OVERSEAS DEVELOPMENT ADMINISTRATION
MINISTRY OF AGRICULTURE, GOVERNMENT OF SOMALIA

HYDROMETRY PROJECT - SOMALIA

Final Report
Phase 3

Sir M MacDonald & Partners Limited
Demeter House, Station Road, Cambridge CB1 2RS
United Kingdom

in association with

Institute of Hydrology
Wallingford, Oxon OX10 8BB
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Note on Place Names

For almost all places in Somalia there are a number of alternative spellings - both in the Somali and in the Italian or English equivalents. In this and other Phase 3 reports we have tried to be consistent and to use the same spelling for each place throughout. In general the most widely accepted anglicised spellings have been used. In the case of the river Jubba an alternative spelling has been retained in reference to the Juba Sugar Project since that is the spelling used in that project's official title.

Acknowledgements

The Consultants would like to thank the Overseas Development Administration and the British Development Division in East Africa for their financial support of and continuing interest in the Project. Thanks are also due to many people in the Ministry of Agriculture for their support and assistance - and most of all to the Director of Irrigation.

SUMMARY

This report describes work carried out during Phase 3 of the Somalia Hydrometry Project between March 1988 and December 1990. This followed two earlier phases of the Project between November 1983 and June 1986, and it marks the completion of support from the Overseas Development Administration for the work of the Hydrology Section of Somalia's Ministry of Agriculture. In addition to a summary of work carried out, this report contains a review of the hydrology of southern Somalia, with particular reference to the Jubba and Shebelli rivers. An appendix lists all reports and publications produced by the Consultants during the three phases of the Project.

Support was provided for all aspects of the work of the Hydrology Section, with particular emphasis on the training of local counterpart staff in field and office work so that they would have the capability to continue the collection, analysis and dissemination of hydrological data after the conclusion of the Project. At that time it was considered that reasonable success had been achieved, though the security situation was restricting fieldwork. Subsequently, however, the outbreak of extensive fighting in Mogadishu left great uncertainty about the position. This development is only referred to in a postcript to the report.

During the Project, all historic river level and flow data was critically examined, with corrections to the previously accepted record being made where appropriate, and missing values infilled wherever possible. Computer models were developed to assist in this procedure, and these should continue to be of value in the future. Models were also provided for forecasting river levels and flows which should improve warnings of impending floods. All data is stored on a microcomputer in the Ministry of Agriculture, using a specialised hydrological database package; daily and monthly flow data has also been published.

Fieldwork concentrated on the maintenance of gauging stations and the measurement of discharge. All rating equations were reviewed and some changes were made; full details are presented in an appendix to this report. The fieldwork programme was severely limited during the second half of Phase 3 by the travel restrictions which resulted from the deteriorating security situation in Somalia. However, sediment levels were measured regularly at a nearby station on the river Shebelli.

In addition to the on-the-job training of counterpart staff, it was planned that there would be some academic and practical training in the UK. Unfortunately this did not materialise, though two local staff members did travel to courses overseas with funding from other organisations. However, neither of these people returned to their previous jobs, so the Hydrology Section did not benefit from their training. As detailed in the report, the non return of trainees had a negative impact on the attempts to arrange training using the British Council funding which had been allocated to the Project.

The report concludes that further external support is required if the important work of the Hydrology Section is to continue in full. However, as noted in the postcript, such support is not likely to be forthcoming in the immediate future because of the developments in January 1991 which resulted in the departure of the British and other diplomatic staff, together with almost all other expatriates. A mission should be undertaken as soon as practicable so that the needs of the Hydrology Section can be reviewed in the light of recent developments.

CHAPTER 1

INTRODUCTION

1.1 Background to Project

In 1983 the Ministry of Agriculture (MOA) of the Government of Somalia in Mogadishu requested assistance from the British Government to maintain and improve its collection of hydrometric data. Following a joint proposal by Sir M. MacDonald and Partners Limited (MMP) and the Institute of Hydrology (IH) to the Overseas Development Administration (ODA), work on the Somalia Hydrometry Project commenced in November 1983. During the subsequent 14 months a great deal was achieved in reorganising the basic work of the Hydrology Section, but further objectives remained and a second phase of the Project was agreed, taking assistance to mid-1986.

Stage 2 was intended to provide continuity to the Section until the start-up of the National Water Centre (NWC), a project supported by the Food and Agriculture Organisation (FAO) and the United Nations Development Programme (UNDP). Subsequently, however, the NWC was delayed and it also became clear that it would not cover the fieldwork and basic data collection undertaken by the Hydrology Section. The MOA requested further assistance and the Consultants prepared a proposal for a third phase of the Project. There was unfortunately a considerable gap before this was approved by ODA and an agreement with the Consultants signed on February 26th 1988. Work started in mid-March and was planned to last for about two years. During the second year it became clear that the allocated budget would not be fully used up by the end of that year, and since the MOA was very keen for assistance to continue it was arranged that the Project would continue until the end of 1990.

1.2 Scope and Layout of Report

This report consists of a main report outlining the work of the Project and a series of appendices covering specific aspects in greater detail. It is not designed to supersede previous reports; Appendix B contains a complete list of project reports and publications, some of which are directly referred to in this report.

Chapter 1 outlines the work carried out by the Project and the position of the Hydrology section at the end of the Project. Chapter 2 reviews the hydrology of southern Somalia, with particular reference to the Jubba and Shebelli rivers and the hydrometric network. Chapter 3 covers the activities of the Project and Chapter 4 provides some conclusions and recommendations.

Three separate volumes are presented in addition to the Final Report; these are the annual hydrographs for 1951-1989 (this is a companion volume to the Hydrometric Data Book), a Data Book for the Jowhar Offstream Storage Reservoir, and the Description and Operating Manual for the Forecasting Models.

1.3 Terms of Reference and Outline of Extent Achieved

The over-riding aims of Phase 3 of the Project were to continue the general assistance to the Hydrology section in office and field work, and to give appropriate training so that the Section's staff could continue their work unassisted on completion of the project. The Terms of Reference (TOR) for Phase 3 (listed in Appendix A) are considered point-by-point below, with comments on the extent to which they have been met.

i) To maintain the existing data collection network of river level stations.

This was successfully achieved during the period from March 1988 to July 1989. From that time, however, opportunities for fieldwork were severely restricted by the security situation in Somalia; many stations could not be visited and in some cases essential work such as the replacement of damaged staff gauges could not be carried out. This is covered in detail in Chapter 3. Figure 1.1 shows station locations.

ii) To improve the flow of data from those stations to Mogadishu, particularly those concerned with providing information required for flood warning.

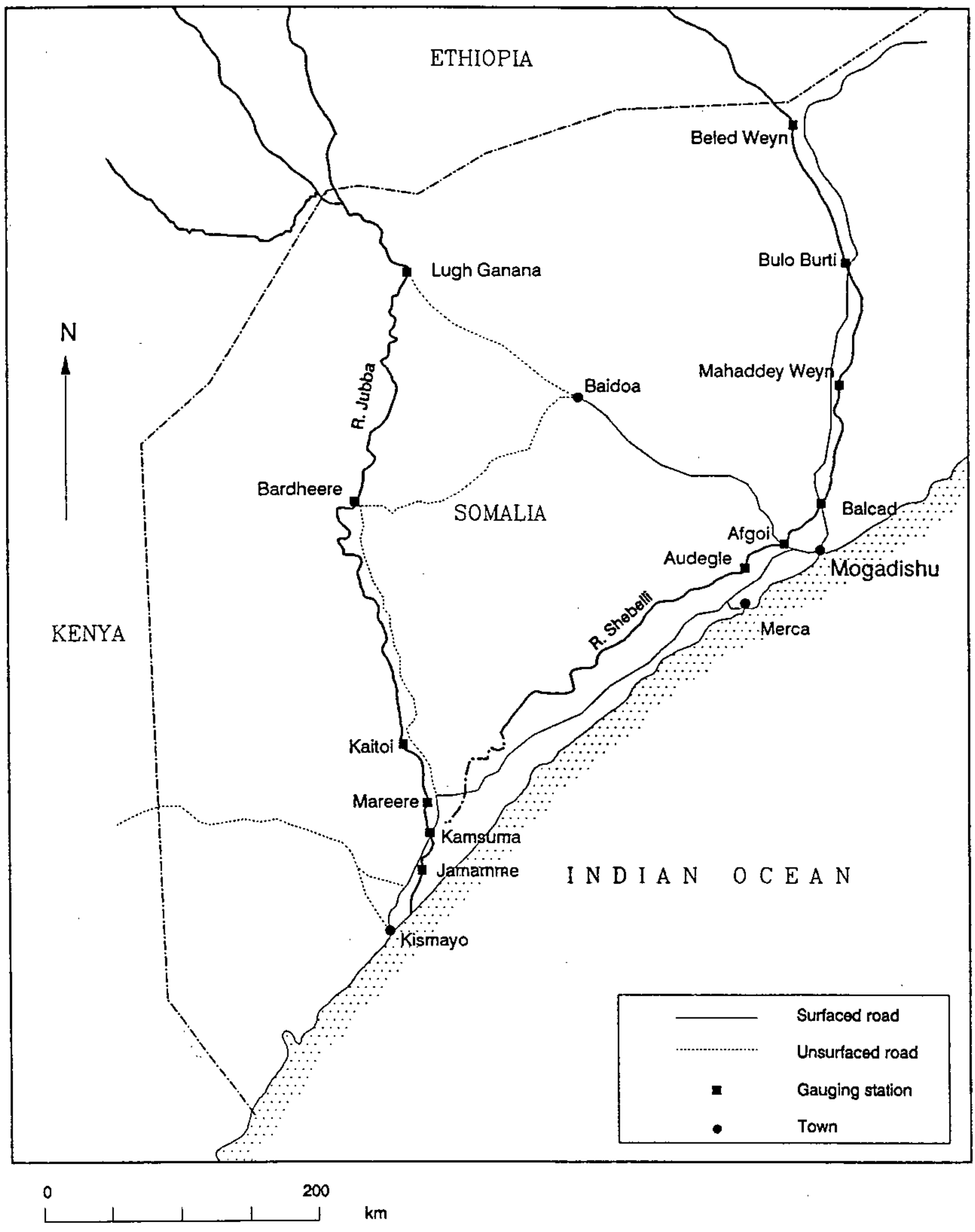
Similar comments to those for (i) above apply. The returns of data improved considerably in 1988 and early 1989. The visits by Hydrology Section staff meant that data was generally collected each month, even from the most distant stations. Besides this, the local observers were obviously encouraged by the fact that staff from Mogadishu were visiting the stations and taking an interest in their work. Some observers have continued to make good data returns, but at certain sites the lack of supervisory visits has probably contributed to a deterioration in the quality and completeness of returns. (At some of these sites the security situation is understood to have been the direct cause of breaks in the data.) Field visits also provided an opportunity to train observers and check their readings; however, at one site the existing observer has left and there has been no chance to recruit and train a suitable replacement.

This item of the TOR also envisaged the installation of radio communication between Mogadishu and the gauging stations so that information could be relayed quickly to Mogadishu to assist with flood warnings. Some of the stations were already equipped with radios as part of the Food Early Warning System (FEWS) Project, and it was planned that this network would be extended. Unfortunately, developments in northern Somalia in May/June 1988 led to concern from the Government authorities about potential misuse of radio communication, and the Ministry felt it was inappropriate to request permission for further installations. However, the existing radios have been used to gain some advance warning of floods.

iii) To continue the programme of river gauging and rating curve development.

An extensive programme of gauging was undertaken up until July 1989, but once again this work was severely curtailed by the security situation. The measurements which were made assisted in the review of the rating equations; some were revised using the new features of the updated computer

Location map



database, and at some stations new equations were developed where there appeared to have been a change in the rating in recent years. The measurements are listed in Chapter 3 and the review of the ratings is covered in detail in Appendix F.

iv) To maintain the data storage and processing facility on the computer at Mogadishu.

This was successfully achieved. A new computer was supplied with improved features (such as a colour display) and some additional software was supplied to supplement the central HYDATA package for the storage, display and analysis of the data. Updated and improved versions of HYDATA were provided as and when they became available.

v) To further develop the computer model of the Shebelli for river flow forecasting.

The model was improved to assist in the data checking work, and was developed to provide real-time flow forecasting.

vi) To develop a model of the Jubba river on the same lines as that for the Shebelli.

A similar model was developed for the Jubba. The use and operation of both the forecasting models is described in the Operation Manual presented in conjunction with this report. The use of the checking and infilling model was described in an appendix to the Fourth Progress Report.

vii) To introduce water sediment measurements (conductivity) at key stations within the network.

Regular conductivity measurements were instituted at Afgoi on the Shebelli. Some measurements were made on the Jubba, but because of the travel restrictions and the inability to train a local observer no regular measurements were made there. However, data recorded by the Juba Sugar Project (JSP) at Mareere since 1977 was included in the computer database and current data was collected and entered from time to time. The JSP data is contained in Appendix E.

viii) To introduce water sediment measurements at key stations within the network.

Regular sediment sampling was also introduced at Afgoi, with analysis in the office in Mogadishu in the absence of laboratory facilities. A few samples were taken on the Jubba, but regular sampling was prevented by the travel restrictions.

ix) To ensure that project staff receive appropriate training to enable them to continue their work unassisted on completion of the project.

Throughout the project work was treated as part of an ongoing training programme. This related to fieldwork as well as to computer and other office work. In general the staff picked up the basic methods and procedures required for carrying out the work. However, the eventual aim of the local staff being able to take over the work unassisted was not helped by problems related to overseas training. Two staff members did not return to the Section after overseas training and another appeared to lose interest in the work when his training in the UK failed to materialise. With the renewed prospect of training elsewhere he is again working, but his long-term commitment to the Section remains uncertain. The situation with respect to training is dealt with in detail in Chapter 3.

The TOR also defined the following additional responsibilities:

1) Liaison with the National Water Centre.

Close contact was maintained with the National Water Centre (NWC) until that project closed down in September 1990. Initially the MOA would not agree to the interchange of data, but later it was agreed that the river level and flow data be copied to the NWC computer system. At intervals this was updated by transfer of data from the Hydrology Section's computer. Besides assisting in the dissemination of data, this provided a security net in case of problems with the Section's computer.

2) Provide the services of a field hydrologist on a continuous basis and two other experts from time to time as required.

The Field Hydrologist was resident throughout the period of Phase 3, except for leave totalling 3-4 months. The computer specialist (Programmer/hydrologist) made four visits totalling about 7 months, and there were brief visits by senior consultant/supervisory staff.

3) Order and procure equipment to be provided under the project and cooperate with Crown Agents who will carry out value for money checks on behalf of ODA.

The quoted TOR were amended for the procurement of equipment. ODA appointed procurement agents who liaised with the Consultants and ODA to obtain and ship the required equipment. Subsequently, consumables and other minor items were procured by the Consultants as required.

4) Report at 6-monthly intervals and at the conclusion of Phase III as specified in ODA's Letter of Appointment.

Progress Reports were issued at approximately six-monthly intervals. An additional report was the Hydrometric Data Book containing all the available validated data up to the end of 1989, with missing data infilled where possible. This was widely circulated to interested parties in Mogadishu (see distribution list in Appendix H). This Final Report concludes the reporting specified in the Terms of Reference.

All reports were submitted to the Ministry of Agriculture as well as to ODA in the UK and to the British Development Division in East Africa (BDDEA) in Nairobi. BDDEA have supervised the progress of the Project, in particular through their Engineering Adviser, with visits to Somalia at intervals of approximately six months.

As noted earlier, a continuation to the Project was agreed to cover the period to the end of 1990. There were no specific Terms of Reference for this period, but the proposal did indicate the proposed scope of the work to be undertaken. The main purpose of the continuation was to maintain the training and general support for the Section's work. This was carried out as far as possible, though the overall situation and travel restrictions continued to limit operations.

Two specific items of work were proposed - the analysis of the validated and infilled data sets, and analysis of rainfall estimates obtained from satellite imagery by the FEWS project. The former is covered in Chapter 2 and the latter is referred to in Chapter 3. However, operational problems with the satellite receiving equipment and the unreliable power supply prevented any significant amount of work being undertaken. A brief qualitative study of the limited available data indicated that the satellite data should assist with flood forecasts for Somalia's rivers, but no quantitative analysis was possible.

1.4 The Hydrology Section - Current Position.

1.4.1 Staffing

At the conclusion of the Project the Hydrology Section has two graduates who are capable of operating the computer equipment to maintain the database and provide information to interested parties as required. They are also able to undertake discharge measurements, sediment sampling and analysis and other standard items of fieldwork. However, one of them may soon be going overseas for training (or may otherwise become unavailable to the Section), so there may be difficulties in maintaining the basic work of the Section in the medium term.

There are also some ten field staff employed by the Ministry of Agriculture to keep records of water level at the gauging stations. There have been some problems, primarily related to the security situation, but in general they should be able to continue with their work which is fundamental to the overall function of the Section.

1.4.2 Data and Office Equipment

At the conclusion of the Project the Hydrology Section has a comprehensive record of river level and flow data, both in print and in the computer database. Validated data covers the period from 1963 to 1989 - a continuous 27-year sequence of daily flows for the stations on the river Shebelli, and for approximately 25 out of the 27 years on the river Jubba. Some 1990 data is available, but this has not yet been validated. Some values are also available between 1951 and 1962, but the reliability of these is not known. In addition there is some data on water quality.

The data is efficiently stored on an up-to-date desk-top computer, and a range of programs (together with manuals) enable the staff to make good use of the facilities. Tabulated and graphical output is easily achieved on either a printer or a plotter. The Section has a number of reports from this and other projects, together with a small number of textbooks.

Original data sheets are available for most of the river level data (those for a few years appear to have been lost); however, it is unlikely that it will be necessary to refer again to original data for the period before 1990 because all this data was thoroughly checked during the data validation prior to the production of the Hydrometric Data Book. Original observation sheets for most discharge measurements are kept on file, with those from Phase 3 of the Hydrometry Project also stored on computer disks.

1.4.3 Field Equipment

The Project has a 110 Land Rover Station Wagon which is in good condition for fieldwork if the conditions allow travel to the gauging stations. During the final two weeks of the Hydrologist's time in Somalia it was considered too dangerous to use the Land Rover because of the number of armed attacks on Land Rovers and similar four-wheel-drive vehicles by vehicle thieves, in some cases resulting in the death of the driver as well as the loss of the vehicle. Field equipment includes all items necessary for current metering and sediment sampling by suspension from a bridge or by wading. An oven, accurate balances and filters are available to permit the analysis of samples to determine total suspended sediment load, and there is also a range of other laboratory equipment to allow more specialised analysis of samples if laboratory facilities become available.

CHAPTER 2

HYDROLOGICAL REVIEW

2.1 The Hydrological System in Southern Somalia

2.1.1 Introduction

Somalia has only two perennial rivers - the Jubba and the Shebelli, both of which flow through the southern part of the country. In order to review the hydrology of the country it is necessary to study a much broader area covering much of the Horn of Africa. A substantial proportion of Somalia's water resources originates from neighbouring countries; this applies to a considerable extent to groundwater resources, and to a greater extent to surface water resources. Kammer (1989) gives a valuable overview of all the major drainage basins affecting Somalia; certain Figures here are based on ones from that report. Figure 2.1 shows the basins and their major watercourses, Figure 2.2 the general topography and Figure 2.3 the isohyets of mean annual rainfall.

For both the Jubba and Shebelli rivers about two-thirds of the catchment area lies outside Somalia, mostly in Ethiopia, but with part of the Jubba catchment in Kenya. The catchments in Somalia are low-lying and almost uniformly flat, but in Ethiopia they rise to well over 4000m above sea level. Rainfall over the Somali parts of the catchments is generally less than 500mm per year, but in the upper reaches of the catchments in the Ethiopian highlands it reaches 1250mm or more. With the major part of the area, and generally higher rainfall, it is not surprising that most of the river flow originates outside Somalia. The virtual absence of tributaries or other drainage channels within Somalia reinforces this position because very little of the rainfall within Somalia actually reaches either river. The general pattern of river flows is similar on the two rivers; this is outlined in this section and comments pertaining to the individual catchments follow in subsequent sections.

The flows are seasonal and are dependent on the rainfall in Ethiopia which is largely related to the northwards and southwards movement of the Intertropical Front (ITF) and the Intertropical Convergence Zone (ITCZ). The ITF is the place where the trade winds from the southern and northern hemispheres meet; this convergence of winds produces atmospheric uplift which results in convectional activity and a high probability of rainfall. The extent of the uplift depends on the locality and the season, and the area where it occurs is known as the Intertropical Convergence Zone. During the first half of the year the ITCZ moves northwards (in line with, though slightly lagging, the apparent movement of the sun) and in the second half of the year it returns southwards. This movement of the ITF and ITCZ is the main cause of the seasonal weather patterns in tropical areas. A detailed explanation of the atmospheric circulation and its effect on the climate of Somalia is presented by Hutchinson and Polishchouk (1989); many of their comments on the seasonal variation in climate also apply to the Ethiopian portions of the Jubba and Shebelli catchments.

The ITF enters southern Somalia in March and has passed through both catchments in a generally north-easterly direction by the end of April. The main rains occur behind the Front in April and May, and consequently the first flood season in Somalia (known as the Gu) is between April and June. The return movement of the ITF (roughly south-westwards) first affects the northern part of the Shebelli catchment in October, and it passes over the southern part of the Jubba catchment in December. The second flood season (known as the Der) occurs between September and November. The period between January and March is generally dry, and in this low-flow season known as the Jilaal the flow into Somalia in each river has virtually ceased on several occasions since records began in 1951.

Although the rains, and hence flows, are largely determined by the movement of the ITCZ, the situation is not quite as simple as outlined above. In the mid-year period (often referred to as the Hagai) between the flood seasons the Shebelli flow generally drops to a low level, but the Jubba flow tends to be maintained at close to the annual average by a succession of minor flood peaks caused by isolated rains in the Ethiopian Highlands. Differences in the flow patterns are also caused by the occurrence of some pre-frontal rainfall ahead of the ITF; in March this sometimes leads to early floods in the Jubba, and in August/September it results in the Der flood in the Shebelli usually starting somewhat before that in the Jubba.

Although the Shebelli has a substantially larger catchment area, the total annual flow in the Jubba is about three times larger; this is partly due to the higher average rainfall, but much more to the better developed drainage network in the upper catchment. Figure 2.4 shows typical hydrographs for the two rivers at the most upstream stations within Somalia which indicate the general seasonal pattern; the form of these hydrographs is discussed in Section 2.3.

2.1.2 The Jubba

The Jubba river is formed from three major tributaries which join at Dolo immediately upstream of the Ethiopia/Somalia border (see Figure 2.1). From west to east these are the Dawa, Genale and Gestro rivers which have catchment areas of approximately 60,000, 57,000 and 27,000 km^2 respectively. The upper parts of the basin have steep slopes and a dense network of deeply incised water courses. The three tributaries flow in a generally south-easterly direction as far as Dolo; the combined Jubba river continues in that direction across the border as far as Lugh Ganana and then flows generally southwards to the sea near Kismayu. The total length of the Jubba and its longest tributary (the Genale) is estimated to be about 1100 km, of which about half lies within Somalia.

No quantitative information is available in Somalia concerning the discharges in the three main tributaries of the Jubba in Ethiopia. MMP (1978) suggested that over half of the Jubba flow downstream of the confluence is contributed by the Genale, less than 40% by the Dawa and only 7% by the Gestro. Kammer (1989) reports that the amounts to be expected purely from average areal rainfall would be 45%, 40% and 15% respectively; he explains the much higher losses in the Gestro catchment by differences in geology.

The total area of the Jubba basin is approximately 223,000 km^2, of which about 65% is in Ethiopia, 5% in Kenya and 30% in Somalia. The catchment area above Lugh Ganana, the first major town within Somalia, is about 166,000 km^2; the remaining quarter of the catchment which drains downstream of Lugh contributes very little to the average annual flow because of the very poorly defined drainage network. It has been widely assumed that well over 90% of the mean annual flow

Figure 2.1
Major Drainage Basins of the Horn of Africa

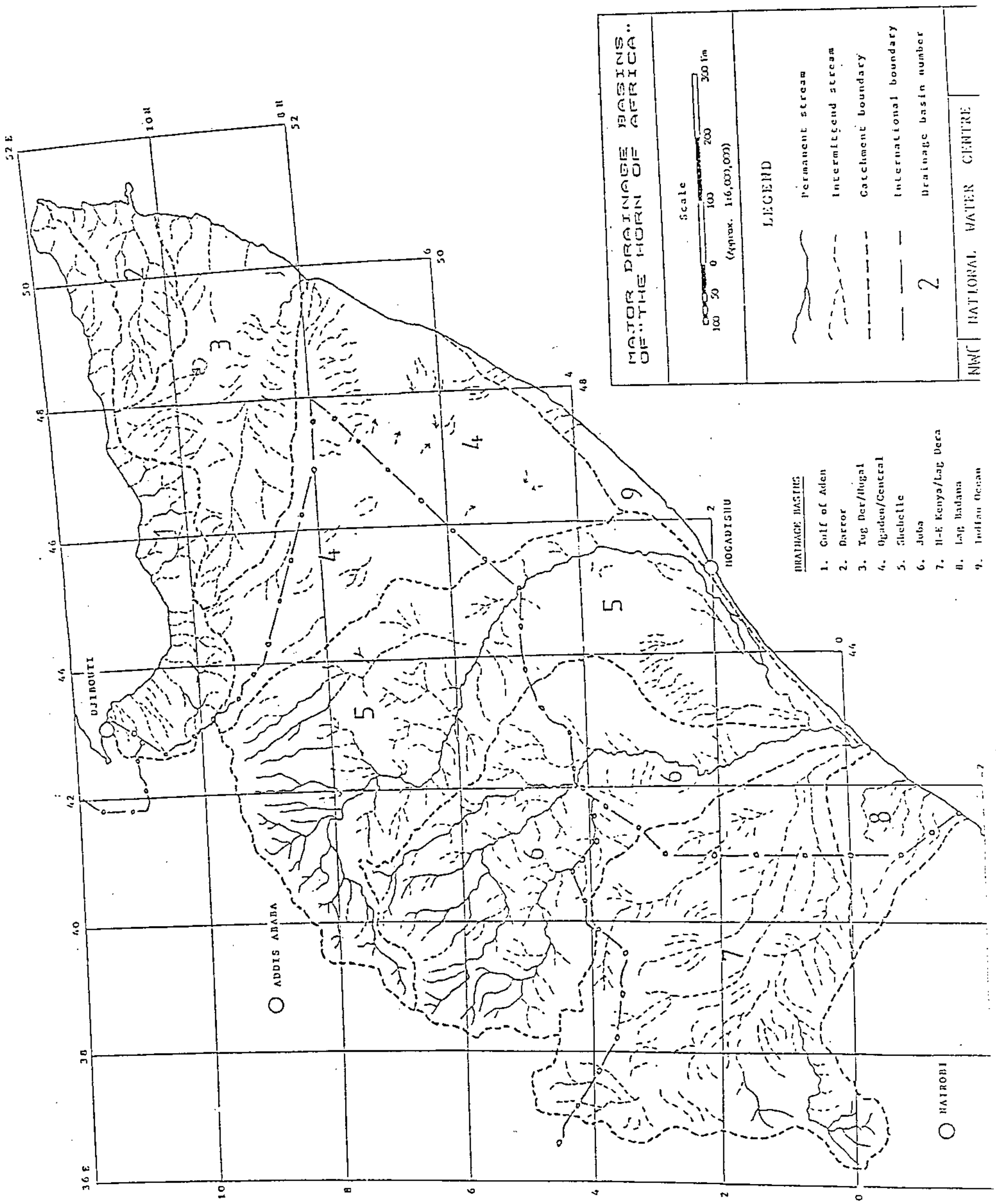


Figure 2.2
General Topography of the Horn of Africa

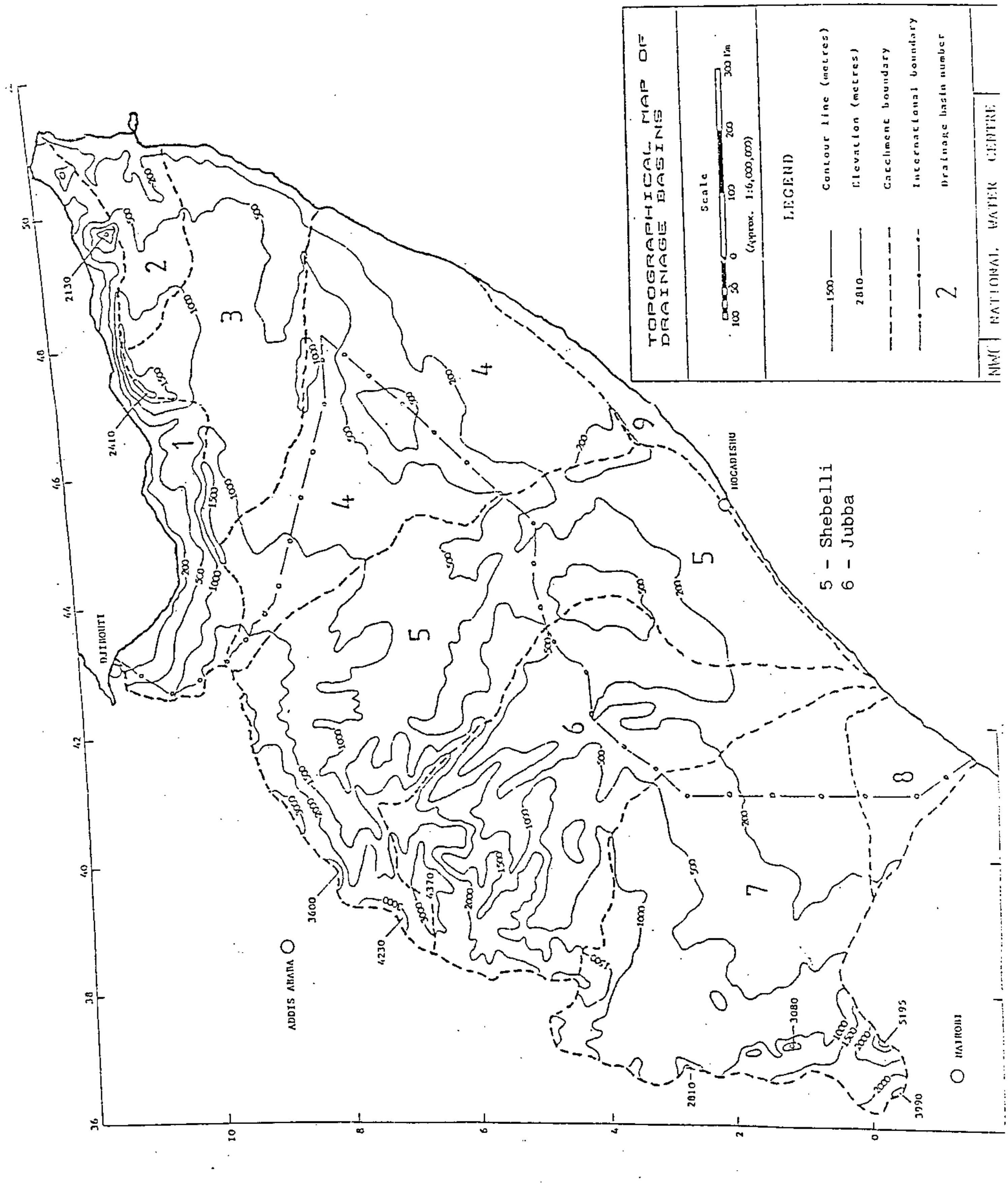


Figure 2.3
Mean Annual Rainfall over the Horn of Africa

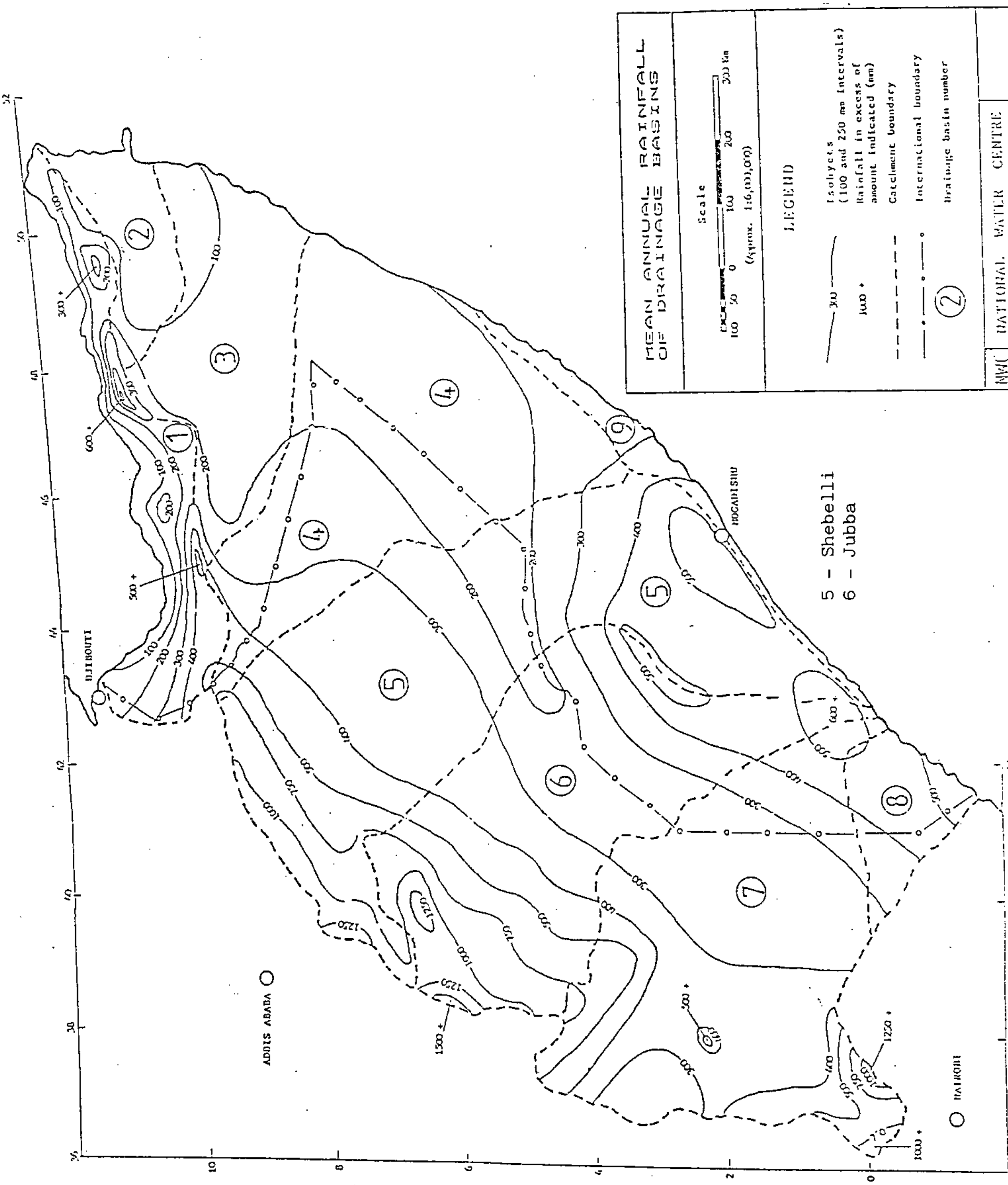
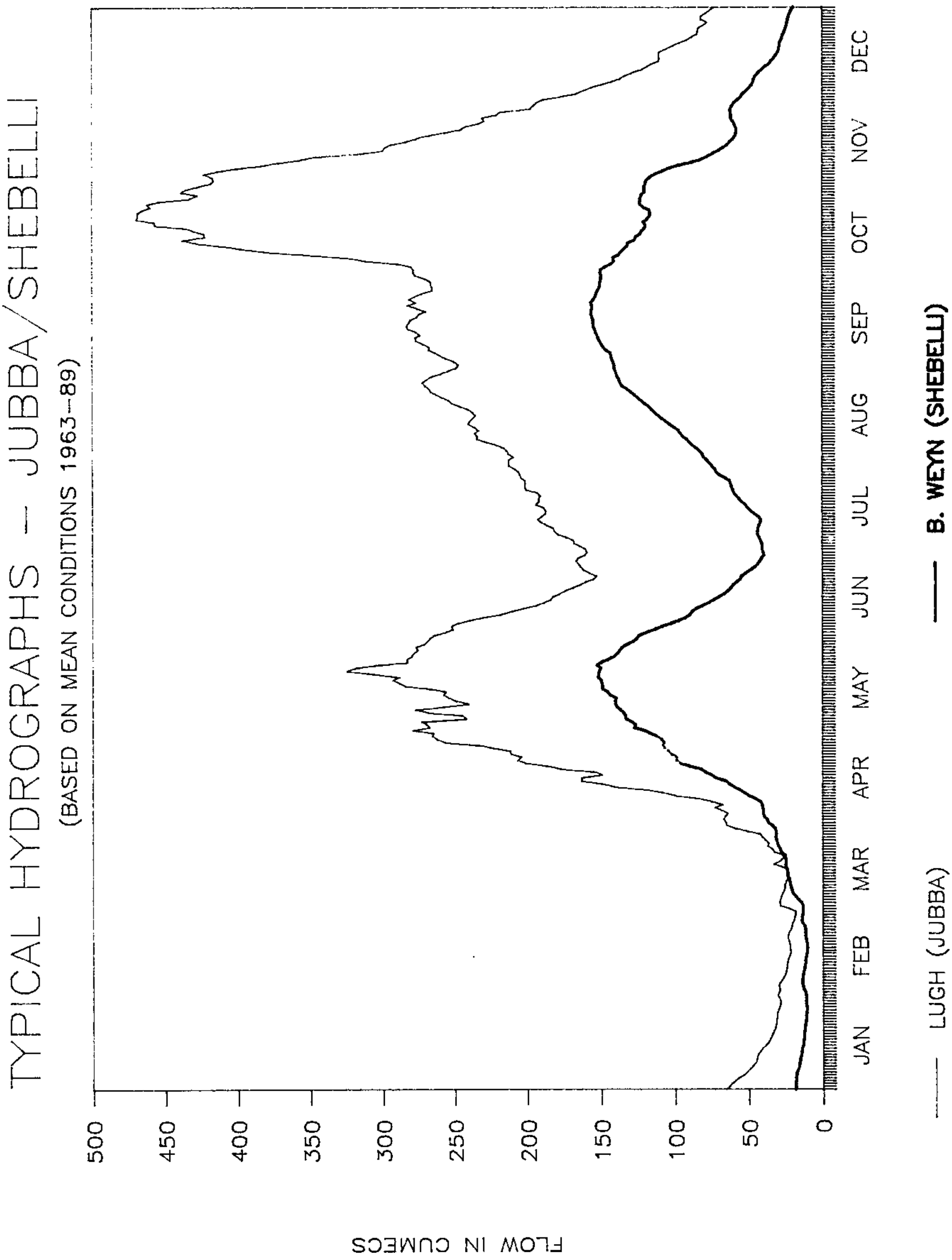


Figure 2.4



TYPICAL HYDROGRAPHS — JUBBA/SHEBELLI
(BASED ON MEAN CONDITIONS 1963–89)
FLOW IN CUMECS
0
50
100
150
200
250
300
350
400
450
500
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
LUGH (JUBBA)
B. WEYN (SHEBELLI)

originates outside Somalia. However, heavy rains within Somalia can cause large increases in the flows reaching Bardheere and stations further downstream, typically lasting for 3-6 days, and they may make a significant contribution to flooding problems in the lower Jubba valley.

