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AN EVALUATION OF HYDROLOGICAL FLOOD ESTIMATION TECHNIQUES: PHASE I. THE ESTABLISHMENT OF A SMALL CATCHMENT DATA BANK (Part 1: Text)

Report to the
WATER RESEARCH COMMISSION
by
STEFFEN ROBERTSON AND KIRSTEN (CIVIL) INC

WATER RESEARCH COMMISSION

RESEARCH PROJECT - EVALUATION OF FLOOD ESTIMATION TECHNIQUES

PHASE 1 : THE ESTABLISHMENT OF A SMALL CATCHMENT HYDROLOGICAL DATA BANK PART 1 : TEXT

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WATER RESEARCH COMMISSION

RESEARCH PROJECT - EVALUATION OF FLOOD ESTIMATION TECHNIQUES

PHASE I : THE ESTABLISHMENT OF A
SMALL CATCHMENT HYDROLOGICAL DATA BANK

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WATER RESEARCH COMMISSION

THE ESTABLISHMENT OF A SMALL CATCHMENT HYDROLOGICAL DATA BANK

1 INTRODUCTION

At present hydrologists and engineers in Southern Africa face two major problems in small catchment hydrology:

- availability of small catchment hydrological data
- absence of suitable guidelines on the selection, use and expected accuracy of the different flood estimation techniques.

Hydrological information is needed by the designer both for basic design and to assess the hydrological effects of land-use modifications. Although extensive research has been conducted using data from small catchments in Southern Africa, these data are not readily accessible. In addition to the Department of Water Affairs, 25 organizations currently collect hydrological data on more than 120 catchments.

Selection of a design technique should normally go hand in hand with data availability. Frequently, however, techniques are applied with insufficient data. The hydrologist or engineer is usually aware of the data deficiencies but is seldom able to assess the effect on the design solution. Even when there are no constraints on data collection or design, it is sometimes not possible to assess the accuracy associated

with hydrological designs. Furthermore, on ungauged catchments where designs are based on some future land-use modification, gauging of the catchment might provide little information of value at the design stage.

Research by universities and institutes in South Africa and overseas has resulted in numerous methods for simulating the response of a catchment to a storm event. The design engineer faces the difficult task of selecting an appropriate design method with little guidance as to which technique can be expected to produce the most reliable result for the situation at hand. Great reliance is often placed on the selected method and seldom is a sensitivity analysis of the various parameters conducted.

To help meet the needs of design engineers and hydrologists, the Water Research Commission has funded a two-phase research project comprising:

- Phase I : Establishment of a small catchment hydrological data bank
- Phase II : Evaluation of small catchment flood estimation techniques

For the purposes of this project a small catchment is defined as one which has a hydrological response that is not influenced significantly by the catchment channel characteristics (with the upper limit set at 100 km^2).

This report contains details of Phase 1 of the project.

The purpose of Phase I of the project is to collate and document the available hydrological catchment information measured on small catchments by organizations in Southern Africa.

Sources of suitable hydrological catchment data were identified by distributing questionnaires to all parties and organizations known or thought to be involved with hydrological studies. Tremendous interest was shown in the survey and over 66 percent of the questionnaires were returned. Details of the questionnaire and data acquisition investigations are presented in Section 2.

A computer-based data file containing information from small catchments throughout Southern Africa has been established. The format of the data bank is described in Section 3. Details of the selected catchments are presented in Section 4.

In addition to the catchments contained in the data bank, several major studies, which at present do not monitor both rainfall and streamflow information, were identified. Descriptions of these are presented in Section 5.

The Department of Water Affairs is currently recording flow information at over 800 hydrological gauging stations. Nearly 300 of these are located on small catchments. Some gauging stations are being operated by other organizations, such as universities, for research purposes, and these are reported on in Section 4. The information for the remainder of the catchments has, however, not been included in the small catchment data bank as the Department of Water Affairs is in the process of establishing its own data bank. Some of the data collected by the Department will however be used in Phase II of the study.

It should also be noted that the Department of Water Affairs is primarily responsible for obtaining streamflow information and it would be necessary to combine Weather Bureau rainfall and climatic information with its data bank to obtain catchment information similar to that contained in the small catchment data bank described in this report.

2 DATA COLLECTION PROCEDURE

2.1. General

Small catchment data sources were identified by distributing questionnaires to all organizations known or thought to be involved with catchment monitoring programmes. Notices requesting information were also placed in relevant technical journals. The response to the latter approach however, was poor. This may be ascribed to the fact that the questionnaires had a very wide coverage.

Direct contact was then made with the organizations identified as being monitors of hydrological aspects of small catchments. A specially prepared data acquisition sheet was used to acquire relevant physiographic and climatic factors pertaining to the monitored catchments.

The objectives, format and results of the questionnaire as well as details of the data acquisition are given below.

2.2 Questionnaire

- **Objectives**

The purposes of the questionnaire were to :

- identify sources of small catchment hydrological data
- establish type of data collected
- establish data requirements of end users
- ascertain flood estimation techniques commonly used.

- **Format of Questionnaire**

To meet these objectives, the questionnaire consisted of four parts addressing matters related to general background, hydrological data collected, hydrological data required and the use of flood estimation techniques.

A system of codes was adopted to minimize time spent on filling out the questionnaire and facilitate handling of the information recorded on the questionnaire.

A copy of the questionnaire is given in Part 2 of the report.

- **Response to Questionnaire**

Questionnaires were sent to 284 organizations located throughout South Africa, South West Africa, Lesotho, Swaziland and the Homelands. A further 11 complimentary copies were sent to interested parties. This latter group was not included in the overall statistics of the project.

To facilitate data handling the organizations were divided into 9 groups. An indication of the coverage received by each organization group is also given in Table 2.1.

The response to the questionnaire was 66 percent, i.e. one hundred and eighty-nine (189) questionnaires were returned. The best response was obtained from the Administration Boards (80%) with State Departments following at 78%. The Homelands and territories outside South Africa recorded a relatively poor response. This may be ascribed to a lower level of development in these regions and consequently a limited interest in hydrological analysis.

TABLE 2.1 : QUESTIONNAIRE STATISTICS

ORGANIZATION	NUMBER SENT	NUMBER RETURNED	PERCENTAGE RESPONSE	NUMBER MONITORING SMALL CATCHMENTS	NUMBER REQUIRING DATA	NUMBER USING MODELS	NUMBER NOT INTERESTED
STATE DEPARTMENTS[1]	23	18	78	4	10	10	6
DEPEND. HOMELANDS	33	17	52	0	8	5	9
ADMINISTRATION[2]	10	8	80	0	6	5	1
MUNICIPALITIES	46	32	70	4	24	28	2
UNIVERSITIES	35	27	77	5	14	8	11
CONSULTANTS[3]	84	51	61	1	44	43	7
STATUTORY BODIES[4]	24	18	75	3	10	6	7
WATER BOARDS	5	3	60	2	1	0	2
OUTSIDE RSA[5]	24	15	62	7	1	1	8
TOTAL	284	189	66	26	118	106	53

1 State Departments
2 Provincial Administration and Development Boards
3 Engineering Consultants
4 Parks Boards; Sasol; Iscor; CSIR; Mining Houses; S A Transport Services
5 Swaziland; Lesotho; South West Africa; Independent National States

The survey revealed that of the 189 organizations that responded to the questionnaire, 26 organizations are involved with catchment monitoring programmes, 106 use flood estimation techniques, 118 organizations required recorded climatic information and 53 have no interest in hydrological parameters or flood estimation.

The 26 organizations involved in monitoring hydrological aspects on small catchments are active on more than 120 small catchments throughout Southern Africa. The catchments are located mainly in rural areas, the land-use being predominantly veld.

The monitoring programmes are undertaken mainly by Universities, Municipalities and State Departments. In most instances catchments are monitored for research purposes. Municipalities and private concerns monitor catchments mainly to obtain design information.

Runoff is the most commonly measured parameter followed by rainfall. Climatic (temperature, evaporation and wind) and water quality data are recorded on about 45% of the catchments.

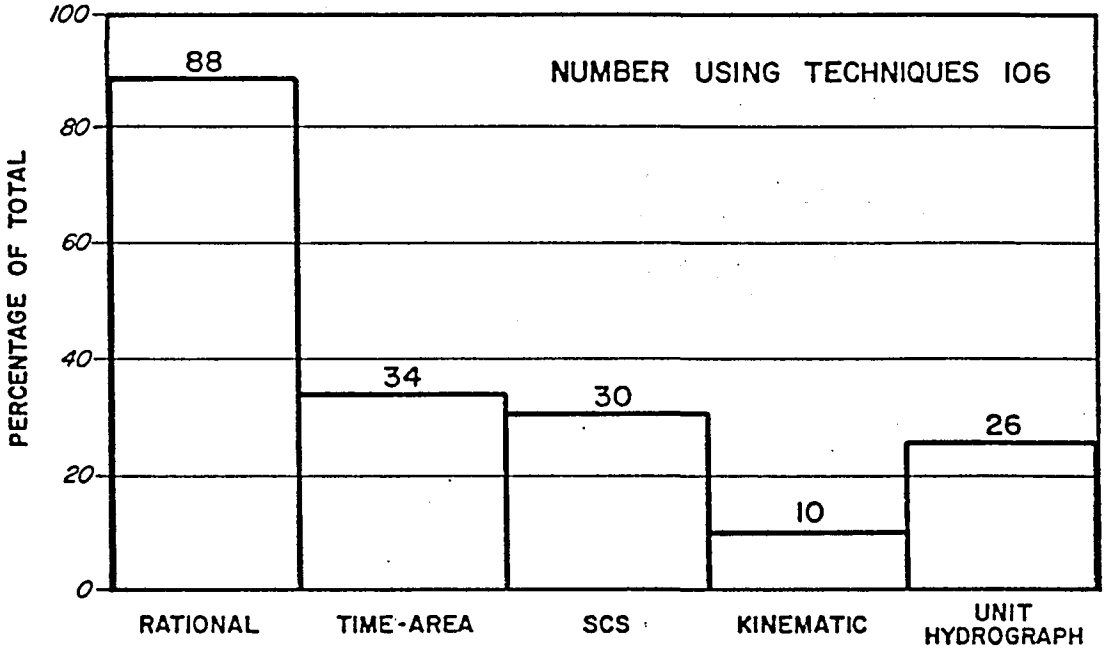
Recorded hydrological data are required by 62 percent (118) of the 189 organizations that responded to the questionnaire. The most frequent data requirements are rainfall (79 percent of 118) and runoff (92 percent of 118). Other climatic and water quality data are required by about 60 percent of the organizations (see Fig 2.1).

Flood estimation techniques are widely used. The Rational method is used by 88 percent of the 106 organizations currently involved with flood estimation. The unit hydrograph method is applied by 26 percent of the organizations and the SCS (U.S.D.A. Soil Conservation Service) method by 30 percent (Fig 2.1). The Time-Area method is used by 34 per cent of the organizations. The kinematic method is rarely applied due to its higher degree of complexity and the need for computer facilities.

