africa

CONGRESS THEMES

- Flood to Drought - problems of temporal distribution
- Water Transfer Schemes
- Environmental aspects of water use in arid regions
- Innovative methods of conserving water

WORKSHOP THEMES

- Research and education needs in Africa in hydraulics and water
- Financial and political constraints of water developments
- The Zambesi River - present and future

For further information please contact:
Genevieve Stephenson, Conference Office, PO Box 327, WITS 2050, South Africa
Tel (27) (011) 716-5091, Fax (27) (011) 339-7835

INTERNATIONAL ASSOCIATION OF APPLIED ALGOLOGY

7th International Conference on Applied Algology

16 - 19 APRIL 1996
Knysna, Southern Cape

Theme

The theme of the conference will be opportunities from micro and macro algae.

The following topics for sessions are suggested:

- Molecular biology: Challenges and prospects
- Microalgal growth and production systems
- Photosynthesis and algal physiology
- Macroalgal growth and production systems
- Products and constraints
- Algae as bioindicators
- Algae and wastewater treatment
- Downstream processing (harvesting, etc.)
- Economics and commercial ventures

Tours

A number of pre and post conference tours will be offered, ranging from three to ten days. These will include visits to the Kruger National Park, the Cape area withwinelands and flora of the Cape and Table Mountain and a trip along the Garden Route. Dr John Bolton of the University of Cape Town will arrange a scientific excursion for those interested in seaweeds.

Registration

Deadline: 30 November 1995.
The registration fee will be R750.
Late registration (after 30 November 1995) will be R950.

The registration fee will cover the costs of the conference together with the banquet, mid-conference excursion, lunches during the conference and all tea and coffee during breaks.

Enquiries

Prof Johan Grobbelaar, Department of Botany and Genetics, University of the Free State, Bloemfontein 9300 Tel: (051) 401-2514 Fax: (051) 488-772 E-mail: pjg@rs.uovs.ac.za