2.1.3 The Shebelli

The Shebelli river has a total catchment area of approximately 307,000 km^2, of which about 199,000 km^2 (65%) lies within Ethiopia. The total length of the river is estimated to be about 1700 km, slightly under half of which is in Somalia. There is one major sub-catchment in Ethiopia, the Fanfan, which drains about 40,000 km^2 of the eastern part of the catchment. The Fanfan channel is intermittent in its lower reaches, as indicated in Figure 2.1, and water only reaches the Shebelli itself at times of high rainfall.

A limited amount of information is available about river flows in the Ethiopian portion of the catchment. Station locations in Ethiopia and Somalia are marked in Figure 2.5, and the development of the river's catchment area and discharge are shown in Figures 2.6 and 2.7. The peak discharge occurs at Imi where the catchment area is only 90,000 km^2; more than a quarter of this flow originates from the 5,300 km^2 above Malka Wakana. It is understood that a dam was completed at Malka Wakana during the 1980's; this will obviously have some impact on river flows in Somalia. However, because the dam's principal purpose is believed to be power generation rather than irrigation, the slight smoothing of flood flows and hence reduction in losses may actually have a beneficial effect on river flows in Somalia.

The mean annual discharge in the Shebelli has already started to drop by the time the river enters Somalia; this reduction continues because of evaporation, seepage, irrigation abstractions and spillages, and the river ends in swamp areas beyond Haaway. The Shebelli is technically a tributary of the Jubba, but it is doubtful whether water from the Shebelli river ever reaches the Jubba and thence the sea. When flow has been observed in the channels leading to the Jubba it is more likely that this is due to local runoff from rainfall in areas beyond the swamp.

There is sometimes some inflow to the river from rainfall in Somalia, primarily in the reach between Beled Weyn and Bulo Burti, but this is even less substantial than that in the Jubba. The same figure of 90% of mean annual flow originating outside Somalia has been widely quoted. This appears to have been obtained from an analysis of the 1968 flood, and it is likely that the long-term figure is at least 95%.

2.2 The Hydrometric Network in Somalia

2.2.1 General Development of the Network

It has been reported that observations of the level of the river Shebelli at Jowhar were recorded as early as 1925, but numerous attempts to unearth this data have been unsuccessful. The earliest river level readings still available in Somalia date from 1951 at two stations, Lugh Ganana on the Jubba and Beled Weyn on the Shebelli. Each of these stations is located close to the Ethiopian border (see

Figure 1.1 for location map). As stated in the previous section, there is very little inflow to either river within Somalia, so these stations are very important for estimating water availability in Somalia. Data for other stations is not available until 1963.

The development of the hydrometric network, and consequently the availability and reliability of data, has been closely dependent on the work of foreign-funded projects. In 1963 the Food and Agriculture Organisation (FAO) funded a study into the Water Resources of Somalia (Lockwood Survey Corporation Ltd., 1966). This established a network of river level and flow gauging stations on each river, and the network has remained largely intact to the present day. At the same time the Russian Selchozpromexport project carried out hydrological investigations on the Jubba river, including the setting up of duplicate staff gauges at two stations, but few records remain of that work.

The network deteriorated after the end of the FAO project, though further work was carried out in the late 1960's for 'The Water Control and Management of the Shebelli River Study' (MMP, 1969). Unfortunately many details of the hydrometry were either not documented or have subsequently been lost. Following this study, FAO supported work on the Shebelli for a further period of about three years. There are many comments on record sheets to indicate the presence of the foreign expert, and some of the specific items of work carried out, but no clear write-up of this work has been available.

A Russian team (Selchozpromexport, 1973) returned to the lower Jubba in the early 1970's to undertake hydrological studies for the design of the Fanoole Irrigation and Hydroelectric Power Project. Several gauging stations were rehabilitated and numerous discharge measurements undertaken. Most of the results of this work are still available in the Hydrology Section office in Mogadishu.

In the late 1970's there was a gradual deterioration in the state of the hydrometric network, and records at many stations became intermittent, unreliable or non-existent. One point of improvement was the introduction of measurements at Mareere by the Juba Sugar Project (JSP). The general decline was arrested by another FAO-funded project in which the consultant hydrologist, B.A.P. Gemmell, reorganised the hydrometric activities; this work was well written up (Gemmell, 1982). The major emphasis was on fieldwork, with the re-establishment of staff gauges and river level recorders and a very extensive programme of discharge measurements to determine new stage-discharge rating curves. Measurements were made over the full range of potential river levels at most stations because the period of the project included a severe drought in early 1981, followed by exceptional flood events on both rivers.

Following Gemmell's departure there was a further decline, particularly on the more remote river Jubba, and much work was required when the Hydrometry project began at the end of 1983. The well-trained field team established by Gemmell had been completely disbanded and the office procedures for processing and storing data had to be updated. The three phases of the Hydrometry Project have introduced and developed computerised data handling methods and have tried to maintain the other aspects of the work of the Hydrology Section.

Figure 2.5

Shebelli Catchment Area

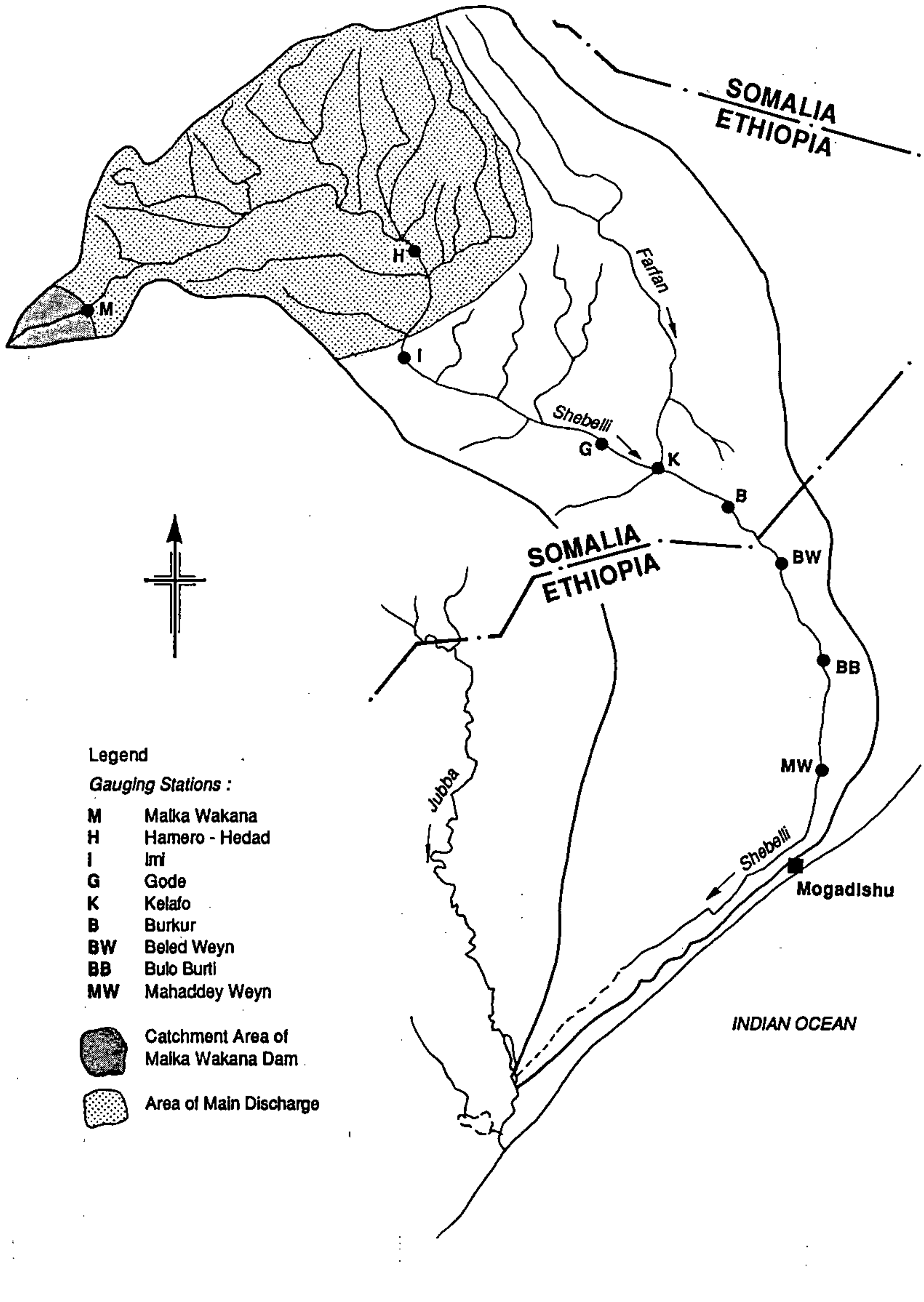


Figure 2.6

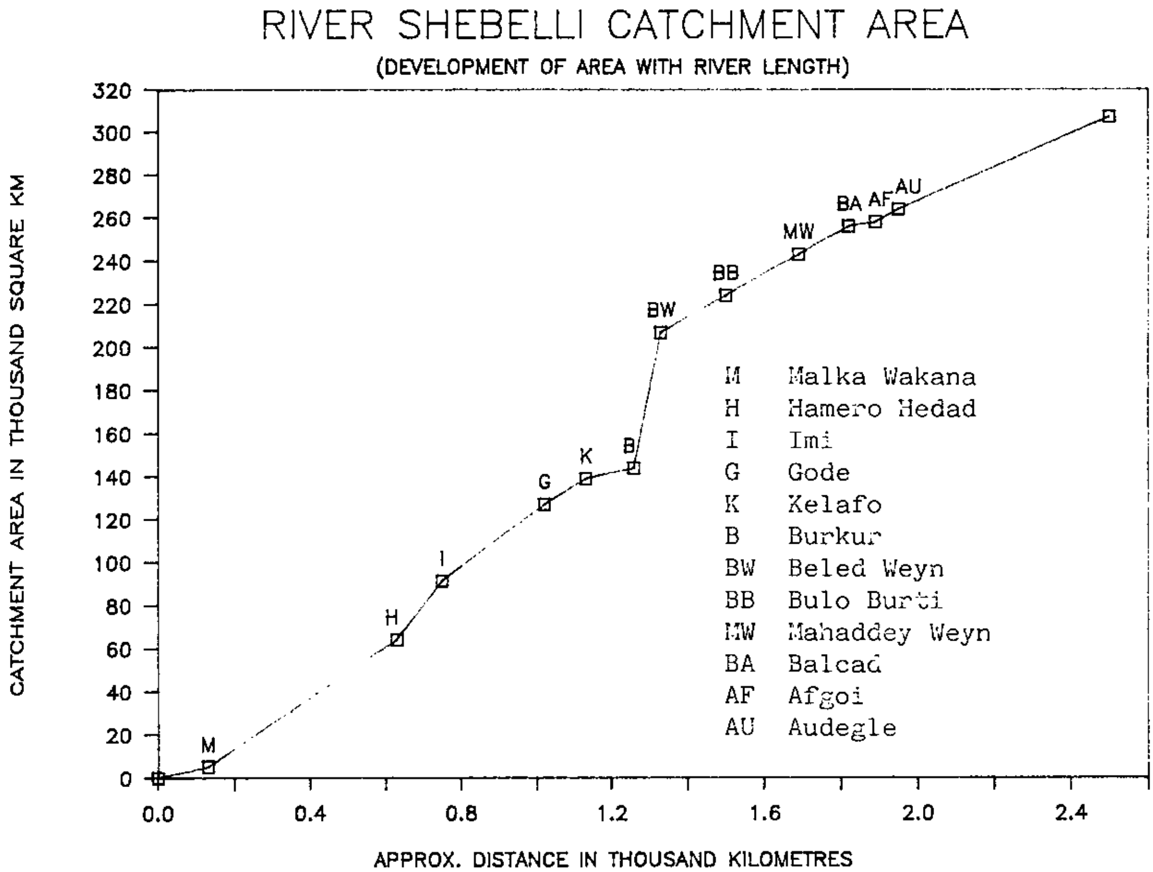
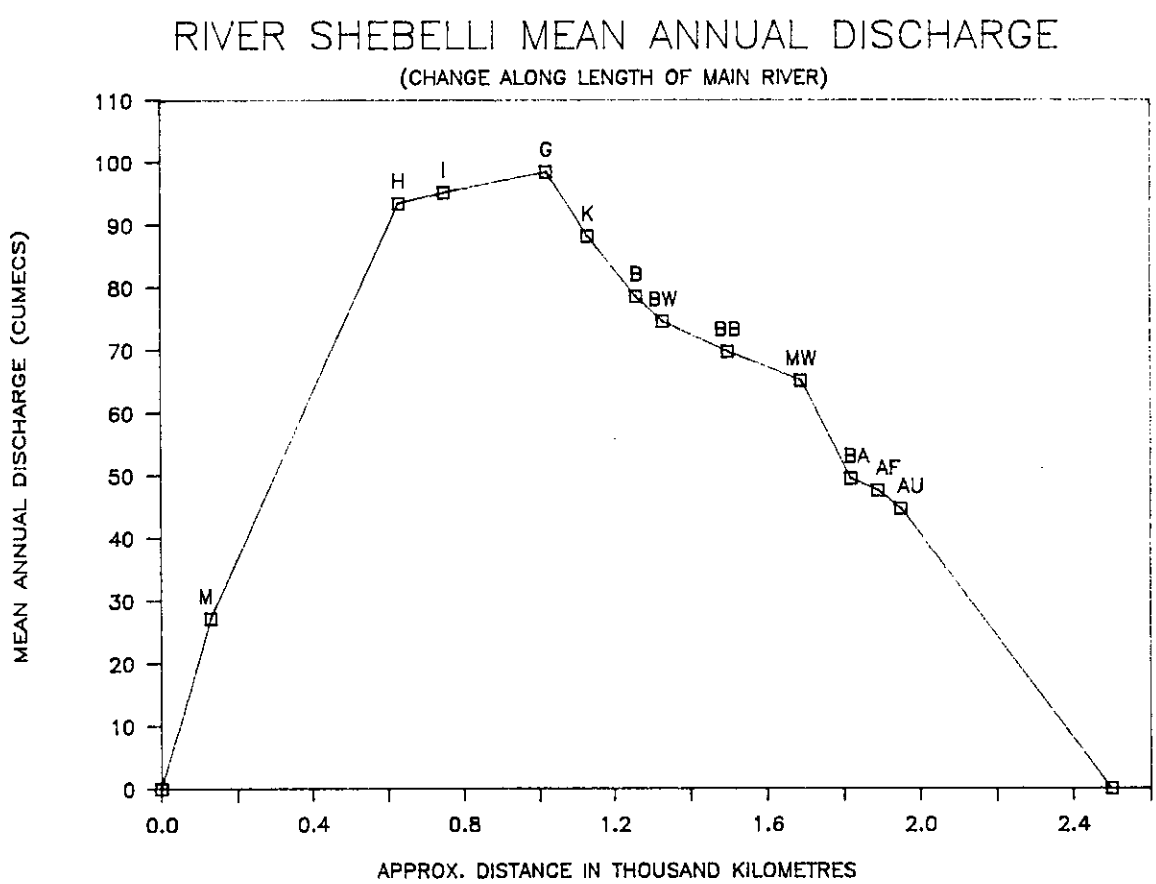


Figure 2.7



2.2.2 River Jubba

Three stations on the river Jubba have records over more than 20 years, though they are all intermittent. Four other stations have useful records for shorter periods. Temporary staff gauges were set up at some other locations in the 1970's, but they do not add much information to the rest of the record in terms of determining long-record discharges. Brief details of the stations are given below (starting from the furthest upstream station); further information on the primary stations was contained in the Stage 2 report, Appendix IV.1.

Lugh Ganana

River level records are first available for 1951. Little definite information is available about the gauges or their zero level until 1963 when the main network was established. However, certain odd notes on file indicate that the gauge zero was probably the same as that in use from 1963 to date. In 1963 a water level recorder was also installed; this only produced reliable data for relatively brief periods in the 1960's and again when it was re-established in 1980. The high silt load of the river means that frequent maintenance work is required to keep the pipes clear; such work was rarely carried out.

The staff gauges have been in good order for the duration of the Project; the 0-2 m range is attached to a bridge pillar and the remainder is securely fixed to an RSJ embedded in concrete in the river bank. The site has not been visited since July 1989, but no problems have been reported by the observer. He is still making regular returns of data, the quality of which seems to be reasonable.

Lugh also has a new automatic water level recorder which was installed in 1985 but was not fully operational until 1988 (see Second Progress report, Appendix D). The recorder (which uses a new stilling pipe, separate from the previous recorder) operated very well for about a year, but no data has been collected since early July 1989. When field visits can be resumed it should be possible to reactivate the recorder with a new battery, and the recorder's store may still contain data for some months subsequent to the last visit.

Bardheere

Staff gauges were first installed in 1963, but the station received relatively little attention until 1980, mainly because of its remote location. Records are intermittent and generally somewhat unreliable because of the lack of information about gauge zeroes. New gauges were installed in 1980/81 to replace those washed away in the 1977 flood, but the new ones were also lost in the 1981 flood. Regular and reasonably reliable readings were only resumed when more new gauges were installed in 1984. These remain in use, but in 1990 it was reported that the lower part of the gauge has been broken; bridge dip readings are being made for levels below 2.0 m. Despite the absence of visits, data is generally still being received in Mogadishu, and it appears to be of acceptable quality.

Bardheere also had a water level recorder installed in 1963; as at Lugh this operated intermittently in the 1960's and again briefly in 1980/81, but the lack of maintenance makes the quality of its data doubtful. A new recorder was also installed by the Hydrometry Project in 1985; this worked briefly in 1985/86 and again successfully from July 1988 to February 1990. Similar comments apply to those given above for Lugh.

Kaitoi

Staff gauges were set up at Kaitoi in 1963, but data was only recorded for a short period. The station was re-established in 1972 and river levels have been recorded almost without interruption since then. However, in terms of discharges useful records end in 1980 because since then the levels have been affected by the backwater effect of the Fanoole barrage.

Mareere

Station operated by the Juba Sugar Project (JSP). Gauges were set up in 1977 and have been read regularly since then. During some very bleak periods for data records at other Jubba stations (especially 1982-83) Mareere provides the only useful record on the river.

Mogambo

Station operated by the Mogambo Irrigation Project. Generally reliable records available from 1983, initially by levelling and later from staff gauges installed near the pump station which supplies the irrigation scheme. Details of the gauges and the data record up to November 1989 are contained in Brown (1989), Attachment 8.

Kamsuma

This station was in use from 1972 to 1976, and because of its good location and the ease of making discharge measurements from the bridge it was rehabilitated in 1985/86. However, the staff gauges installed then were severely damaged by subsequent floods, so the observer has to use a bridge dipper. Unfortunately the opportunity of installing new gauges in 1989 was missed, and no visit was possible in 1990. The observer was returning good data, but he left the area in September 1989 because of the local security situation. A replacement was appointed via a third party, but his data returns indicated that considerable training was required, and the Section has been unable to travel there to undertake such training. Currently this station is therefore effectively closed.

Jamamme

Staff gauges and a water level recorder were again established in 1963. A number of different sets of staff gauges have been used since then; the data records were homogenised during the first part of the project by referencing them to the same datum. Even though the recorder was rarely fully operational, the well datum assisted in fixing the relative levels of sets of gauges. Gauges installed in 1980/81 were destroyed or covered in silt by 1984, and after a period of very poor records obtained by bridge dipper the station was abandoned; it was believed that an alternative station at Kamsuma would provide better data. However, it was later decided to make a further attempt to get data at

Jamamme and a new observer was appointed in June 1989. He has returned good quality data (using a bridge dipper), and this is of particular importance in view of the problems at Kamsuma (see above). It had been hoped that staff gauges could be reinstalled in the 1990 low flow season, but no visit has been possible.

2.2.3 River Shebelli

Six stations on the river Shebelli have long period records, five of them covering the period from 1963 to date (though with substantial gaps in some cases). Additional data recorded in connection with the Jowhar Offstream Storage Reservoir since 1980 is of some value in checking the validity of other records, and would be useful for forecasting if the data could be transmitted to Mogadishu by radio.

Beled Weyn

Some data is available from 1951, but there is virtually no information about the staff gauges used. From 1963 the records are better and all values have been referenced to a fixed gauge zero. A water level recorder was in use occasionally in the 1960's and was re-established in 1980. However, as noted above for the Jubba, these recorders are unsuitable unless frequent maintenance work is carried out; in the absence of foreign-funded projects the necessary work has not been done and most data recorded is unreliable. A new automatic recorder was installed in 1985, but there has been a succession of problems and very little useful data has been collected.

The main part of the current staff gauge (from about 1.5 m to 6 m) is fixed to the bridge abutment; this is easy to read and to clean and paint. The 0-2 m gauge (which partly overlaps the main gauge) was fixed in the river bank nearby and has suffered from siltation. Part of this staff gauge has broken and data from a bridge dipper is used in its place. Section staff did observe this on an unaccompanied field trip in February 1989, but unfortunately they did not make notes and the exact problem could not be identified from their recollections. A replacement 0-2 m gauge, attached to a 3 m stand, was subsequently taken to Beled Weyn, but the river level was too high to permit installation.

Currently no data is being received from this station as a result of the local security situation. From early November the observer was in Mogadishu.

Bulo Burti

Readings commenced by dipping from the bridge or the recorder well in 1963; staff gauges were first installed in 1964. However, information about the gauge zeroes, overlaps etc is sparse until 1980, though there was generally dip data from the bridge. For some time in the 1980's two parts of the staff gauge were missing - 0-1m and 5-7m. It would only be possible to replace the lower gauge in exceptionally low flow conditions (which did not materialise in 1989), but the upper one was replaced that year. Prior to that the observer was sometimes obtaining data from a dipper, but the staff gauge is much more appropriate and the data is less prone to error.

Currently no data is being received from this station as a result of the local security situation. From mid November the observer was in Mogadishu.

Mahaddey Weyn

Staff gauges were first installed in late 1962, but there has never been a water level recorder at this site. Bridge dip data has tended to be more reliable than the staff gauges because of the limited amount of information about the replacement of gauges; for a considerable time there were overlaps between the gauges. All the staff gauges (three 2 m stands) are intact, but the condition of the bottom staff gauge (0-2 m) is giving cause for concern. This may need to be replaced when the situation allows; such work would have to be done during a period of very low flow.

Currently no data is being received from this station as a result of the local security situation.

Balcad

Staff gauges and a water level recorder were installed by the FAO project in 1963. The station was abandoned as a flow measuring station in 1980 when it became clear that the recently-constructed barrage a short distance downstream was affecting the water level and hence there could be no clearly defined stage-discharge relationship. The available data was analysed earlier in Phase 3 and reported on in the Second Progress Report, Appendix C.

Afgoi

Gauges were installed in 1963 and it appears that the same datum has been in use throughout. Most of the staff gauge plates had to be re-fixed to the bridge pillar at the start of Phase 3. Since then there has been no problem, though in the longer term relocation of the gauges is likely to be necessary because of the state of the old bridge to which they are fixed.

Audegle

The staff gauge record starts at the end of 1962. All gauge records have been referenced to the same datum, but for substantial periods there was no data. Plates were initially attached to the bridge, but in 1980 new gauges were fixed in the river bank a short distance upstream. By the late 1980's the gradual collapse of the old bridge and the resulting accumulation of debris affected the water level in the region of the staff gauges. The effect of this on the stage-discharge relationship is discussed in Appendix F.

Because of the collapse of the old bridge at Audegle the staff gauges are not in a good position. It was planned to install new gauges further downstream close to the new bridge, but the river remained far too high in 1989 and 1990 for this to be possible. This should be considered again in the future.

Kurten Waarey

Staff gauges covering the range 1-6 m were established in 1986, but river level records since then have been intermittent and of uncertain quality. The level is generally below the 1 m level for several months each year, but in 1989 and 1990 it did not drop low enough to facilitate the installation of an additional gauge.

2.3 Data Analysis

This section summarises the availability and quality of the data and presents some analysis of the validated data sets covering 1963 to 1989. In general the results are presented graphically, with analysis tables of monthly and 10-daily flows included in Appendix M.

2.3.1 Data Availability

Section 2.2 contained some comments on the availability and reliability of data, and in particular the importance of foreign-funded projects. Station maintenance has generally had to wait for a project, which leads to breaks in data when staff gauges have been washed away in floods, and the observers have always shown more interest in their work when there have been visits from Mogadishu staff - which rarely take place without the support and presence of a project.

A broad view of the availability of data over the period from 1963 is shown in Figure 2.8. This shows the average percentages of original data for each river for each year. These refer to the amount of original data remaining after the work on checking and validating the data which is described briefly in Chapter 3 and in more detail in Appendix C of the Fourth Progress Report. The graphs appeared in the Hydrometric Data Book, together with similar graphs for individual stations. For all stations there was some additional original "data" which was rejected during the checking process. In this respect the best quality record was probably that of Beled Weyn where about 90% original data remains, and almost all the remaining 10% was missing rather than rejected. In contrast, at Bulo Burti original records were initially available for at least 73% of the period but this was reduced to 63% in the final record.

Figure 2.8 clearly shows the periods for which original data is very limited. The overall data availability is much better for the Shebelli than the Jubba, primarily because the Shebelli stations are closer and more easily accessible that those on the Jubba. The pattern differs between the two rivers, reflecting a slightly different set of projects working on hydrometry. On the Shebelli a slight decline after the initial FAO project in 1963/64 was reversed in 1968 by the Project for the Water Control and Management of the Shebelli River (MMP, 1969), but a serious decline set in during the 1970's. 1975 appears as the nadir, but the improvement afterwards was very minor. A major improvement resulted from the rehabilitation under FAO funding in 1980/81, though with much of the work taking effect towards the end of 1980 the overall percentage did not show a marked improvement until 1981. Thereafter the graph shows that the situation has been broadly maintained during the 1980's, with the best returns occurring in years with a significant presence from the Hydrometry Project.

On the Jubba there is no data at all from late 1967 to late 1969, but the early to mid 1970's were better than on the Shebelli because of the influence of the Russian studies for the Fanoole project. The improvement in 1980/81 again stands out clearly, but there was a serious decline afterwards and for much of 1982/83 the only acceptable data was from JSP at Mareere. Returns have been maintained at a reasonably high level during the Hydrometry Project. The decline in the overall percentage in 1988/89 was caused by the restarting of measurements at Kamsuma and Jamamme in mid-year; the returns for the other three stations remained very nearly complete.

2.3.2 Data Quality

The previous section noted the effect of foreign-funded projects on the availability of data; their effect on the reliability and quality of data has generally been even more significant. Besides the fact that staff gauges and bridge dippers are maintained during projects, there is no doubt that observers are more conscientious about their work when people are visiting from Mogadishu and are clearly taking an interest in the data being recorded - and of course are making spot checks of river levels. It is noticeable that during the Hydrometry Project there have been very few periods of gross data fabrication, whereas in earlier years there were many instances of values being copied from earlier months or years or otherwise being invented. Furthermore, when data is available from most stations (as is usually the case during projects) it is much easier to identify erroneous values than for periods when data is only available for one or two stations.

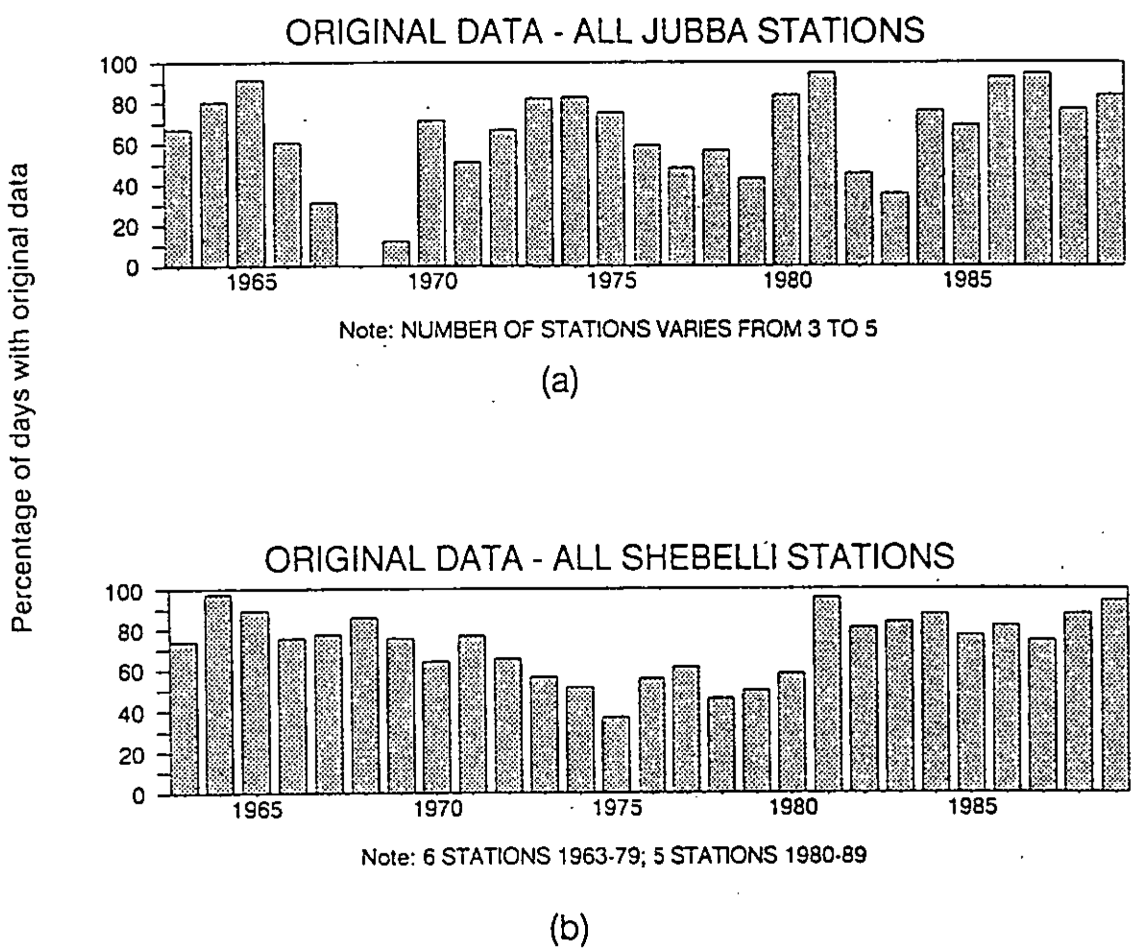
The amount of flow data marked as original on the computer and in the Hydrometric Data Book is effectively the same as the amount of original river level data, since a daily flow value is calculated for any day with one or more observations of river level. However, the quality of the two data sets is not necessarily the same because the quality of the flow data also depends on the accuracy of the stage-discharge equation. Flow measurements are largely confined to specific periods (again linked to foreign-funded projects), separated by long gaps when very few if any measurements were made. For stations where there has been some change in the rating it has generally been difficult to identify the appropriate date for the change to be applied, so that flow values are less reliable for some periods than others, even if river level records are complete. The main periods with a significant number of discharge measurements are 1963-64, 1968-69 (most Shebelli stations), 1972-77 (Jubba stations except Bardheere) and 1980-81.

The annual flow printouts in the Hydrometric Data Book contain comments on the data, some of which refer to the quality of the data for that year.

2.3.3 Normal Flow Patterns

Average conditions may be represented by either the mean or the median flow. Of these the median is probably more suitable as a representation of "normal" conditions, because at times of generally low flow the mean may be raised significantly by the presence of one or two very high values. As an example, the median flow at Beled Weyn for the month of March is 11 cumecs, but the mean is more than twice as high (24 cumecs) because of some exceptional values, including one of over 120 cumecs. To represent 24 cumecs as the "normal" would be misleading because that value was only

Average percentages of original data available for all stations for the period 1963 - 1989 (a) River Jubba (b) River Shebelli



exceeded in seven years out of the 27 years of record - i.e. about one quarter of the time. Monthly mean and median flows are shown in Table 2.1.

Monthly median flows for the two upstream stations, Lugh and Beled Weyn, are shown in Figure 2.9. Each has two peaks, the smaller of which occurs in May (the Gu) and the larger in September/October (the Der). The pattern is more clearly shown in Figure 2.10 which presents flows for 10-day periods; the bimodal nature of the Shebelli flow is particularly apparent. Both rivers have an extended low flow season at the start of the year, but the patterns differ somewhat in mid-year between the flood seasons. On the Shebelli there is a sharp drop after the Gu flood, but on the Jubba the drop is fairly small as the average flow is generally maintained by a succession of small flood peaks. A similar graph can be produced by averaging the values for each individual day rather than for 10 day periods, though this does rather reduce the magnitude of the flood peaks. For much of the year the mean and median values of daily data are similar, but since the median curve has many more small oscillations the mean curve produces a clearer graph. These daily mean curves were shown in Figure 2.4.

The way the flows change between upstream and downstream stations is also of interest, and in this respect the two rivers differ substantially. In both cases there is some natural attenuation of floods, but whereas most of the Jubba flow reaches the sea near Kismayu, none of the Shebelli flow does so (except possibly during very exceptional floods - see Section 2.1.3). Figure 2.11 shows the normal (median) flow pattern for upstream and downstream stations on each river. On the Jubba the reduction in average flow between Lugh and Jamamme is very small. There is in fact some increase between Lugh and Bardheere because of the occasional storm runoff in that reach, and this is only just cancelled out by abstractions and other losses between Bardheere and Jamamme. On the Shebelli, however, the reduction in flow during the flood seasons is very marked. This is because the bank-full capacity in the lower Shebelli is much lower than at Beled Weyn, and it is usual for the river to stay at or close to this level for a considerable period in the flood seasons. This feature of the river's flow characteristics is well illustrated by some flood hydrographs in the next Section. The Jubba does experience similar bank-full conditions in its lower reaches, but these are usually for much shorter periods, and the river's capacity at Jamamme is similar to normal peak flows at Lugh.