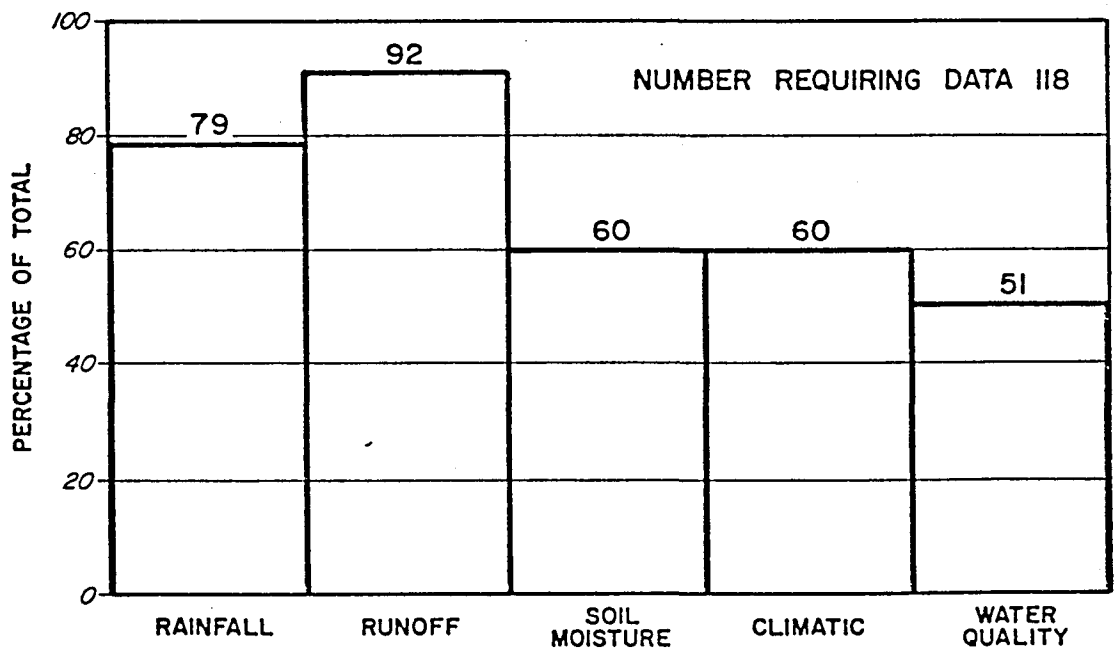
The survey also revealed that presently only 79 (viz 42%) of the 189 participating organizations have access to electronic computers.

2.3 Data Acquisition

The questionnaire survey showed that some 26 organizations were involved with catchment monitoring programmes. Contact was made telephonically with these organizations to establish the suitability of the monitored catchments for inclusion in the Small Catchment Data Bank. A visit was then made to these organizations to gather the relevant catchment information. A data acquisition form was prepared for this purpose. A system of codes was used to ease the filling out of the data acquisition sheet. A copy of the data acquisition sheet is given in Part 2 of the report.



EXTENT OF FLOOD ESTIMATION TECHNIQUES USED



HYDROLOGICAL DATA REQUIREMENTS

	JOB Nº		FIG Nº
	CI 3392	CATCHMENT HYDROLOGICAL DATA BANK	2.1

The information obtained for each catchment included:

- physical parameters of the catchment
- instrumentation type and distribution
- rainfall, runoff, other climatic and water quality data
- status of data processing.

Contact with the organizations revealed that of the 26 involved with catchment monitoring programmes, 14 collected both rainfall and runoff data. The catchments monitored by these organizations were therefore considered suitable for Phase II of this project, ie the evaluation of flood estimation techniques. These catchments are termed "Selected" Catchments. Details of each of these catchments are given in Section 4 of this report.

For each of the selected catchments cursory checks were made on the information recorded on the data acquisition sheets. In cases where basic parameters were omitted, an estimated value was inserted where possible. For example, the average catchment slope was estimated and presented as one of the following ranges:

- flat 0- 5%
- moderate 5-10%
- steep +10%

The mean altitude was taken to be the average between the elevation of the highest point in the catchment and the elevation of the flow recording stations.

During the course of the study, the need for additional information on the data acquisition sheet such as magisterial district, province, vegetation, soils and geology was identified and the sheet was updated.

Several telephone conversations were had with the organizations monitoring selected catchments to verify the information finally contained on the data acquisition sheets. The information was subsequently captured on computer and is stored in code form as described in Section 3.

3 SMALL CATCHMENT DATA BANK

The Small Catchment Data Bank was assembled to provide ready access to hydrological data monitored on small catchments. Unlike other current hydrological data banks, the Small Catchment Data Bank also contains the complete range of physical and hydrological parameters of each of the monitored catchments.

Only 109 of the monitored catchments were considered suitable for detailed description and inclusion in the data bank. These catchments are discussed in Section 4. Other monitored catchments not included in the data bank include:

- catchments monitored by the Department of Water Affairs, who have an already established data bank for streamflow
- catchments with an inadequate rainfall/runoff data base, i.e. either rainfall or runoff not recorded.

Brief descriptions of these other catchments are, however, given in section 5 together with details of the organizations involved.

The data bank was established in two forms :

- printed
- computer magnetic tape.

3.1 Printed format

The printed form consists of two pages of information per catchment as discussed in Section 4 and listed in Part 2 of the report. The information given, in sequential order, includes:

- catchment identification and location
- catchment details
- data collected
- streamflow recording station details

- background information on the monitoring organization and programme
- information files
- physical catchment information
- a map of the catchment
- recorded data, ie type of data, station number, instrument type, period of records and status of data.

The printed form is structured to assist the end user to :

- minimise time spent on locating relevant catchment information
- identify monitored catchments in the particular area of interest
- establish the type and format of data recorded
- establish the availability of recorded data
- provide access to the information stored on the computer based data bank.

These files are similar in format to the Data files presently being developed by the Department of Water Affairs (DWA), the major difference being that the DWA catchment and measuring weir descriptions will be in essay form.

3.2 Computer Based Data File

The computer based Data Bank contains two file types viz, catchment information files, and data files.

The catchment information files contain the same details of the 109 monitored selected small catchments as that shown on the printed form. The information is not stored as text, but as codes, derived from the data acquisition sheet. The information is also stored in the sequential format of the data acquisition form, which is different to the printed form.

A computer program was written to translate the computer information file into the printed form.

It was envisaged at the start of the project that the data files would contain raw data recorded by the monitoring organization and, in cases where available, processed data. However, data formats developed by the individual organizations were developed specifically for their own use and consequently the formating is inconsistent and the computer compatibility of the files varies from organization to organization (see Table 3.1). This computer incompatibility has made it difficult to store raw or processed data on the data files. The Data Bank will therefore contain at this stage only selected hyetographs and hydrographs for the catchments used in Phase II of the research project.

3.3 Access to the Data Bank

On completion of the research project it is proposed that the computer files comprising the Data Bank would be taken over and operated by the Department of Water Affairs. Catchment information files and data files containing selected events could therefore be accessed through DWA.

Additional hydrological data would become available as the Data Bank develops and data are re-formatted and made compatible with DWA formats. In the meantime, six of the monitoring organizations have computerized data which are available, from these organizations, for more than 40 catchments with an average period of record of about 10 years, as shown in Table 3.1. In most cases the chart reduction procedure is break-point digitization. The captured information can therefore be retrieved at any convenient time resolution.

TABLE 3.1 : SELECTED CATCHMENTS FOR WHICH COMPUTERISED DATA FILES ARE AVAILABLE

Organization	Catchment	RAINFALL RECORD		RUNOFF RECORD		Computer
		Period (years) From To	Status of Data	Period (years) From To	Status of Data	
Directorate of Forestry	G1M14	1968-1984	Processed	1968-1984	Processed	Univac 1100
	G1M15	1968-1984	Processed	1968-1984	Processed	IBM Compatible
	G1M16	1968-1984	Processed	1968-1984	Processed	
	G1M17	1968-1984	Processed	1968-1984	Processed	
	G1M18	1968-1984	Processed	1968-1984	Processed	
	G2M02	1961-1984	Processed	1961-1984	Processed	
	G2M03	1961-1984	Processed	1961-1984	Processed	
	G2M06	1940-1984	Processed	1940-1984	Processed	
	G2M07	1936-1984	Processed	1942-1984	Processed	
	G2M09	1940-1984	Processed	1947-1984	Processed	
	G2M10	1940-1984	Processed	1947-1984	Processed	
	G2F01	1944-1984	Processed	1961-1984	Processed	
	G1F02	1936-1984	Processed	1966-1984	Processed	
	G4M08	1967-1984	Processed	1968-1984	Processed	
	G4M12	1967-1984	Processed	1968-1984	Processed	
	G4F01	1967-1984	Processed	1970-1984	Processed	
	G4F02	1967-1984	Processed	1970-1984	Processed	
Department of Water Affairs	C8M24	1980-1984	Processed	1980-1984	Processed	Burroughs
	C8M25	1980-1984	Processed	1980-1984	Processed	
CSIR (Durban)	Pinetown	1978-1981	Processed	1978-1981	Processed	CYBER 750 CDC Compatible
Rhodes University	Q9M20	1975-1984	Processed	1976-1984	Processed	CDC
	Q9M21	1975-1984	Processed	1976-1984	Processed	
	Q9M22	1975-1984	Processed	1976-1984	Processed	
	Q9M23	1975-1984	Processed	1976-1984	Processed	
	Q9M24	1975-1984	Processed	1976-1984	Processed	
	FR01	1983-1984	Not available	1976-1984	Processed	
University of Natal*	V1M12	1965-1984	Processed	1965-1984	Processed	Univac 1100
	V1M15	1977-1984	Processed	1977-1984	Processed	IBM Compatible
	V1M19	1964-1984	Processed	1964-1984	Processed	
	V1M20	1964-1984	Processed	1964-1984	Processed	
	V1M28	1977-1984	Processed	1977-1984	Processed	
	V7M03	1977-1984	Processed	1974-1984	Processed	
	V7M11	1964-1984	Processed	1964-1984	Processed	
	U2M16	1977-1984	Processed	1977-1984	Processed	
	U2M18	1977-1984	Processed	1977-1984	Processed	
University of Zululand	W1M12	1975-1984	Processed	1977-1984	Processed	IBM
	W1M13	1975-1984	Processed	1977-1984	Processed	
	W1M14	1975-1984	Processed	1980-1984	Processed	
	W1M15	1975-1984	Processed	1977-1984	Processed	
	W1M16	1975-1984	Processed	1977-1984	Processed	
	W1M17	1975-1984	Processed	1977-1984	Processed	

*Only stations with the most suitable data for general use are provided.

4 SELECTED MONITORED CATCHMENTS

Catchments are classed as "selected" if the recorded data are extensive and considered of value in terms of Phase II of this project, i.e., Evaluation of Flood Estimation Techniques. Generally, these catchments contain a good rainfall/runoff data base.

There are 109 selected catchments presently being monitored by 14 organizations throughout Southern Africa. The location of the selected catchments are shown on Fig 4.1.

TABLE 4.1 : LOCALITY, LAND-USE AND AREA OF MONITORED SMALL CATCHMENTS

LOCALITY (Drainage Zone)	LAND USE					
	URBAN	AGRICULTURE	VELD	FOREST	MINING	TOTAL
A	1- 10 km^2 1*		10-100 km^2 1			2
B			0- 1 km^2 2	0- 1 km^2 1		3
C			1- 10 km^2 1 10-100 km^2 3			4
D		10-100 km^2 1 +100 km^2 1	10-100 km^2 10			12
G	10-100 km^2 2		0- 1 km^2 8 1- 10 km^2 10	0- 1 km^2 2 1- 10 km^2 2 10-100 km^2 1		25
K			10-100 km^2 2	10-100 km^2 1		3
Q			0- 1 km^2 1 1- 10 km^2 3 10-100 km^2 2			6
U	0- 1 km^2 1	0- 1 km^2 4		1- 10 km^2 2		7
V			0- 1 km^2 14 1- 10 km^2 5 10-100 km^2 2	0- 1 km^2 1 1- 10 km^2 2		24
W		1- 10 km^2 1 10-100 km^2 2	0- 1 km^2 1 1- 10 km^2 1 10-100 km^2 5 +100 km^2 1	1- 10 km^2 1		12
X			0- 1 km^2 4 1- 10 km^2 3	0- 1 km^2 3 10-100 km^2 3		13
SWA			10-100 km^2 6			6

*Number of monitored catchments

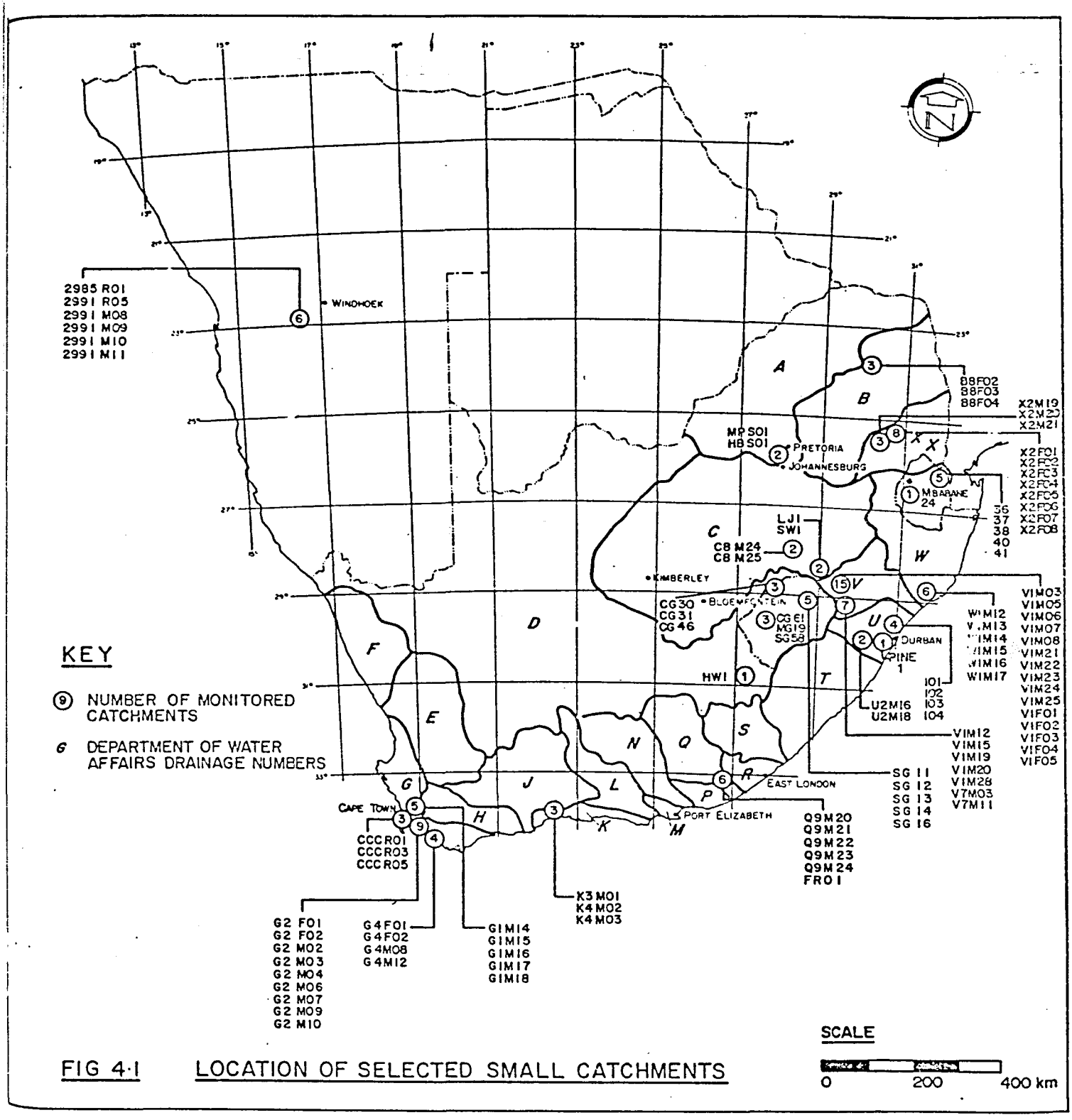


FIG 4·1 LOCATION OF SELECTED SMALL CATCHMENTS

The majority of the catchments (97%) are located in predominantly rural environments and the land-use is therefore mainly veld. Four of the selected catchments are located in urban areas. Nineteen catchments are predominantly forested areas while nine catchments are predominantly agricultural catchments (see Table 4.1 and 4.2). Because land-use changes have occurred on certain of the catchments during the course of the monitoring programme, the totals given in Table 4.1 and 4.2 exceed the total number of selected catchments.

TABLE 4.2 : AREA AND LAND-USE DISTRIBUTION OF SELECTED MONITORED CATCHMENTS

Area km^2	LAND-USE				TOTAL
	Urban	Agriculture	Veld	Forest	
0- 1	1	4	30	7	42
1- 10	1	1	23	10	35
10-100	2	3	31	2	38
+100		1	1		2
TOTAL	4	9	85	19	117

Rainfall and runoff are recorded on all of the selected catchments. The average period of record is about 20 years. Other climatic data and water quality information are monitored on about one-third of the catchments.

Details of the organizations undertaking monitoring programmes and information regarding the monitoring programmes are given in Table 4.3. A list of all the selected catchments is given in Table B1 in Part 2. The catchments are grouped according to the DWA drainage regions. Details are also given of the organization undertaking the monitoring programme, catchment area, land-use and period of available rainfall/runoff record.

TABLE 4.3 : DETAILS OF MONITORING ACTIVITIES

Name of Organization	No of Catch-ments	Catchment size (km^2)	Land-use	Locality	Monitoring Period	Purpose of study	Future Extensions
Department of Water Affairs*	2	9-83	Urban, agricul-ture and veld	Bethlehem	1980-present	To investigate possibility of increasing runoff by cloud seeding.	None
Directorate of Forestry	47	0,121-3,564	Veld and afforestation	Stellenbosch, Cathedral Peak, Sabie	1935-present	To determine the influence of manage-ment regimes on the water yielding pro-perties of mountain catchment areas	None
Department of Agriculture and Water Supply	1	100	Veld	Lady Grey	1973-present	Research into sediment estimation and silt movement	None
Cape Town Municipality	3	20-61	Urban, mountain and forest	Cape Town	1958-present	For flood drainage design	Extension of flow and moni-toring
University of Natal	9	0,41-34	Agriculture, veld and afforestation	De Hoek Ntabahlope Cedara	1964-present 1977-present	To develop rainfall/ runoff models for small catchments	Sediment, TDS sampling
Rhodes University	9	0,04-73	Agriculture, veld and afforestation	Grahamstown Wilderness	1975-present	Research into the development and testing of lumped parameter conceptual rainfall/runoff models in semi-arid and sub-humid catch-ments	Installation o 5 rainfall gauges
University of the Witwatersrand	2	1-10,36	Urban	Johannesburg	1982-present	To determine rain-fall, runoff and water quality for research purposes	None
University of Zululand	6	0,67-82,9	Agriculture, veld and afforestation	Zululand	1975-present	To evaluate techni-ques for estimating catchment runoff	Sediment and TDS sampling
De Wet Shand	2	14,5-25	Veld	Qwa Qwa	1976-present	To estimate catch-ment yield	None
CSIR Natal	1	0,12	Urban	Pinetown	1978-1981	To estimate the input of pollutants to an urban catch-ment	None
S A Sugar Assoc.	4	0,035-0,5	Agriculture	Tongaat	1977-present	Studying effects of different cane management practices on runoff	Rainfall simul tion and model ling technique on adjacent pl
Lesotho Met Office	11	6-108	Veld and agriculture	Lesotho	1950-present	To determine catch-ment runoff yield	None
SWA Water Affairs	6	17,3-131	Veld	South West Africa	-	Research for struc-ture design and erosion control	None
Swaziland Met Office	6	8-119	Urban, agricul-ture, veld and forest	Swaziland	1974-present	To estimate catch-ment runoff yield.	None

*Special monitoring programme and not included in the general DWA hydrological data accumulation programme.

Each of the selected catchments is documented in a standardized two-page information sheet. Information contained in the description includes catchment characteristics, hydrological parameters, gauge details and recorded data. Also affixed to the information sheet is a map of the catchment showing gauge location, topography and in some cases, land-use. Examples of the two-page information sheets of a selected catchment are given below (see Rhodes University - Q9M21 - Albany, Eastern Cape and Council for Scientific and Industrial Research - Pine 1 - Pinetown, Natal).

The two-page information sheets for each of the selected catchments are given in Part 2 of the report. The catchments have been grouped firstly under DWA drainage region, then in accordance with the numerical numbering system as used by DWA. Fig 4.1 and Table B.1, also given in Part 2, facilitate the location of the write-up of a particular selected catchment.

Part 2 of the report also contains a list of references related to the catchment monitoring programme.