2.3.4 Flood Events

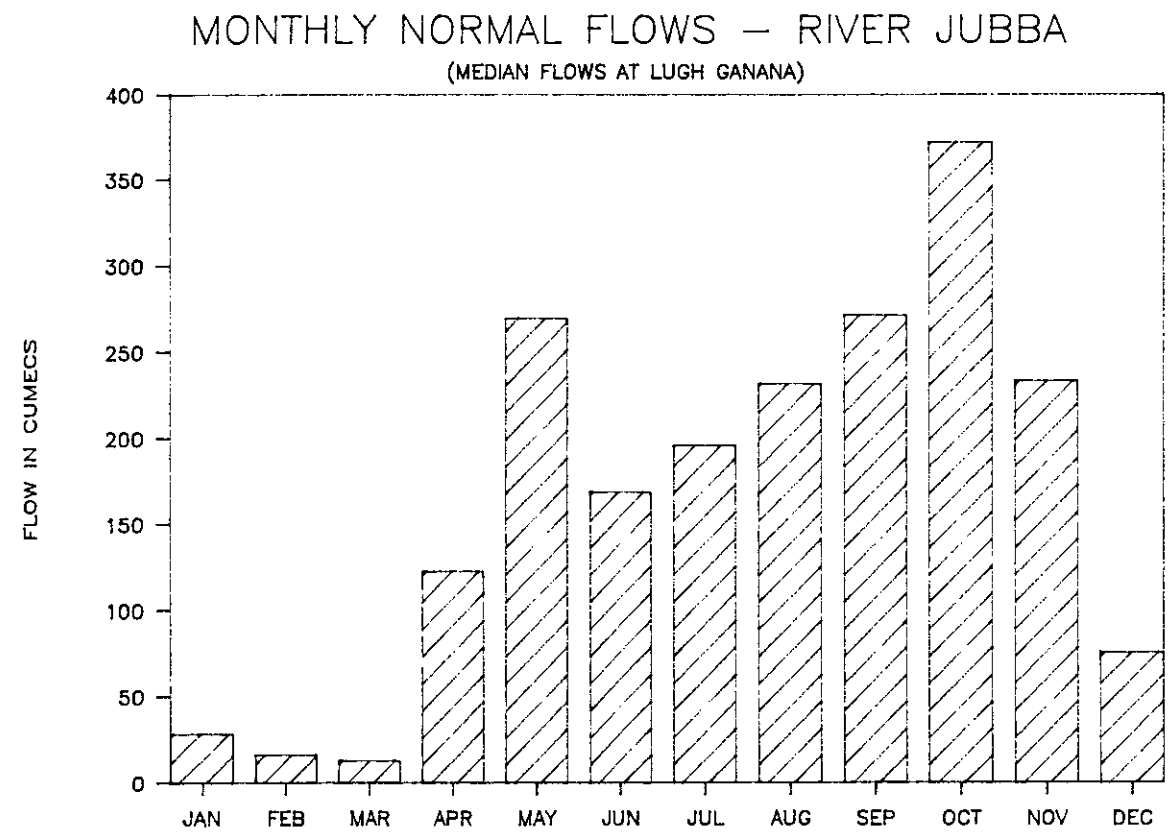
Both the Jubba and Shebelli rivers are prone to flooding, especially in their lower reaches. Since the main contributing catchments are fairly close together in the Ethiopian highlands major floods often occur on both rivers in the same year. The highest flows on the Jubba were in 1977, 1981 and 1987, and on the Shebelli in 1981 and 1987. There have also been severe flooding problems in other years, including some when the flow levels were not particularly extreme. There was extensive flooding in the middle and lower Shebelli in 1990 (and in the lower Shebelli in 1989 also), even though the flow magnitudes were not unusually high. The return period of the 1990 flood flow at Beled Weyn was only about 2 years, but serious flooding occurred downstream, primarily because of the lack of maintenance work on the river banks and control structures. This subject is covered in detail by van Urk (1990).

TABLE 2.1

Monthly Mean and Median Flows (cumecs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
River Jubba												
Lugh Ganana												
Mean	42	24	31	150	275	198	190	243	271	392	302	111
Median	28	16	13	123	270	169	196	232	272	372	233	76
Bardheere												
Mean	47	30	36	149	294	212	188	239	271	394	330	124
Median	36	22	19	125	267	180	196	222	286	356	279	83
Kaitoi												
Mean	65	42	39	111	230	196	177	231	243	298	320	155
Median	55	28	22	84	206	175	162	238	259	301	262	101
Mareere												
Mean	45	26	30	137	290	253	189	212	236	340	326	146
Median	32	17	14	107	262	216	190	221	225	380	336	77
Kamsuma												
Mean	44	21	12	74	214	194	172	257	290	324	335	140
Median	36	16	4	73	170	167	165	250	290	318	340	102
Jamamme												
Mean	51	23	22	97	233	205	167	211	247	309	311	143
Median	34	22	12	75	237	177	152	215	248	306	308	103
River Shebelli												
Beled Weyn												
Mean	14	12	24	72	140	77	53	111	151	130	77	34
Median	10	6	11	58	119	56	54	123	154	110	54	18
Bulo Burti												
Mean	13	11	21	61	133	79	50	100	136	123	76	34
Median	9	6	9	46	115	62	53	108	137	101	57	17
Mahaddey Weyn												
Mean	17	13	21	54	105	75	52	98	123	111	75	38
Median	13	9	10	47	109	72	49	102	131	104	68	24
Balcad												
Mean	15	10	19	38	71	53	42	77	89	82	62	35
Median	10	10	6	27	75	55	43	82	94	86	61	25
Afgoi												
Mean	14	10	15	35	71	57	40	73	85	79	60	32
Median	9	5	3	26	75	60	42	79	91	82	62	26
Audegle												
Mean	14	10	15	32	66	56	41	67	75	72	57	32
Median	9	4	5	23	74	61	42	72	74	74	59	25

Figure 2.9


MONTHLY NORMAL FLOWS – RIVER JUBBA
(MEDIAN FLOWS AT LUGH GANANA)
FLOW IN CUMECS
400
350
300
250
200
150
100
50
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

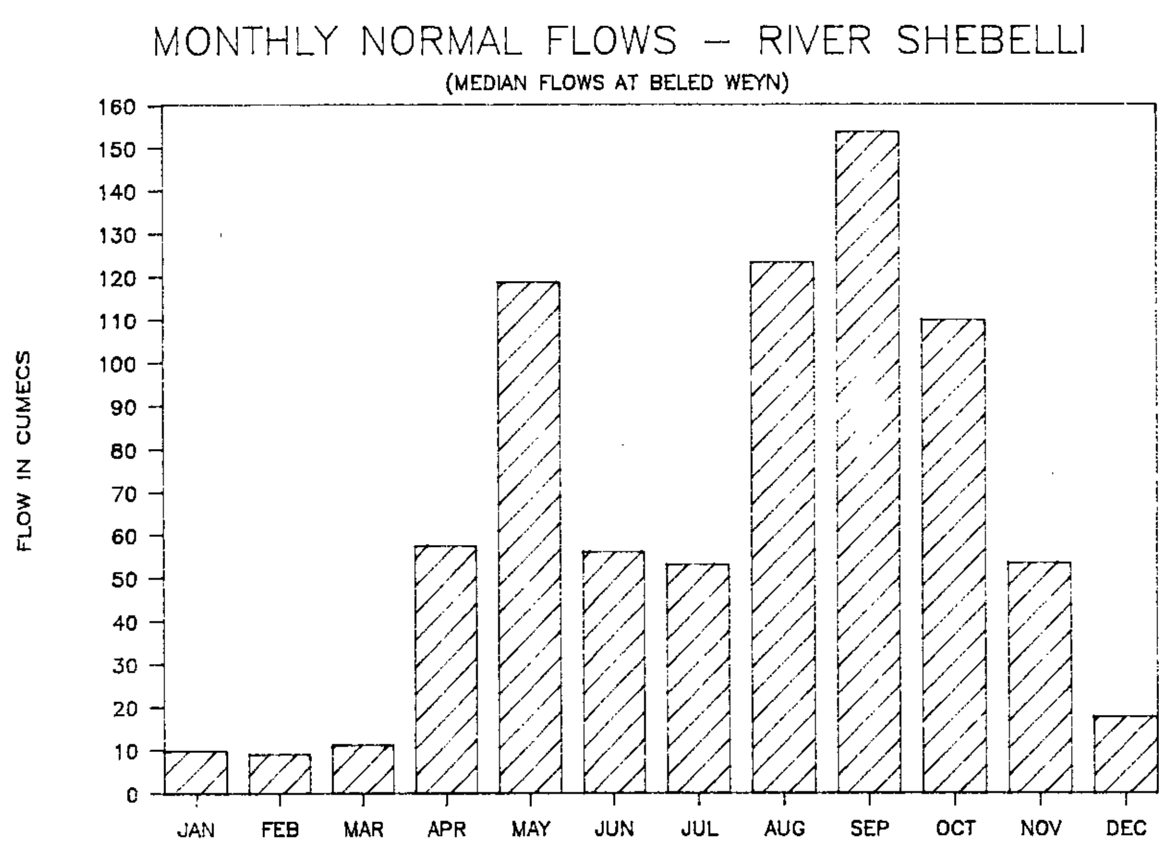
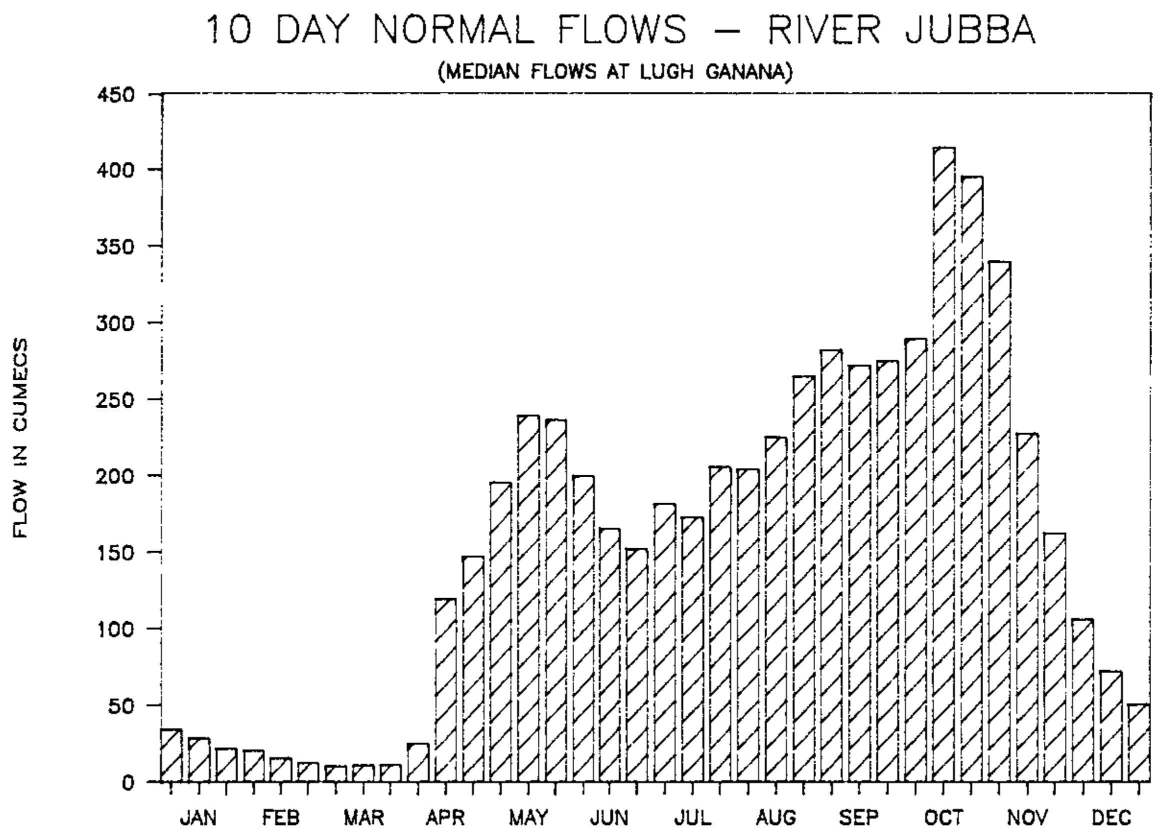
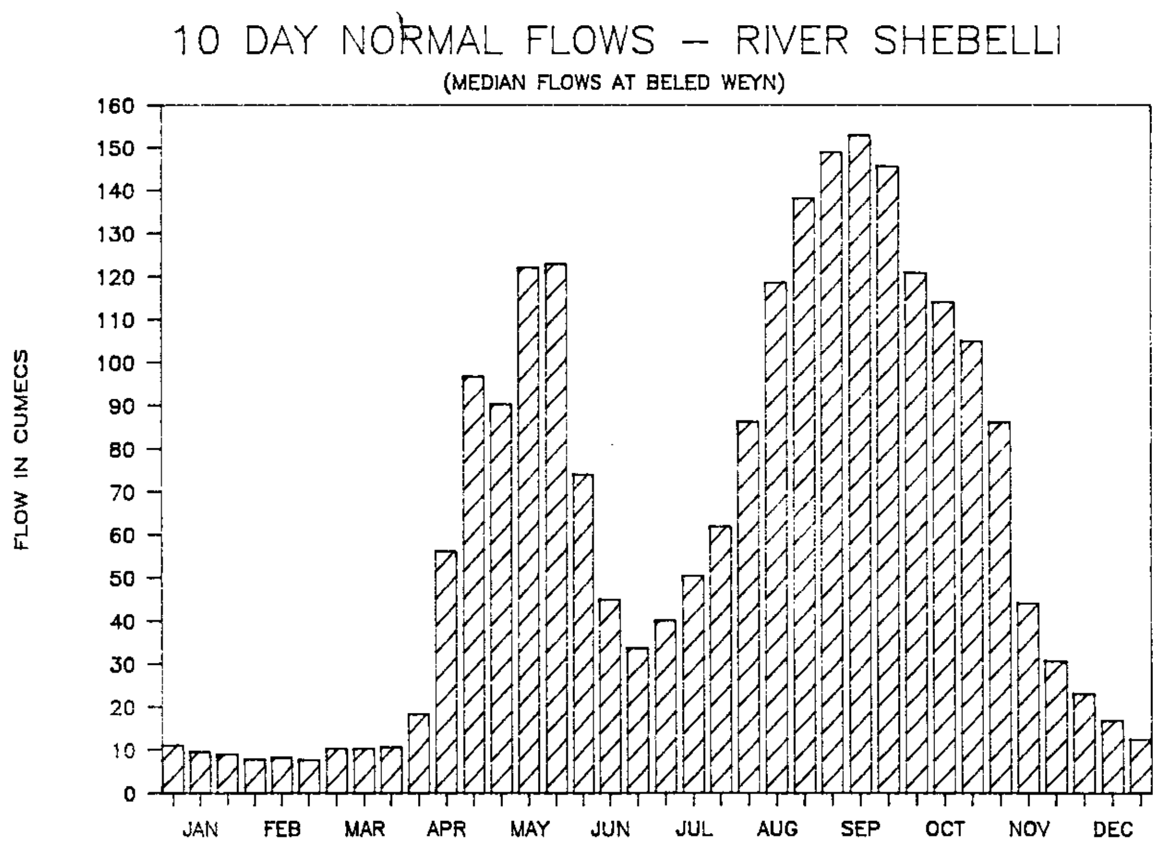

MONTHLY NORMAL FLOWS – RIVER SHEBELLI
(MEDIAN FLOWS AT BELED WEYN)
FLOW IN CUMECS
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Figure 2.10


10 DAY NORMAL FLOWS – RIVER JUBBA
(MEDIAN FLOWS AT LUGH GANANA)
FLOW IN CUMECS
450
400
350
300
250
200
150
100
50
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


10 DAY NORMAL FLOWS – RIVER SHEBELLI
(MEDIAN FLOWS AT BELED WEYN)
FLOW IN CUMECS
160
150
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120
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100
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80
70
60
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40
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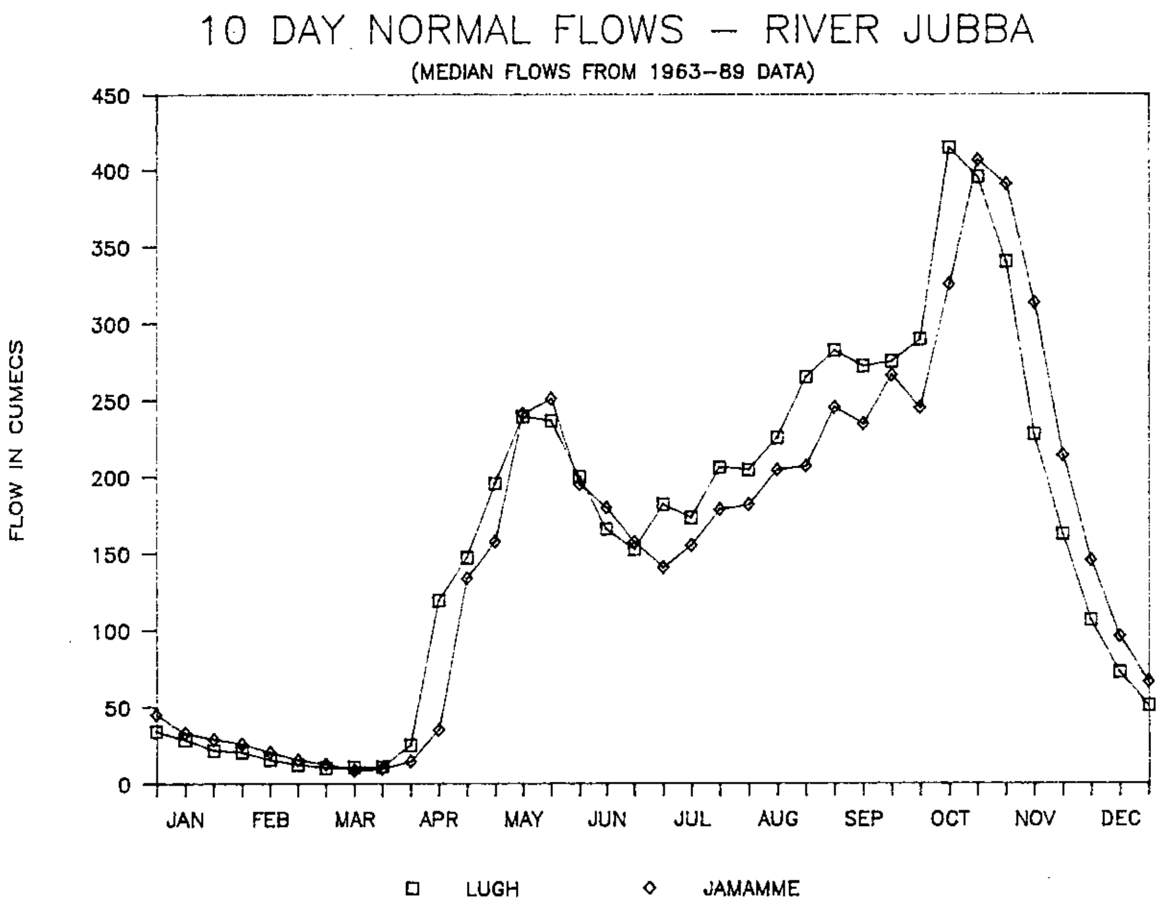
10 DAY NORMAL FLOWS – RIVER JUBBA
(MEDIAN FLOWS FROM 1963–89 DATA)
FLOW IN CUMECS
450
400
350
300
250
200
150
100
50
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
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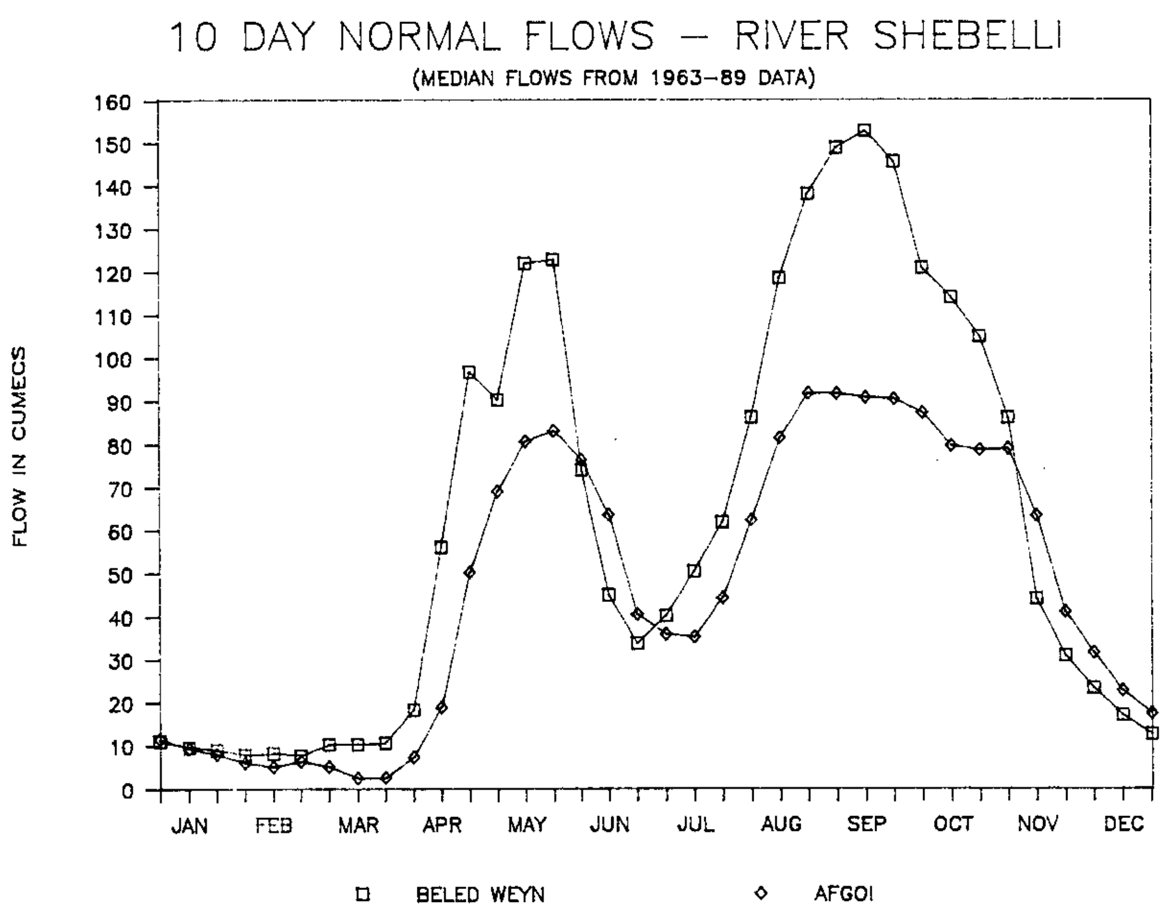
DEC
LUGH
JAMAMME


10 DAY NORMAL FLOWS – RIVER SHEBELLI
(MEDIAN FLOWS FROM 1963–89 DATA)
FLOW IN CUMECS
160
150
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JAN
FEB
MAR
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JUL
AUG
SEP
OCT
NOV
DEC
BELED WEYN
AFGOI

Table 2.2 lists the maximum daily mean flow for each year for the most upstream station on each river, and Table 2.3 the estimated values for certain return periods, derived by fitting a Gumbel Type I extremal distribution to the data. The quoted flood values must be treated with caution because of the uncertainty of the stage-discharge relationship at high levels, particularly for the Shebelli at Beled Weyn. The highest river level recorded at Beled Weyn was 6.65 m in 1981, which converts to a maximum flow level of just over 470 cumecs, but the FAO Consultant, B. Gemmell, estimated the total flow at that time (including flow in a flood relief bypass canal and over the flood plain) to be over 1000 and possibly as much as 1400 cumecs. At Lugh on the Jubba the possible error in flood magnitude is much less because the river remains substantially in-bank, even at high levels, and extrapolation of the rating curve is more acceptable.

The previous section noted the reduction in bank-full capacity in the lower reaches; this is best illustrated by graphs of extreme flood events. Figures 2.12 and 2.13 show hydrographs for 1981 of the Jubba and Shebelli respectively. In each case the river at the downstream station was full for some months. These are extreme conditions, but it is normal for the Shebelli at Afgoi to be full for several weeks each year, and it is very unusual for it to fail to reach that level in one or other of the flood seasons. Bank-full conditions on the Jubba at Jamamme are generally much more short-lived, and in about one year in three there is no sustained period of bank-full flow.

2.3.5 Flow Variability and Trends

Flows in Somalia's rivers are extremely variable, even though there is a clear seasonal pattern. Figures 2.14 and 2.15 show comparison graphs for two different years on each river. In each case these are the years with the highest and lowest annual flow at the key upstream stations; on the Shebelli the years were consecutive. The difference is much less marked for the downstream stations on the Shebelli because of the extent of the reduction in flood flows, and in fact the highest year at Beled Weyn (1981) was a fairly average year overall at Afgoi. The highest annual flow there was in 1968, and Figure 2.16 shows the comparison between that and the lowest year which is again 1980.

To investigate the possible presence of trends in the data due to changes in climate or other matters a long-term data sequence is required. For the Shebelli the data infilling resulted in a 27-year continuous sequence of daily data, but for the Jubba the sequence is broken by a gap of about two years in 1967-69. In terms of climatic change these are relatively short periods, but they are sufficient to give some useful information. The first test for trend concerns the mean annual flow; Figures 2.17 and 2.18 show this information for Lugh and Beled Weyn, together with the 5-year running mean. The substantial variation is clearly seen, but there is no apparent upward or downward trend over the period on either river. Standard tests for periodicity also indicate that there is no significant cyclical pattern.

Similar analysis can be carried out for the magnitude of the annual flood peak; Figures 2.19 and 2.20 show this data - once again there is no sign of any trend or other significant pattern.

TABLE 2.2

Annual Maximum Daily Mean Flow for Upstream Stations (cumecs)

Year	Lugh Ganana (Jubba)	Beled Weyn (Shebelli)
1963	690	351
1964	840	227
1965	1069	226
1966	485	191
1967	1051	285
1968	-	350
1969	-	200
1970	1119	230
1971	901	168
1972	612	228
1973	622	156
1974	556	161
1975	544	231
1976	867	373
1977	1823	345
1978	829	255
1979	354	151
1980	250	165
1981	1431	474
1982	851	245
1983	678	362
1984	503	179
1985	641	353
1986	544	166
1987	1475	420
1988	856	227
1989	958	299
1990	747	243
Mean	819	259