Rhodes University - Q9M21 - Albany,Eastern Cape

CATCHMENT IDENTIFICATION

CATCHMENT NAME	ECCA B	GAUGE REFERENCE NO	Q9M21
LOCATION LAT.	33 deg. 13.00 min. S.	NEAREST TOWN	Grahamstown
LONG.	26 deg. 39.00 min. E.	MAGISTERIAL DISTRICT	Albany
RIVER	Tributary of Brak	PROVINCE OR COUNTRY	Eastern Cape

CATCHMENT DETAILS

CATCHMENT AREA	9.10 sq.km.	VEGETATION	Valley Bushveld
AVERAGE CATCHMENT SLOPE	Flat (3.7%)	LAND USE	Veld
MEAN ALTITUDE	370 m AMSL	SOILS	Lithosols
MEAN ANNUAL PRECIPITATION	420 mm	BINOMIAL SOIL TYPE	No details
NO OF DAMS IN CATCHMENT	0	GEOLOGY	Sandstone, mudstone & shales of the Ecca Group (Karoo Sequence) and Dwyka tillite (Karoo Sequence)
SHAPE FACTOR	No details		
DRAINAGE DENSITY	No details		

DATA COLLECTED

RAINFALL	Yes	TEMPERATURE	Yes
RUNOFF	Yes	WIND	Yes
CHEMICAL	Yes	RELATIVE HUMIDITY	Yes
TDS	Yes	NET RADIATION	No
SEDIMENT	Yes	SOIL MOISTURE	No
EVAPORATION	Yes	INFILTRATION	No

RAINFALL data are available, RUNOFF data are available, OTHER CLIMATIC data are available

STREAMFLOW RECORDING STATION DETAILS

CONTROL	Compound V-notch Broad-crested Weir
MEASURING LIMIT	75.90 cumec at 3.04 metres
RATING CURVE	Calculated
STORAGE CAPACITY BEHIND CONTROL	No details
PERCENTAGE OF STORAGE SILTED	No details

BACKGROUND INFORMATION

ORGANIZATION	Rhodes University
DEPARTMENT	Hydrological Res Unit, Geography Dept
CONTACT PERSON	Dr D A Hughes
ADDRESS	Hydrological Research Unit P O Box 94 GRAHAMSTOWN 6140
TELEPHONE	(0461) 4014

THE MONITORING PROGRAMME
- started : 1976
- purpose : To develop & test lumped parameter conceptual rainfall/runoffmodels in semi-arid sub-humid catchments
- future extensions : None

INFORMATION FILES

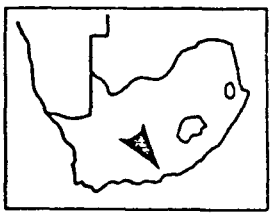
CATCHMENT INFORMATION FILE	Q9M21	(Last update : January 1985)
CATCHMENT MAP	Q9M21.MAP	
LIST OF REFERENCES	RHODES.REF	
RAINFALL DATA	Q9M21.RAIN	
RUNOFF DATA	Q9M21.FLOW	

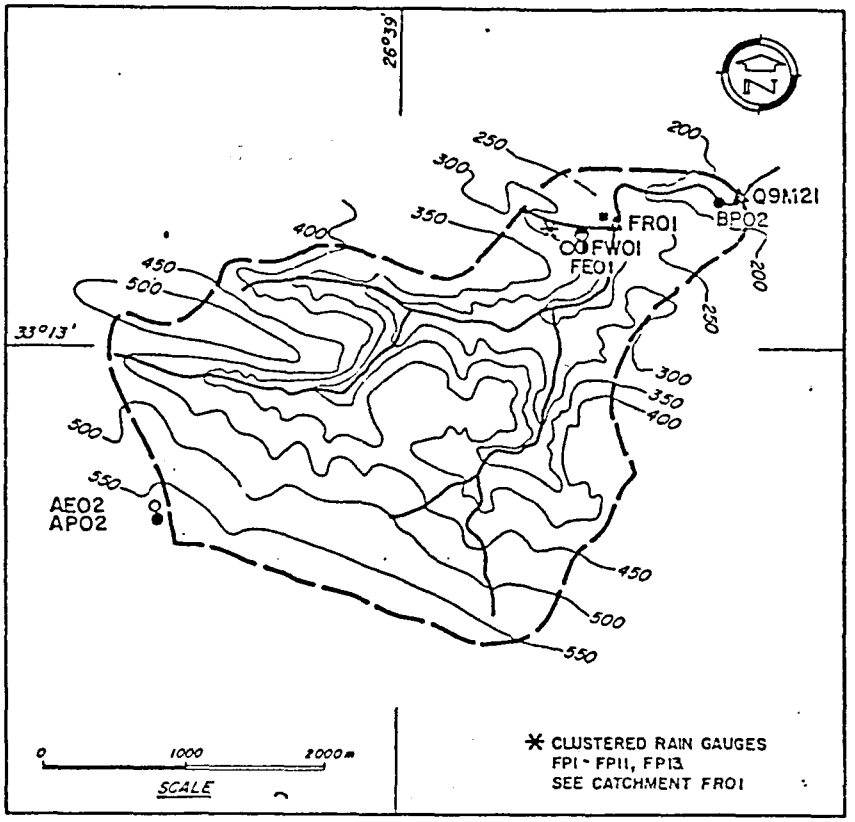
PHYSICAL CATCHMENT INFORMATION

LAND USE	1976 to 1984	100 % veld
DRAINAGE CHARACTERISTICS	Stream is seasonal and well defined	

. KEY : Measuring site for

- Rainfall ●
- Runoff ▲
- Water Quality ■
- Evaporation ○
- Temperature ⊖
- Wind ◑
- Soil Condition □





RECORDED DATA

PARAMETER MEASURED	STATION NUMBER	INSTRUMENT TYPE	PERIOD FROM-TO	NO. OF BREAKDOWNS	MEASURING FREQUENCY	RAW DATA STORAGE STATUS	PROCESSED DATA STORAGE STATUS
RAINFALL	AP02	Casella Siphon	1975-1984	0-25 %	Continuous	Computer tape	Computer tape
	BP02	Casella Siphon	1975-1984	0-25 %	Continuous	Computer tape	Computer tape
	FP1	Tipping Bucket	1983-1984	0-25 %	Continuous	Computer tape	Computer tape
	FP2	Tipping Bucket	1983-1984	0-25 %	Continuous	Computer tape	Computer tape
	FP3	Tipping Bucket	1983-1984	0-25 %	Continuous	Computer tape	Computer tape
	FP4	Tipping Bucket	1983-1984	0-25 %	Continuous	Computer tape	Computer tape
	FP13	Tipping Bucket	1983-1984	0-25 %	Continuous	Computer tape	Computer tape
	FP4	Storage Gauge	1983-1984	0-25 %	> Daily	Data sheet	
	FP5	Storage Gauge	1983-1984	0-25 %	> Daily	Data sheet	
	FP6	Storage Gauge	1983-1984	0-25 %	> Daily	Data sheet	
	FP7	Storage Gauge	1983-1984	0-25 %	> Daily	Data sheet	
	FP8	Storage Gauge	1983-1984	0-25 %	> Daily	Data sheet	
	FP9	Storage Gauge	1983-1984	0-25 %	> Daily	Data sheet	
	FP10	Storage Gauge	1983-1984	0-25 %	> Daily	Data sheet	
RUNOFF	Q9M21	Ott	1976-1984	0-25 %	Continuous	Paper strip	Computer tape
	FR01	Ott	1982-1984	0-25 %	Continuous	Paper strip	Computer tape
CHEMICAL	FR01	Pump Sampler	1983-1984	0-25 %	> Daily	Data sheet	
TDS	FR01	Cond Meter	1981-1984	75-100%	Continuous	Paper strip	
SEDIMENT	FR01	Surveys	1982-1984	0-25 %	> Daily	Data sheet	
EVAPORATION	AE02	Class A Pan	1983-1984	0-25 %	> Daily	Data sheet	
	FE01	Class A Pan	1983-1984	0-25 %	> Daily	Data sheet	
TEMPERATURE	FW01	Thermograph	1983-1984	0-25 %	Daily	Paper strip	
WIND	FW01	Anemometer	1983-1984	0-25 %	Daily	Paper strip	
REL.HUMIDITY	FW01	Hydrograph	1983-1984	0-25 %	Daily	Paper strip	
NET RADIATION							
SOIL MOISTURE							
INFILTRATION							

Majority of gauges are owned by Water Research Commission

Council for Scientific & Indus Research - PINE1 - Pinetown,Natal

CATCHMENT IDENTIFICATION

CATCHMENT NAME	Pinetown 1	GAUGE REFERENCE NO	PINE1
LOCATION LAT.	29 deg. 49.00 min. S.	NEAREST TOWN	Pinetown
LONG.	30 deg. 52.00 min. E.	MAGISTERIAL DISTRICT	Pinetown
RIVER	Palmiet	PROVINCE OR COUNTRY	Natal

CATCHMENT DETAILS

CATCHMENT AREA	.12 sq.km.	VEGETATION	
AVERAGE CATCHMENT SLOPE	Flat (2%)	LAND USE	Urban
MEAN ALTITUDE	347 m AMSL	SOILS	Lithosols
MEAN ANNUAL PRECIPITATION	1000 mm	BINOMIAL SOIL TYPE	No details
NO OF DAMS IN CATCHMENT	0	GEOLOGY	Table Mountain Group - Quartzite, shale, tillite
SHAPE FACTOR	No details		
DRAINAGE DENSITY	No details		

DATA COLLECTED

RAINFALL	Yes	TEMPERATURE	No
RUNOFF	Yes	WIND	No
CHEMICAL	Yes	RELATIVE HUMIDITY	No
TDS	Yes	NET RADIATION	No
SEDIMENT	Yes	SOIL MOISTURE	No
EVAPORATION	No	INFILTRATION	No

RAINFALL data are available, RUNOFF data are available

STREAMFLOW RECORDING STATION DETAILS

CONTROL	Pipe section 762mm diameter
MEASURING LIMIT	.50 cumec at .61 metres
RATING CURVE	Calibrated
STORAGE CAPACITY BEHIND CONTROL	No details
PERCENTAGE OF STORAGE SILTED	No details

BACKGROUND INFORMATION

ORGANIZATION	Council for Scientific & Indus Research
DEPARTMENT	National Institute for Water Research
CONTACT PERSON	Mr D E Simpson
ADDRESS	National Institute for Water Research Council for Scientific & Indus Research P O Box 17001 CONGELLA 4013
TELEPHONE	(031) 255531

THE MONITORING PROGRAMME
- started : 1978
- purpose : To estimate the import of pollutants to an urban catchment by atmospheric fallout & their export by storm runoff
- future extensions : None

INFORMATION FILES

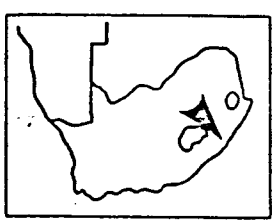
CATCHMENT INFORMATION FILE	PINE1	(Last update : January 1985)
CATCHMENT MAP	PINE1.MAP	
LIST OF REFERENCES	CSIR.REF	
RAINFALL DATA	PINE1.RAIN	
RUNOFF DATA	PINE1.FLOW	