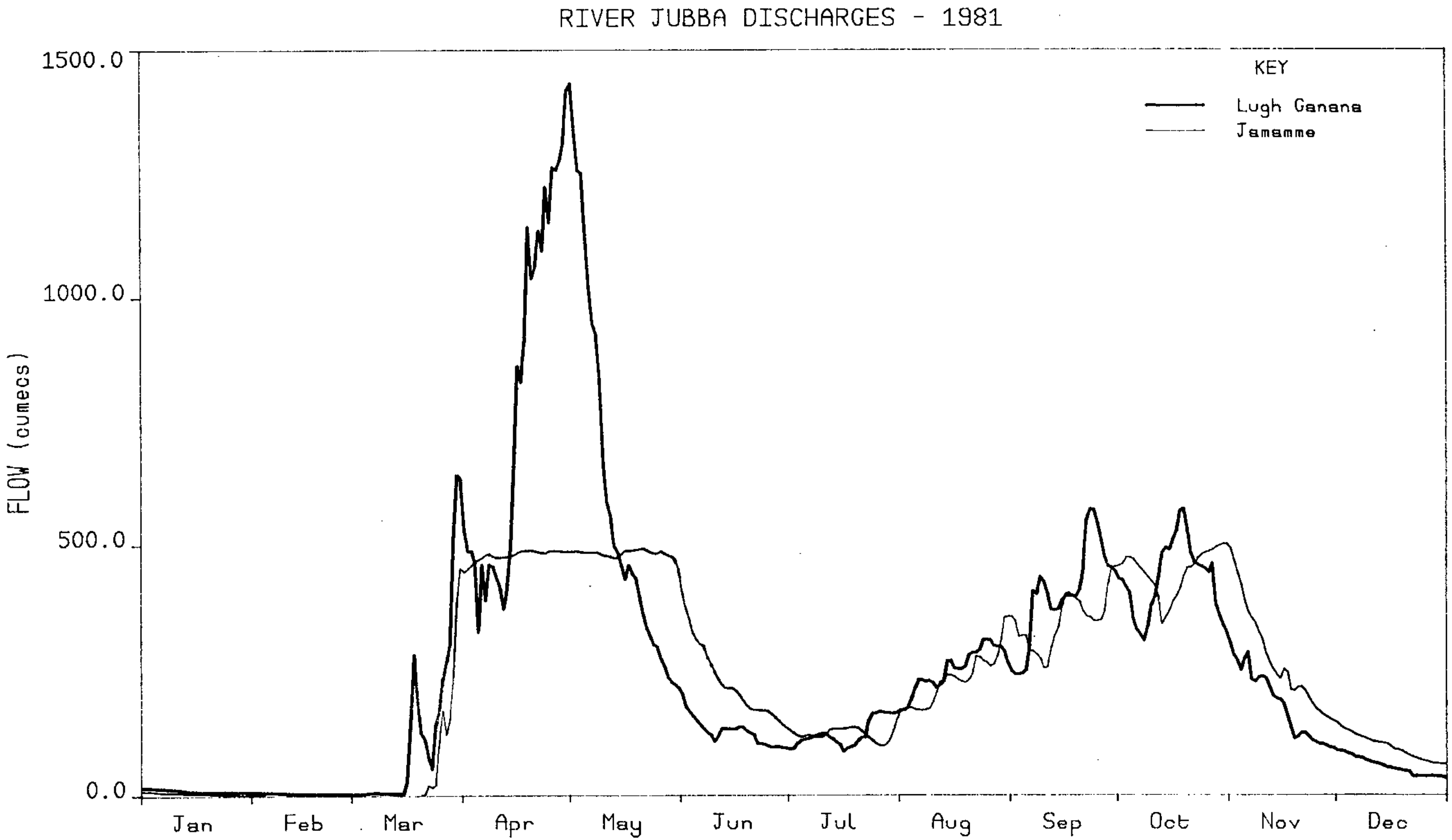


Figure 2.12

Department of Hydrology, Ministry of Agriculture

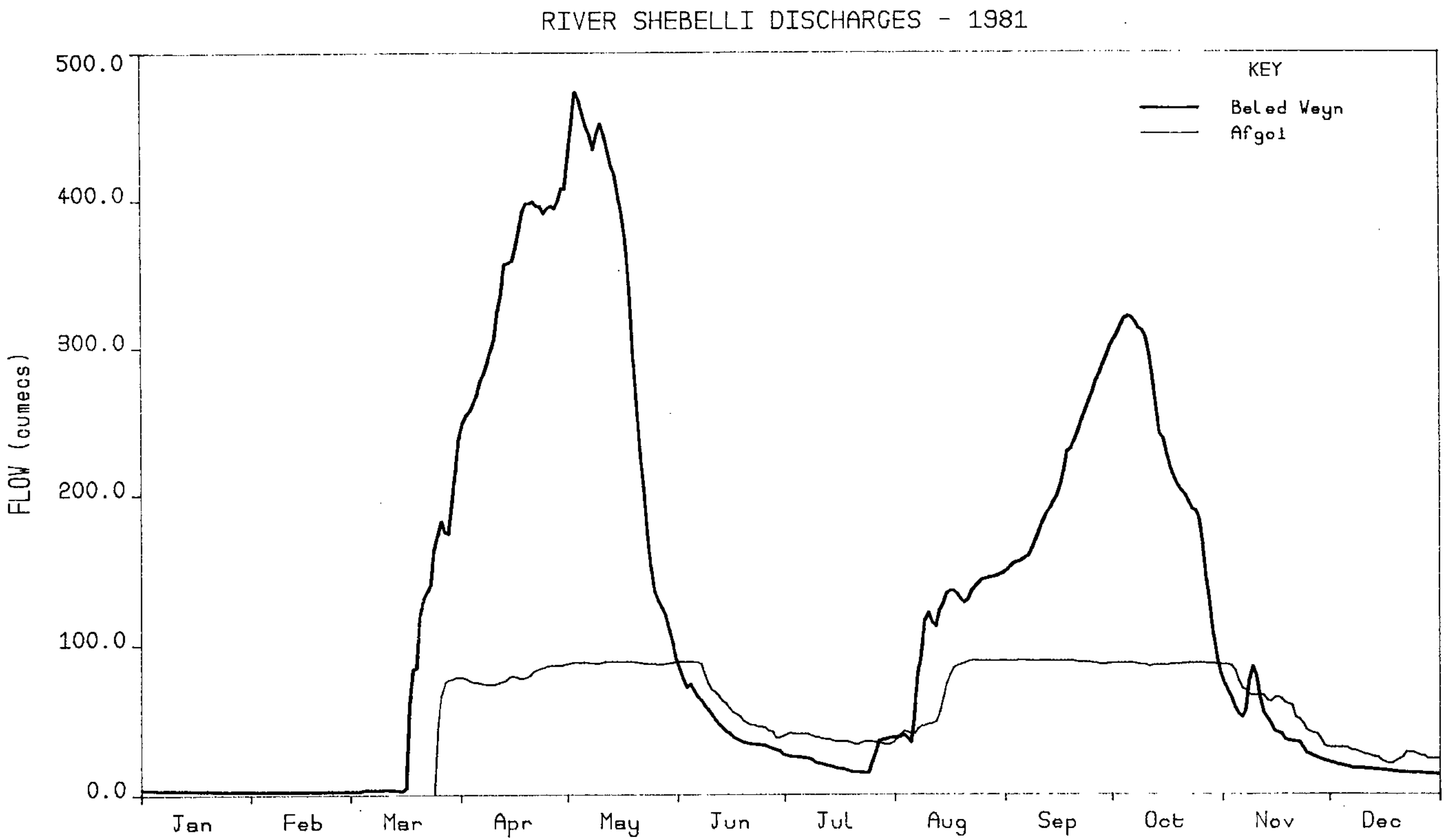


Figure 2.13

Department of Hydrology, Ministry of Agriculture

JUBBA at LUGH GANANA 1977 and 80

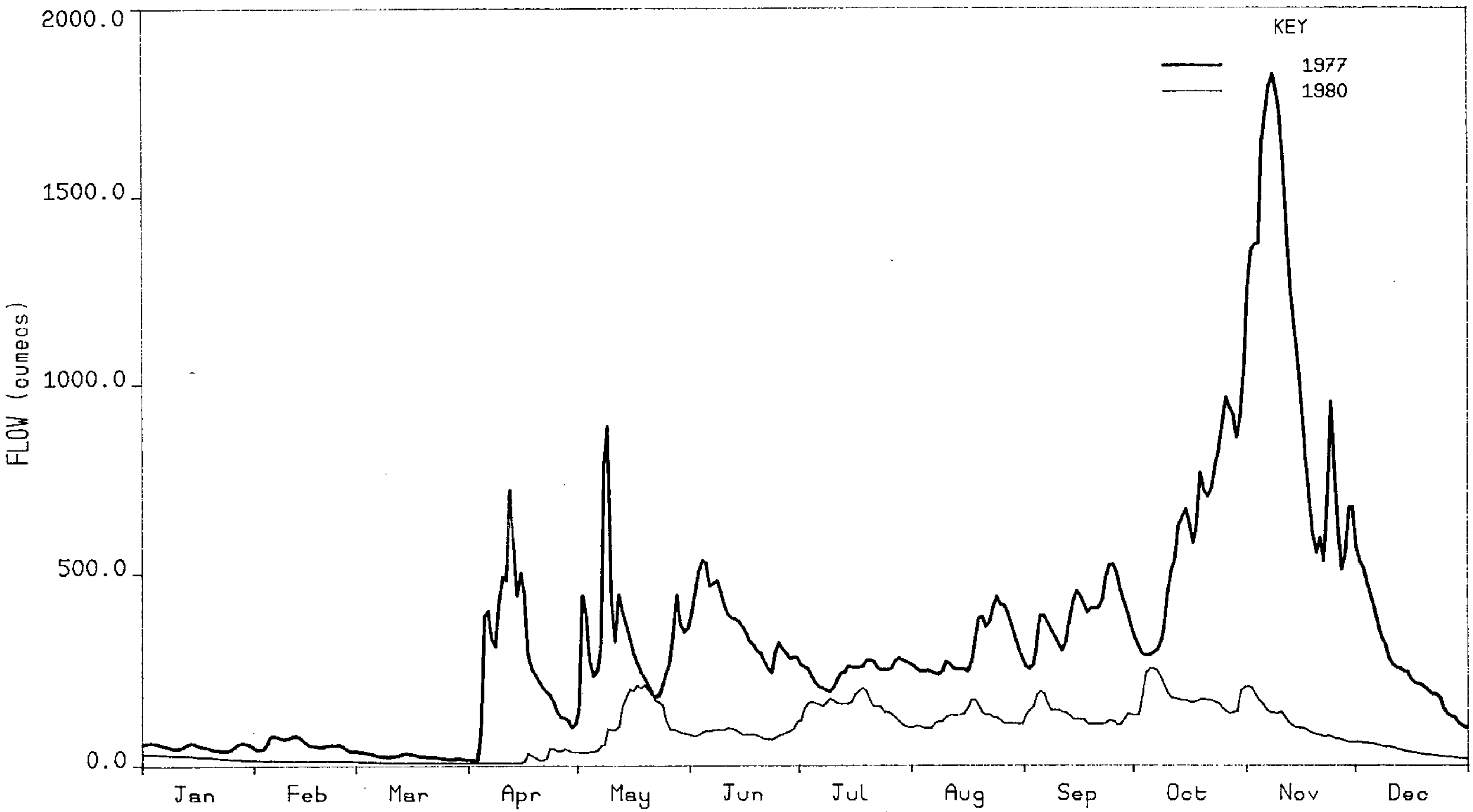


Figure 2.14

Department of Hydrology, Ministry of Agriculture

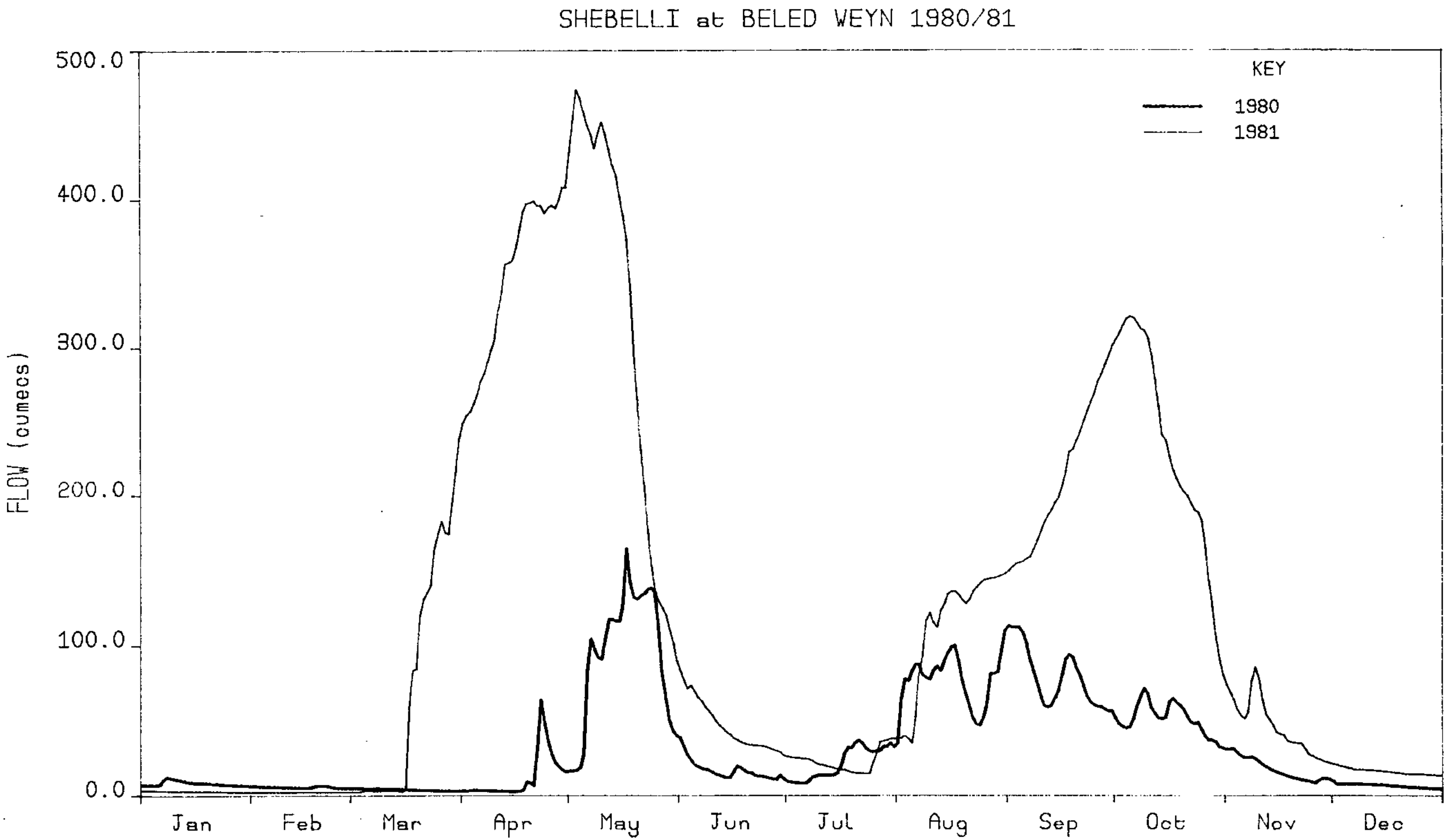


Figure 2.15

Department of Hydrology, Ministry of Agriculture

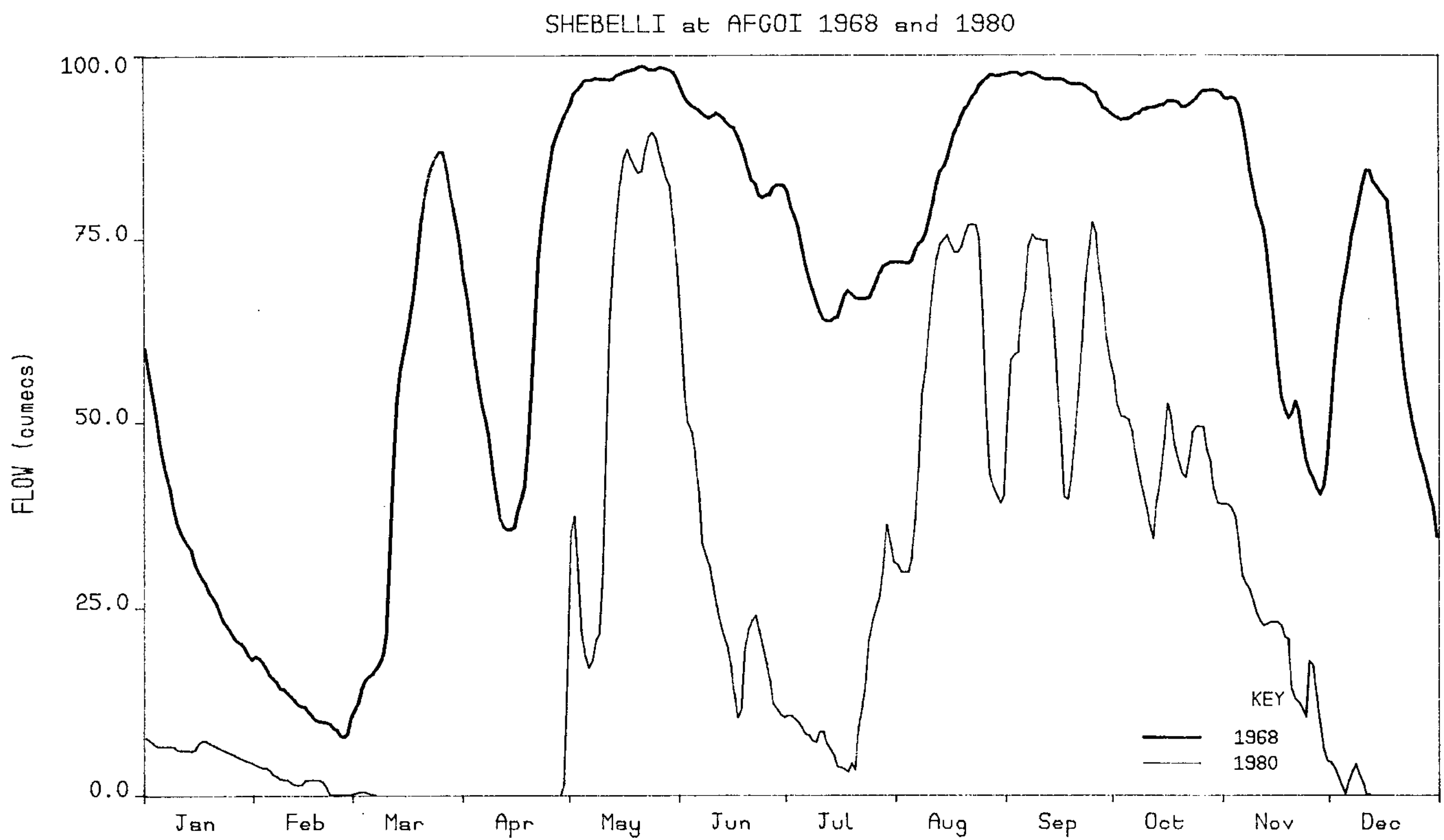


Figure 2.16

Department of Hydrology, Ministry of Agriculture

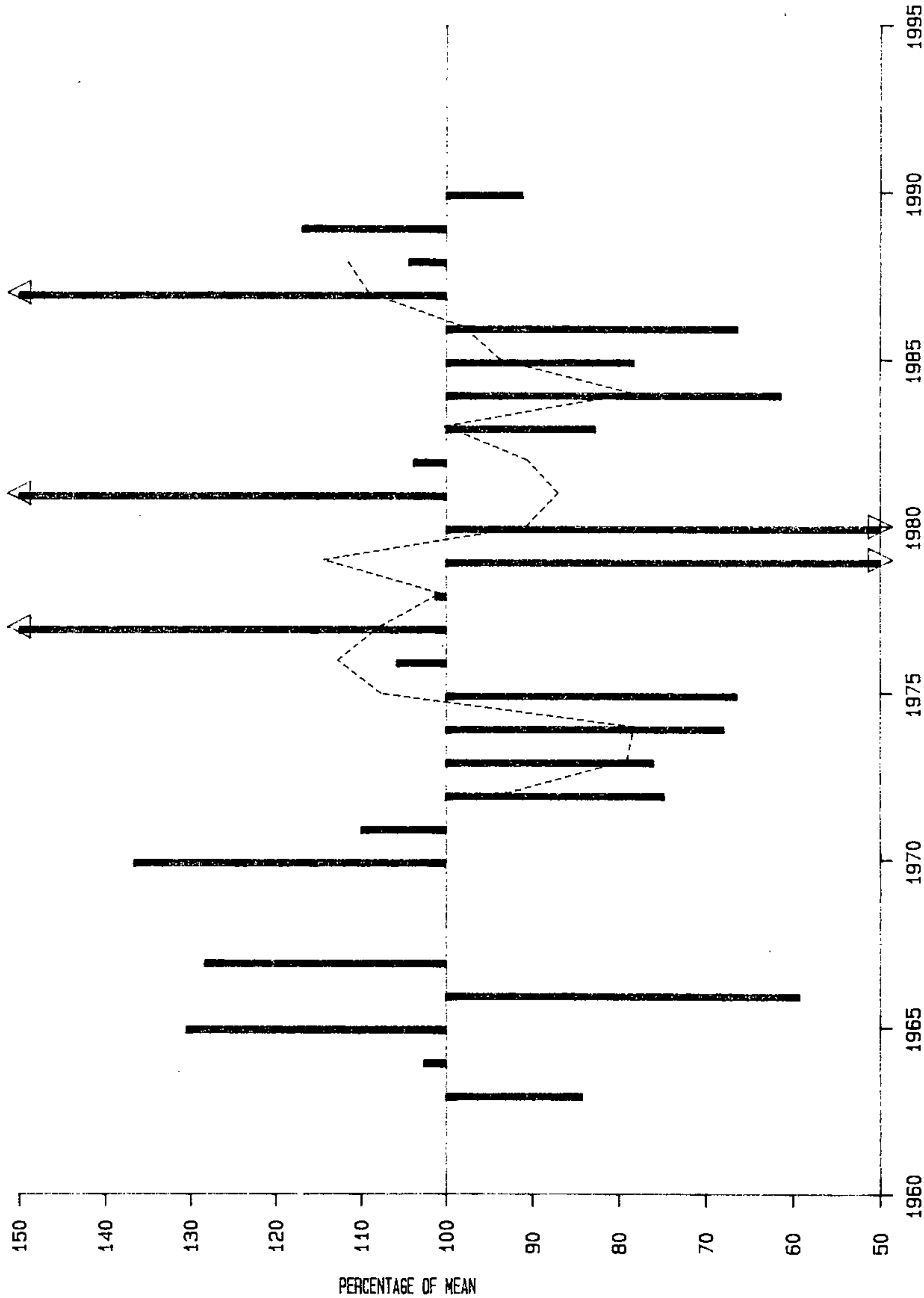
RIVER JUBBA AT LUGH GANANA

Figure 2.17

ANNUAL MAXIMUM FLOW (CUMECS)

______ ANNUAL MEAN ------ 5 YEAR RUNNING MEAN

LONG TERM MEAN = 819.1



RIVER SHEBELLI AT BELED WEYN

ANNUAL MAXIMUM FLOW (CUMECS)

Figure 2.18

——— ANNUAL MEAN ------ 5 YEAR RUNNING MEAN

LONG TERM MEAN = 259.3

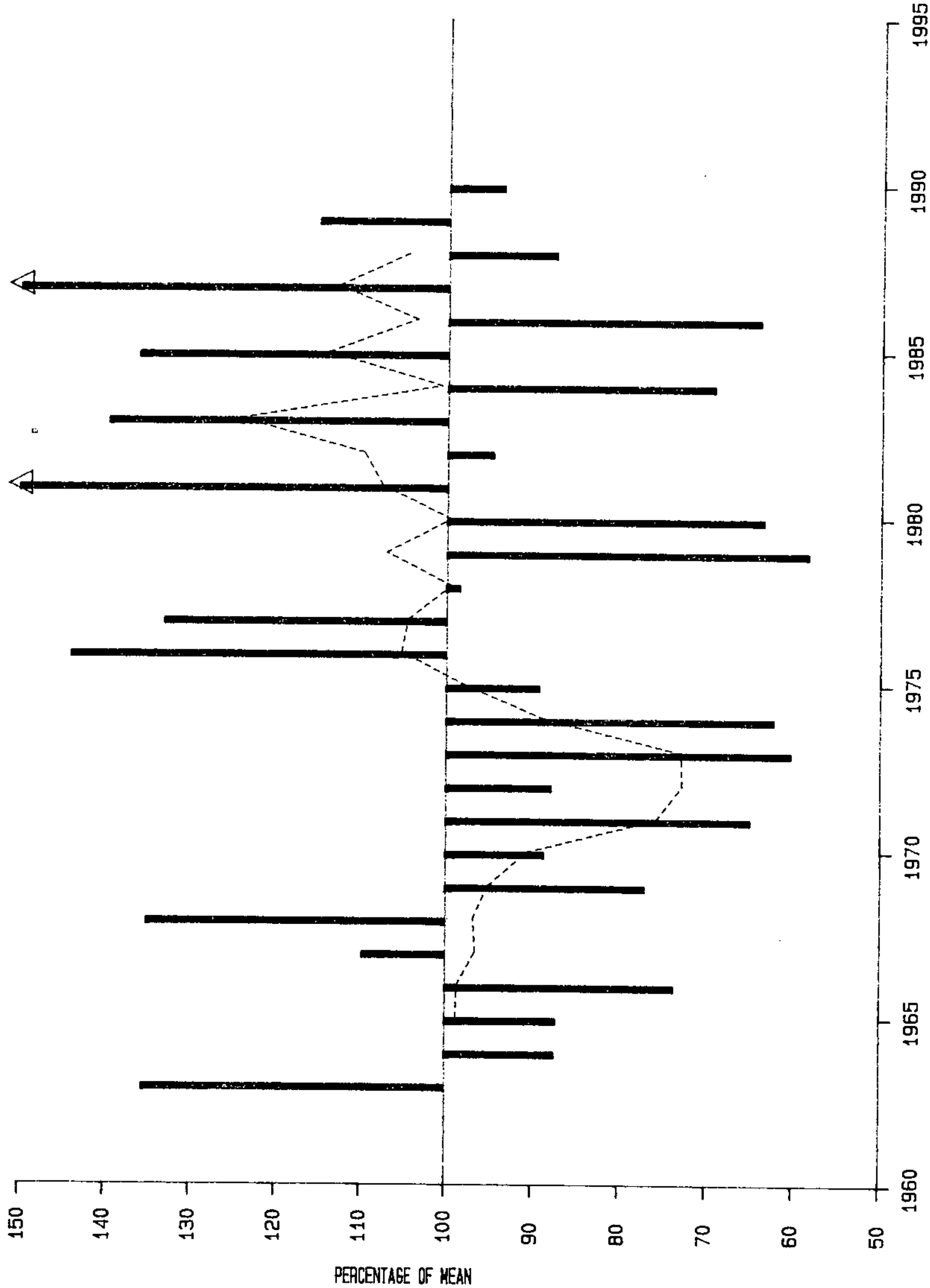
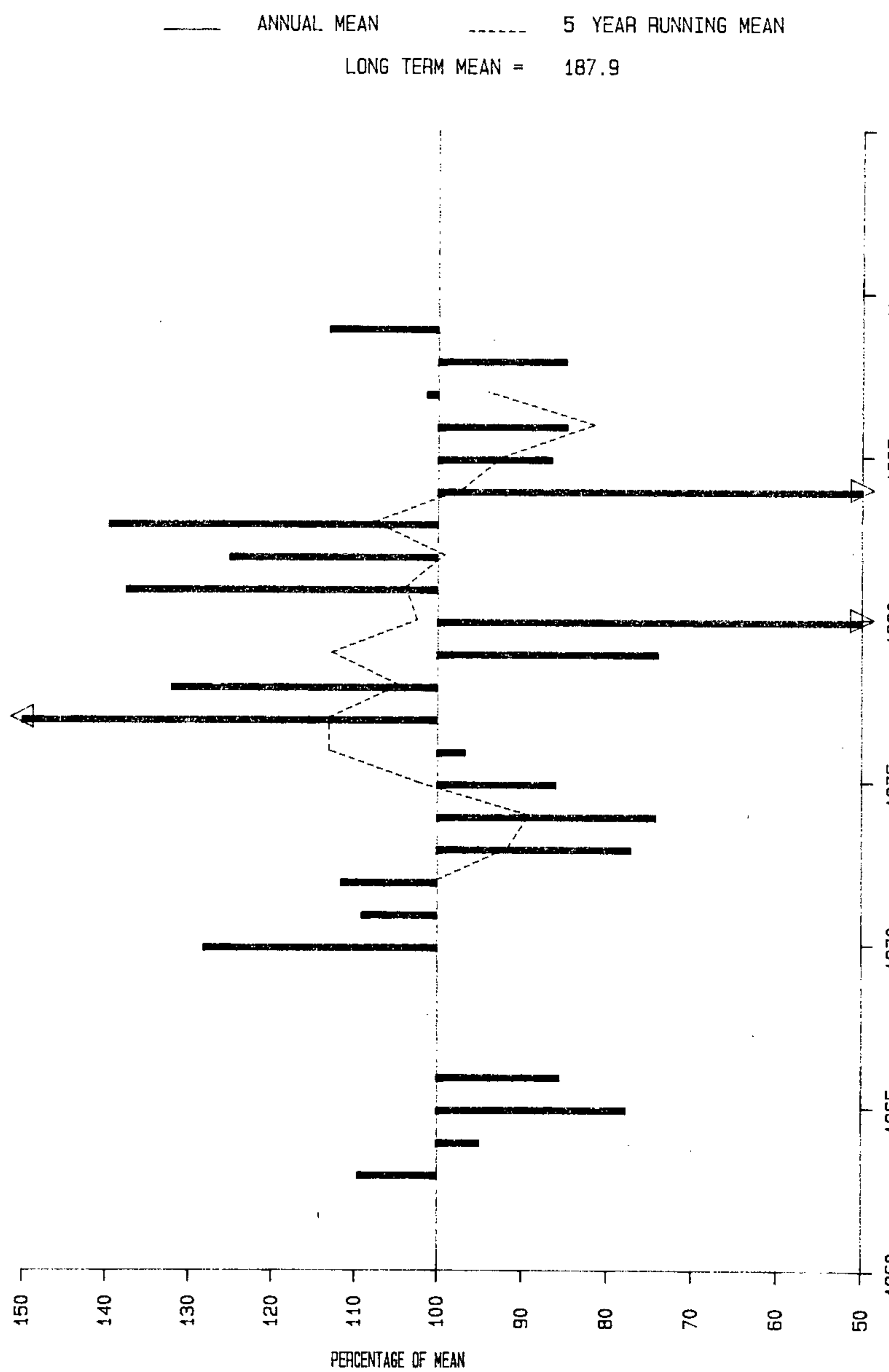


Figure 2.19

ANNUAL MEAN DISCHARGE (CUMECS)
LUGH GANANA, RIVER JUBBA



ANNUAL MEAN DISCHARGE (CUMECS) Figure 2.20

BELED WEYN, RIVER SHEBELLI

——— ANNUAL MEAN ------ 5 YEAR RUNNING MEAN

LONG TERM MEAN = 74.8

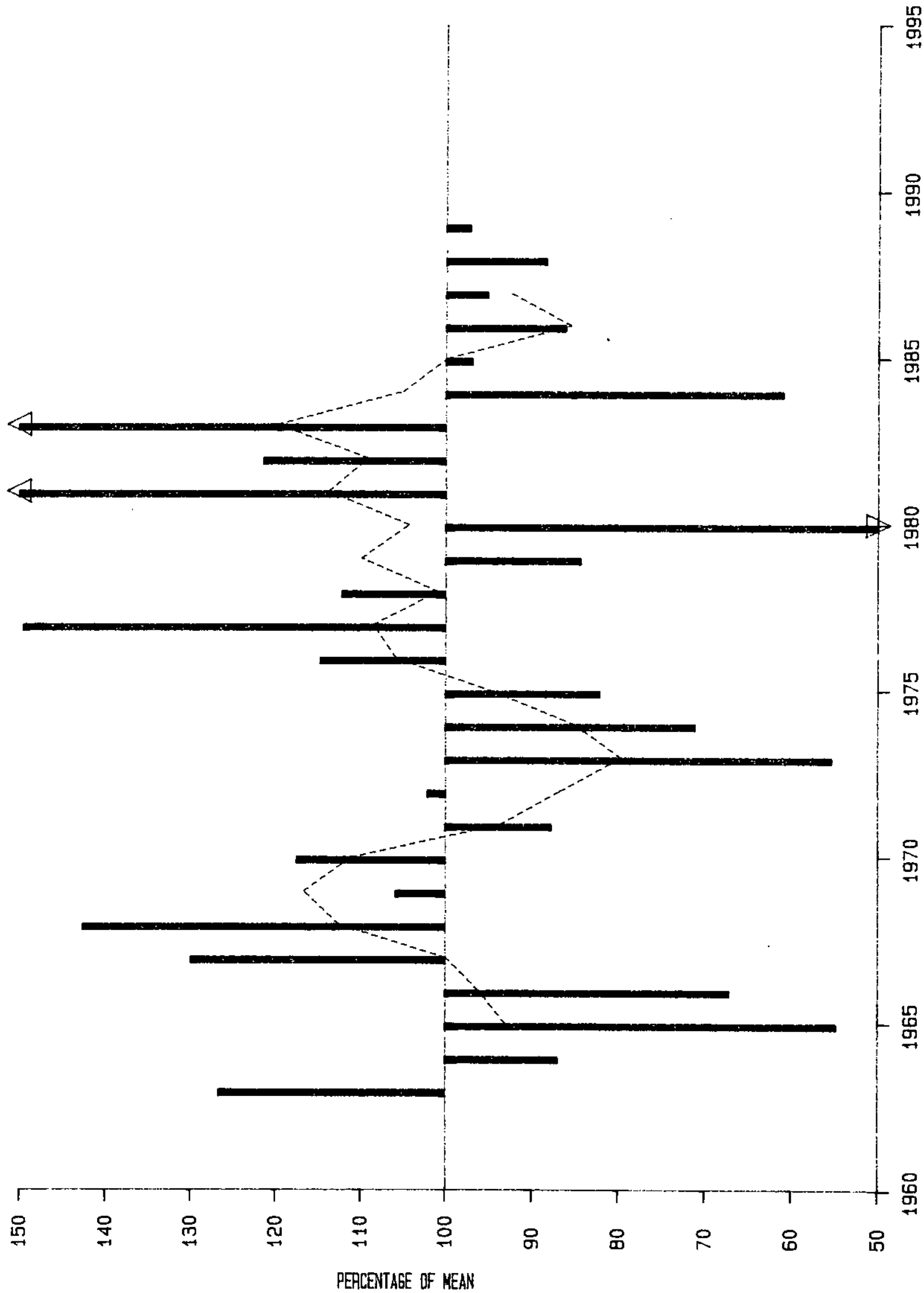


TABLE 2.3

Estimated Flood Peaks (Daily Mean Flow in cumecs) for Various Return Periods

Return Period (years)	Probability of exceedance (percentage)	Lugh Ganana (Jubba)	Beled Weyn (Shebelli)
1.01	99	230	110
1.05	95	350	140
1.25	80	530	190
2	50	760	250
5	20	1100	320
10	10	1300	380
20	5	1500	430
50	2	1700	490
100	1	1900	540
1000	0.1	2600	700

Note: All flow values expressed to 2 significant figures.

It would be useful to do such checks for rainfall, and indeed to relate rainfall to river flow, but unfortunately Ethiopian rainfall data is not available in Somalia. Rainfall in Somalia does not significantly influence the river flows, but it may be noted that trend analysis of the long sequence of rainfall data for Mogadishu (almost 80 years) does not indicate any significant trend or periodicity.

2.3.6 Reliable River Flows

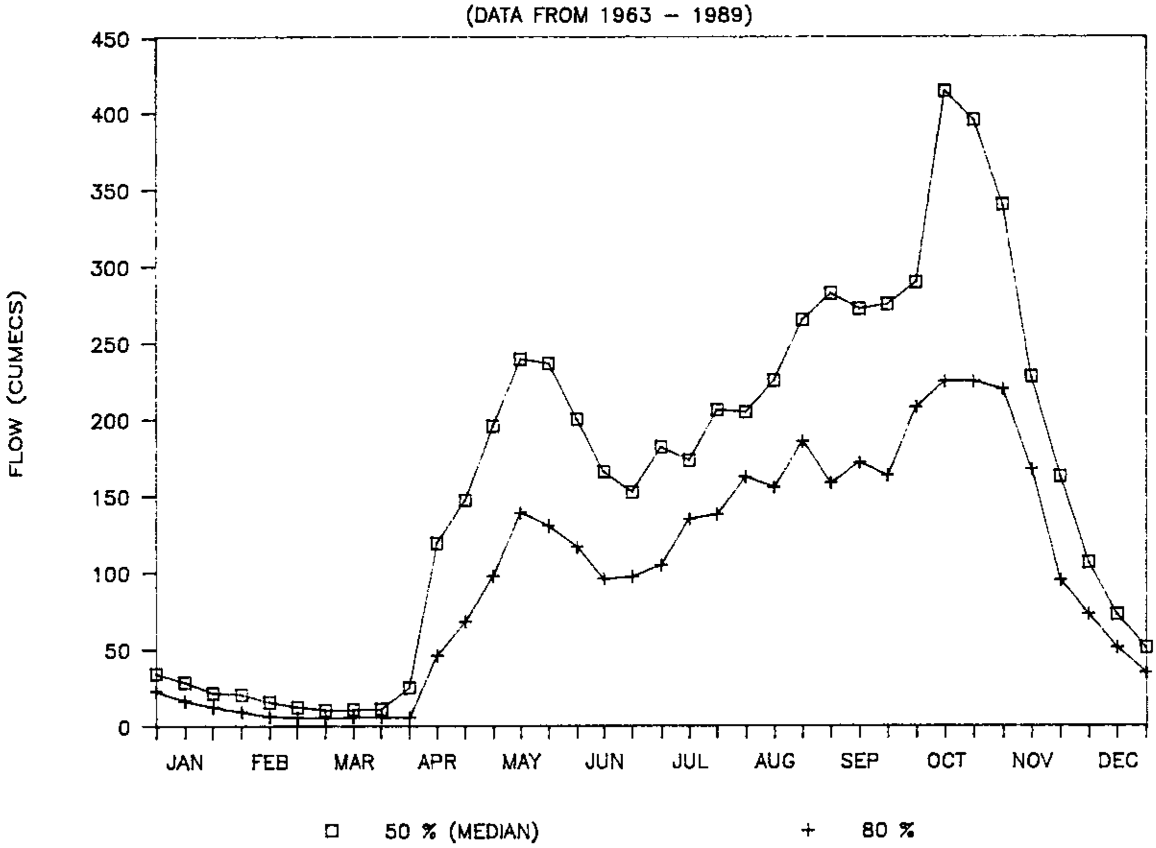
The degree of variability in river flows referred to above indicates that the "normal" conditions are not of themselves sufficient for consideration of the potential use of the river water for irrigation or other purposes. No amount of water (even the lowest ever recorded) can be absolutely guaranteed; what is required is a measure of how much water may be expected with a certain degree of reliability. When this is known a scheme may be designed to use that amount of water, and the economic analysis of the benefits of the scheme may be carried out, taking into account the fact that the full amount of water may only be expected to be available for a certain proportion of the time. For irrigation schemes it is usual practice to use a reliability of 80% - i.e. the amount of water available will equal or exceed the given value for 80% of the time. An alternative description of this concept is the "1-in-5 year low flow". For other uses such as the potable supply to a town the required reliability might be considerably higher.

Figures 2.21 and 2.22 compare the median (or 50% exceedance) and 80% exceedance curves of 10 day flows for upstream and downstream stations on each river. The Afgoi graph indicates that there is no reliable flow at all in the lower reaches of the Shebelli for over two months during the Jilaal season; in the lower part of the Jubba reliable flows at this time are very low, but do not quite fall to zero. With the exception of the times of lowest flow, the 80% exceedance values are generally between about 50 and 70 percent of the median; however, during the Der season the 80% exceedance flows at Afgoi are rather higher than this, and in fact are only a little lower than the median. This indicates that Der season flows are particularly reliable at Afgoi because the river is generally either at or close to its bank-full level. In the reaches downstream from Afgoi (and particularly between Audegle and Genale), most irrigation is carried out by gravity via canals close to the top of the river bank. These canals receive supply only when the river is close to bank-full, but because the river tends to stay at or close to that level for a considerable period this is a sufficiently reliable source of irrigation water.

Figure 2.21

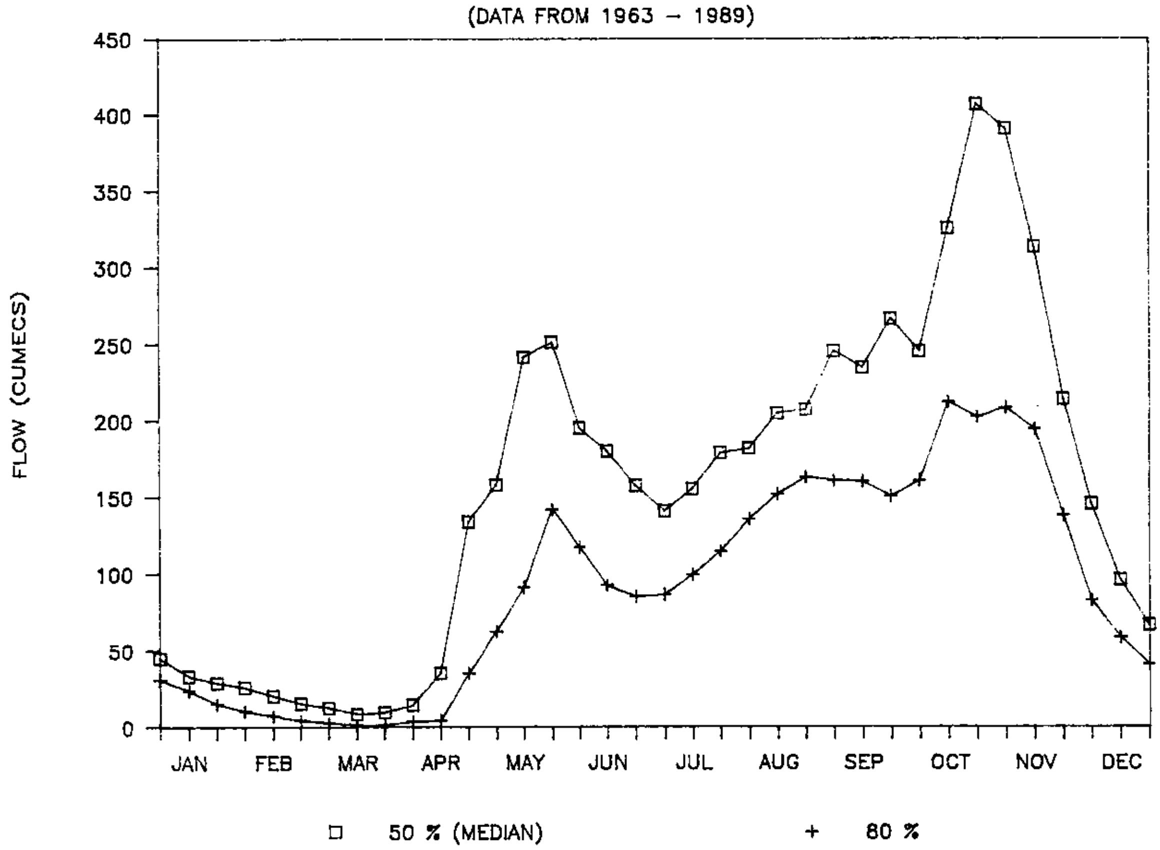
10 DAY EXCEEDANCE FLOWS – LUGH GANANA

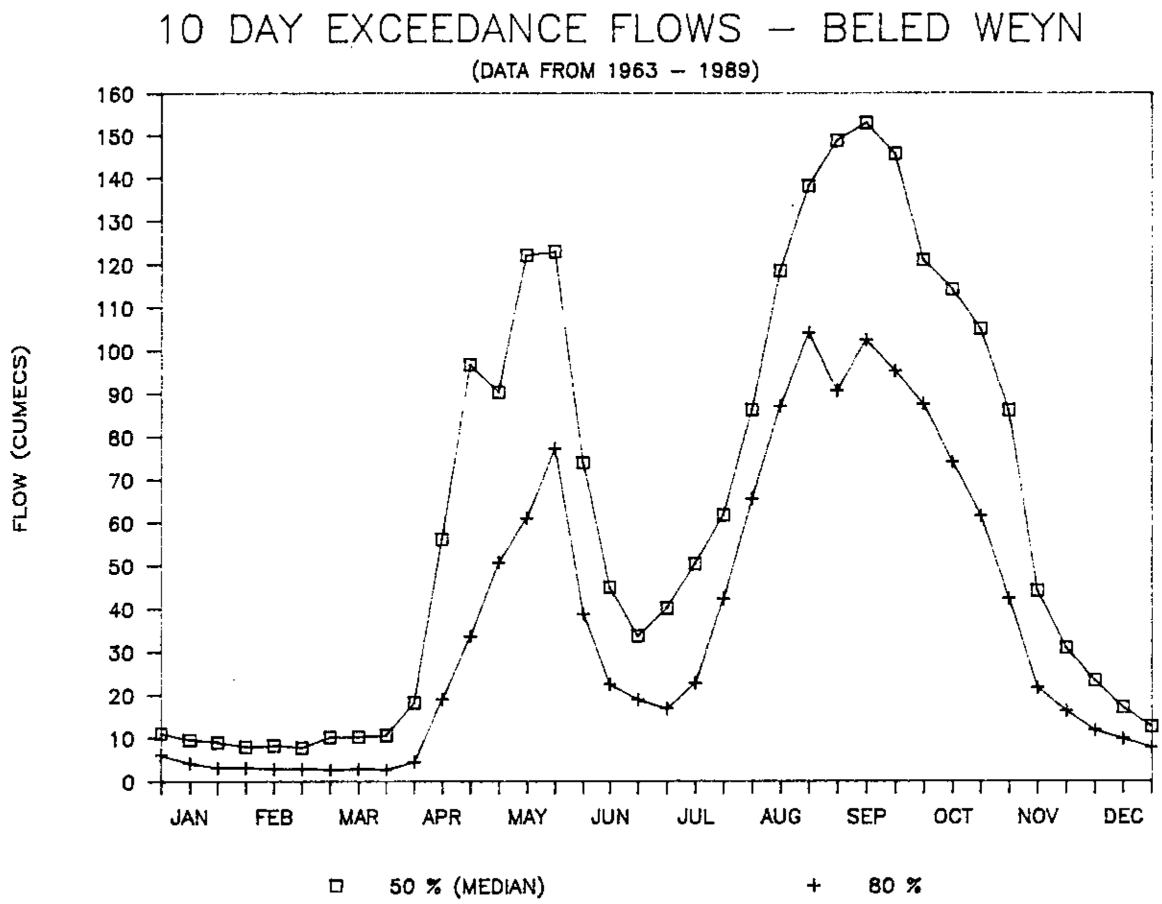
(DATA FROM 1963 – 1989)

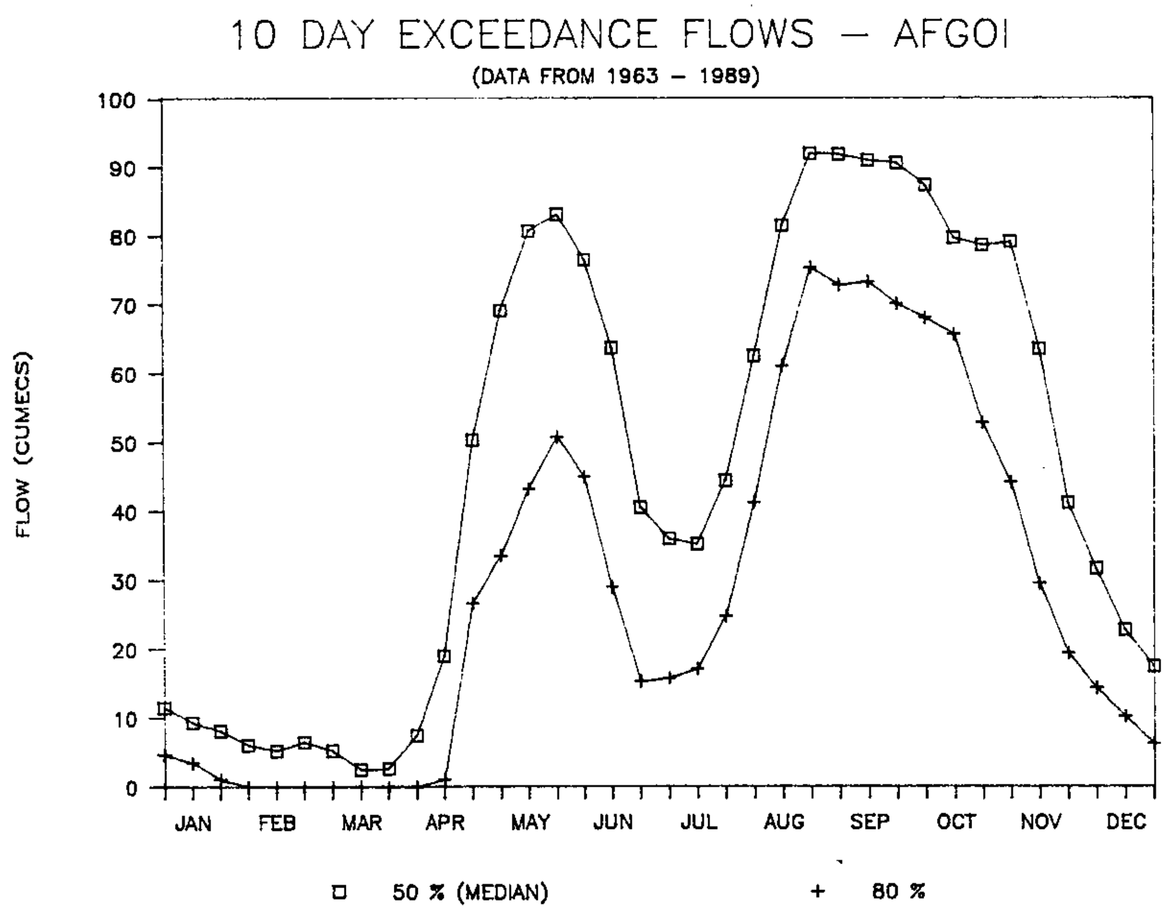


10 DAY EXCEEDANCE FLOWS – JAMAMME

(DATA FROM 1963 – 1989)




10 DAY EXCEEDANCE FLOWS – BELED WEYN
(DATA FROM 1963 – 1989)
FLOW (CUMECS)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
50 % (MEDIAN)
+ 80 %


10 DAY EXCEEDANCE FLOWS – AFGOI
(DATA FROM 1963 – 1989)
FLOW (CUMECS)
100
90
80
70
60
50
40
30
20
10
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
50 % (MEDIAN)
+ 80 %

CHAPTER 3

PROJECT ACTIVITIES AND GENERAL OPERATIONS

3.1 Introduction

The principle role of the Project, and of the resident Field Hydrologist in particular, was to manage the day-to-day activities of the Hydrology Section in the Ministry of Agriculture in Mogadishu. The Hydrology Section is part of the Department of Irrigation (Irrigation and Land Use prior to a division of the Department in 1990), and as such the Hydrologist reported to the Director of Irrigation. The Director provided helpful assistance throughout, but in general he did not involve himself in the detailed activities of the Section, preferring to leave such arrangements to the Hydrologist. On a number of occasions the Director commented on the advisability of field visits to certain areas, and from July 1989 he made it clear that no visits could be undertaken to the distant stations using the Project Land Rover because of fears for the vehicle's safety.

The Project was primarily one of Technical Assistance, and it was therefore considered important that the work fitted into the existing framework of the Ministry of Agriculture, rather than being a separate entity. This is of particular relevance at the end of the Project because the Ministry is already responsible for the office, power supply, staff salaries etc, and much of the Project work should be able to continue without the need for the Ministry to commit additional resources. It had been agreed that the Ministry would pay for all running expenses, but in the end this did not prove to be possible and the Overseas Development Administration (ODA) covered fuel and other vehicle running costs, together with some supplementary field allowances. With the severe curtailment of the fieldwork programme in the second half of Phase 3 the scale of these expenses has been substantially reduced, but some additional input will be required if the current work programme is to be able to continue in full.

At the start of Phase 3 the scope of the Section's work was somewhat restricted because the new equipment (including the computer) was not available for over three months due to delays in shipping and in customs formalities in Mogadishu; however, it was considered that the interests of the Hydrology Section would be best served by the earliest possible expatriate input, and this approach was justified by some of the fieldwork which was undertaken before the Gu flood in 1988. Without the staff gauge repairs carried out at that time the returns of data in 1988 would have been significantly less complete, and problems could have continued in 1989/90 because the virtually zero flow in the Shebelli in early 1988 did not recur in the two subsequent years.

3.2 Staffing

3.2.1 Expatriate Staff

A total of five expatriate staff were involved in the Project, three from Sir M. MacDonald and Partners Limited (MMP) and two from the Institute of Hydrology (IH).

Three of these staff members had only minor inputs to the Project. The approximate total staff inputs in man-months were as follows:

Project Member		Somalia	UK
Field Hydrologist	MMP	29.9	0.5
Programmer/hydrologist	IH	6.8	6.5
Senior Hydrologist	IH	0.6	-
Consultant Hydrologist	MMP	0.3	1.3
Project Coordinator	MMP	0.5	-
Head Office Backup	MMP	-	2.9
Total		38.1	11.2

The totals both in Somalia and in the UK were very close to those in the final revised agreement.

3.2.2 Local Staff

A driver was employed and paid for by the Project throughout. All other local staff were employees of the Ministry of Agriculture who were assigned to the Hydrology Section. There were generally two or three such people available for office and field work, but during the period of the Project some 8-10 staff were involved because of the relatively high turnover of staff. The majority were graduates from the Agriculture Faculty of the local University. The names of both local and expatriate staff have appeared in the Progress Reports.

3.2.3 Supervision

Supervision of the Project was carried out for ODA by the British Development Division in East Africa (BDDEA) during visits from Nairobi (usually at six-monthly intervals), and through the Aid Attache at the British Embassy in Mogadishu.

3.3 Field Work

3.3.1 General

One of the main reasons for the near-continuous expatriate presence in Phase 3 (compared to the intermittent visits arranged previously) was to allow a full programme of fieldwork to be undertaken - as indicated by the resident expatriate's job title of Field Hydrologist. It was envisaged that each station would be visited approximately once per month.

Many of the stations are situated a long distance from Mogadishu, and the road conditions are extremely variable. Beled Weyn, the most distant station on the river Shebelli, is about 6-8 hours' drive from Mogadishu, even though the distance is only about 350 km. All stations on the river Jubba are more remote than this and also take most of a day to reach. Field trips therefore required careful planning in order to combine work at a number of stations during one trip; inevitably, however, much of the time was spent in unproductive travelling time.

In order to visit all stations, three major trips were required - one for the middle and upper Shebelli (Jowhar to Beled Weyn), one for the upper Jubba (Bardheere and Lugh), and one for the lower Jubba (Jilib/Mareere to Jamamme). Stations in the lower Shebelli were either visited on the way to the Jubba, or more usually in separate day trips from Mogadishu. A full visit programme would therefore require three 3-4 day trips and one or two day trips. To undertake this within a month means being away from Mogadishu for about half of the working days, and preparation for field trips adds several more days. Such a programme was attempted during the first year, but in practice visits to stations were slightly less frequent than intended. If monthly visits had been maintained throughout the project there would have been an adverse effect on the amount of office work undertaken.

The fieldwork programme, and hence the balance of the work of the project, changed dramatically in July 1989 because of security developments in Somalia. Initially, this mainly affected the upper part of the Shebelli and most of the Jubba valley, but in 1990 problems spread closer to Mogadishu - and indeed the security situation in the capital itself became a serious cause for concern in mid-1990. For a time no fieldwork was carried out, but subsequently day trips were made to the lower and middle Shebelli. Throughout this time close contact was maintained with the British Embassy concerning the advisability of travel to the various regions.

The resident Hydrologist and the local staff felt able to undertake some distant field trips; however, the Director was not prepared to let the Land Rover be taken to the Jubba or to the upper Shebelli. He did suggest the possibility that trips could be made by bus or truck, but both expatriate and local staff felt personal safety to be at least as important as the safety of the vehicle and consequently this idea was not pursued. However, the Hydrologist did make two trips to the Jubba (in November 1989 and February 1990) with expatriates from other projects, and these trips enabled valuable data to be collected from Bardheere and from various stations in the lower Jubba. It had been hoped to make a return visit to Bardheere, but the security of the road deteriorated to such an extent that the expatriates working there are now only able to travel to and from Mogadishu by plane.

The Land Rover was not used at all in the last two weeks of the Project following a succession of thefts of 4-wheel-drive vehicles by armed attackers; in one such incident the driver of a Ministry of Agriculture Land Rover was murdered.

The severe curtailment of the fieldwork programme had an adverse effect on the aims of the project, and this is detailed in the following sections.

3.3.2 Station Maintenance

When there has been a break between foreign-funded projects there has generally been some deterioration in the state of the hydrometric network. Staff gauges may be lost or damaged during major floods, and other equipment such as bridge dippers may malfunction. Such problems can usually only be resolved by a team visiting from Mogadishu, and in general the resources and/or expertise within the Section have been inadequate for such trips to be undertaken. Deterioration in the network inevitably results in a reduction in the availability and quality of river level data. There was a gap of about two years between field visits during Stage 2 of the Project and the first ones made during Phase 3. The data returns during this period remained good, but gaps occurred at certain stations because of staff gauge or bridge dipper problems. An early priority of Phase 3 was therefore to correct these problems. Unfortunately, the unavailability of field allowances for local staff meant that not all matters could be attended to before the arrival of the 1988 Gu flood.

Some important work was carried out in the first year, but the subsequent curtailment of field visits meant that deterioration set in at some stations before the end of the project. It must regrettably be expected that the situation will not improve until conditions allow regular visits. The main items of maintenance work carried out were the replacement of staff gauges at Bulo Burti, Afgoi, Audegle and in the supply canal for the Jowhar reservoir. Similar work is now required at a number of stations; this has been referred to in Section 2.2 and is also noted in Appendix K.

3.3.3 Discharge Measurements and Rating Curves

Besides maintaining the stations, the most important part of the fieldwork programme was the measurement of discharge so that existing rating equations could be checked, and new ones derived if necessary. During Phase 3 a total of over sixty measurements were carried out (at a total of thirteen different sites), but the great majority of them were done during the year from July 1988 to July 1989. Thereafter, measurements were largely restricted to Afgoi on the river Shebelli. Table 3.1 contains a full list of these measurements. Most measurements were made by suspending the current meter from a bridge using the gauging derrick, but some low flow measurements were made by wading.

Results of discharge measurements were calculated both manually and by means of a computer spreadsheet. An example spreadsheet is contained in Appendix C. Results were entered to the database which facilitated comparison of the measured discharge to the existing rating curve, and also to other measurements. All rating equations were reviewed, and a number of changes were made. This work is described in detail in Appendix F, which also contains a full listing of the equations used throughout the period of data records.

3.3.4 Water Quality Measurements and Analysis

There has been relatively little work done previously regarding the quality of water in Somalia's rivers. In an attempt to rectify this shortcoming the proposal for Phase 3 included the introduction of sediment sampling and salinity measurements. Sediment sampling equipment was obtained, together with electrical conductivity (EC) meters for measuring salinity, and a wide range of laboratory equipment.

At the start of Phase 3 there were no laboratory facilities available, but the Director was confident that space for a laboratory would become available within the first year. He therefore requested that efforts be concentrated on other aspects of the Project, with water quality work to be started later

TABLE 3.1

Discharge Measurements Carried Out During Phase 3 of the Project

Date	Station	Gauge height (m)	Velocity (m/s)	Area (m)	Discharges Measured (m /s)	Discharges Equation (m /s)	% diff
05/07/88	Afgoi	2.06	0.54	35.3	19.1	18.0	+6
08/07/88	Afgoi	2.005	0.55	33.7	18.4	17.0	+8
12/07/88	Mahaddey	2.01	0.44	50.3	22.2	22.4	-1
21/07/88	Lugh	2.625	0.76	256.5	193.9	190.3	+2
28/07/88	Kamsuma	4.60	0.87	352.4	307.2	299.5	+3
30/07/88	Kamsuma	5.11	0.92	401.2	370.4	357.9	+3
14/08/88	Afgoi	3.58	0.66	83.3	55.4	49.8	+11
18/08/88	Afgoi	4.845	0.62	128.8	79.7	79.8	0
27/08/88	Mahaddey	5.085	0.87	155.8	136.2	147.1	-7
28/08/88	Beled Weyn	2.815	1.38	119.1	164.8	169.2	-3
31/08/88	Afgoi	5.01	0.61	129.7	79.6	83.8	-5
03/09/88	Lugh	2.90	0.72	351.4	254.0	245.7	+3
08/09/88	Kamsuma	4.05	0.78	309.8	241.9	240.5	+1
02/10/88[c]	Afgoi	4.84	0.67	123.2	82.7	79.6	+4
26/10/88	Lugh	4.60	1.08	674.0	730.4	729.7	0
02/11/88	Kamsuma	6.24	1.02	474.6	484.9	499.6	-3
09/11/88	Afgoi	4.965	0.67	127.6	84.9	82.7	+3
16/11/88	Beled Weyn	1.40	0.88	70.0	61.9	60.6	+2
17/11/88	Mahaddey	3.99	0.66	116.7	76.9	89.7	-14
30/11/88	Bardheere	1.255	0.52	310.9	161.6	119.8	+35
01/12/88	Lugh	2.03	0.31	270.3	83.3	93.2	-11
11/12/88	Kamsuma	2.31	0.46	173.6	79.3	86.3	-8
18/12/88	Beled Weyn	0.65	0.46	44.6	20.5	19.8	+4
18/12/88	Bulo Burti	1.48	0.72	27.7	19.9	15.5	+28
19/12/88	Mahaddey	2.03	0.37	54.9	20.3	22.9	-11
05/01/89[c]	Lugh	1.49	-	205.5	Equipment faulty		
11/01/89	Bardheere[b]	0.555	0.15	235.3	35.3	41.5	-15
12/01/89	Lugh	1.42	0.15	170.0	25.5	27.8	-8
26/ 1/89	Afgoi	1.83	0.46	27.2	12.5	13.8	-9
8/ 2/89[c]	Beled Weyn	0.47	0.36	34.2	12.3	13.1	-6
8/ 2/89[c]	Bulo Burti	1.205	0.65	20.6	13.4	8.6	+55
9/ 2/89[c]	Mahaddey	1.63	0.33	37.9	12.5	14.8	-16
1/ 3/89	Kamsuma	0.65	0.03	71.5	2.0	2.0	0
8/ 3/89	Bardheere	0.22	0.26	37.6	9.7	17.9	-45

TABLE 3.1. (continued)

Discharge Measurements Carried Out During Phase 3 of the Project

Date	Station	Gauge height (m)	Velocity (m/s)	Area (m)	Discharges Measured (m /s)	Discharges Equation	% diff
9/ 3/89	Lugh	1.11	0.25	28.5	7.2	8.7	-17
15/ 3/89	K. Waarey	0.50	0.31	4.1	1.27	-	
22/ 3/89	Mogambo	6.59	0.32	6.1	1.94	-	
26/ 3/89	Audegle	2.53	0.40	23.8	9.5	11.7	-19
3/ 4/89	Bulo Burti	2.86	0.90	78.7	70.8	66.1	+7
1/ 5/89	Lugh	4.72	1.04	753.7	782.1	772.8	+1
2/ 5/89	Lugh	4.995	1.10	789.4	871.3	875.8	-1
9/ 5/89	Afgoi	5.31	0.59	150.2	89.1	91.3	-2
11/ 5/89	Kamsuma	6.30	1.03	498.4	513.1	507.5	+1
11/ 5/89	Mogambo canal	-	0.48	76.2	36.6	-	
11/ 5/89	Jamamme	6.765	1.00	418.1	418.7	467.9	-11
28/ 5/89	Afgoi	5.475	0.62	150.3	93.7	95.5	-2
30/ 5/89	Mahaddey	5.345	0.85	160.6	137.0	162.9	-16
30/ 5/89	Bulo Burti	4.21	1.25	127.2	158.5	135.2	+17
31/ 5/89	Beled Weyn	2.12	1.24	99.2	123.4	118.9	+4
1/ 6/89	Sabuun canal	1.03	0.62	22.9	14.3	25.3	-43
7/ 6/89	Kamsuma	3.21	0.71	247.2	176.4	159.5	+11
7/ 6/89	Kamsuma	3.19	0.61	228.1	152.5	157.7	-3
18/ 6/89[c]	Afgoi	3.025	0.55	64.1	35.5	37.6	-6
7/ 7/89[c]	Lugh	2.15		Equipment faulty			
26/ 9/89	Mahaddey	3.915	0.65	113.9	73.8	86.3	-14
25/11/89	Afgoi	2.77	0.54	56.3	30.7	32.2	-5
30/12/89	Afgoi	3.715	0.52	88.5	46.4	52.9	-12
6/ 1/90	Afgoi	3.885	0.55	94.8	51.8	56.8	-9
10/ 2/90	Afgoi	2.025	0.51	35.8	17.3	17.4	0
26/05/90	Afgoi	5.385	0.57	146.3	83.1	93.2	-11
29/10/90	Afgoi	4.29	0.61	109.9	66.6	66.3	0

Notes: [a]Mean gauge height during measurement period.

[b]It is believed that there is an error in the distance measuring equipment at the Bardheere cableway which results in a significant over-estimation of area and hence discharge.

[c] Discharge measurement carried out by counterpart staff without supervision.

when facilities were available. When it became apparent that this would not materialise during the life of the Project the Director suggested that the Research Section of the Ministry of Agriculture be approached with a view to possible collaboration. The Research Section has good laboratory facilities, but unfortunately these are at Afgoi and it would be impracticable for the Mogadishu staff to carry out analysis there. In order to start some water quality work it was therefore decided that basic analysis of water samples would have to be done in the office.

The office is quite unsuitable for use as a laboratory because of the limited space and the absence of a water supply or cleaning facilities. However, it is possible to weigh, filter and dry samples to determine sediment concentration; electrical conductivity (salinity) was also measured from these samples. More detailed work such as particle size distribution must await proper facilities. However, some additional samples were taken each week and the Director made arrangements with a research scientist, Dr. Bashir, for these to be analysed. The results which he provided to the Hydrology Section are contained in Appendix E.

It was decided that a weekly programme of field visits to Afgoi for water sampling would be the most effective way to get information about the pattern of sediment concentration through the seasons. This started in November 1989 and therefore a complete year of data is now available. It had been hoped that this would be supplemented by occasional samples from the Jubba, or from other stations on the Shebelli, but unfortunately this did not prove to be possible. Visits to Afgoi were normally made on Saturdays, with the analysis completed by the end of that week. However, at times the unavailability of the mains power supply, or the Ministry generator, created a backlog of several weeks. Ideally samples would be dried in the oven for 24 hours, but this was impracticable and 4-5 hours had to suffice as this was generally the maximum time possible within one working day.

Calculations of sediment concentration were carried out by hand and also on the computer by using a spreadsheet. An example results sheet is shown in Table 3.2. It was found that even with oven drying and the use of a desiccator the weights of dry filter papers were affected by changes in humidity. With each weekly set of four samples a control (unused) filter paper was dried and weighed both before and after the analysis, and its change of weight was used to give some idea of potential error in the results.

The sediment concentrations and salinity readings are given in Table 3.3. Figure 3.1 shows the sediment concentration plotted against river flow; there is a certain amount of scatter, but there is clearly a reasonable correlation between the two variables. The cross correlation coefficient is about 0.70. Figure 3.2 shows a similar graph for river flow and salinity; there is no apparent correlation between them, and this is confirmed by the cross correlation coefficient of -0.10.

Figures 3.3 and 3.4 show time series graphs for sediment concentration and salinity respectively, with the flow hydrograph plotted on each graph for comparison. The isolated values of sediment and salinity have been joined by straight lines to assist in following the seasonal pattern. The correlation between flow and sediment is confirmed, though certain variations may be noted.

TABLE 3.2

Analysis of Total Suspended Sediment Load
(Example Calculation Table)

Site: Date: Level: Sample:	Afgoi 15/09/90 4.31 1	Afgoi 15/09/90 4.31 2	Afgoi 15/09/90 4.31 3	Afgoi 15/09/90 4.31 4	Combined Sample
	Weight (g)	Weight (g)	Weight (g)	Weight (g)	Weight (g)
Sample + bottle Dry bottle	377.64 52.33	409.01 51.94	419.65 53.14	413.13 52.52	
Total Sample	325.31	357.07	366.51	360.61	1409.50
Clean filter paper Filter + sediment	1.2058 2.4951	1.1851 2.5882	1.2082 2.6436	1.1821 2.6063	
Total Sediment	1.2893	1.4031	1.4354	1.4242	5.5520
Concentration (ppm or mg/l) (g/litre)	 3963 4.0	 3929 3.9	 3916 3.9	 3949 3.9	 3939 3.9
Estimated accuracy from change of weight in control (unused) filter paper:					
	0.1%	0.1%	0.1%	0.1%	0.1%
Elec conductivity Temp comp in Temp comp out	 380 420	 370 410	 370 410	 360 400	 370 410
Control Filter Paper	(g)				
At start	1.2062				
At finish	1.2050				
Change	-0.0012				

Figure 3.1

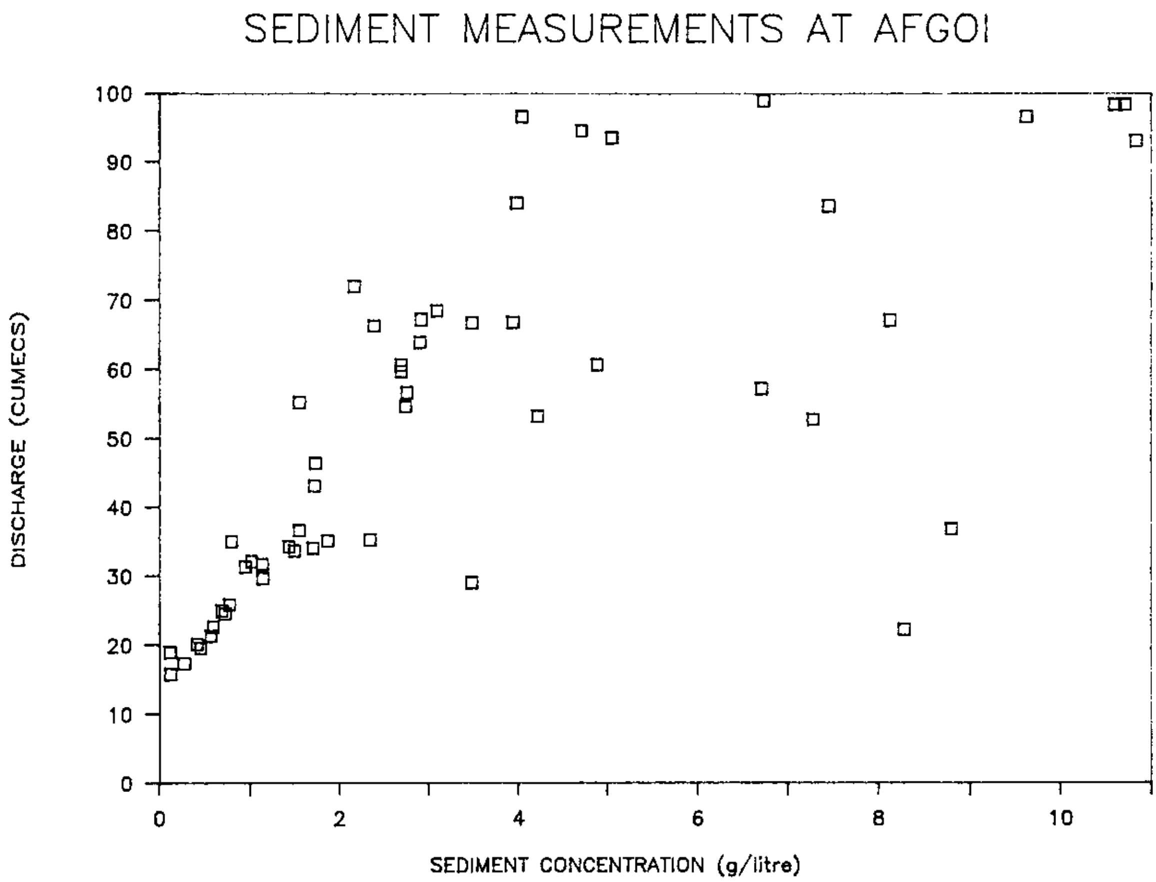
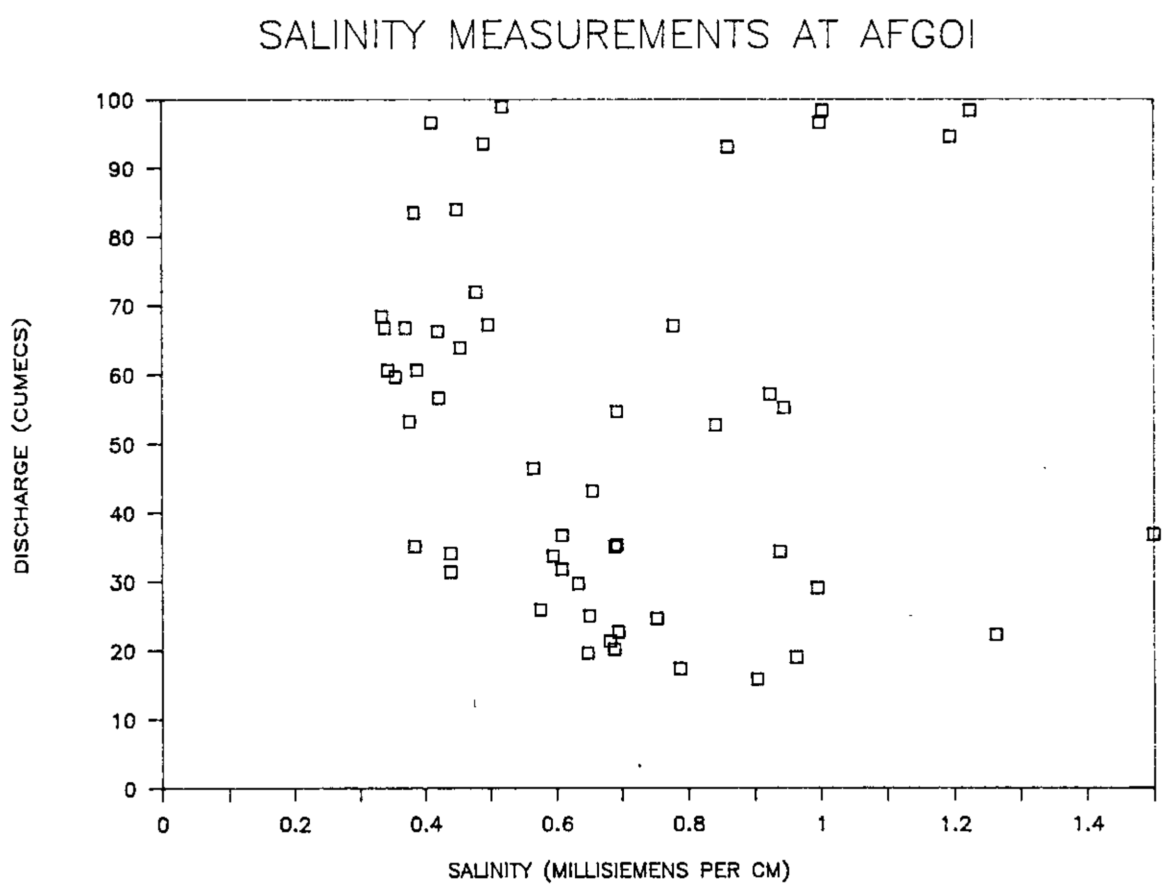
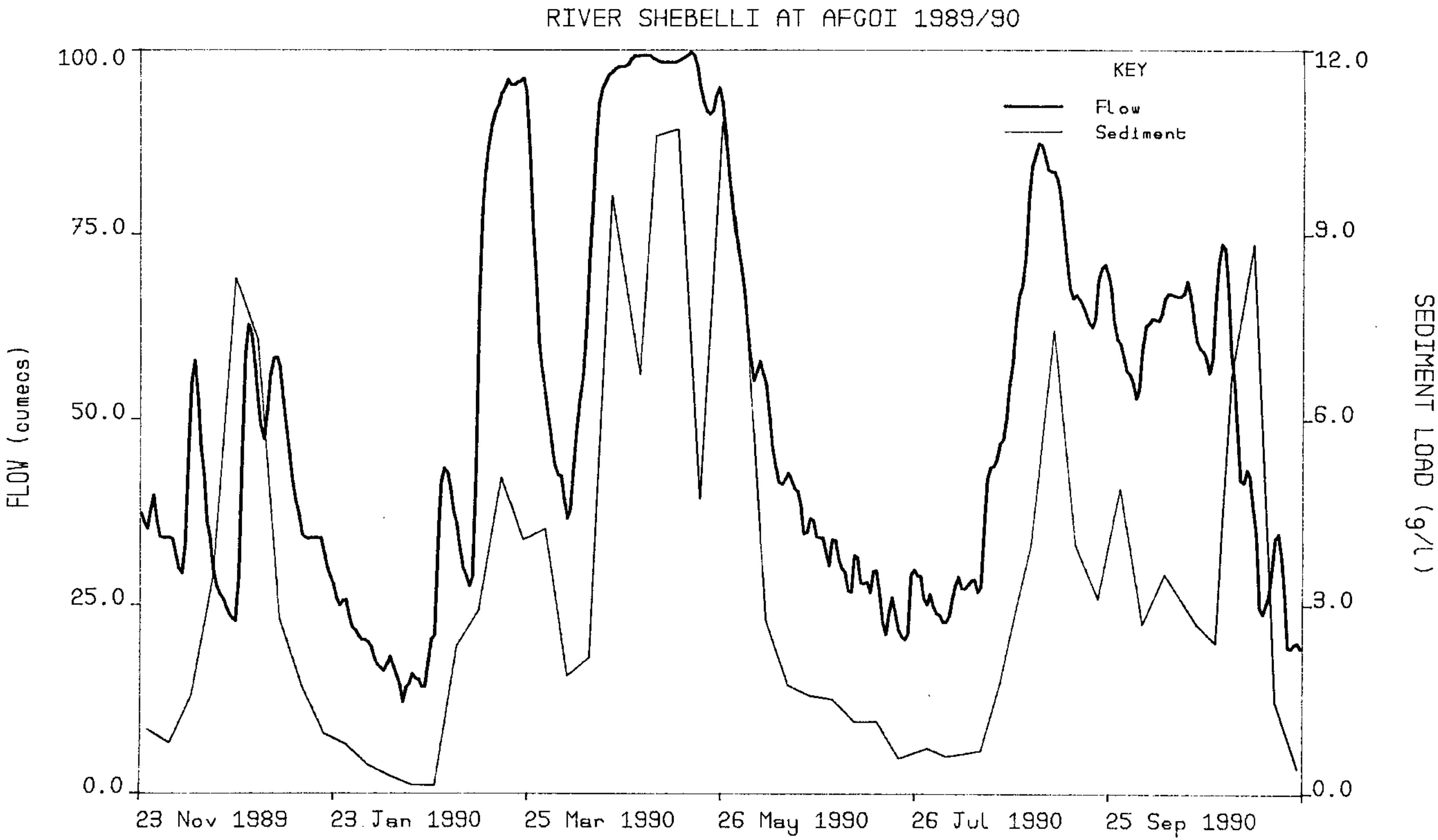


Figure 3.2





Department of Hydrology, Ministry of Agriculture

Figure 3.3

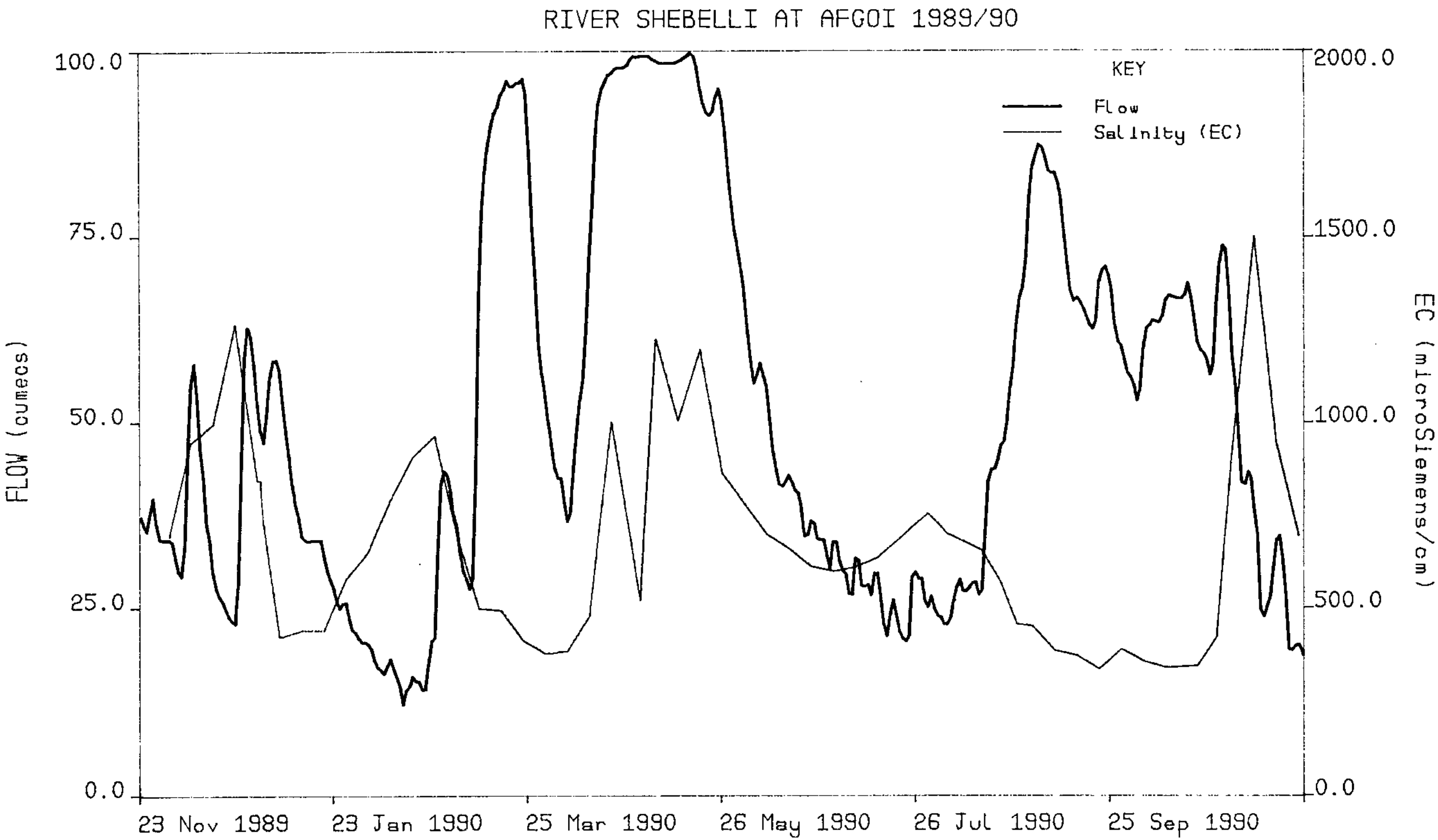


Figure 3.4

Department of Hydrology, Ministry of Agriculture

TABLE 3.3

Results of Sediment Sample Analysis

(Samples from River Shebelli at Afgoi)

Date	River Level (m)	Rated Discharge (cumecs)	Sediment Concentration (g/litre)	Electrical Conductivity (microS/cm)
25/11/89	2.77	32	1.0	-
02/12/89	2.91	35	0.8	690
09/12/89	3.82	55	1.6	945
16/12/89	2.62	29	3.5	690
23/12/89	2.28	22	8.3	1263
30/12/89	3.71	53	7.3	841
06/01/90	3.88	57	2.8	421
13/01/90	2.86	34	1.7	439
20/01/90	2.73	31	0.9	439
27/01/90	2.46	26	0.8	576
03/02/90	2.14	20	0.4	648
10/02/90	2.02	17	0.3	788
17/02/90	1.94	16	0.1	904
24/02/90	2.11	19	0.1	963
03/03/90	2.92	35	2.3	693
10/03/90	4.33	67	2.9	496
17/03/90	5.40	94	5.1	490
24/03/90	5.52	97	4.0	410
31/03/90	3.73	53	4.2	376
07/04/90	2.91	35	1.9	384
14/04/90	4.53	72	2.2	478
21/04/90	5.52	97	9.6	1000
30/04/90	5.61	99	6.7	518
05/05/90	5.59	98	10.6	1225
12/05/90	5.59	98	10.7	1003
19/05/90	5.44	95	4.7	1195
26/05/90	5.38	93	10.8	860
02/06/90	4.32	67	8.1	778
09/06/90	3.79	55	2.7	693
16/06/90	3.28	43	1.7	655
23/06/90	2.98	37	1.5	608
30/06/90	2.84	34	1.5	595
07/07/90	2.75	32	1.1	608
14/07/90	2.65	30	1.1	633
21/07/90	2.23	21	0.6	683

TABLE 3.3 (continued)
Results of Sediment Sample Analysis
(Samples from River Shebelli at Afgoi)

Date	River Level (m)	Rated Discharge (cumecs)	Sediment Concentration (g/litre)	Electrical Conductivity (microS/cm)
30/07/90	2.40	25	0.7	753
05/08/90	2.30	23	0.6	695
16/08/90	2.42	25	0.7	650
22/08/90	3.43	46	1.7	565
27/08/90	4.19	64	2.9	454
01/09/90	5.02	84	4.0	448
08/09/90	5.00	84	7.4	383
15/09/90	4.31	67	3.9	370
22/09/90	4.38	68	3.1	334
29/09/90	4.03	60	4.9	388
06/10/90	4.01	60	2.7	355
13/10/90	4.31	67	3.5	338
23/10/90	4.05	61	2.7	341
29/10/90	4.29	66	2.4	420
03/11/90	3.90	57	6.7	924
10/11/90	2.99	37	8.9	1500
17/11/90	2.87	34	1.4	938
24/11/90	2.17	20	0.4	689

The sediment concentration was exceptionally low for a period in February when the Shebelli water from Ethiopia was being supplemented by releases from the Jowhar reservoir, which was virtually clean because its sediment had been deposited in the reservoir. The highest values were recorded during the Gu season, which accords with the general understanding that the Gu floods carry a higher sediment load than those in the Der. However, this observation should be viewed with some caution because the Der flood in 1990 was rather small and the river at Afgoi did not reach a sustained bank-full level as it did in the Gu; had it done so the sediment load would probably have been closer to that measured in the Gu.