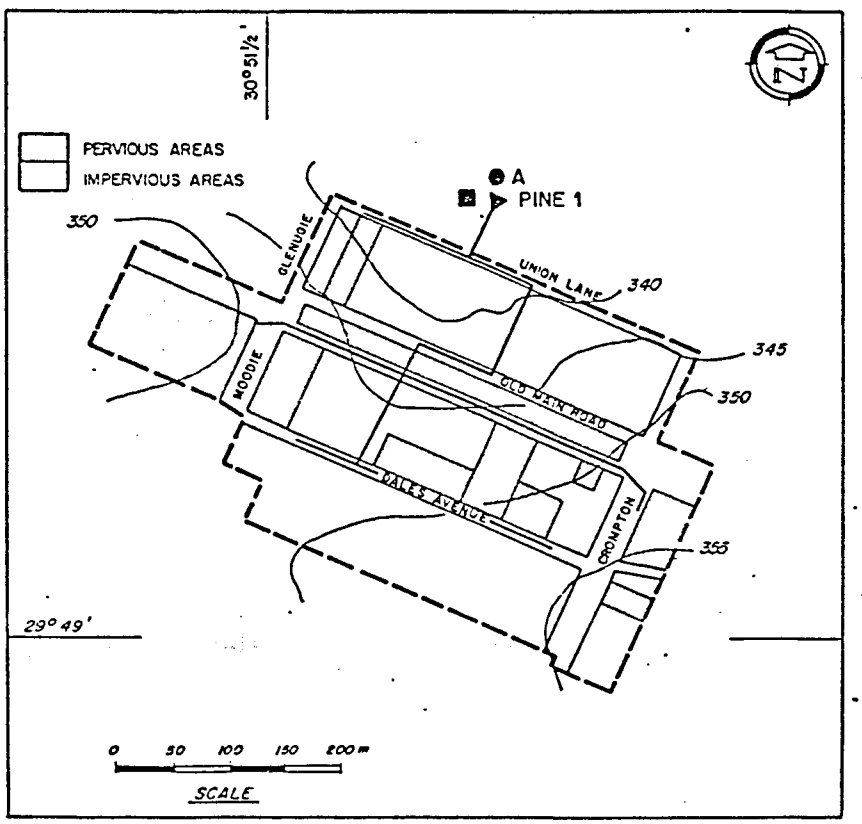
PHYSICAL CATCHMENT INFORMATION

LAND USE	1978 to 1981	100 % urban
DRAINAGE CHARACTERISTICS	Stream is seasonal but not well defined	

KEY : Measuring site for

- Rainfall ●
- Runoff ▲
- Water Quality ■
- Evaporation ○
- Temperature ⊖
- Wind ◑
- Soil Condition □





RECORDED DATA

PARAMETER MEASURED	STATION NUMBER	INSTRUMENT TYPE	PERIOD FROM-TO	NO. OF BREAKDOWNS	MEASURING FREQUENCY	RAW DATA STORAGE STATUS	PROCESSED DATA STORAGE STATUS
RAINFALL	A	Casella Sipnon	1978-1981	0-25 %	Continuous	Paper strip	Computer tape
RUNOFF	PT1	Ultrasonic	1978-1981	0-25 %	Continuous	Paper strip	Computer tape
CHEMICAL	PT1	Auto Sampler	1978-1981	0-25 %	Continuous	Data sheet	Computer tape
TDS	PT1	Auto Sampler	1978-1981	0-25 %	Continuous	Data sheet	Computer tape
SEDIMENT	PT1	Auto Sampler	1978-1981	0-25 %	Continuous	Data sheet	Computer tape
EVAPORATION							
TEMPERATURE							
WIND							
REL.HUMIDITY							
NET RADIATION							
SOIL MOISTURE							
INFILTRATION							

Majority of gauges are owned by Council for Scientific & Indust Research

5 OTHER CATCHMENTS

Apart from the catchments described in Section 4, a considerable amount of additional hydrological information is being gathered throughout Southern Africa. The information includes a wide range of hydrological parameters, but in many instances, the various parameters are being monitored in isolation. The data therefore does not represent a complete hydrological and physical picture of the monitored catchment. This information is consequently not considered suitable for inclusion in the Small Catchment Data Bank.

Catchments classed as 'other catchments' include catchments monitored by the South African Department of Water Affairs. These catchments are maintained by the Department and are presently being banked in the Water Affairs Data Bank now under development. Including these catchments in the Small Catchment Data Bank would therefore be a duplication of work. Also included under other catchments are details of data accumulated by the Weather Bureau.

There are also a number of monitoring programmes which are still in the planning stage. Where sufficient details are available, the scope of work to be undertaken is given.

The 'other catchment' monitoring programmes are a good source of additional small catchment information and enhances the usefulness of the Small Catchment Data Bank. Details regarding the monitoring programmes are therefore given below. The information presented includes :

- details of the organization undertaking monitoring programmes
- background to monitoring programme
- details of monitoring programme
- discussion of data recorded.

5.1 Department of Water Affairs

The primary function of the Department of Water Affairs is the development and control of South Africa's water resources to ensure the provision of sufficient water of acceptable quality at reasonable cost.

To meet these objectives, a country-wide network of more than 800 river flow stations has been established. Flow records are also obtained from 180 existing dams and provide information on river flow, flood peaks, chemical quality and sediment loads. About 280 of the monitored catchments are smaller than 100 km^2 in area and are listed in Table 5.1. Evaporation is measured at about 170 sites near large dams.

The earliest monitoring programmes were started at the turn of the century. Readings were initially taken on a daily basis, but many of the gauging points are now fitted with continuous flow recorders.

The recorded data are processed by hydrologists in the Department and part of the hydrological data is already stored in computerized data banks. Access may be had through the Department.

Contact Person : Mr D Zietsman; Mr J Schutte
Address : Directorate of Hydrology
Department of Water Affairs
Private Bag X313
Pretoria
0001
Telephone : (012) 299-2736/8

TABLE 5.1 : DIRECTORATE OF WATER AFFAIRS - RIVER GAUGING STATIONS (<100 km²)

Station No	River	Latitude	Longitude	Area km²	Start Date	Date Closed
A2M24	Brandvlei	26° 09'	27° 35.3/4'	13	1958	
A2M33	Nouklip-Oog	25° 52.1/2'	27° 47'	15	1964	
A2M35	Skeerpoort	25° 52'	27° 47'	93	1964	
A2M38	Waterkloof Onder	25° 44'	27° 12.3/4'	17	1970	
A2M39	Waterkloof Bo	25° 43'	27° 11.1/4'	3,6	1971	
A2M43	Riverside Spruit	25° 47.1/2'	28° 02'	24	1971	1973
A2M47	Klein Jukskei	26° 04'	27° 58.1/4'	65	1971	
A2M53	Sterkstroom	25° 48.1/2'	2/° 28.1/2'	88	1973	
A2M54	Hartbeesspruit	25° 41'	28° 17.1/4'	35	1982	
A2M56	Steenoondspruit	25° 44'	28° 10.3/4'	10	1982	
A2M57	Skinnerspruit	25° 44'	28° 10'	66	1982	
A3M16	Wilgeboomspruit	25° 35.3/4'	26° 18.1/2'	39	1965	
A4M09	Witbanksspruit	23° 58.3/4'	2/° 43'	10	1980	
A6M10	Badeloop	24° 34.1/2'	28° 38.1/2'	70	1954	
A6M11	Groot-Nyl	24° 45.1/2'	28° 20.3/4'	73	1966	
A6M18	Rasloop	24° 46.1/4'	28° 21.1/4'	12	1973	
A6M19	Hessie se Water	24° 39.3/4'	28° 27.1/4'	16	1973	
A6M20	Middelfonteinspruit	24° 40.1/4'	28° 33.3/4'	45	1973	
A6M21	De Wetspruit	24° 38'	28° 35.3/4'	16	1973	
A6M22	Hartebeeslaagte-spruit	24° 36'	28° 36.1/2'	1,7	1973	
A6M24	Kootjie se Loop	24° 18.1/2'	28° 54.1/2	23	1973	
A9M02	Mutshindudi	22° 54.1/2'	30° 31.3/4'	95	1931	
A9M03	Tshinane	22° 53.3/4'	30° 31.1/2'	62	1931	
A9M06	Livhungwa	23° 02.1/4'	30° 16.3/4'	16	1961	
A9M07	Latonanda	23° 03.1/4'	30° 14.3/4'	47	1961	
B6M02	Treur	24° 41'	30° 49'	97	1929	1939
B6M03	Treur	24° 41.1/4'	30° 48.3/4'	92	1959	
B6M06	Kransklooffspruit	24° 55.1/2'	30° 32.3/4'	43	1963	
B6M07	Vyehoek	24° 43.1/4'	30° 38.3/4'	85	1971	
B7M02	Ngwabitsi	24° 05.1/2'	30° 16.1/2'	58	1948	
B7M03	Selati	24° 07.1/2'	30° 21.1/2'	84	1948	1973
B7M06	Ngotso	24° 08'	31° 42.3/4'	41	1952	1961
B7M14	Selati	24° 07.1/2'	30° 21.1/4'	83	1973	
B8M05	Broederstroom	23° 49.1/2'	29° 58'	17	1948	1956
B8M06	Broederstroom	23° 51'	29° 56.3/4'	39	1948	1956
B8M12	Madkeleni	23° 44'	30° 04.1/4'	1,15	1961	
C2M20	Klip	26° 11'	27° 49'	45	1952	1964
C2M23	Wonderfonteinspruit	26° 13.1/2'	27° 44.1/2'	83	1957	
C2M26	Middelvleispruit	26° 14'	27° 40'	26	1957	
C2M27	Kooksoordspruit	26° 14'	27° 39'	4,3	1957	
C2M28	Pietfonteinspruit	26° 14.3/4'	27° 35.1/2'	31	1957	
C2M30	Oog van Wonder-fontein	26° 18.3/4'	27° 29.1/4'	0,83	1957	
C2M33	Buffelsdoring-spruit	26° 26.1/2'	27° 19.1/2'	21	1957	1971
C2M34	Blyvooruitsigspruit	26° 24.1/4'	2/° 24.1/4'	18	1957	1966
C2M36	Rietvalleispruit	26° 23.3/4'	27° 06'	7,6	1957	1963
C2M37	Du Toitspruit	26° 27.1/2'	2/° 03.1/4'	71	1957	1963
C2M38	Donkerspruit	26° 16.3/4'	27° 50'	13	1957	1963
C2M51	Kraalkop	26° 26.1/4'	2/° 28.3/4'	2,1	1966	
C2M52	Oog van Klands-fontein	26° 24.3/4'	27° 27.1/2'	5,1	1966	1969
C2M62	Klein-Rietspruit	26° 24.1/4'	27° 36'	1,4	1970	
C5M21	Masters Hoek-oog	29° 40'	26° 14.3/4'	28	1969	
C5M22	Kwatamyane	29° 17.1/4'	26° 55.1/4'	38	1980	

Station No	River	Latitude	Longitude	Area km²	Start Date	Date Closed
D2M15	Caledon	28° 35.3/4'	28° 36'	88	1969	
D4M03	Swartbas	26° 43'	20° 01.1/2'	70	1941	1948
D4M14	Molopo-oog	25° 53'	25° 01.1/4'	22	1965	
E1M02	Tee	32° 47.3/4'	19° 05'	45	1938	1943
E1M03	Noordhoeks	32° 42.3/4'	19° 04'	68	1938	1943
E1M04	Boontjies	32° 37.3/4'	19° 04.1/2'	61	1938	1943
E2M05	Kleinbrak	31° 56'	19° 45.1/2'	85	1929	1947
E2M06	Kruis	33° 09'	19° 22.1/4'	40	1929	
E2M10	Kruis	33° 06.3/4'	19° 23.1/2'	77	-	
G1M01	Wemmers	33° 50'	19° 05'	85	1903	1922
G1M03	Franschhoek	33° 53.1/2'	19° 04.3/4'	46	1949	
G1M04	Berg	33° 55.1/2'	19° 03.3/4'	70	1949	
G1M09	Brakkloofspruit	33° 23.1/4'	19° 10.1/4'	5,7	1964	
G1M10	Knolvleispruit	33° 23.1/2'	19° 09.1/2'	10	1964	
G1M11	Watervals	33° 22.3/4'	19° 06'	27	1964	
G1M12	Watervals	33° 21.1/4'	19° 06.3/4'	36	1964	
G1M19	Banghoek	33° 54.3/4'	18° 56.1/2'	25	1968	
G1M21	Klein-Berg	33° 11'	19° 09.1/4'	19	1968	
G1M29	Leeu	33° 09.1/2'	19° 03'	36	1972	
G1M30	Krom	33° 37.1/2'	19° 05'	12	1969	
G1M32	Banghoek	33° 57.1/4'	18° 58.3/4'	7,6	1975	
G1M33	Banghoek	33° 56.3/4'	18° 58'	11	1975	
G1M37	Krom	33° 37.3/4'	18° 59.1/2'	69	1978	
G1M38	Wolwehoek	33° 56.1/2'	19° 02.1/2'	17	1978	
G1M39	Doring	33° 32.1/2'	18° 55.1/2'	43	1978	
G1M40	Vis	33° 21.1/2'	18° 57.1/2'	39	1979	
G1M41	Kompagnjies	33° 28.3/4'	18° 58.3/4'	121	1979	
G1M42	Banghoek		-	7,6	1980	
G2M01	Plankenbrug	33° 54.1/4'	18° 51.1/4'	70	1934	1937
G2M05	Jonkerhoek	33° 58.1/2'	18° 56.1/4'	31	1940	
G2M08	Jonkershoek	33° 59.1/4'	18° 57.1/4'	20	1947	
G2M16	Lourens	34° 05.1/4'	18° 51.1/2'	92	1970	
G2M17	Veldwagters	33° 54.1/2'	18° 47'	0,35	1971	
G2M18	Silverstroom	33° 35'	18° 21.3/4'	26	1974	
G3M05	Papkuils	32° 39'	18° 38'	86	1973	
G4M09	Jakkals	34° 10'	19° 08'	2,0	1964	
G4M10	Jakkals	34° 10.1/2'	19° 07.3/4'	6,7	1964	
G4M11	Palmiet	34° 07.1/2'	19° 02'	63	1965	1975
G4M13	Klein-Jakkals	34° 09.3/4'	19° 08'	2,1	1965	
G5M06	Klein-Sanddrif	34° 31'	19° 58.1/2'	3,2	1956	
H1M04	Jan Dutoits	33° 33.3/4'	19° 20.1/2'	54	1928	1941
H1M05	Jan DuToits	33° 36.1/2'	19° 19.1/4'	80	1950	1952
H1M07	Wit	33° 34'	19° 09'	84	1950	
H1M11	Wit	33° 38.1/2'	19° 06.3/4'	28	1953	1954
H1M13	Koekedou	33° 21.1/2'	19° 18'	53	1965	
H1M14	Vals	33° 25.3/4'	19° 24.1/2'	18	1965	
H1M16	Rooikloof	33° 25.1/4'	19° 28.3/4'	11	1966	1973
H1M17	Elands	33° 44'	19° 07'	61	1969	
H1M19	Slanghoek	33° 35.1/2'	19° 13.1/2'	66	1969	
H1M20	Harthees	33° 33.1/2'	19° 26'	13	1972	

TABLE 5.1 : DIRECTORATE OF WATER AFFAIRS - RIVER GAUGING STATIONS (<100 km²)

Station No	River	Latitude	Longitude	Area km²	Start Date	Date Closed
H2M05	Rooielskloof	33° 27.1/2'	19° 37'	15	1969	
H4M03	Vink	33° 41.1/3'	19° 45.1/4'	57	1931	1947
H4M05	Willem Nels	33° 45.3/4'	19° 52'	24	1950	
H4M07	Koo	33° 38.1/4'	19° 48.3/4'	48	1965	
H4M09	Hoeks	34° 00.1/2'	19° 50.1/4'	18	1967	
H4M10	Houtbaais	33° 59.1/2'	19° 49.1/4'	26	1967	1977
H4M12	Waterkloofspruit	33° 57.1/4'	19° 35.1/4'	14	1969	
H4M15	Houtbaais	33° 59.1/2'	19° 49'	25	1978	
H5M03	Boesmans	34° 02.1/2'	19° 58.3/4'	25	1969	
H6M04	Baviaans	34° 03'	19° 33.1/2'	34	1949	1963
H6M05	Baviaans	34° 01.3/4'	19° 33.1/2'	24	1963	
H6M06	Elands	33° 58'	19° 27.1/2'	56	1964	
H6M07	Du Toits	33° 56.1/2'	19° 10.1/4'	46	1964	
H6M08	Riviersonderend	34° 03.3/4'	19° 04.1/4'	38	1964	
H6M10	Waterkloof	33° 59'	19° 19.3/4'	15	1969	
H6M11	Waterkloof	34° 05.3/4'	19° 07.1/2'	11	1974	
H7M02	Buis	33° 55'	20° 45'	16	1938	1948
H7M04	Buis	33° 54.3/4'	20° 42.3/4'	28	1951	
H7M05	Hermitage	33° 59.1/4'	20° 25.1/2'	9,0	1954	
H7M07	Grootkloof	34° 00.1/4'	20° 33'	24	1968	
H9M01	Karferkuils	34° 01.1/2'	21° 24.1/2'	27	1955	1958
H9M02	Vet	34° 00.3/4'	21° 12'	89	1963	
H9M03	Korinte	34° 00.1/4'	21° 10'	37	1963	1964
H9M04	Kruis	34° 00.3/4'	21° 17.1/2'	50	1969	
J1M15	Bok	33° 21.1/4'	19° 43.1/4'	8,8	1974	
J1M16	Smalblaar	33° 17.1/4'	19° 43.3/4'	30	1974	
J2M06	Wilgehout	33° 29.1/2'	21° 29.1/2'	25	1955	
J2M07	Joubert	33° 29.1/2'	21° 30.3/4'	25	1955	
J3M05	Klip	33° 46.1/2'	22° 19.1/4'	95	1926	1947
J3M13	Perdepoort	33° 22.1/4'	22° 10.3/4'	29	1966	
J3M15	Klein-Leroux	33° 25.1/2'	22° 15.1/4'	70	1966	
J3M16	Wilge	33° 32.3/4'	22° 58.1/2'	32	1967	
J3M20	Meul	33° 27.1/2'	21° 57.3/4'	35	1974	
J4M03	Weyers	34° 02'	21° 35.1/4'	95	1965	
J4M04	Langtou	33° 59.1/4'	21° 46.3/4'	99	1967	
K1M02	Beneke	33° 56'	22° 08'	3,8	1958	
K2M01	Groot-Brak	33° 56'	22° 10'	45	1952	1958
K3M02	Pooi	33° 56'	22° 27.3/4'	1,04	1961	
K3M04	Malgas	33° 57'	22° 25.1/2'	34	1961	
K3M05	Touws	33° 56.3/4'	22° 36.3/4'	78		
K5M01	Gouna	33° 59.1/2	23° 02.1/2'	91	1959	
K7M01	Bloukrans	33° 57 1.4'	23° 38.1/2'	57	1961	
K8M01	Kruis	33° 59'	24° 01.1/4'	26	1961	
K8M02	Elands	33° 59'	24° 03'	35	1961	
L8M01	Waboems	33° 52'	23° 50.1/4'	21	1965	
L8M02	Haarlemspruit	33° 44.1/4'	23° 18.1/4'	52	1970	
Q5M01	Kromspruit	32° 29.1/2'	25° 48.1/2'	52	1927	1947
Q8M03	Naude's	32° 43'	25° 39'	54	1955	1965
Q9M07	Balfour	32° 33.1/4'	26° 40.1/4'	82	1928	1943
Q9M09	Markazana	32° 39.1/4'	25° 41.1/2'	78	1928	1938
Q9M13	Kap	33° 21.1/4'	26° 51.3/4'	46	1963	
Q9M19	Balfour	32° 33.1/4'	26° 40.1/4'	76	1972	