The time series of salinity (EC) data shows a quite different pattern. There are some fairly high values in the Gu flood, but few in the Der; this is similar to observations in the Jubba (see Appendix E). At very low flows the salinity tends to increase. These conflicting trends result in the total absence of correlation between flow and salinity referred to above. In terms of the suitability of the water for irrigation, few of the salinity readings would be considered to be particularly excessive.

3.4 Office Work

3.4.1 General

The main office work was the checking of data and the maintenance of the computer database. However, whenever possible manual procedures were also gone through, both as a back-up and check of the computer methods and because it was felt that this was most helpful in the understanding of basic hydrological principles. Without such an understanding the staff of the Section are unlikely to appreciate the importance of the regular collection of hydrological data.

Office work was often severely restricted by the absence of electricity. Generally the Ministry generator was available for most of the morning when the city supply failed, but at times the lack of fuel prevented its operation. This was particularly so in the latter stages of the Project when the fuel shortage coincided with the main supply to the Irrigation Department being cut for several months, apparently because the Ministry had been unable to pay its electricity bill. Fortunately these problems appeared to have been resolved before the end of the Project.

3.4.2 Data Processing, Checking and Analysis

This formed the major part of the office work carried out by the Resident Hydrologist, assisted by the Programmer/hydrologist during his work on modelling. Some data was normally received daily by radio (especially from the key stations of Lugh and Beled Weyn); this was converted to flow by using stage-discharge tables and the information was then passed to the Director and to the Minister of Agriculture, together with appropriate comments and/or flood warnings. This data and other incoming data was also entered to the computer database where it was subjected to initial checks using the graphics facilities. Any major mis-typing of data would be identified and corrected. Where data was available for two or more stations on the same river they would be plotted together and any suspicious values would be checked with the observer at the next opportunity.

The local staff very quickly picked up the techniques needed to operate the database (it can fairly be described as "user-friendly"), but they found the data checking work much more difficult. After extensive repetition and demonstration of general techniques they were generally able to identify gross errors in the data such as an incorrect number of metres, but a follow-up check was always required. Despite strenuous efforts the local staff have never really acquired sufficient "hydrological feeling", and therefore have not fully appreciated the need for a methodical and rigorous approach to hydrological data processing.

The checking of incoming data formed a regular part of the work of the Section, but a more major job was the checking of the historic data entered to the database during the first two parts of the Project. The work during Phase 1 had included the essential job of checking and allowing for changes in gauge zeroes and overlaps between gauge plates, so that all data entered to the computer was referenced to the same datum for each station. A number of periods of data error or fabrication had also been identified, but there had been insufficient time to check for typing errors in the entry of values to the computer. During Phase 3 a thorough check was therefore carried out, taking advantage of the improved and flexible on-screen graphics of the HYDATA package. This check was carried out on a step-by-step basis as follows:

a) Plot data for an individual station to check for sudden changes such as errors in the number of metres; these were checked against the original records and the computer record changed as necessary. Some further periods of obvious data fabrication were also identified.

b) Comparison plots of data for adjacent stations; this identified some periods of gross error (data entered for the wrong month or the wrong station, bridge dip data entered incorrectly as staff gauge data, periods of 1 m errors etc etc). Values were corrected or deleted as necessary.

c) A detailed study of correlation and lag times between data for adjacent stations. This was done as part of the modelling work and was reported in the Fourth Progress Report, Appendix C. During this work some further errors were identified; many were more minor errors which were not easily identified by the earlier checks, but this procedure also acted as a further general check on the data. Table 10 of that Appendix listed the most common causes of data errors which were found.

All periods of obviously erroneous data were deleted and infilled where possible using the computer models. Because of the rarity of lateral inflow to the rivers within Somalia the hydrographs at different stations on the same river are usually similar; a substantial difference almost certainly indicates an error in the data. When data is available for three or more stations it is usually easy to identify the faulty record, but where only two stations have data it is more difficult and at times doubtful values had to be retained.

3.4.3 Modelling and Forecasting

During Phase 3 the existing model of the river Shebelli was further developed and a similar model produced for the river Jubba. This work was the responsibility of the Programmer/hydrologist and is written up in detail elsewhere. The Progress Reports have included appendices dealing with various aspects of the model development (the Fourth Progress Report containing an operation manual for the infilling part of the models), and the Forecasting models are covered in a separate volume presented at the end of the Project. The models forecast river levels and flows from information recorded at other stations on the river; the use of information about rainfall to improve the forecasts is considered later.

The models were designed to be "user-friendly" so that they can be easily used by the local staff and by others who are not specialists in hydrology or computer applications. The operation proceeds via a network of menus which are very similar in principle to those in the HYDATA database package with which the staff are already familiar. Internally they are also fully compatible with HYDATA since they use the same data files and can produce output for direct transfer to the database or to files in a format suitable for later reading by HYDATA.

The models have two primary purposes - the checking of data and infilling of missing values, and the forecasting of flows and levels at downstream stations from information received from upstream stations. The latter is often referred to as "real-time" forecasting because it is used to make forecasts for the immediate future rather than for a longer period simulation. Because of the amount of computer memory required, and for ease of operation, the models are split into two parts in line with the primary purposes of infilling and forecasting.

Infilling Model

The Infilling model was invaluable in the process of checking and validating the historic data prior to the publication of the Hydrometric Data Book - see the Fourth Progress Report, Appendix C. It continues to be useful for checking incoming data because up to five stations can be plotted on the same graph and it is generally easy to identify erroneous values. At some stations there have been considerable periods of missing data in 1990, and data for recent months has not been received from all stations; the model has been used to produce estimated values which appear in the tables and graphs in the Data Book Supplement (Appendix D of this report). If observed values become available later then they will automatically supersede the estimates - though with the possibility that some might subsequently be rejected when the model is used to validate them.

Forecasting Model

A provisional version of the Forecasting model was installed on the computer in March 1990, and the final version in October. It has already been of use in providing warnings of approaching floods to people in the lower reaches of the two rivers. The lead-time of the forecast is about one week for the most downstream stations in the network if data is available from the furthest upstream stations (Lugh Ganana and Beled Weyn); however, the potential lead-time for forecasts for the lower reaches of the Shebelli is much greater and could be achieved in the future if adequate data is available from (for example) Sablaale to extend the model. The model allows the user to adjust the forecasts in line with current observed levels at the downstream stations, and the forecasts are presented both graphically and numerically. The model includes a sub-model of the Jowhar Offstream Storage Reservoir, and also allows lateral inflow or abstractions to be taken into account. The model is described in detail in a separate report which also acts as an operating manual.

Forecasting River Flows from Rainfall

For the downstream stations it is usually possible to get reasonable warning of impending floods from information recorded further upstream. However, to increase the warning or lead-time of the forecast, and to provide any warning for the most upstream stations, it is necessary to look back to rainfall and to try to model the relationship between rainfall and river flow.

It has already been noted that rainfall in Somalia makes little contribution to the river flows because of the generally low rainfall and the lack of tributaries or major drainage channels. When rainfall in Somalia does contribute significantly to river flows it is usually in the upper reaches (particularly the Jubba), and the resulting flood peaks generally arrive suddenly and are short-lived. Forecasting such floods is therefore difficult, though rainfall reports from such places as Bardheere and Lugh Ganana have at times helped to alert the authorities to likely flooding problems.

The major potential use of rainfall-runoff forecasting for Somalia would be to model the relationship between rainfall over the upper catchments and river flows at or near to the entry to Somalia. Most of the upper catchment areas lie within Ethiopia and it would be impracticable to get rainfall data from conventional gauges because of the large area involved and the problems of transmitting data across the international boundary. However, there is a potential alternative - the estimation of rainfall from satellite imagery.

Satellite Rainfall Estimates

In association with the Food Early Warning System (FEWS) Project, a dish, computers and other equipment were installed in the Ministry of Agriculture in January 1990. This equipment allows the receipt of data on cloud cover and temperatures over a very large area, and from cloud temperatures some estimate of rainfall can be made. The main FEWS Project is financed by the European Community (EEC), but the satellite component is being supported by ODA. The system has wide potential benefits for the FEWS Project itself, but a major aim was to use the rainfall estimates to provide forecasts of river flows.

Satellite images are available every half hour, over pixels approximately 7 km square. Because of the uncertainty in the relationship between cold cloud and rainfall, an individual value is of little value for a model; however, if values are aggregated over time and/or averaged over space, it is expected that the satellite estimate of rainfall will be reasonably close to actual rainfall on the ground and that consequently it should be possible to develop some sort of rainfall-runoff model to forecast river flows. The meteorologists who are developing the system have generally recommended that values should be aggregated over a period of 4-10 days, but if values over a sizable area are averaged then daily aggregation should be acceptable.

To obtain daily totals of estimated rainfall it is clear that an uninterrupted 24-hour power supply is required. The public power supply in Mogadishu has been problematical for some time, and worsened considerably in the late 1980's, when full days of power became a comparative rarity and complete power failures of days (and sometimes weeks) were commonplace. Breaks in supply of one or two hours can be covered by a standard Uninterruptible Power Supply (UPS) unit, but it is not feasible to have UPS support to guard against cuts of more than a few hours. When the satellite part of the FEWS project was under consideration in 1988/89 it was made very clear by the staff of the Hydrology Section and of FEWS that the value and use of the equipment would be very substantially reduced if means could not be found to resolve this problem. However, following discussions with the World Bank representative about the Bank's Power Project in Mogadishu, ODA and FEWS decided to proceed with the installation of the satellite equipment in the hope that the public supply would be adequate for operation.

In the event this optimism proved to be mis-placed, and the public power supply deteriorated further. The equipment was generally operating successfully from January 1990, but typically no more than 6-8 of the 48 half-hourly images could be received on any day (and sometimes none if the generator was unavailable). This was sufficient to give some picture of the development of storm systems over the Horn of Africa and the Indian Ocean, but was of no quantitative value. Further details about the attempts to improve the operation of the equipment are contained in Appendix C.

The same satellite images were being received and archived in the UK, and daily cold cloud data was extracted for each of the Jubba and Shebelli catchments upstream of the key gauging stations (Lugh Ganana and Beled Weyn respectively). This data was sent to Somalia for analysis in the hope that some sort of model could be developed, though it could only be of real use for forecasting if the Mogadishu equipment is fully functioning. Unfortunately, the satellite itself was out of operation for certain periods, including during the critical period of rains prior to the Gu flood. Figure 3.5 shows the available data during the Gu season for the Jubba catchment, together with the flow at Lugh; Figure 3.6 has similar information for the Shebelli. It can be seen that there is some relationship between the cold cloud data and the river flow, but with the extent of missing data it is not possible to make any detailed analysis.

3.4.4 Publication and Dissemination of Information

Although not directly referred to in the Terms of Reference, it was recognised by both BDDEA and the Consultants that making the data available to interested parties must be a primary aim of the project. Such data has not always been freely available in Somalia, with the result that reports and studies have sometimes used out-of-date or incorrect data sets. It was therefore agreed at an early stage that a Data Book would be produced after the checking and validation of the historic data had been completed, with the intention that this would become the definitive record of river flows in Somalia. The Hydrometric Data Book covering flow data from 1951 to 1989 was duly published in mid-1990 and was widely distributed to potentially interested parties in Mogadishu. This is supplemented by a volume of hydrographs which is presented in conjunction with this Final Report. In earlier years the Ministry of Agriculture had sometimes expressed reservations about the handing out of data, but the Director of Irrigation gave his full support to the publication of the Data Book, and the Minister himself indicated his approval.

Besides the Data Book, data was regularly distributed via the Food Early Warning System (FEWS) Project's 10-day Bulletin. The Hydrology Section continues to provide summary flow data for both rivers for this publication. An example Bulletin is included as Appendix L.

Throughout the project there has been a steady stream of visitors to the Hydrology Section requesting information about one or both rivers. In keeping with the aim of wide dissemination of information all possible assistance has been provided, with graphs, data printouts and analysis as required. The recipients of information included International funding agencies, foreign consultants, students in Somalia and overseas, other Government ministries and a number of projects and organisations who use the river water or are threatened by flooding. A particular area of cooperation occurred following the severe Shebelli floods in 1990 when UNDP brought in a floods consultant to review the situation and recommend a programme of action to reduce future problems. He worked closely with the expatriate and local staff in office and field work; the latter included an aerial survey of the Shebelli from north of Mahaddey Weyn to Kurten Waarey.

3.5 Training

3.5.1 General

Throughout the project items of work were treated as training exercises wherever possible. In the field, staff were trained to do discharge measurements and to take water samples for sediment analysis, and various hydrological principles were discussed during this work and also during visits for station maintenance. Field visits were followed up in the office by the calculation and discussion of results; although all data is processed using the computer parallel processing was done by hand for most items because it was felt that this would be the best way to assist with the understanding of the principles involved.

Some unaccompanied field trips were undertaken by the local staff; this was generally required when the expatriate hydrologist was away on leave, but it also provided a good opportunity for the staff to demonstrate their understanding of the basic field techniques. In general the staff showed themselves to be capable of carrying out the necessary standard procedures, but they were less successful in applying their experience when some slightly new problem was encountered. As an example of this, Table 3.1 shows that two discharge measurements were not completed as a result of faulty equipment. In one case this was due to damage to the current meter which could not have been repaired on site, but in the other it was caused by a faulty connection and the measurement could have been completed using the alternative cable carried in the Land Rover.

Most of the staff had been trained in Agriculture at the local university, but they were generally less strong in mathematics which is essential for hydrological calculations and consequently important for the understanding of hydrological concepts. Training therefore started from first principles, with hand calculations used as far as possible. Extensive repetition of basic mathematical problems led to an assimilation of techniques, but as with fieldwork attempts to instill the understanding of basic principles were unfortunately less successful - as indicated by the difficulty staff found in applying previously learned procedures to slightly different problems.

3.5.2 Overseas Training

Overseas training proved to be one of the more problematic aspects of the Project. It had previously been recommended that one or more members of the Section's staff would benefit from postgraduate training to MSc or Diploma level, and that of necessity such training would need to be carried out overseas. It was therefore arranged that one British Council scholarship would be available for each

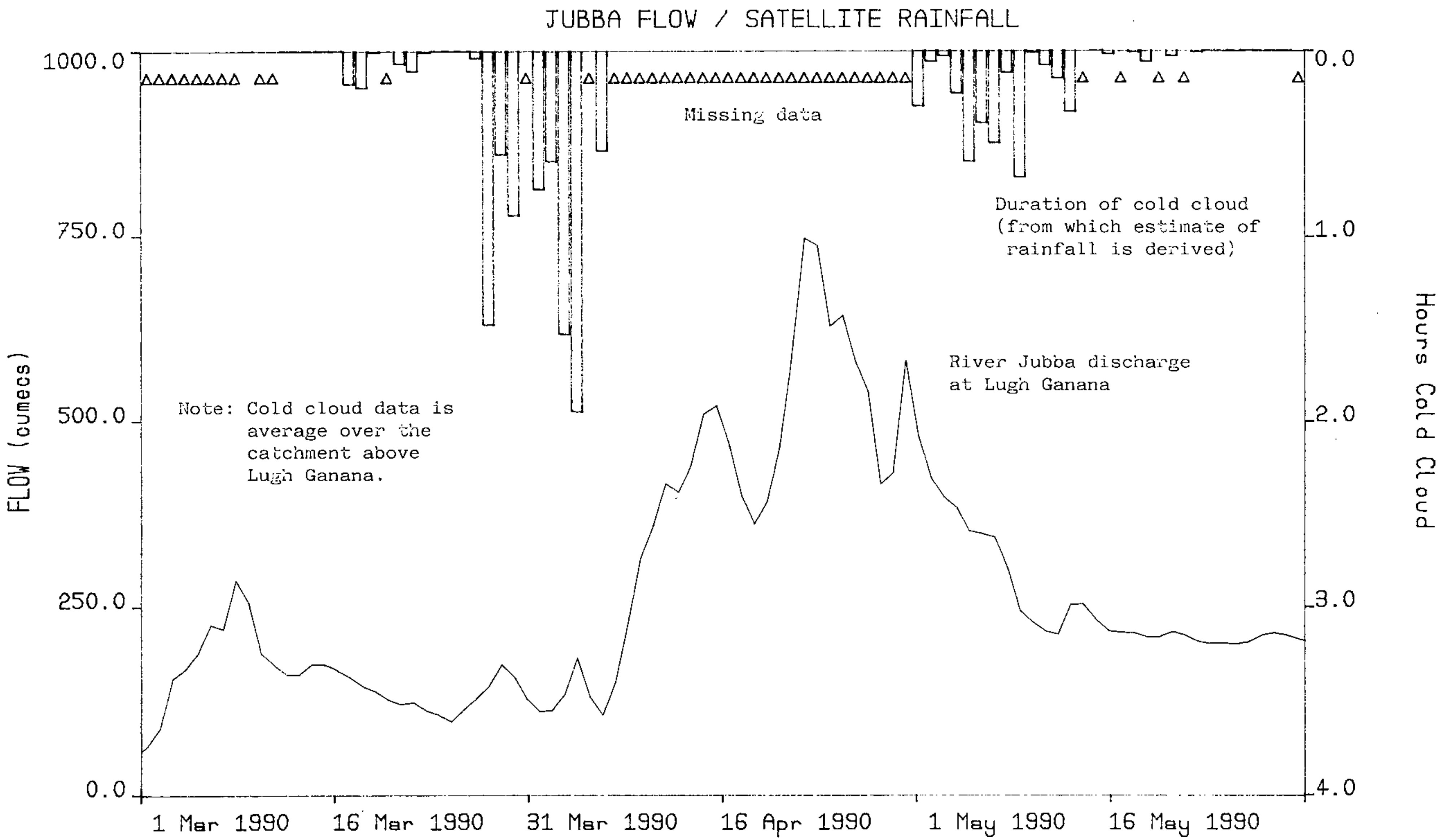


Figure 3.5

Department of Hydrology, Ministry of Agriculture

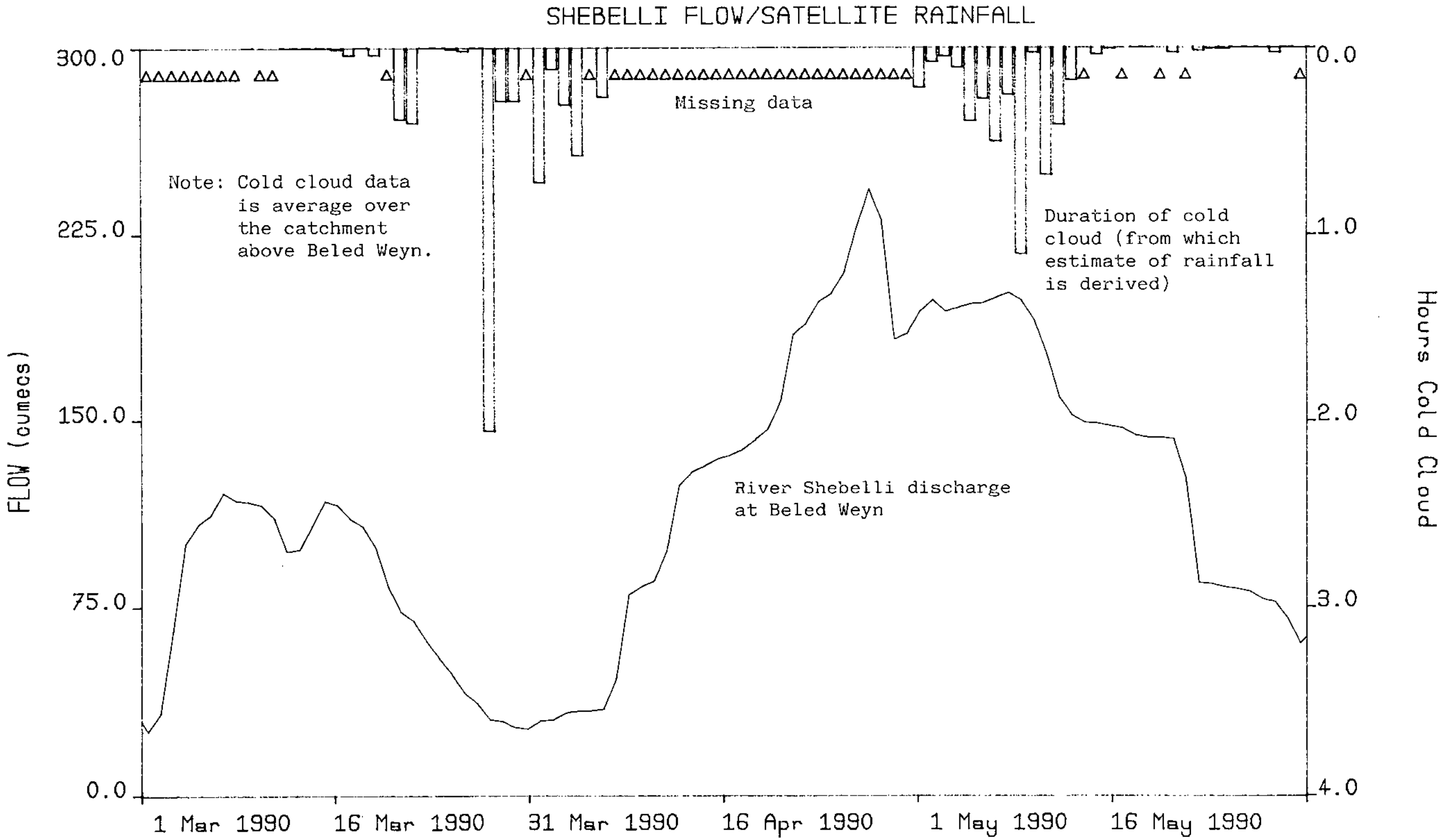


Figure 3.6

Department of Hydrology, Ministry of Agriculture

year of the Project so that appropriate training could be undertaken at a British university. When Phase 3 finally began it was unfortunately too late for this to be arranged for the 1988/89 academic year, so plans were made for 1989/90. The candidate selected for training (by agreement between the Director of Irrigation and the Hydrologist) regrettably proved unable to raise his command of English to the level required for acceptance to the course, even allowing for an additional English course in the UK prior to the MSc course. The nominated reserve was not available because she had in the meantime been accepted for a short course in the USA. The scholarship for 1989/90 therefore lapsed.

Similar procedures were gone through for the following year and the same candidate was accepted for a course at Birmingham University during the 1990/91 academic year. However, after he was interviewed by the Vice-Consul, the British Embassy in Mogadishu indicated that he was very unlikely to satisfy UK immigration law and if so would not be granted a visa. He was therefore unable to proceed on the course. At this late stage there was no potential alternative candidate.

The tightening of visa approval procedures for scholarship candidates results from the increasing number of students who have failed to return to Somalia after training in the UK; many other countries have also restricted the issue of visas to Somalis because of similar experiences. Besides the requirement to satisfy immigration law (which in the case of students means fundamentally that the purpose of entry is to study and not to work or otherwise stay beyond the length of the course), the failure of many students to return to Somalia invalidates the primary reason for the scholarship - namely, to help the candidate to carry out his work more effectively following the course.

The Hydrology Section, and hence the aim of the Hydrometry Project, has already suffered in this respect. As noted above, one member of the Section went to the USA for a two month course in June 1989 (arranged by the Ministry separately from the Project); she failed to return. A second member went on a UNESCO course for hydrology technicians in Zimbabwe from January to April 1990. The Project assisted with the arrangements, but funding was from UNESCO. He returned to Somalia after the course, but he did not return to the office and he showed absolutely no interest in the work of the Hydrology Section, despite the fact that he was frequently to be seen in the Ministry and was presumably still receiving his salary. The total lack of appreciation from a returning trainee for efforts made on his behalf inevitably leads to doubts about the wisdom of making such efforts.

This 0% return rate does not engender much encouragement with regard to the future of the Section. The member who was meant to go to Birmingham showed greatly reduced interest in the Section when it became clear that he was unable to go on the course. His interest revived when the prospect of third country training through the British Council was investigated, but his long-term commitment to the Hydrology Section remains unclear. It remains possible that he will be able to attend a course at the Asian Institute of Technology in Bangkok in 1991. Another member who had been attached to the Section for several years (though absent for significant periods on maternity leave) left for a two-year course in the Netherlands in September 1990. Such long-term courses should be of benefit to the individual, but it must be doubted whether they are in the best interests of the future work of the Section.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

4.1 Achievements of the Project

The major concrete achievement of the Project has been the production of the Hydrometric Data Book. For the first time validated sets of flow data are available for the Jubba and Shebelli rivers, and the infilling of missing values using the models developed during the Project means that continuous or nearly continuous data sequences are available over a long time period. Besides the Data Book and the volume of hydrographs, the data is readily available from the computer database in the Ministry of Agriculture, and it is expected that this will continue to be of value to Consultants and International Agencies as well as to the Government of Somalia. Reliable long-term information about water availability is of vital importance to the effective development of Somalia's water resources.

Other Project achievements are not necessarily easy to quantify. The hydrometric network has been maintained as far as possible, but its condition started to deteriorate in the latter part of the Project period when it became impracticable to carry out regular and reasonably frequent field visits. It must be expected that the deterioration will continue at least until the general situation permits easy travel to the measurement sites.

A number of Ministry of Agriculture staff have received training in basic hydrological work and have shown themselves generally capable of learning standard techniques, and of continuing to maintain the hydrological data bank. However, in most cases the people trained have subsequently left the Section so that the benefits of training to the work of the Section are likely to be transitory. With the extremely low level of Government salaries it is inevitable that most staff see their jobs, and in particular their association with a foreign-funded project, primarily as a potential stepping stone to better personal opportunities - usually outside Somalia.

4.2 Future Needs

4.2.1 The Hydrology Section

It is difficult to say anything which is both new and constructive concerning the future work and requirements of the Hydrology Section. The Phase 2 report - like others before it - recommended further support and training (both in Somalia and overseas) so that the staff of the Section could maintain the necessary work, subject to the availability of equipment and transport. The evidence from Phase 3, supported by the experience of a range of other projects in Somalia, is that overseas training is not an effective means of furthering the relevant work in Somalia because very few Somalis now return from such training courses, and even fewer return to their previous jobs. Approximately three-quarters of students sent to the UK on British Council scholarships for the 1989/90 academic year have failed to return at the appointed time. The non-return of staff does not necessarily mean that the training produces no benefits for Somalia, but this report is not the place to assess such wider potential benefits to the country from overseas travel opportunities.

In addition to the uncertain benefits of overseas training, the poor return rate of trainees in recent years also means that it is becoming increasingly difficult for Somalis to obtain visas for entry to foreign countries.

In these circumstances, further external support and in-country training (preferably on-the-job) seem to provide the most realistic hope for maintaining the work of the Hydrology Section. However, it should be noted that the enthusiasm of local staff often wanes if there is no prospect of overseas travel.

It was emphasised at the start of Phase 3 that this should be the conclusion of ODA's assistance to the Hydrology Section, and that at the end of Phase 3 the local staff in the Ministry of Agriculture should be able to continue with their work unassisted. In principle the local staff are probably able to continue with their work, but the Government of Somalia seems unlikely to be able to allocate sufficient resources to enable all of the Section's work to proceed. In particular, fuel and other vehicle running costs need to be met. If such resources are not available on a regular and long-term basis then there must be considerable doubt about the viability of the concept of sustainability.

In spite of the intention that this should be the conclusion of ODA's support, the Engineering Adviser at the British Development Division in East Africa (BDDEA) has indicated that BDDEA would like to arrange one or more brief follow-up monitoring visits to assist in maintaining the continuity of data records. The Ministry of Agriculture keenly support this and it is hoped that a visit might be possible sometime in mid-1991. It would probably last for one or two weeks, and would if possible be arranged in conjunction with a BDDEA monitoring visit.

4.2.2 The Water Sector in Somalia

The Water Sector in Somalia has historically covered a number of Ministries and organisations. Cooperation between Ministries has not always been perfect, and even different sections of a single Ministry have at times experienced breakdowns in communications. It would certainly be beneficial for the future development of Somalia if cooperation could be improved and the interchange of data facilitated. The Ministry of Agriculture is the obvious centre for most water-related activity, and it is perhaps unfortunate that the most recent attempt at an overall approach to the management of the Water Sector (The National Water Centre, 1987-1990) was not more closely tied to this Ministry. The importance of full integration within a Ministry was well illustrated by the aftermath of the NWC Project. It came under the control of the Ministry of Mineral and Water Resources, but was physically separated from it. Within a few weeks of the departure of the project's expatriate staff the project office was no longer functional - computers, air-conditioners, generator, photocopier and other equipment having been removed to unknown destinations. A particularly sad event for other people working in the Water Sector in Somalia was the effective loss of the library which was certainly the most extensive in this field in Somalia. Had the Water Centre been physically part of an existing Ministry (preferably the Ministry of Agriculture), it is unlikely that such rapid deterioration would have set in.

With relation specifically to the Hydrology Section, consideration should be given to linking it more closely to the Food Early Warning System Department within the Ministry of Agriculture. It could well be beneficial to bring all the computer resources and data collection activities together under one umbrella. This would apply particularly if progress is made on the receipt of rainfall estimates from the satellite monitoring equipment set up under the FEWS project.

4.3 Postscript

At several points of the report there are references to the deteriorating security situation in Somalia and its negative impact on the work of the project. The situation dramatically worsened in late December 1990 (shortly after the departure of the expatriate hydrologist) when widespread fighting broke out in Mogadishu itself. Almost all remaining foreigners were evacuated and subsequent reports indicated that foreign embassies, government ministries and other buildings had been ransacked. The state of the Hydrology Section in the Ministry of Agriculture is not known, but it must be feared that data processing has ceased and that much of the project equipment has been lost. If the computer should no longer be available it would be possible to retrieve all data up to 15 December 1990 from floppy disks held by both the Institute of Hydrology and Sir M MacDonald and Partners Ltd, and to transfer it to a replacement computer. It must be hoped that conditions will permit an early resumption of external assistance to the Ministry of Agriculture so that continuity of hydrological records can be maintained as far as possible.

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Note: Other reports produced by Sir M MacDonald and Partners Limited and the Institute of Hydrology for the Hydrometry Project are listed in Appendix B.

APPENDIX A

TERMS OF REFERENCE

APPENDIX A

TERMS OF REFERENCE FOR CONSULTANTS FOR PHASE III

Sir M MacDonald and Partners Limited will undertake the work required to achieve the objectives of the project which are:

i) To maintain the existing data collection network of river level stations.

ii) To improve the flow of data from those stations to Mogadishu, particularly those concerned with providing information required for flood warning.

iii) To continue the programme of river gauging and rating curve development.

iv) To maintain the data storage and processing facility on the computer at Mogadishu.

v) To further develop the computer model of the Shebelli for river flow forecasting.

vi) To develop a model of the Jubba river on the same lines as that for the Shebelli.

vii) To introduce water sediment measurements (conductivity) at key stations within the network.

viii) To introduce water sediment measurements at key stations within the network.

ix) To ensure that project staff receive appropriate training to enable them to continue their work unassisted on completion of the project.

In addition, their responsibilities will include the following:

1) Liaison with the National Water Centre.

2) Provide the services of a field hydrologist on a continuous basis and two other experts from time to time as required.

3) Order and procure equipment to be provided under the project and cooperate with Crown Agents who will carry out value for money checks on behalf of ODA.

4) Report at 6-monthly intervals and at the conclusion of Phase III as specified in ODA's Letter of Appointment.

APPENDIX B

LIST OF PROJECT REPORTS AND PUBLICATIONS

APPENDIX B

LIST OF PROJECT REPORTS AND PUBLICATIONS

1. 1983 Proposal for Consultancy Services.

2. 1984 Progress Report.

3. 1985 Final Report - Stage 1.

4. 1985 Annual Summaries of Daily River Flow for the Primary Gauging Stations operated on the Jubba and Shebelli Rivers (to 1984).
(All values provisional)

5. 1986 Project Review and Proposal for Stage 3.

6. 1986 Water Resources of Wadis of Northern Somalia.

7. 1986 Annual Summaries of Daily River Flow for the Primary Gauging Stations operated on the Jubba and Shebelli Rivers (1984-86).
(All values provisional)

8. 1986 Annual Summaries of Daily River Flow of the Jubba River at Bardheere (1963-86).
(All values provisional)

9. 1986 Mission Report - Stage 2.

10. 1988 Inception Report - Phase 3.

11. 1988 First Progress Report, Phase 3. March-August 1988.

12. 1989 Second Progress Report, Phase 3. September 1988-February 1989.

13. 1989 Third Progress Report, Phase 3. March-September 1989.

14. 1989 Proposal for Continuation of Phase 3.

15. 1990 Fourth Progress Report, Phase 3. October 1989-April 1990.

16. 1990 Hydrometric Data Book. Jubba and Shebelli Rivers 1951-1989.

17. 1990 Annual Flow Hydrographs. Jubba and Shebelli Rivers 1951-1989.

18. 1990 Hydrometric Data Book. Jowhar Offstream Storage Reservoir 1980-1989.

19. 1990 Flow Forecasting Models. Jubba and Shebelli Rivers.

20. 1991 Final Report, Phase 3.

Note: Reports 4, 7 and 8 were superseded by reports 16 and 18.