Station No	River	Latitude	Longitude	Area km²	Start Date	Date Closed
R1M06	Rabula	32° 45.1/4'	27° 06.1/4'	100	1948	
R1M07	Mtwaku	32° 38.1/4'	27° 11.1/2'	33	1948	
R1M08	Ngolongolo	32° 38.1/4'	27° 11.1/4'	39	1948	
R1M09	Wolf	32° 43'	27° 06.1/4'	57	1940	
R1M10	Gwiligwili	32° 40'	27° 12.1/4'	31	1948	
R1M11	Mnyameni	32° 38.1/4'	27° 05.1/4'	43	1948	
R1M12	Cata	32° 38.1/4'	27° 06.3/4'	56	1948	
R1M14	Tyume	32° 38.1/4'	26° 56.1/4'	70	1953	
R2M01	Buffalo	32° 44'	27° 17.3/4'	29	1919	
R2M04	Tyusha	32° 45'	27° 18.1/2'	12	1941	1952
R2M07	Zele	32° 46.3/4'	27° 23.1/4'	82	1947	
R2M08	Quencwe	32° 46'	27° 22.1/2'	61	1947	
R2M12	Mqqakvebe	32° 47.1/4'	2/° 15.3/4'	15	1959	
R2M13	Mnqqesha	32° 48.3/4'	27° 11'	8,6	1959	
S2M03	Lubisi Stream	31° 47.1/2'	2/° 27'	8,4	1970	
S4M01	Cathcartspruit	32° 17.1/4'	27° 08.1/4'	6,0	1947	1957
S6M01	Kubusi	32° 34.3/4'	2/° 22'	90	1947	
T5M08	Mvumukazi	30° 16'	29° 53.3/4'	42	1962	
T7M02	Mqazana	31° 37.3/4'	29° 12.1/4'	73	1967	1968
U2M08	Inkwaleni	29° 37.1/4'	30° 16.1/2'	9,6	1957	
U2M09	Tenjaan	29° 37.1/4'	30° 14.3/4'	8,1	1957	
U2M10	Msindusaan	29° 37.1/2'	30° 14.1/2'	30	1957	
U2M17	Rietspruit	29° 33.3/4'	30° 15.1/4'	3,6	-	
U2M19	Rietspruit Trib.2	29° 32.3/4'	30° 16.3/4'	0,06	-	
U2M20	Rietspruit Trib.3	29° 32.3/4'	30° 16.3/4'	0,10	-	
U2M21	Cramond	29° 25.1/4'	30° 25.3/4'	4,3	1981	
U4M03	Elimbitwa	29° 00.1/2'	30° 47.1/4'	49	1956	1976
U4M04	Nseleni	29° 01'	30° 47'	11,5	1956	1976
U7M01	Zwateni	29° 50.3/4'	30° 14.1/4'	16	1949	
U7M03	Lovu Trib. 1	29° 50.1/2'	30° 16.1/2'	0,28	1955	1973
U7M04	Lovu Trib. 2	29° 50.1/2'	30° 16.1/4'	0,31	1962	1973
U7M05	Lovu. Trib. 3	29° 50.1/2'	30° 16.1/4'	0,57	1962	1973
U7M06	Lovu. Trib. 4	29° 50.3/4'	30° 16'	0,28	1956	1973
V1M11	Bloukrans Trib. 11	29° 00.3/4'	29° 37.3/4'	0,21	1962	
V1M13	Bloukrans Trib. 15	29° 01.3/4'	29° 40'	0,10	1962	
V1M14	Bloukrans Trib. 16	29° 01.3/4'	29° 38.1/4'	0,10	1962	
V1M16	Bloukrans Trib. 10	29° 00.3/4'	29° 38'	0,08	1962	
V1M17	Bloukrans Trib. 13	29° 01.1/2'	29° 39.3/4'	0,31	1962	
V1M18	Bloukrans Trib. 1	28° 59.1/4'	29° 40.1/4'	7	1962	1967
V1M27	Bloukrans Trib. 7	29° 001./4'	29° 38'	0,21	1967	
V1M29	Geluksburgspruit	28° 30.1/2'	29° 21'	21	1968	
V1M30	Njongola	28° 30.3/4'	29° 20.1/4'	23	1968	
V1M32	Putterill Spruit	28° 39.1/2'	29° 02'	69	1974	
V1M34	Kombe	28° 40.1/2'	29° 05.1/4'	51	1974	
V2M03	Mayamvubu	29° 13.1/2'	30° 15'	42	1959	1960
V7M04	Klein-Boesmans Trib. 25	29° 03.1/2'	29° 39.1/2'	0,34	1962	
V7M05	Klein-Boesmans Trib. 19	29° 02.1/4'	29° 39'	26	1962	
V7M06	Klein-Boesmans Trib. 20	29° 02.1/2'	29° 39.3/4'	0,44	1962	
V7M07	Klein-Boesmans Trib. 21	29° 02.1/2'	29° 38.1/2'	25	1962	
V7M08	Klein-Boesmans Trib. 24	29° 03.1/4'	29° 39'	2,8	1962	

TABLE 5.1 : DIRECTORATE OF WATER AFFAIRS - RIVER GAUGING STATIONS (<100 km2)

Station No	River	Latitude	Longitude	Area km2	Start Date	Date Closed
V7M09	Klein-Boesmans Trib. 26	29° 02.1/4'	29° 38.1/2'	0,49	1962	
V7M10	Klein-Boesmans Trib. 28	29° 02.1/4'	29° 39'	0,08	1962	
V7M13	Klein-Boesmans Trib. 27	29° 02.1/4'	29° 38.3/4'	0,28	1962	
V7M14	Klein-Boesmans	29° 02.3/4'	29° 39'	0,83	1967	
V7M15	Klein-Boesmans Trib. 31	29° 02.1/2'	29° 39.1/2'	0,10	1967	
W1M03	Nwafini	28° 43'	31° 31'	62	1928	1931
W1M04	Mlalazi	28° 52.1/2'	31° 27.1/2'	20	1948	
W1M05	Mfuluzane	28° 34.1/4'	31° 23.1/2'	45	1948	
W2M07	Bizamkulu	27° 57.1/2'	31° 11.1/2'	78	1965	
W3M10	Mbarwana	27° 29.1/2'	32° 35'	10	1968	
W3M14	Mpate	28° 20'	32° 21.3/4'	48	1969	
W4M08	Braksloot	27° 23.3/4'	31° 38.1/2'	3	1972	
W5M01	Jessievale Spruit	26° 15.1/2'	30° 33'	16	1910	
W5M16	Mfendisi	26° 19.1/4'	30° 31.1/2'	6	1963	
X1M10	Raverfontein	26° 00'	30° 05.1/2'	23	1964	
X1M15	Shivalongubo	25° 45.1/2'	31° 15.1/4'	34	1969	
X1M20	Poponyane	25° 50.1/4'	30° 41'	48	1973	
X2M12	Dewson's Spruit	25° 39.1/2'	30° 15.1/2'	91	1956	
X2M24	Suidkaap	25° 42.3/4'	30° 50'	80	1954	
X2M25	Boutbosloop	25° 17.1/2'	30° 34.1/4'	25	1966	
X2M26	Research	25° 17.1/4'	30° 34.1/2'	14	1966	
X2M27	Blystaanspruit	25° 17.3/4'	30° 35.3/4'	78	1966	
X2M28	Kantoorbosspruit	25° 17.3/4'	30° 34'	5,7	1966	
X2M29	Visspruit	25° 28'	30° 49.1/4'	30	1964	
X2M30	Suidkaap	25° 43'	30° 47.1/4'	57	1966	
X3M02	Klein-Sabie	25° 05.1/4'	30° 46.3/4'	55	1948	
X3M03	Mac-Mac	24° 59.1/2'	30° 48.3/4'	52	1948	
X3M07	White Waters	25° 09.1/4'	31° 00.1/4'	46	1963	1972
X3M10	Nwaritsi	24° 53.1/4'	31° 02.3/4'	97	1975	
X4M03	Metzimitsi	24° 42'	31° 56.3/4'	27	1952	1961

5.2 Weather Bureau

The Weather Bureau is responsible for the accumulation and processing of meteorological statistics such as rainfall, temperature, wind and humidity. The Weather Bureau is also responsible for supplying daily weather forecasts.

In order to provide this service, the Weather Bureau has at present about 2 600 meteorological observation stations throughout South Africa. Rainfall is recorded continuously at about 100 of these stations, (Fig 5.1). Other meteorological parameters are also measured at these stations. At the remaining stations, rainfall is usually measured on a daily basis. The earliest of the stations was established in the 1850's.

The recorded data are stored on computer tape. The processed data have also been published in monthly and yearly reports and in a series of publications on the "Climate of South Africa". Published reports include information on long-term normal rainfall, mean temperatures, sunshine hours and surface winds. Access to the processed data may be had through the Weather Bureau, whereas published data are also available in the larger public libraries and those of the universities.

Address : Chief Director: Weather Bureau
Climatological Information
Private Bag X97
PRETORIA
0001

Telephone : (012) 290-8025

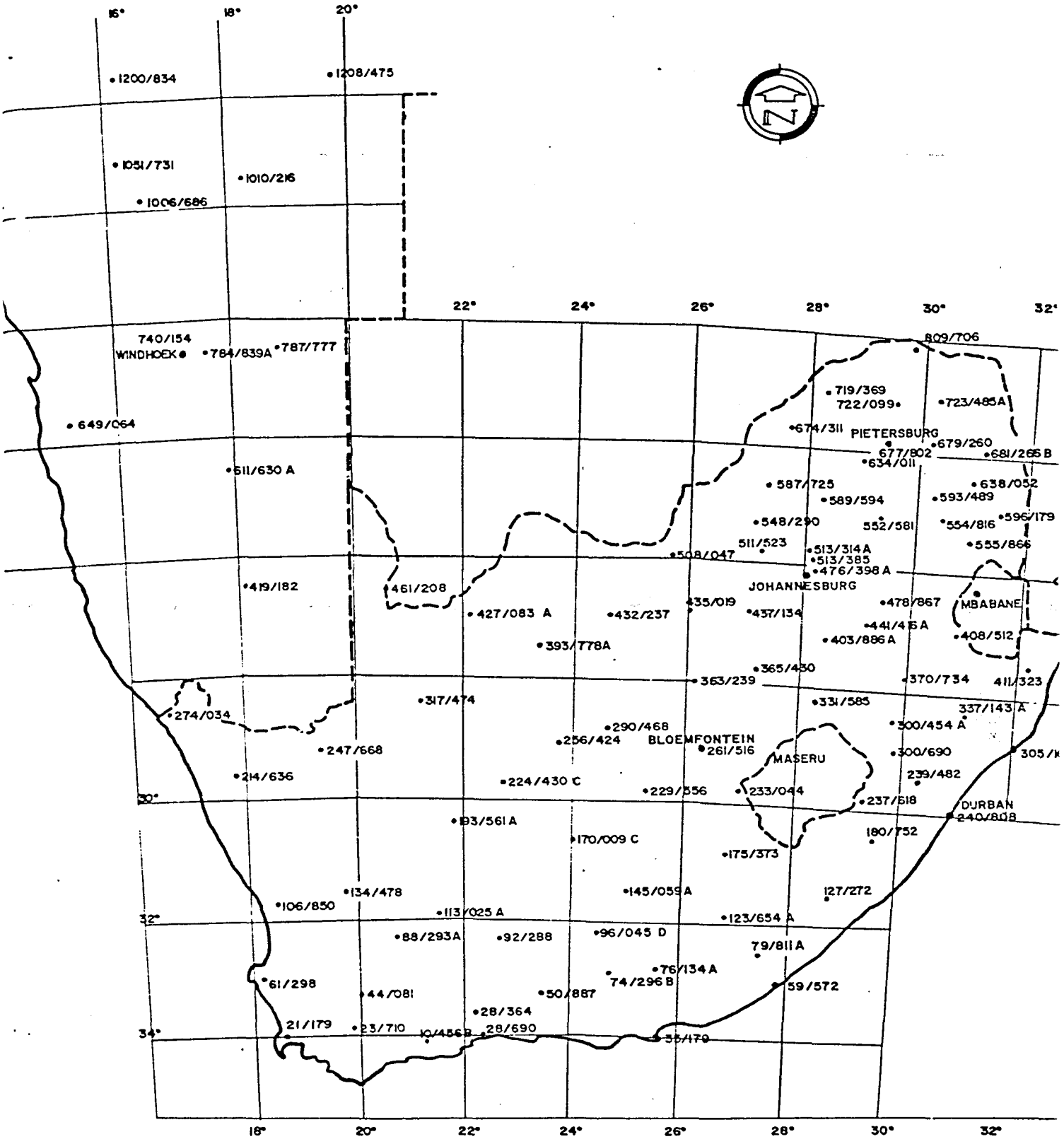


FIG 5.1 WEATHER BUREAU FIRST - ORDER METEOROLOGICAL STATIONS & WEATHER OFFICES

5.3 Port Elizabeth Municipality

The City Engineer's Department, Roads and Stormwater Division is responsible for the design and maintenance of roads and stormwater systems in the Port Elizabeth Municipal area.

The municipal area embraces five river systems having catchment areas of between 10 and 100 km^2. A network of 12 automatic rainfall recording stations has been established. The recorders are all of the Casella tipping bucket type and the period of record is 5 years. Data on large storm events recorded from 1938 are also available.

The recorded rainfall data are processed by the Council and are being stored on ICL- compatible computer tapes. Access to the data may be had through Port Elizabeth City Engineers Department.

The processed data have been used, amongst other things, to prepare Intensity-Duration-Frequency Curves for the Port Elizabeth area.

Contact Person : Mr J McGillivray
Address : City Engineers Department
P O Box 7
PORT ELIZABETH
6000
Telephone : (041)52-2080

5.4 Durban Municipality

The Hydraulics Branch of the City Engineers Department is responsible for the design of major stormwater systems in the Durban Municipal area. This area is spread over a large number of catchments with some streams rising outside the Municipal area.

A network of 16 automatic tipping bucket rain gauges covers most of the Municipal area. The gauges have been linked to a telemetry system to facilitate data collection and processing. The system has not been fully assembled and therefore very little recorded information is available as yet. Flow gauging on one catchment is planned for 1985.

Further information may be obtained from the Hydraulics Branch of the City Engineers Department.

Contact Person : Mr M W Pfaff
City Engineers Department
P O Box 680
Durban
4000
Telephone : (031) 69946

5.5 Johannesburg Municipality

The City Engineers Department of the Municipality of Johannesburg maintain 19 automatic rainfall recording gauges located throughout the greater Johannesburg area. The purpose of the monitoring programme is to provide storm rainfall input for design purposes.

The earliest rainfall recorders were installed in 1964. A further 7 recorders were installed in Johannesburg in 1983. All of the above recorders are of the Lambrecht Siphon type.

The recorded information is processed by the Municipality and is stored on computer tape. The data may be accessed through the Municipality.

Contact Person : Mr R J Rutter
Johannesburg Municipality
Addresses : City Engineers Department
Design Branch
P O Box 4323
JOHANNESBURG
2000
Telephone : (011) 777-1111

5.6 Durban-Westville University

The Geography Department of the University of Durban-Westville is undertaking a monitoring programme in the Palmiet River Basin. The purpose of the study is to determine the water quality parameters of an urbanized catchment.

The Palmiet river is a tributary of the Umgeni river. The monitored catchment is 35,4 km^2 in extent and is located in the Pinetown area north of Durban. Almost the entire western portion of the catchment has been developed for industrial and urban use. The remainder of the catchment is a residential area.

The Palmiet study catchment contains 4 subcatchments. An extensive network of gauges has been established throughout these subcatchments and include :

- a continuous rainfall recorder
- three standard rainfall gauges with readings taken daily
- A Pan and Symons type evaporation pans
- maximum and minimum thermograph with measurements taken on a hourly basis
- twelve water samplers to determine the water quality.

The overall period of record for the above stations is 10 years. Most of the data is on data sheets. The water quality data has been computerized. The data may be accessed through the Department of Geography.

Contact Person : Prof G Du T De Villiers
Address : Geography Department
University of Durban-Westville
: Private Bag X54001
Durban
4000
Telephone : (031) 821-211 Ext. 320.

5.7 Pilanesberg Game Reserve

The Pilanesberg Game Reserve was proclaimed as a nature conservation area in 1979 and covers some 600 km^2. An intensive programme of land rehabilitation and game restocking has been undertaken.

To assist the programme, an extensive network of rainfall, evaporation and temperature gauges was established. Readings are taken on a daily basis in most cases, the remainder on a weekly basis. No runoff gauges have been installed.

The data are used to examine soil erosion hazards and to establish the veld carrying capacity.

The recorded data may be accessed through the Pilanesberg Game Reserve authorities.

Contact Person : Mr H D Patrickson
Address : Pilanesberg Game Reserve
Research Section
P O Box 1201
MOGWASE
0302
Telephone : (014292) 2405

5.8 Rand Water Board

The Rand Water Board was established in 1903 for the purpose of distributing potable water to an area presently covering about 17 000 square kilometers. The area extends from Pretoria in the north to Sasolburg in the south, and from Bethal in the east to Carletonville and Rustenburg in the west.

The Board abstracts nearly all its water requirements from the Vaal Dam and the Vaal River Barrage, with a small quantity being abstracted from boreholes at Zuurbekom pumping station. The water quality of the abstracted raw water is of concern to the Board in terms of its influence on purification costs. An extensive network of monitoring points has therefore been established on streams contributing flow to Vaal Dam and Vaal Barrage.

There are about 60 sampling points located in the Blesbokspruit, Elsburgspruit, Klipriver, Natalspruit and Rietspruit systems. A further 13 sampling points are located in the Vaal River Catchment upstream of Vaal Dam. Water samples are taken from the sampling points on a regular basis. The discharge is also noted. At major sampling stations, of which there are 6, flow recorders have been installed. The Board also has an extensive rain gauge network to facilitate water demand predictions. Rainfall is measured on a daily basis.

The analysed data are presented in the Annual Reports produced by the Board. Data sheets and flow charts are disposed of after a number of years.

Contact Person : Mr J Jones
Mr S van der Merwe

Address : Chief Engineer
Rand Water Board
P O Box 1127
JOHANNESBURG
2000

Telephone : (011)833-6650

5.9 Phalaborwa Water Board

The Phalaborwa Water Board was established in 1963 to supply water for mining, industrial and domestic purposes. The main source of supply is the Olifants river. Storage is provided by a barrage constructed 16 km south of Phalaborwa.

The Board is particularly concerned about the quality of both the abstracted water and the effluents returned to the Olifants river. Two monitoring stations have therefore been established viz at Olifantsrivier near Mica and at Phalaborwa. Both catchments are about 47 000 km^2 in area and are therefore not suitable for inclusion in this report. Extensive records are however available for both stations and details can therefore be obtained for the catchment located between the two stations. A brief description of this area (called the Phalaborwa catchment) follows.

The Phalaborwa catchment area is 58 km^2 and land use is predominantly grazing veld. Rainfall and evaporation has been recorded since 1967. River flow is measured daily at the Barrage (since 1967), the control being calibrated sluice gates and outlet valves. Daily water samples are taken to establish the chemical content, and sediment load, the latter record being since 1974 and the former since 1967.

The above data are available on the original data sheets and may be accessed through the board.

Contact Person : Mrs I M Retief
Address : Phalaborwa Water Board
Private Bag X01014
PHALABORWA
1390
Telephone : (01524) 5821

5.10 Fort Hare University

The Faculty of Agriculture of the University of Fort Hare in the Eastern Cape is monitoring the runoff from an 80 ha catchment. The monitoring programme was initiated in 1981 to determine runoff yields from small catchments to aid design of rural development schemes.

The catchment is located about 30 km south of Fort Beaufort on the Grahamstown road. It is relatively steep and the vegetation consists mainly of mixed veld and shrub. The catchment is underlain by the Ecca series. There are two dams in the catchment. The upper dam has a storage capacity of 4 000 m^3 and the lower dam 41 000 m^3.

Recorded information includes rainfall and runoff volumes, both on a daily basis. Runoff volumes are determined by measuring the levels in the lower dam.

The recorded data are stored on data sheets. Access to the available catchment and hydrological data may be had through the Faculty of Agriculture, Fort Hare University.

Contact Person : Prof M D Radford
Address : Faculty of Agriculture
Fort Hare University
Private Bag X1314
Alice
5700
Republic of Ciskei
Telephone : (043) 522-281

5.11 Ciskei Department of Agriculture and Forestry

The Department of Agriculture of the Ciskei Government is responsible for the development of Agricultural Schemes throughout the Ciskei. To assist the analysis of peak runoffs and runoff yields, a large network of flow recording stations have been developed.

The stations were originally established by the South African Department of Water Affairs, who are still responsible for the processing of the recorded data. Since independence of Ciskei, two additional monitoring programmes were initiated on small catchments (Cata Catchment and Sandile Catchment).

The Cata catchment has its outlet at the Cata Dam Reservoir. Water levels are recorded on a weekly basis. Continuous recorders are provided at the spillway and on a weir some 900 m downstream of the dam. The weir commands an additional catchment area (other than the dam catchment area) of 1,3 km^2. Information on peak runoff estimates from a 1,3 km^2 catchment are therefore possible.

The Sandile Catchment has its outlet at the recently constructed Sandile dam. A hydrological recording station measuring rainfall, runoff, evaporation and temperature will be established at the dam. The monitoring programme will commence in 1985.

The above catchment and hydrological information may be accessed through the Department of Agriculture and Forestry, Ciskei Government.

Contact Person : Mr D Walters
Address : Department of Agriculture and Forestry
Engineering Branch
Private Bag X501
Zwelitsha
5608
Telephone : (0433) 4525

5.12 Transkei Department of Agriculture and Forestry

The Department of Agriculture and Forestry, Government of Transkei is responsible for the development of rural water supply schemes, agricultural and forestry projects throughout Transkei. A network of flow gauging on major river stations has been established for the evaluation of available water resources.

The existing gauging network consists of 25 stations, of which 19 were established by the S A Department of Water Affairs (DWA). Since the independence of Transkei, the responsibility of managing the monitoring programme has passed to the Transkei Department of Agriculture and Forestry.

Unfortunately, due to shortages of technical staff, data collection, since 1979 has been erratic. The situation, after 1983, has improved with the appointment of professional and technical staff in the hydrological sub-section.

Information regarding hydrological data can be obtained from the Department of Agriculture and Forestry, Transkei Government.

Contact Person	:	Mr P N Mbokodi, (Secretary General)
		Mr B Mian, (Hydrological Engineer)
Address	:	Department of Agriculture & Forestry
		Engineering Branch
		Private Bag X5002
		UMTATA
		5100
		TRANSKEI
Telephone	:	(0471) 249430
Telex	:	TT701

6 CONCLUSIONS

- A Questionnaire survey was used to identify:
  - sources of small catchment hydrological data
  - type of data collected
  - hydrological data requirements of end users
  - flood estimation techniques currently in use.

- Of the total of 284 questionnaires distributed (excluding duplications and complimentary copies):
  - 189 were returned (66% of those sent)
  - 53 answered no to all categories (28%)
  - 26 collect hydrological data (14%)
  - 135 use hydrological data (71%)
  - 106 use flood estimation techniques (56%)

  (53, 26, 135 and 106: of those returned)

- Twenty-six organizations collect hydrological data on over 120 small catchments. Fourteen organizations monitor both rainfall and runoff on 109 catchments.

- Most of the monitored catchments are located in rural areas. Four of the catchments have been extensively developed.

- Of those organizations using hydrological data, runoff and rainfall parameters are most frequently required followed by other climatic information and water quality aspects.

- A variety of flood estimation techniques is currently being used, the Rational method being the most extensively adopted. The SCS (U.S.D.A. Soil Conservation Service) and Time-Area methods are also in frequent use.

- A Small Catchment Data Bank has been established. It contains information on 109 selected small catchments.

- Information on other relevant monitoring programmes is given.