APPENDIX C

PROGRESS REPORT MAY-DECEMBER 1990

APPENDIX C

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APPENDIX C

PROGRESS REPORT MAY-DECEMBER 1990

C1 INTRODUCTION

This Appendix describes work on the Project during the period from May to December 1990, and is included in the Final Report in order to complete the record of Project progress presented in the four Progress Reports which cover the period from March 1988 to April 1990. It is more limited than the previous reports because it is presented in conjunction with the Final Report and certain sections included in those reports are covered in the main report or in other appendices.

C2 STAFFING

C2.1 Expatriate Staff

Five expatriate staff members (three from Sir M. MacDonald and Partners and two from the Institute of Hydrology) were scheduled to work on the project in Somalia; two of them have made inputs during this period. The Programmer/hydrologist has also worked on the project in the UK, and there has been intermittent Head Office backup when required.

C2.2 Staff Movements

The Field Hydrologist (Mr. P.F. Ede, MM) was resident throughout the period until his final departure from Somalia on December 16th. The Programmer/hydrologist (Dr. K.J. Sene, IH) worked in Somalia from September 9th until October 14th.

C2.3 Local Staff

The main members of the local staff have been as follows:

Ibrahim Abdullahi Sheikh Ahmed
Abshir Abdi Hussein
Ahmed Nuur Garaash (driver)
(replaced by Ali Mohamed Burro for the last 3 weeks)

The driver has been employed by the Project; the remaining staff are employed by the Ministry of Agriculture to work in the Hydrology Section. The work of the Section comes under the overall direction of Omar Haji Dualeh, the Director of Irrigation (whose previous title was Director of Irrigation and Land Use).

It is most regrettable that a previous member of the Section (Ali Yusuf Wayrax) who went on a UNESCO Hydrology Technicians Course in Zimbabwe did not return to the Section office after the course, even though he was frequently present in the Ministry. Another previous member of the Section, Zakia Abdissalam Alim, was absent on maternity leave for much of the period and subsequently left to study in the Netherlands.

In connection with the project one Technical Cooperation (TC) award is available from British Council funds to enable one of the local staff to receive postgraduate training at a UK university. Ibrahim was due to be attending a Diploma course in Water Resources for Developing Countries at Birmingham University from September 1990 (preceded by additional English training); however, the British Embassy in Mogadishu indicated that he was unlikely to be granted a visa to visit the United Kingdom and therefore this course opportunity was lost. Ibrahim's enthusiasm for the work of the Hydrology Section was understandably diminished by this, but he did later show renewed interest when the possibility of third country training was investigated. It is hoped that he will in due course be attending a course at the Asian Institute of Technology in Bangkok. If he then returns to work in the Hydrology Section this course should be of great value to his work. However, the return rate of previous trainees from the Section during the project (0 out of 2) does not give grounds for optimism.

C2.4 Supervision

The British Development Division in East Africa (BDDEA) has maintained a close interest in the progress of the project, in particular through Mr. H.B. Jackson, Engineering Advisor. He visited Somalia in November and held discussions with the Hydrologist and the Director of Irrigation concerning the progress and conclusion of the project. The British Embassy in Mogadishu has continued to provide support and communication with BDDEA in Nairobi.

C3 WORK UNDERTAKEN

C3.1 General

The regular office work of the Hydrology Section continued, but the programme of fieldwork was very restricted compared to that up until July 1989. The uncertain security situation reported in the last two Progress Reports worsened substantially during the period. Trips to the Jubba were not possible and the area of the Shebelli considered safe was further reduced. Problems spread south to include the area around Jowhar, and by the end of the period there was also concern about travel in the lower Shebelli - and indeed about safety in Mogadishu itself. The Land Rover was not used at all during the last two weeks of the Hydrologist's input following the murder during car thefts of the drivers of two other four-wheel-drive vehicles (one of them a Ministry of Agriculture Land Rover).

Office work was hindered at times by problems with the electricity supply. For a considerable period the mains supply to about half of the Ministry was cut off (apparently because the Ministry had been unable to pay its electricity bill); if the other half was also without power the generator would usually be operated, but the Ministry had difficulties obtaining diesel fuel and consequently the availability of generator power was also uncertain.

C3.2 Fieldwork

C3.2.1 Introduction

As indicated above, the fieldwork programme has been very severely curtailed by the prevailing situation in Somalia. However, some valuable work has been carried out, particularly regarding sediment sampling and analysis. This was done in a programme of weekly visits to Afgoi.

The programme was briefly affected by an accident on the road between Mogadishu and Afgoi in which the project Land Rover was written off; miraculously the driver, Hydrologist and counterpart escaped with only minor injuries. A replacement Land Rover was obtained through the British Embassy, and while the transfer paperwork was being dealt with a vehicle was hired locally to enable project work to continue.

C3.2.2 Data Collection

The return of observer data to Mogadishu has unfortunately deteriorated, mainly because of the absence of regular field visits. In addition, the security situation at some sites has restricted the flow of data. The most important loss in this respect was at Beled Weyn in September when the radio was not operating and no river level data was recorded; the radio operated again briefly in October, but no data has been received from this station for November and December. In mid-November the observer from Bulo Burti arrived in Mogadishu (with only the clothes he stood in), and made it clear that he had no intention of returning.

The quality of data has also suffered from the absence of field visits. As an example, the data sheets brought by the observer from Beled Weyn showed identical values for March and April. The values received by radio (which were different) have been retained, but confidence in the data is obviously limited.

No visits have been possible to the sites with automatic water level recorders, and it must reluctantly be expected that no further data will be collected from them. The staff gauge records will therefore continue to be essential.

C3.2.3 Discharge Measurements

The regular measurement of river discharge at each station is important in order to check the validity of the existing rating curve, and if necessary to derive a new equation. Unfortunately, measurements during this period have only been possible at Afgoi; they are noted in Table 3.1 in the main report, with calculation sheets at the end of this Appendix.

C3.2.4 Water Quality Measurement

Water quality measurements have provided the only significant success of fieldwork during this period. Until December (when it became unwise to use the Land Rover) a visit was made to Afgoi each week, usually on Saturday, and samples taken for sediment analysis in the office in Mogadishu. The results are listed in Table 3.3 of the main report, and are also shown in Figure C1. This shows the sediment concentration plotted against river flow; as is usual with sediment measurements there is considerable scatter, though the scatter is less than that for the first six months of measurements reported in the previous Progress Report. Time series graphs of river level and sediment concentration/salinity are contained in the main report.

C3.2.5 Field Trip Reports

Because no full length field trips were undertaken, there are no specific field trip reports as previously produced.

C3.3 Office Work

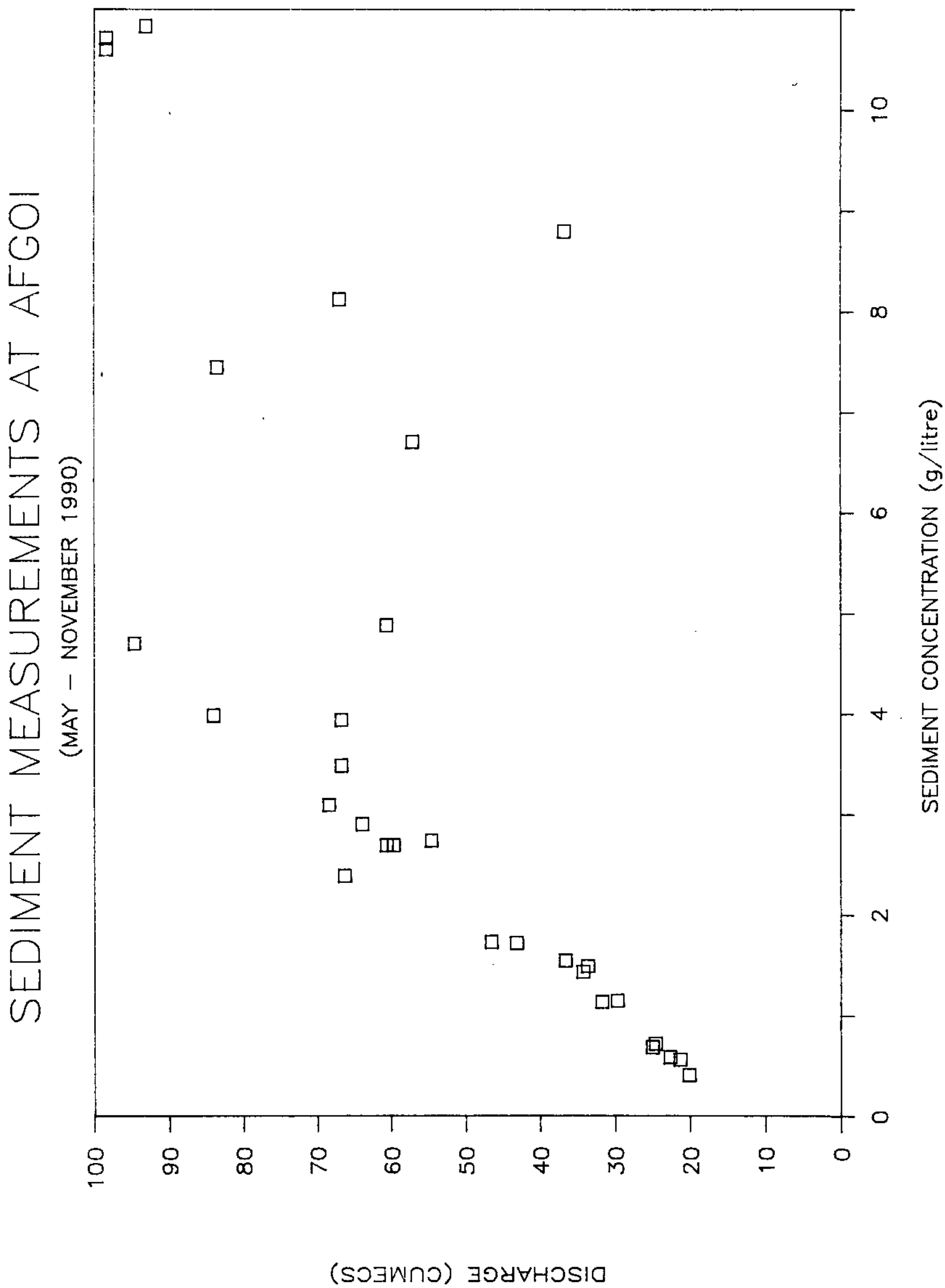
Office work has been centred on the computer, primarily the use of the HYDATA package for the entry and checking of data. Training has also been given in the use of Lotus spreadsheets, mainly for the calculation of discharges and sediment concentrations from field observations and for producing the river flow bulletins.

The last part of the data checking described in previous reports was completed and the Hydrometric Data Book was printed. This contains the completed daily and monthly flow records for the stations on both the Jubba and Shebelli rivers from 1951 to 1989. It was widely circulated to Ministries, International Agencies and other organisations in Mogadishu so that as far as possible all interested parties can be aware of the existence of up-to-date and validated data sets. A companion volume of hydrographs is presented in conjunction with this report.

C3.4 Liaison With Other Organisations

The close links established with the Food Early Warning System (FEWS) project and the National Water Centre (NWC) were maintained as far as possible. Data received via the MOA radio network set up by FEWS has been made available to the Hydrology Section, and in return summary tables and analysis are produced every ten days for the regular bulletin on rainfall, river flows and crop conditions. The NWC computer contains a complete back-up system for HYDATA and the Hydrology Section's database; periodically the revised database was copied to the NWC computer so that their staff could use up-to-date data, and so that there was a back-up in case there should be a major problem with the computer in the Hydrology Office. However, FAO support for the National Water Centre Project ended in September and it is extremely doubtful whether either purpose will be usefully served in the future.

Figure C1



SEDIMENT MEASUREMENTS AT AFGOI
(MAY – NOVEMBER 1990)
SEDIMENT CONCENTRATION (g/litre)
DISCHARGE (CUMECS)
0
2
4
6
8
10
0
10
20
30
40
50
60
70
80
90
100

The link with FEWS was furthered by the direct involvement of ODA in that Project; ODA has provided the equipment for receiving satellite data from which rainfall estimates may be made. This should be of great value to the Hydrology Section because the information received covers neighbouring countries as well as Somalia; estimates of rainfall over the Jubba and Shebelli catchments in Ethiopia should help to provide advance warning of floods on the two rivers in Somalia. Unfortunately, continuing problems with the equipment, and in particular the power supply, have prevented use of the data for quantitative analysis. Special equipment to permit continuous operation from batteries recharged by solar panels was brought to Somalia in August but found to be faulty. A further attempt was made to install it in October; however, after initial success there was another failure of the battery-operated computer (which has been specially developed for the Mogadishu set-up) and therefore 24-hour operation of the equipment was still not possible. Shortly afterwards, a separate failure of the amplifier on the receiving dish - and the apparent disappearance from store of the spare unit purchased as cover for such an eventuality - meant that the system ceased to function altogether. The equipment did become operational again a few days before the Hydrologist's departure in December, but this was too late for any useful work to be undertaken.

C4 FUTURE PROSPECTS

A review of the future prospects for the Hydrology Section after the end of ODA support is presented in the last chapter of the Final Report. Although the Terms of Reference for Phase 3 of the Project indicated that this should be the conclusion of ODA's assistance, it is possible that a short follow-up monitoring visit will be arranged, utilising a part of the budget which is still unspent. Such a visit might take place in June 1991.

TABLE C1

DISCHARGE MEASUREMENT BY CURRENT METER

Station:	Shebelli at Afgoi			Start	Finish
Date:	26th May 1990				
Method:	Suspension from bridge (d/s face) with 25kg weight		Time	0850	1015
Origin:	Left bank		Stage	5.39	5.38
Observers:	Peter/Ibrahim/Abshir/Ahmed				
Meter:	Braystoke BFM 001 No. 75-880 Impellor No. 8011-1247				

Calculations made by method of mean velocity over section between two verticals. Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	1.2	0.0	-	50	0	0.000	0.000					
								0.020	0.70	1.8	1.26	0.026
2	3.0	1.4	.8d	50	5	0.038	0.041					
			.2d	50	6	0.043		0.127	2.00	2.0	4.00	0.508
3	5.0	2.6	.8d	50	38	0.211	0.213					
			.2d	50	39	0.216		0.319	2.85	2.0	5.70	1.817
4	7.0	3.1	.8d	50	85	0.461	0.424					
			.2d	50	71	0.387		0.489	3.30	2.0	6.60	3.230
5	9.0	3.5	.8d	50	109	0.589	0.555					
			.2d	50	96	0.520		0.608	3.75	2.0	7.50	4.561
6	11.0	4.0	.8d	50	124	0.669	0.661					
			.2d	50	121	0.653		0.669	4.20	2.0	8.40	5.623
7	13.0	4.4	.8d	50	119	0.643	0.677					
			.2d	50	132	0.712		0.668	4.45	2.0	8.90	5.946
8	15.0	4.5	.8d	50	116	0.627	0.659					
			.2d	50	128	0.691		0.595	4.65	2.0	9.30	5.531
9	17.0	4.8	.8d	50	71	0.387	0.531					
			.2d	50	125	0.675		0.651	4.85	2.0	9.70	6.312
10	19.0	4.9	.8d	50	119	0.643	0.771					
			.2d	50	167	0.899		0.780	4.90	2.0	9.80	7.645
11	21.0	4.9	.8d	50	119	0.643	0.789					
			.2d	50	174	0.936		0.745	4.95	2.0	9.90	7.380
12	23.0	5.0	.8d	50	92	0.499	0.701					
			.2d	50	168	0.904		0.705	5.05	2.0	10.10	7.125
13	25.0	5.1	.8d	50	106	0.573	0.709					
			.2d	50	157	0.845		0.559	4.85	2.0	9.70	5.420
14	27.0	4.6	.8d	50	68	0.371	0.408					
			.2d	50	82	0.445		0.517	4.45	2.0	8.90	4.605
15	29.0	4.3	.8d	50	105	0.568	0.627					
			.2d	50	127	0.685		0.635	4.40	2.0	8.80	5.586
16	31.0	4.5	.8d	50	114	0.616	0.643					
			.2d	50	124	0.669		0.605	4.45	2.0	8.90	5.388
17	33.0	4.4	.8d	50	87	0.472	0.568					
			.2d	50	123	0.664		0.480	4.30	2.0	8.60	4.129
18	35.0	4.2	.8d	50	68	0.371	0.392					
			.2d	50	76	0.413						

(cont.)

(cont.)

Shebelli at Afgoi 26th May 1990

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Velocity Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
18	35.0	4.2	.8d	50	68	0.371	0.392					
			.2d	50	76	0.413		0.305	3.55	1.6	5.68	1.735
19	36.6	2.9	.8d	50	33	0.184	0.219					
			.2d	50	46	0.253		0.158	2.30	1.4	3.22	0.508
20	38.0	1.7	.8d	50	21	0.120	0.097					
			.2d	50	12	0.073		0.048	0.85	1.6	1.36	0.066
21	39.6	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 146.32 Total discharge (cumecs) = 83.14 Mean Velocity (m/s) = 0.57

TABLE C2

DISCHARGE MEASUREMENT BY CURRENT METER

Station:	River Shebelli at Afgoi			Start	Finish
Date:	29th October 1990				
Method:	Suspension from bridge (d/s face) with 10kg weight		Time	0900	1005
Origin:	Left Bank		Stage	4.29	4.29
Observers:	Peter/Ibrahim/Abshir				
Meter:	Braystoke BFM 001 No. 75-880 Impellor No. 8011-1247				

Calculations made by method of mean velocity over section between two verticals. Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	1.6	0.0	-	50	0	0.000	0.000					
								0.172	0.75	2.4	1.80	0.310
2	4.0	1.5	.8d	50	70	0.381	0.344					
			.2d	50	56	0.307		0.433	1.75	2.0	3.50	1.517
3	6.0	2.0	.8d	50	100	0.541	0.523					
			.2d	50	93	0.504		0.604	2.25	2.0	4.50	2.718
4	8.0	2.5	.8d	50	132	0.712	0.685					
			.2d	50	122	0.659		0.731	2.80	2.0	5.60	4.092
5	10.0	3.1	.8d	50	131	0.707	0.776					
			.2d	50	157	0.845		0.749	3.20	2.0	6.40	4.796
6	12.0	3.3	.8d	50	117	0.632	0.723					
			.2d	50	151	0.813		0.679	3.35	2.0	6.70	4.548
7	14.0	3.4	.8d	50	94	0.509	0.635					
			.2d	50	141	0.760		0.581	3.60	2.0	7.20	4.186
8	16.0	3.8	.8d	50	98	0.531	0.528					
			.2d	50	97	0.525		0.644	3.85	2.0	7.70	4.959
9	18.0	3.9	.8d	50	131	0.707	0.760					
			.2d	50	151	0.813		0.792	4.00	2.0	8.00	6.337
10	20.0	4.1	.8d	50	124	0.669	0.824					
			.2d	50	182	0.979		0.799	4.05	2.0	8.10	6.470
11	22.0	4.0	.8d	50	117	0.632	0.773					
			.2d	50	170	0.915		0.683	4.00	2.0	8.00	5.462
12	24.0	4.0	.8d	50	67	0.365	0.592					
			.2d	50	152	0.819		0.520	3.90	2.0	7.80	4.056
13	26.0	3.8	.8d	50	89	0.483	0.448					
			.2d	50	76	0.413		0.460	3.85	2.0	7.70	3.542
14	28.0	3.9	.8d	50	117	0.632	0.472					
			.2d	50	57	0.312		0.571	3.75	2.0	7.50	4.281
15	30.0	3.6	.8d	50	119	0.643	0.669					
			.2d	50	129	0.696		0.625	3.60	2.0	7.20	4.503
16	32.0	3.6	.8d	50	100	0.541	0.581					
			.2d	50	115	0.621		0.497	3.40	2.0	6.80	3.382
17	34.0	3.2	.8d	50	81	0.440	0.413					
			.2d	50	71	0.387		0.325	2.50	1.5	3.75	1.220
18	35.5	1.8	.8d	50	48	0.264	0.237					
			.2d	50	38	0.211		0.119	0.90	1.8	1.62	0.192
19	37.3	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 109.87 Total discharge (cumecs) = 66.57 Mean Velocity (m/s) = 0.61

APPENDIX D

DATA BOOK SUPPLEMENT AND REVIEW OF 1990 DATA

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APPENDIX D

RIVER LEVEL AND FLOW DATA FOR 1990

D1 INTRODUCTION

This appendix presents tables and hydrographs showing the daily discharges for 1990 to date for the primary gauging stations operated by the Hydrology Section, and as such is a supplement to the Hydrometric Data Book published in May 1990. Data for two stations from the Jowhar Offstream Storage Reservoir scheme is also included, supplementing values presented in the Jowhar Data Book. The pattern of river flows during the year is described in general terms and specific comments are made on the data for individual stations. The flow values are considered to be provisional because some data has not yet been received from the observers; it is anticipated that a number of the values presented here as estimates will in due course be replaced by original data.

D2 STATE OF RIVER FLOWS IN 1990

D2.1 River Jubba

D2.1.1 General

The overall mean flow during the year is likely to be significantly above the long-term mean - probably by 10-20% at most stations. The river was unusually high at the beginning of the year and there was an early flood in March; the main Gu flood was of average size, but the Der was substantially lower than normal.

D2.1.2 Lugh Ganana

The flows at Lugh (Table D1 and Figure D1) have been derived from the staff gauge record because no visit was possible for collecting data from the automatic recorder. The morning river level has usually been received by radio, with the second and third daily values being hand carried to Mogadishu at a later date. The observer's data generally appears to be reliable, though there were some doubtful values when the recorder data would have been useful for clarification.

After the publication of the Hydrometric Data Book some additional stage values were received from Lugh for the last few weeks of December 1989. These result in very slight adjustments to the daily flow values. The revised values are presented in Table D12 which appears after the 1990 data for the remaining stations.

D2.1.3 Bardheere

The flows for Bardheere (Table D2 and Figure D2) have been derived from the automatic water level recorder up until late February and thereafter from the staff gauge record because no further visit for data collection was possible. The observer's staff gauge data generally seems to be reliable. The overall mean flow for the year is somewhat greater than at Lugh because of the local runoff and also possibly because of a shift in the river bed level which means that the rating equation probably requires a slight adjustment. However, any adjustment can really only be considered when a further programme of gauging has been undertaken.

D2.1.4 Mareere

Mareere river level records are not the responsibility of the Hydrology Section, but as the records maintained by the Juba Sugar Project since 1977 have generally been very reliable it is treated here as a primary station. For some periods in the early 1980s the Mareere data provided the only record on the whole river. The hydrograph in Figure D3 shows a substantial flood peak in the Gu season, but only a minor rise during the Der. Daily mean flows are presented in Table D3.

D2.1.5 Kamsuma and Jamamme

As reported in the review of 1989 data (see Fourth Progress Report), the observer recruited at Kamsuma in November 1989 proved to be unsuitable. No further visit has been possible for training this man or appointing a replacement, and therefore there is no reliable data for Kamsuma for 1990.

In contrast, the observer at Jamamme has produced reliable records. The flow values are presented in Table D4 and the hydrograph is shown in Figure D4.

D2.2 River Shebelli

D2.2.1 General

The average flow during 1990 seems likely to be fairly close to the long-term average, though the seasonal pattern was far from typical. For the first half of the year the flows were generally much higher than normal, with a large Gu flood being preceded by a substantial early flood in March. The Der flood season, however, was below normal, though this may have come as some relief to farmers in the middle and lower Shebelli who suffered severe floods in the Gu for the second year in succession.

D2.2.2 Beled Weyn

The hydrograph (Figure D5) shows the pattern described above, with the Gu flood peaking at just under 250 cumecs. This was above average, but as it has a return period of only about two years it cannot be described as a rare flood event, and consequently flooding problems such as those experienced this year must be expected to recur unless suitable preventative measures are taken.

It has still not been possible to replace the section of staff gauge reported broken in 1989, so bridge dip data had to be used at low levels. There was no data for a significant period in September when the local security situation prevented the observer from recording levels or operating the radio to the Ministry in Mogadishu, and although data was received for October that may be the last because the observer has subsequently been in Mogadishu. In addition to this, the quality of the data returned is in doubt because the sheet for April proved to be a copy of that for March. Neither agreed fully with values received by radio and the latter have been retained. The resulting flow values shown in Table D5 must therefore be viewed with some caution.

D2.2.3 Bulo Burti

Little data has been available for Bulo Burti. The lack of regular visits to supervise and encourage the observer must have contributed to this situation, but the situation prevailing in that region for much of the year is probably more significant - indeed, the observer appeared in Mogadishu in mid-November and explained that he would not be returning to Bulo Burti, even though he had left his personal possessions there. In the absence of reliable data the remaining flow values (see Table D6 and Figure D6) have been estimated using the computer model.

D2.2.4 Mahaddey Weyn

When river level data is available it continues to be of good quality, though doubts remain about the rating equation (see Appendix F). For most of the year the observer has not returned data; it is understood that this is because it is no longer safe for him to take the readings..

The data (Table D7 and Figure D7) shows that the river was high for an extended period during the Gu season, but that it hardly reached that level in the Der. This is somewhat similar to that observed in 1989. The peak river level in the Gu was somewhat higher than in 1989, which is the reverse of the position at Beled Weyn. This is presumed to be because the flood relief canal at Duduble was not functioning properly this year. The severe floods near Jowhar may have been a direct consequence of this. As noted in Appendix F, a provisional change has been made to the rating equation with effect from January 1990 and consequently the quoted peak flow value is slightly lower than that presented in the Data Book for 1989.

D2.2.5 Afgoi

The data quality at Afgoi remains good thanks in part to the frequency of check visits by the Hydrology Section staff. Data is presented in Table D8 and Figure D8. The total flow volume for the year is somewhat above the long-term normal.

D2.2.6 Audegle

The river level stayed too high in the Jilaal season for the top 1m of the staff gauge to be replaced. The bridge dip data had to be accepted as a substitute. Flow values are given in Table D9 and the hydrograph is shown in Figure D9.

D2.2.7 Jowhar Reservoir

Data is available for most of 1990 for two of the stations operated in connection with the Jowhar Offstream Storage Reservoir; this provisional data is included here as a supplement to the Jowhar Data Book published at the end of the Project. The reservoir storage dropped steadily through the year, largely as a result of evaporation and seepage losses rather than releases to augment the river flow. There was a slight halt in April when the inlet canal was opened, but this was very short-lived because the canal bank was breached and the offtake gates had to be closed. This failure of the canal may have significantly contributed to the severity of the floods in the Jowhar area this year. The canal was not repaired in time to refill the reservoir during the Der season, and this may have serious consequences for irrigated agriculture in the lower reaches of the Shebelli in early 1991. Figure D10 shows the estimated storage, with the 1989 values plotted for comparison; the difference between the curves clearly illustrates the potentially serious situation. The data for 1990 is also printed in Table D10; as noted in Appendix F, the equation used to convert level to storage probably requires some revision.

The data from the river station just downstream of the outlet canal is shown in Table D11 and Figure D11. At the end of November the level was almost down to that at which water would normally be released from the reservoir to augment the flow; there is, however, very little water in the reservoir, and furthermore the situation in that region would not allow the necessary maintenance work on the outlet canal to be undertaken.

River Jubba at Lugh Ganana 1990

Daily mean flows (cubic metres per second)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	170.5	56.5	64.9	109.4	478.1	202.0	155.5e	186.2	295.5	219.9	189.6	97.0
2	163.5	52.4	88.6	111.8	421.3	197.0	153.8e	211.5	268.6	204.9	180.3	96.1
3	165.0	50.3	154.1	133.4	394.8	190.5	149.6e	214.6	262.4	179.8	163.3	115.5
4	168.7	48.2	167.3	181.5	379.8	183.9	143.6	216.7	257.9	176.2	147.5	119.8
5	172.2	45.3	188.2	129.1	349.9	181.1	143.3	204.3	243.1	207.5	130.2	126.7
6	166.7	42.6	226.1	104.4	346.1	188.1	144.4	175.5	246.4	217.5	120.1	142.2
7	161.9	39.9	219.6	148.2	341.4	210.9	143.3	172.6	264.9	215.7	115.5	175.5
8	156.5	38.3	284.8	227.8	301.3	205.4	145.0	170.7	308.2	196.4	122.0	175.0
9	149.4	36.9	254.9	314.4	243.4	197.1	147.4	167.2	273.3	209.2	131.1	155.6
10	144.3	35.5	187.7	357.4	228.1	193.2	157.1	163.8	254.5	219.6	123.2	130.5
11	136.2	34.7	172.1	414.4	216.3	186.0	154.1	161.9	218.2	213.3	113.5	137.0
12	126.2	34.8	158.6	401.5	212.2	174.2	156.3	170.0	218.6	210.3	115.6	118.1
13	121.3	34.0	159.8	439.8	252.3	173.0	156.9	210.6	207.2	208.1	148.4	89.2
14	116.7	37.2	173.8	509.2	253.1	181.1	163.0	213.1	214.9	179.1	151.0	85.5
15	113.2	42.4	172.4	521.1	231.4	191.7	158.0	210.9	201.9	209.0	166.7	76.3
16	110.2	58.2	164.5	468.7	216.9	195.1	161.7	211.2	202.2	221.9	160.0	m
17	103.5	61.4	155.2	396.8	214.6	188.7	125.4	208.5	212.3	261.3	151.2	m
18	89.3	59.3	143.3	359.0	214.1	177.5	131.5	204.7	205.3	258.0	166.2	m
19	86.5	60.8	136.4	388.6	208.7	180.4	138.7	200.9	178.5	295.4	171.1	m
20	83.2	56.7	125.5	463.6	208.8	181.6	138.9	205.9	174.7	317.0	172.3	m
21	75.3	49.1	118.9	589.3	216.3	181.0	142.3	231.9	163.4	331.1	179.3	m
22	71.7	41.8	122.3	747.4	211.3	178.2	142.4	234.9	145.7	300.4	159.7	m
23	69.0	39.3	110.9	736.4	202.9	173.2	139.8	226.2	148.6	261.3	144.2	m
24	67.3	37.8	105.0	627.3	199.9	162.9	136.5	215.5	152.2	239.8	125.7	m
25	65.5	37.7	95.9	642.7	201.3	145.8	133.3	210.5	162.4	220.8	115.5	m
26	68.3	37.2	112.9	580.2	199.1	145.2	134.1	203.6	180.4	209.0	109.4	m
27	66.6	41.8	127.8	539.3	202.5	143.1	138.2	230.9	192.8	205.3	93.0	m
28	67.2	50.2	144.0	413.0	211.2	143.3	139.8	307.2	175.2	205.0	104.2	m
29	62.6		172.9	430.0	214.9	145.9	145.3	313.3	182.9	206.4	102.1	m
30	59.9		155.7	581.5	211.4	160.6	172.9	311.1	195.8	216.2	92.2	m
31	58.7		126.8		206.2		177.8	306.4		200.9		m
Mean	110.9	45.0	154.6	402.2	257.7	178.6	147.4	215.2	213.6	226.3	138.8	-
Maximum	172.2	61.4	284.8	747.4	478.1	210.9	177.8	313.3	308.2	331.1	189.6	-
Minimum	58.7	34.0	64.9	104.4	199.1	143.1	125.4	161.9	145.7	176.2	92.2	-
Total	297	109	414	1043	690	463	395	577	554	606	360	-

(Total flows in million cubic metres per month)

Annual statistics

Insufficient data for annual statistics

Data availability

Original values	:	346
Estimated values (Flag e)	:	3
Missing values (Flag m)	:	16

Comments :

TABLE D.2

River Jubba at Bardheere 1990

Daily mean flows (cubic metres per second)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	237.5	90.0	59.3	152.1	515.2	230.8	166.4	160.4	356.9	184.0	260.9e	131.7
2	227.2	85.7	55.9	151.6	625.5	230.8	163.2	176.7	334.5	186.9	246.3e	130.0
3	217.5	81.8	60.7	155.3	527.5	228.7	162.7	213.2	324.2	201.4	227.0	137.1
4	206.9	78.7	97.9	151.3	507.7	220.1	168.3	246.5	309.8	217.5	219.2e	137.6
5	204.7	75.7	168.0	173.7	449.5	211.2	171.1	242.3	296.2	210.2	206.7e	126.9
6	207.6	73.5	208.8	226.0	462.3	206.6	171.8	213.1	293.1	207.0	192.9	110.9
7	203.0	72.2	256.1	205.3	409.3	204.4	171.5	199.4	310.1e	221.1	188.7	111.7
8	205.1	72.2	293.9	297.4	361.0	216.3	169.3	193.4	336.4e	244.3	185.5	114.8
9	206.3	69.7	255.0	283.2	321.7	227.0	160.4	197.8	378.2	258.9	178.7	115.8
10	197.2	66.6	307.3	414.6	298.7	226.0	170.1	227.0	372.5	295.0	160.4	110.9
11	188.3	64.2	272.7	795.2	273.6	220.1	181.1	259.4	324.9	279.5	131.6	110.9
12	185.0	62.5	230.6	467.6	250.5	210.2	186.1	268.1	299.9	252.7	138.9	117.0e
13	177.3	60.4	216.9	472.2	233.8	203.0	173.0	269.3	278.8	244.3	132.1	123.3
14	167.9	58.8	192.2	467.6	239.5	196.9	169.7	265.4	253.5	271.6e	137.1	115.2
15	159.4	59.2	186.2	501.3	279.2	195.3	162.8	238.9	231.8	300.3e	140.9	112.3
16	153.0	61.9	208.3	569.9	290.2	199.9	150.1	214.8	237.8	311.2e	147.0	101.4e
17	146.8	61.4	230.8	552.2	265.4	208.0	144.7	210.2	223.0	354.2	154.5	94.1e
18	140.7	60.2	212.9	483.5	244.3	215.9	138.4	207.0	231.8	415.0	184.4	m
19	132.9	71.4	228.9	414.8	242.8	213.8	135.5	213.2	236.2	324.9	240.4	m
20	125.2	83.9	202.1e	389.4	259.6	207.6	133.3	223.7	211.8	306.0	243.4	m
21	119.0	81.6	178.0	387.1	250.4	206.0	140.1	250.9	195.5	342.6e	271.7	m
22	112.4	82.0	170.0	464.3	256.1	207.6	158.6	270.4	179.7	380.3e	250.6	m
23	106.9	79.0	153.5	632.8	251.1	203.0	160.0	270.6	172.6	408.4	223.9	m
24	101.8	72.8	144.3	766.4	236.3	196.9	156.8	246.7	161.8	371.7	212.8	m
25	97.8	67.5	132.8	983.5	227.6	189.5	156.3	221.2	162.3	336.4	202.0	m
26	93.4	63.9	118.2	876.1	221.7	175.4	160.0	215.9	156.8	319.8	192.4	m
27	90.9	61.9	110.8	793.9	227.0	167.9	155.9	252.9	156.3	304.2	181.7	m
28	89.3	60.4	109.2	644.0	226.0	163.6	150.6	355.4	164.5	288.9	156.7	m
29	88.9		119.7	550.5	226.4	169.7	147.5	356.7	176.7	275.8e	136.2	m
30	90.0		134.4	459.3	234.6	167.4	150.5	356.1	184.0	267.4e	146.3	m
31	91.6		144.2		233.5		162.3	351.3		261.0e		m
Mean	153.9	70.7	176.1	462.7	311.2	204.0	159.6	244.8	251.7	285.2	189.7	-
Maximum	237.5	90.0	307.3	983.5	625.5	230.8	186.1	356.7	378.2	415.0	271.7	-
Minimum	88.9	58.8	55.9	151.3	221.7	163.6	133.3	160.4	156.3	184.0	131.6	-
Total	412	171	472	1199	834	529	428	656	652	764	492	-

(Total flows in million cubic metres per month)

Annual statistics

Insufficient data for annual statistics

Data availability

Original values	:	333
Estimated values (Flag e)	:	18
Missing values (Flag m)	:	14

Comments :

River Jubba at Mareere 1990

Daily mean flows (cubic metres per second)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	198.8	78.7	61.2	100.7	606.3	211.5	159.9	131.4	255.8	125.3	250.7	157.9
2	197.3	76.4	55.7	96.7	608.8	209.9	151.7	133.1	279.2	126.7	246.2	155.2
3	203.9	78.1e	51.5	99.4	604.0	214.6	136.5	131.7	301.0	132.5	226.6	128.4e
4	212.2	80.4e	46.2	116.8	588.1	225.5	127.2	135.0	306.9	137.4	212.2	126.9e
5	207.7	80.1e	42.7	127.6	582.1	222.9	128.6	151.1	299.2	146.3	205.8	115.9e
6	199.7	77.4	40.8	130.9	581.6	216.6	139.6	162.9	293.0	150.5	201.5	113.1e
7	189.6	76.5	43.2	132.5	565.1	214.7	139.1	164.1	277.9	156.7	198.5	118.8e
8	184.5	70.8	53.1	136.1	544.5	203.4	138.4	164.2	262.2	167.5	198.9	119.8e
9	180.4	66.0	86.5	138.8	515.8	196.3	149.3	180.2	254.8	173.2	203.4	111.1e
10	176.5	66.4	125.6	146.5	492.2	191.5	159.6	193.5	249.7	172.1	200.8	97.1e
11	173.6	62.2	178.4	170.4	433.9e	186.8	153.0	180.5	252.5	175.7	191.5	96.2e
12	172.2	59.4	212.3	231.3	373.6	190.2	144.9	169.0	272.0	187.4	170.0	98.8e
13	170.1	56.9	209.5	356.4	344.5	197.6	143.5	158.7	293.1	194.4	162.5	100.0e
14	166.4	53.7	226.9	461.2	317.5	201.7	136.9	163.7	295.8	210.1	158.8	96.1e
15	162.5	51.6	228.6	476.9	300.4	200.5	133.6	193.6	280.6	224.5	160.5	95.6e
16	159.0	51.3	219.4	474.7	269.1	194.0	141.2	212.6	262.5	218.0	157.4	100.6e
17	157.5	48.7	216.5	459.3e	252.5	187.8	154.6	216.5	241.5	205.8	139.0e	106.4e
18	154.1	47.0	198.8	466.5e	263.1	182.5	150.9	205.4	224.5	208.0	129.1e	100.3e
19	145.0	46.1	170.6	504.3	286.6	176.8	142.0	196.4	203.9	221.4	119.2e	97.1e
20	128.9	44.5	178.4	516.2	280.0	168.8	129.3	184.2	191.8	248.4	111.1e	87.9e
21	124.6	44.1	195.8	507.2	264.3	170.5	121.0	170.5	182.2	301.0	104.4e	81.0e
22	123.8	43.1	192.6	463.2e	248.5	184.9	115.0	163.9	179.3	377.4	116.1	m
23	120.5	41.3	178.7	414.5	238.4	190.7	115.8e	161.4	186.3	417.6	170.9	m
24	114.9	40.1	166.0	397.3	231.7	188.4	117.6e	163.9	179.3	461.3e	186.8	m
25	108.6	40.7	156.6	426.9	234.5	184.3	126.7	163.0	160.0	468.9	190.2	m
26	102.9	51.4	147.5	527.6	236.1	183.6	121.6	162.4	153.0	434.7	195.2	m
27	97.1	63.0	139.0	572.6	231.5	178.6	125.5	183.6	148.3	411.0	195.0	m
28	92.8	63.6	130.8	587.4	226.7	173.7	132.5	199.8	141.8	372.7	188.1	m
29	87.5		125.2	595.5	221.7	166.2	132.1	193.4	126.8	316.8	181.3	m
30	83.7		115.8	603.3	214.0	162.6	131.1	188.8	125.6	288.1	164.5	m
31	80.9		106.0		210.7		130.5	204.4		255.1		m
Mean	150.9	59.3	138.7	348.0	366.7	192.6	136.4	173.6	229.4	248.0	177.9	-
Maximum	212.2	80.4	228.6	603.3	608.8	225.5	159.9	216.5	306.9	468.9	250.7	-
Minimum	80.9	40.1	40.8	96.7	210.7	162.6	115.0	131.4	125.6	125.3	104.4	-
Total	404	143	372	902	982	499	365	465	595	664	461	-

(Total flows in million cubic metres per month)

Annual statistics

Insufficient data for annual statistics

Data availability

Original values	:	321
Estimated values (Flag e)	:	34
Missing values (Flag m)	:	10

Comments :

TABLE D.4

River Jubba at Jamamme 1990

Daily mean flows (cubic metres per second)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	224.2	81.9	57.5	114.4	480.9	227.2	167.9	133.7	197.8	131.0	287.2	173.6
2	213.4	80.4	57.2	102.1	483.1	221.4	163.2	133.0	259.6	130.2	279.9	159.5
3	211.7	78.8	53.6	107.5	487.6	220.9	158.3	130.6	282.7	129.3	272.8	148.8
4	208.4	75.7	48.9	112.6	490.3	222.1	157.7	122.7	301.9	133.9	266.5	135.9
5	207.1	73.4	46.2	104.9	492.7	226.0	153.1	129.9	307.6	138.6	250.5	128.0
6	212.1	71.1	47.6	130.4	493.2	224.3	147.2	149.0	302.6	147.1	228.8	114.4
7	200.8	69.0	48.6	141.7	492.7	219.3	140.9	159.9	289.6	153.6	211.3	110.4
8	192.8	68.7	51.0	150.5	490.1	215.3	140.2	169.2	277.2	157.0	218.4	109.6
9	184.1	67.1	58.0	164.1	489.7	209.7	143.5	190.6	271.1	174.3	226.8	105.5
10	178.6	65.0	88.5	182.7	479.9	204.5	149.7	205.8	260.6	179.4	228.7	105.0
11	184.6	59.2	116.5	194.1	457.9	197.7	159.1	196.7	253.0	172.2	226.2	100.2
12	186.8	54.9	180.3	268.7	417.0	193.4	145.4	182.6	247.9	172.7	180.8	94.6
13	183.8	52.2	211.6	283.5	383.5	194.1	143.3	171.1	267.0	168.1	171.9	88.5
14	175.5	51.5	221.2	344.5	350.6	203.8	139.6	166.9	305.2	190.6	163.2	96.2
15	169.1	50.3	231.9	395.8	325.2	212.8	140.3	173.5	303.0	208.4	149.1	100.3e
16	160.9	50.2	248.2	424.8	298.1	204.5	150.1	192.5	280.4	196.1	134.4	99.8e
17	160.4	49.4	265.6	421.6	281.3	195.3	165.5	215.0	262.1	208.8	126.2	105.1e
18	158.5	46.6	265.2	422.4	271.8	188.5	162.2	220.3	245.0	216.6	120.3	111.2e
19	154.0	41.0	253.9	437.2	270.5	182.5	155.1	216.9	224.4	216.6	118.6	104.7e
20	145.1	38.2	229.8	451.9	289.9	180.3	144.8	208.0	220.0	229.6	116.1	101.4e
21	134.6	43.7	215.7	456.4	281.9	182.7	139.1	196.7	212.3	249.7	108.4	91.6e
22	126.8	41.8	201.1	449.6	264.4	190.9	129.2	192.6	198.1	356.7	113.1	84.2e
23	122.2	39.8	188.8	427.5	253.8	192.8	120.5	185.6	191.5	390.8	124.7	m
24	116.2	38.2	181.3	410.3	244.5	191.7	115.9	183.6	194.1	395.0	176.2	m
25	110.8	36.7	158.6	428.0	243.9	190.8	114.6	191.1	181.7	423.5	196.2	m
26	105.5	40.5	152.3	444.9	245.6	188.6	119.2	198.8	169.1	419.3	208.3	m
27	99.7	53.2	147.7	463.2	243.4	187.6	126.8	212.1	161.0	418.5	207.8	m
28	95.5	54.6	140.6	473.0	238.8	184.4	128.0	223.6	150.5	418.0	199.3	m
29	89.4		137.0	476.8	235.1	181.2	126.8	215.1	141.1	386.7	193.8	m
30	84.1		129.1	478.1	231.1	172.6	129.4	200.1	131.1	350.7	183.2	m
31	82.3		117.3		228.1		133.0	193.8		306.5		m
Mean	157.4	56.2	146.8	315.4	352.8	200.2	142.2	182.6	236.3	244.2	189.6	-
Maximum	224.2	81.9	265.6	478.1	493.2	227.2	167.9	223.6	307.6	423.5	287.2	-
Minimum	82.3	36.7	46.2	102.1	228.1	172.6	114.6	122.7	131.1	129.3	108.4	-
Total	422	136	393	818	945	519	381	489	612	654	492	-

(Total flows in million cubic metres per month)

Annual statistics

Insufficient data for annual statistics

Data availability

Original values	:	348
Estimated values (Flag e)	:	8
Missing values (Flag m)	:	9

Comments :

River Shebelli at Beled Weyn 1990

Daily mean flows (cubic metres per second)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	51.5	20.1	25.4	29.8	193.7	65.6	33.2	29.7	104.5	90.5	42.6e	26.4e
2	47.8	19.7	32.7	30.1	198.4	60.2	33.6	30.4	107.0	89.9	37.1e	25.3e
3	46.5	19.1	65.4	32.9	193.6	59.3	33.8	30.9	103.5e	89.2	32.6e	25.9e
4	45.8	18.4	100.4	33.6	195.3	58.1	34.3	30.7	99.5e	87.7	30.6e	27.6e
5	43.8	17.7	107.9	33.8	196.8	54.9	34.7	31.1	95.4e	86.7	28.1e	m
6	42.9	17.3	111.8	34.4	197.2	51.5	34.5	31.2	92.9e	84.5	27.5e	m
7	43.1	17.0	120.4	46.4	199.3	44.8	33.5	31.6	93.5e	89.8	28.7e	m
8	42.1	16.9	117.0	79.9	201.3	43.0	31.4	32.0	93.3e	90.2	30.8e	m
9	38.4	16.6	116.5	83.1	197.9	43.4	29.3	35.9	90.0e	86.0	34.3e	m
10	38.0	16.2	115.2	85.4	190.1	47.7	28.6	45.7	88.3e	85.2	36.8e	m
11	36.8	15.9	110.1	97.4	176.4	46.7	28.1	51.1	89.5e	87.7	36.3e	m
12	36.5	15.8	97.0	123.6	158.8	43.6	27.0	49.3	91.4e	88.5	32.8e	m
13	34.4	15.6	97.9	129.0	151.7	41.9	27.7	48.1	91.3e	88.4	27.3e	m
14	30.8	15.5	107.3	131.4	148.7	40.7	27.3	51.5	94.6e	86.5	23.1e	m
15	29.7	15.0	117.0	134.2	148.3	40.3	26.1	53.3	100.2e	82.6	22.8e	m
16	28.6	14.5	115.2	135.7	147.4	39.5	25.8	53.3	101.8e	73.4	23.2e	m
17	28.6e	14.3	109.9	138.1	146.4	39.5	26.3	53.7	101.6e	70.8	23.1e	m
18	28.5	24.2	106.7	142.1	143.6	39.4	28.3	57.2	102.0e	69.2	22.2e	m
19	28.1	57.3	98.7	146.4	142.6	38.8	30.5	64.1	102.1	66.6	21.1e	m
20	28.0	43.5	82.9	157.5	142.6	38.4	32.1	66.9	89.0	65.1	20.5e	m
21	27.7	14.4	72.9	184.4	142.0	38.1	34.0	76.4	85.8	68.6	20.2e	m
22	27.5	14.2	69.0	189.0	125.6	37.3	34.3	79.7	78.9	72.3	19.4e	m
23	26.5	14.2	61.3	197.7	84.3	37.3	31.9	74.4	66.6	81.1	18.5e	m
24	24.4	19.7	54.5	201.0	83.8	37.0	30.9	79.8	66.3	92.1	18.6e	m
25	23.0	36.5	48.0	209.3	82.5	36.2	29.1	94.8	70.6	78.8	19.3e	m
26	22.6	37.2	40.6	227.6	81.9	35.9	29.0	100.7	65.5	76.9	19.3e	m
27	22.1	36.8	36.4	242.7	80.8	35.3	28.5	100.0	62.6	70.8	20.1e	m
28	21.7	33.4	30.1	230.1	77.8	35.4	28.0	101.0	64.9	66.6	21.2e	m
29	21.3		29.3e	182.4	76.6	34.2	28.1	103.5	66.9	60.8	23.5e	m
30	20.9		26.8e	184.8	69.9	33.1	29.2	102.3	77.8e	50.4	26.6e	m
31	20.5		26.2e		60.1		29.6	100.4		44.7		m
Mean	32.5	22.0	79.0	129.1	143.1	43.2	30.3	61.0	87.9	78.1	26.3	-
Maximum	51.5	57.3	120.4	242.7	201.3	65.6	34.7	103.5	107.0	92.1	42.6	-
Minimum	20.5	14.2	25.4	29.8	60.1	33.1	25.8	29.7	62.6	44.7	18.5	-
Total	87	53	212	335	383	112	81	163	228	209	68	-

(Total flows in million cubic metres per month)

Annual statistics

Insufficient data for annual statistics

Data availability

Original values	:	283
Estimated values (Flag e)	:	55
Missing values (Flag m)	:	27

Comments :

TABLE D.6

River Shebelli at Bulo Burti 1990

Daily mean flows (cubic metres per second)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	60.2e	15.0e	35.9e	25.8e	155.8	53.5	25.9	26.8	91.8e	65.5e	49.8e	21.9e
2	53.8e	14.9e	32.5e	25.1e	158.8	53.0	24.6	30.2	93.6e	74.6e	44.0e	25.0e
3	50.4e	14.7e	24.2e	28.8e	160.0	55.7	25.5	30.6e	97.0e	85.3e	41.4e	24.9e
4	46.6e	14.6e	31.8e	29.1e	161.0	56.5	26.2	31.5e	99.2e	84.2e	35.7e	23.7e
5	45.1e	14.3e	64.2e	31.9e	152.7	49.1	26.8	32.3e	96.2e	82.0e	31.1e	24.3e
6	44.2e	13.8e	93.6e	32.7e	159.3	46.7	26.8	32.3e	92.8e	81.0e	29.1e	26.0e
7	42.0e	13.3e	99.9e	52.2	169.4	43.9	26.8	33.0e	89.4e	82.1e	26.5e	m
8	41.0e	13.2e	103.1e	51.8	175.5	42.7	26.1	33.3e	87.3e	81.0e	26.0e	m
9	41.0e	13.2e	110.4e	62.9	175.1	40.8	24.5	34.0e	87.8e	86.7e	27.2e	m
10	39.8e	13.3e	107.6e	70.8	174.3	40.2	20.6	34.7e	87.6e	85.0e	29.3e	m
11	35.9e	13.2e	107.1e	77.8	172.2	42.4	20.5	38.9	84.8e	81.5e	32.9e	m
12	35.3e	13.1e	106.0e	86.7	164.8	42.6	24.1	42.9	83.4e	80.8e	35.5e	m
13	33.9	13.1e	101.7e	97.9	156.5	39.8	26.5	44.6	84.4e	82.9e	34.9e	m
14	32.1	13.2e	90.7e	109.2	146.0	38.6	23.7	41.5	86.0e	83.6e	31.3e	m
15	28.8	13.2e	91.5e	116.1	136.5	37.8	21.4	41.5	86.0e	83.5e	25.8e	m
16	26.3	13.4e	99.4e	117.9	135.6	37.1	20.1	45.4	88.7e	80.6e	21.4e	m
17	25.4	13.2e	107.6e	117.9	140.5	36.7	19.8	46.8	93.4e	75.3e	21.2e	m
18	24.0	12.9e	106.0e	116.5e	144.8	36.7	19.0	49.5	94.8e	71.6e	21.6e	m
19	21.4	13.0e	101.5e	115.8e	146.0	37.0	18.5	54.7	94.6e	68.8e	21.5e	m
20	20.1	23.1e	98.9e	116.5e	143.5	37.0	18.9	58.7	94.9e	67.4e	20.6e	m
21	19.4	56.8e	92.1e	117.4e	144.2	35.2	22.1	59.9	95.0e	65.2e	19.4e	m
22	19.9	42.8e	78.9e	124.1e	131.9	33.5	25.1	62.6	84.0e	63.9e	18.8e	m
23	19.5	13.1e	70.5e	144.0e	78.1	32.2	25.8	64.4	81.3e	66.9e	18.5e	m
24	18.8	12.8e	67.2e	145.2e	74.0	30.3	25.1	66.0	75.5e	70.0e	17.7e	m
25	17.9	12.8e	60.7e	149.8e	72.8	28.7	23.6	68.5	65.2e	77.4e	16.7e	m
26	17.1	18.5e	54.0e	149.9e	70.2	30.6	23.0	73.3	64.9e	86.6e	16.8e	m
27	15.9e	35.7e	47.4e	154.2	64.9	30.5	22.6	78.7	68.5e	75.4e	17.6e	m
28	15.7e	36.3e	39.8e	152.5	60.0	28.9	21.1	86.6	64.3e	73.8e	17.6e	m
29	15.6e		35.5e	153.4	57.3	27.5	19.6	93.9	61.8e	68.7e	18.4e	m
30	15.4e		29.1e	153.8	54.8	26.9	20.4	93.9	63.7e	65.2e	19.6e	m
31	15.2e		28.2e		53.2		24.5	89.5		60.3e		m
Mean	30.3	18.2	74.7	97.6	128.7	39.1	23.2	52.3	84.6	76.0	26.3	-
Maximum	60.2	56.8	110.4	154.2	175.5	56.5	26.8	93.9	99.2	86.7	49.8	-
Minimum	15.2	12.8	24.2	25.1	53.2	26.9	18.5	26.8	61.8	60.3	16.7	-
Total	81	44	200	253	345	101	62	140	219	204	68	-

(Total flows in million cubic metres per month)

Annual statistics

Insufficient data for annual statistics

Data availability

Original values : 144
Estimated values (Flag e) : 196
Missing values (Flag m) : 25

Comments :

River Shebelli at Mahaddey Weyn 1990

Daily mean flows (cubic metres per second)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	69.5	23.6	43.0	46.2	164.0e	71.2e	40.5	34.6	114.4	70.4e	88.7e	20.8e
2	66.7	22.9	36.4	42.6	164.0e	69.7e	40.3	36.7	113.8	71.8e	84.3e	22.2e
3	65.3	21.7	33.1	41.6	164.0e	69.9e	39.9	36.9	113.7	75.0e	75.9e	23.1e
4	60.3	20.9	32.0	39.2	164.0e	70.2e	39.4	38.7	114.6	82.6e	68.1e	27.7e
5	56.8	20.6	30.4	36.7	164.0e	72.1e	38.7	40.2	116.2	94.2e	62.9e	28.7e
6	53.0	20.4	30.1	38.7	164.0e	74.3e	38.3	41.4	114.4	99.2e	54.8e	26.8e
7	48.1	20.2	40.0	43.5	163.4e	70.6e	40.4e	42.1	108.1	98.7e	43.1e	26.8e
8	44.7	20.0	78.6	52.6	162.7e	66.7e	42.2e	43.3	103.3	98.5e	39.8e	28.3e
9	42.5	20.0	110.1	56.1	162.9	64.6e	43.7e	43.3	97.4	100.1e	30.3e	30.3e
10	41.5	19.8	121.9	59.2	163.4e	63.2e	44.8e	43.6	92.8	101.2e	28.6e	m
11	41.0	19.8	123.9	59.7	163.9e	62.2e	45.1e	34.7	88.4	105.5e	29.8e	m
12	40.8	19.8	128.4	73.9	164.0e	61.5e	43.6e	33.4	84.6	108.1	31.1e	m
13	42.1	19.5	128.2	84.6	164.0e	63.2e	43.5	32.4	81.8	105.3e	34.6e	m
14	42.1	19.4	127.3	99.1	164.0e	64.8e	42.5	35.0	80.0	103.5e	38.3e	m
15	40.4	19.3	126.4	121.8	164.0e	63.7e	41.0	33.6	78.6	104.5e	39.3e	m
16	38.2	19.1	122.6	135.4	158.5e	62.3e	40.3	32.8	82.5	105.8e	36.4e	m
17	36.2	19.0	119.6	140.8	149.0e	61.9e	39.4	33.4	82.6e	106.0e	31.6e	m
18	34.6	19.0	127.4	145.0	145.1e	61.7e	39.1	34.5	83.8e	104.1e	24.8e	m
19	33.8	19.0	130.4	143.5	148.3e	61.7e	38.9	56.2	87.3e	99.7e	24.0e	m
20	33.7	18.8	131.7	136.4	153.5e	62.1e	41.3	61.4	89.6	95.3e	24.5e	m
21	32.9	18.5	127.2	143.0	156.5e	62.9e	40.3	63.0	88.7	92.1e	24.8e	m
22	31.6	18.5	118.2	150.2e	155.9e	63.5e	39.0	67.4	88.3	90.1e	24.1e	m
23	30.7	28.2	108.2	158.1	155.9e	62.9	35.8	71.5	88.5	88.2e	22.8e	m
24	29.9	48.8	98.6	153.7e	149.3e	56.1	33.0	75.2	87.2	86.5e	21.9e	m
25	29.4	54.4	89.2	159.8	112.0e	51.9	32.9	83.6	82.4e	87.8e	21.7e	m
26	28.7	51.4	76.5	164.0e	88.1e	50.4	32.6	88.2	79.1e	90.9e	21.0e	m
27	27.5	47.9	65.1	164.0e	86.3e	48.6	32.1	89.7	71.7e	96.7e	20.0e	m
28	26.0	46.1	60.3	164.0e	84.7e	44.2	31.1	92.7	68.7e	105.3e	19.2e	m
29	25.4		57.6	164.0e	81.0e	42.2	30.6	108.5	72.1e	102.3e	20.6e	m
30	24.4		53.7	164.0e	76.4e	41.1	30.3	113.0	72.3e	96.7e	20.4e	m
31	23.8		49.9		73.3e		30.3	114.3		92.9e		m
Mean	40.1	25.6	87.9	106.1	142.9	61.4	38.4	56.6	90.9	95.4	36.9	-
Maximum	69.5	54.4	131.7	164.0	164.0	74.3	45.1	114.3	116.2	108.1	88.7	-
Minimum	23.8	18.5	30.1	36.7	73.3	41.1	30.3	32.4	68.7	70.4	19.2	-
Total	107	62	235	275	383	159	103	152	236	256	96	-

(Total flows in million cubic metres per month)

Annual statistics

Insufficient data for annual statistics

Data availability

Original values	:	200
Estimated values (Flag e)	:	143
Missing values (Flag m)	:	22

Comments :

TABLE D.8

River Shebelli at Afgoi 1990

Daily mean flows (cubic metres per second)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	47.1	20.2	40.7	50.0	99.2	70.3	33.5	24.7	84.4	56.6	73.2	14.4
2	51.0	20.3	37.3	46.9	99.2	67.2	31.1	23.8	85.8	56.0	67.6	16.0
3	56.1	20.0	35.7	43.7	99.2	62.3	29.8	23.6	87.3	54.9	58.8	15.5
4	58.2	19.3	32.3	42.4	98.8	58.2	29.3	22.7	86.9	52.8	54.9	16.1
5	58.3	17.9	29.8	42.3	98.6	55.1	26.8	22.7	85.5	54.4	48.3	17.6
6	57.0	17.0	28.8	39.2	98.3	56.3	26.6	23.5	83.7	59.9	41.6	18.4
7	52.7	16.5	27.4	36.4	98.2	57.9	31.5	25.8	83.4	62.7	41.4	23.4
8	48.9	16.1	28.7	37.8	98.2	56.1	31.2	27.6	83.4	63.0	43.2	24.0
9	45.6	17.1	42.3	43.7	98.2	54.6	27.8	28.7	82.2	63.7	42.2	21.8
10	41.5	18.1	66.0	48.9	98.2	50.6	27.7	27.1	79.7	63.4	37.8	22.0
11	38.8	16.8	77.7	53.0	98.2	45.9	28.0	27.1	75.6	63.3	34.6	23.7
12	37.1	15.6	83.5	56.0	98.5	43.4	26.5	27.6	71.4	64.3	24.5	25.7
13	34.4	14.4	87.3	62.8	98.7	41.5	29.5	28.2	67.6	66.4	23.7	m
14	33.8	11.9	89.9	72.2	99.0	41.1	29.4	28.3	66.2	67.0	25.1	m
15	33.7	14.0	91.6	78.8	99.2	41.8	26.3	26.6	66.8	66.8	26.4	m
16	33.8	14.4	92.4	87.8	99.7	42.7	22.6	27.3	66.1	66.7	30.1	m
17	33.9	15.8	94.1	93.0	99.2	41.7	21.0	34.6	65.3	66.6	33.9	m
18	33.9	15.1	94.7	94.9	97.8	40.6	24.0	42.1	64.2	66.6	34.5	m
19	33.8	15.0	95.9	95.8	94.8	40.2	26.0	43.5	63.0	67.1	31.3	m
20	31.9	14.0	95.2	96.6	92.9	38.2	23.7	43.6	62.4	68.7	26.3	m
21	29.9	14.1	95.2	97.0	91.6	34.3	21.6	44.8	63.6	66.7	19.2	m
22	28.7	17.4	95.6	97.4	91.2	34.6	20.7	46.8	68.9	63.7	19.2	m
23	27.6	20.5	95.7	97.7	91.7	36.5	20.3	47.3	70.4	60.6	19.8	m
24	25.8	20.9	96.2	97.7	93.7	36.1	21.1	50.2	70.9	59.6	20.0	m
25	24.8	32.6	94.1	97.7	94.8	34.0	29.1	54.8	69.7	59.2	19.2	m
26	25.5	41.6	86.6	98.0	92.9	33.9	29.7	57.9	67.6	58.2	17.9	m
27	25.6	43.3	76.2	98.7	89.0	33.8	28.8	63.5	63.0	56.2	17.0	m
28	23.4	42.7	69.2	99.2	83.5	31.8	28.8	66.9	60.8	58.1	16.9	m
29	21.9		60.5	99.0	79.3	30.1	25.8	68.3	60.2	65.9	16.2	m
30	21.5		56.3	99.2	75.7	33.7	24.9	72.0	58.3	71.4	15.1	m
31	20.8		53.5		73.0		26.4	79.8		73.7		m
Mean	36.7	20.1	69.4	73.5	94.2	44.8	26.8	39.7	72.1	62.7	32.7	-
Maximum	58.3	43.3	96.2	99.2	99.7	70.3	33.5	79.8	87.3	73.7	73.2	-
Minimum	20.8	11.9	27.4	36.4	73.0	30.1	20.3	22.7	58.3	52.8	15.1	-
Total	98	49	186	190	252	116	72	106	187	168	85	-

(Total flows in million cubic metres per month)

Annual statistics

Insufficient data for annual statistics

Data availability

Original values	:	346
Estimated values (Flag e)	:	0
Missing values (Flag m)	:	19

Comments :

River Shebelli at Audegle 1990

Daily mean flows (cubic metres per second)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	58.7	20.5	43.6	61.2	94.9	80.0	33.0	30.9	58.6	61.4	73.7e	15.5e
2	56.1	20.5	42.9	57.6	94.9	78.9	32.3	30.7	62.3	60.8	73.8e	14.6e
3	55.9	20.4	42.1	57.4	94.9	76.1	31.5	26.3	65.7	60.0	69.5e	15.7e
4	55.9	20.2	32.6	52.3	94.9	69.5	31.5	25.1	68.8	59.6	61.4e	15.8e
5	55.8	18.9	31.9	48.6	95.0	63.4	31.5	24.1	77.0	61.1	56.3e	16.0e
6	54.5	18.1	30.9	46.8	95.2	62.0	31.5	24.1	76.4	59.3e	50.3e	17.3e
7	52.0	16.8	28.5	49.1	95.2	62.7	31.5	25.2	77.7	61.4e	43.6e	18.3e
8	50.9	15.2	27.0	49.4	95.2	62.7	32.8	27.0	78.9	62.4e	41.8e	22.3e
9	50.7	15.2	34.8e	52.1	95.2	61.2	32.3	29.4	79.9	63.4e	43.0e	24.0e
10	49.4	16.8	52.5	57.0	95.2	56.6	31.9	29.7	79.2	64.0e	42.7e	22.5e
11	49.2	17.6	66.4	58.0	95.2	53.6	31.3	31.1	78.2	63.9e	39.2e	22.1e
12	47.3	17.4	80.0	61.2	95.2	49.8	28.0	30.6	72.4	63.8e	35.7e	23.4e
13	44.2	14.3	84.9	65.6	95.2	47.8	27.8	30.6	68.7	64.5e	27.2e	25.4e
14	41.0	14.3	86.6	86.3	95.1	44.8	28.1	31.9	66.3	66.4e	24.1e	m
15	38.7	14.5	88.4	90.7	95.1	44.7	31.8	33.5	67.2	67.3e	24.9e	m
16	34.3	14.1	89.4	90.9	95.5	45.6	30.8	33.4	66.7	67.4e	26.3e	m
17	32.4	14.1	90.3	90.9	95.6	46.3	21.0	31.2	66.6	67.2e	29.4e	m
18	32.4	14.1	90.9	91.0	95.5	42.8	19.6	38.6	65.1	67.1e	33.2e	m
19	32.4	13.4	91.2	92.4	95.3	41.6	20.1	44.7	64.5	67.1e	34.6e	m
20	32.0	13.0	91.2	92.5	95.0	41.1	26.5	45.3	64.5	67.5e	32.3e	m
21	31.9	12.1	91.6	93.6	94.4	41.1	27.8	47.9	65.1	68.8e	27.8e	m
22	31.1	11.6	92.1	93.7	94.3	41.1	28.4	49.2	66.7	67.7e	21.2e	m
23	30.8	13.8	92.2	93.9	93.7	40.6	28.5	49.0	68.2	64.9e	19.3e	m
24	27.4	20.4	92.7	94.0	93.4	40.5	28.5	44.9	69.5	61.8e	19.8e	m
25	25.3	20.8	92.9	94.0	94.0	38.7	28.6	44.6	70.1	60.2e	20.1e	m
26	25.1	31.5	90.5	94.6	94.0	38.4	30.6	45.1	70.0	59.7e	19.5e	m
27	24.1	42.2	86.7	94.6	93.4	35.4	30.8	45.3	67.9	58.9e	18.3e	m
28	23.0	43.6	79.0	94.6	91.5	35.2	30.7	47.9	66.6	57.1e	17.3e	m
29	23.0		77.2	94.6	87.6	35.2	29.6	49.3	65.0	58.0e	17.0e	m
30	22.8		76.3	94.6	84.9	35.1	27.7	52.4	63.4	64.4e	16.5e	m
31	21.0		64.4		81.3		27.6	54.8		70.5e		m
Mean	39.0	18.8	69.7	76.4	93.7	50.4	29.1	37.2	69.2	63.5	35.3	-
Maximum	58.7	43.6	92.9	94.6	95.6	80.0	33.0	54.8	79.9	70.5	73.8	-
Minimum	21.0	11.6	27.0	46.8	81.3	35.1	19.6	24.1	58.6	57.1	16.5	-
Total	104	45	187	198	251	131	78	100	179	170	92	-

(Total flows in million cubic metres per month)

Annual statistics

Insufficient data for annual statistics

Data availability

Original values	:	277
Estimated values (Flag e)	:	70
Missing values (Flag m)	:	18

Comments :

TABLE D.10

Reservoir storage 1990

Daily mean volumes (million cubic metres)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	194.5	171.0	147.5	133.6	133.7	116.5	102.0	88.1	73.7	59.5	52.2	48.5
2	193.8	170.4	147.0	132.8	133.6	116.0	101.6	88.0	73.6	59.1	52.7	48.5
3	192.7	169.5	146.4	132.6	132.7	115.5	101.1	87.3	73.0	58.5	52.2	48.6
4	191.7	169.3	145.5	131.7	131.8	115.1	100.3	86.9	72.6	57.9	52.2	49.1
5	191.0	168.4	144.5	130.8	131.7	115.0	99.9	86.5	71.8	57.5	52.2	49.1
6	190.4	168.2	143.5	130.7	131.3	114.2	99.4	86.1	71.1	57.2	52.2	49.1
7	189.9	167.2	143.0	130.0	130.8	113.7	99.0	85.3	70.8	56.9	52.1	49.4
8	189.3	166.2	142.4	131.6	130.7	113.2	98.6	84.5	70.4	56.6	51.6	49.7
9	189.2	165.6	141.5	132.2	129.9	112.4	97.8	83.8	70.1	56.6	51.6	m
10	188.2	165.1	141.0	132.6	129.8	112.4	97.4	83.4	69.7	56.2	51.5	m
11	187.6	165.0	140.0	131.8	128.9	111.9	96.9	83.3	69.3	55.9	51.0	m
12	187.0	163.1	139.4	131.7	128.4	111.5	96.2	82.7	68.7	55.9	50.9	m
13	186.0	162.4	138.6	131.3	127.5	111.1	96.1	82.6	68.3	55.3	50.6	m
14	185.4	161.9	138.5	130.3	126.5	110.6	95.4	81.9	68.0	55.3	50.3	m
15	184.7	161.9	137.6	129.9	125.6	110.6	95.3	81.5	67.6	55.3	50.3	m
16	183.7	161.9	137.1	130.3	125.1	109.8	94.9	81.0	66.9	54.7	49.8	m
17	182.6	159.8	136.6	129.8	124.7	109.7	94.5	80.4	66.5	55.0	49.7	m
18	182.0	157.7	136.5	129.8	124.2	108.9	94.4	80.3	65.9	55.3	49.8	m
19	181.4	156.7	135.7	129.8	124.1	108.0	93.7	79.6	65.2	55.3	50.3	m
20	180.9	155.1	135.1	129.9	123.3	108.0	93.6	79.5	64.5	55.6	49.8	m
21	180.3	153.6	134.6	130.7	122.4	107.9	92.9	78.9	63.8	55.6	49.7	m
22	179.2	152.6	134.1	130.8	122.3	107.2	92.8	78.4	63.2	55.3	49.4	m
23	178.2	151.6	133.7	130.8	121.4	106.7	92.1	77.7	62.8	55.6	49.1	m
24	177.6	151.0	133.7	130.8	120.5	106.2	91.6	77.0	62.4	55.6	49.1	m
25	177.0	150.4	133.2	130.8	119.6	105.4	90.8	76.6	61.8	55.3	49.1	m
26	176.5	149.5	132.7	132.2	119.6	104.5	90.4	76.5	61.5	55.3	49.1	m
27	175.8	148.5	132.7	134.1	119.5	103.7	90.0	75.9	61.1	55.0	49.1	m
28	174.8	148.0	132.8	134.1	118.7	103.3	89.2	75.8	60.5	54.6	48.6	m
29	173.7		133.7	133.7	118.7	102.8	88.8	75.2	60.1	54.0	48.5	m
30	172.7		134.6	133.7	118.2	102.8	88.8	74.7	59.8	53.4	48.5	m
31	172.1		134.1		117.7		88.1	74.3		52.8		m
Mean	183.6	160.4	138.3	131.5	125.6	109.8	95.0	81.1	66.8	55.9	50.4	-
Maximum	194.5	171.0	147.5	134.1	133.7	116.5	102.0	88.1	73.7	59.5	52.7	-
Minimum	172.1	148.0	132.7	129.8	117.7	102.8	88.1	74.3	59.8	52.8	48.5	-

Annual statistics

Insufficient data for annual statistics

Data availability

Original values : 342
Estimated values (Flag e) : 0
Missing values (Flag m) : 23

Comments :

Shebelli downstream of outlet canal 1990

Daily mean flows (cubic metres per second)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	75.7	29.8	51.4	60.7	m	87.1	41.1	34.6	119.0	84.1	86.0	22.0
2	79.8	29.2	47.9	56.2	m	83.0	40.6	35.2	119.9	82.9	82.6	22.5
3	78.4	28.5	44.1	53.1	m	80.2	40.8	37.0	118.7	84.2	77.9	24.3
4	76.2	27.5	41.5	50.8	m	78.4	41.7	37.5	116.6	91.4	72.0	26.3
5	72.6	26.9	38.7	49.5	m	77.9	42.4	38.7	115.1	98.6	68.5	27.7
6	68.4	26.5	38.2	52.2	m	77.9	42.9	39.8	114.2	101.2	64.1	28.7
7	65.1	26.5	53.5	56.9	m	78.2	42.9	40.7	113.3	101.0	52.4	28.5
8	60.2	26.8	89.0	59.4	m	77.9	42.5	41.6	110.2	100.0	44.7	27.6
9	57.1	26.5	110.9	62.2	m	77.6	41.7	41.7	104.4	99.7	42.4	m
10	54.3	26.1	118.1	66.7	m	77.1	40.7	41.9	99.6	101.1	40.4	m
11	52.3	25.0	120.5	78.0	m	74.9	40.0	41.6	95.7	102.9	39.1	m
12	49.5	24.0	123.3	89.9	m	71.4	39.5	41.3	90.8	103.9	38.8	m
13	46.9	25.0	125.0	99.1	m	66.1	38.9	40.7	91.8	104.6	39.5	m
14	47.3	26.4	126.3e	111.8	m	60.3	38.4	39.5	92.9	104.4	40.6	m
15	48.9	28.4	127.0e	124.5	m	54.2	37.2	42.2	92.3	104.9	41.4	m
16	48.9	28.5	125.2e	m	125.0	52.0	35.9	54.0	91.3	104.6	41.7	m
17	46.7	28.2	121.7e	m	123.3	50.8	34.9	63.0	91.7	104.3	40.8	m
18	44.2	27.5	121.9e	m	120.3	49.7	34.1	63.0	91.1	103.8	39.0	m
19	42.4	27.4	128.3e	m	118.5	51.6	32.8	63.8	93.6	102.7	36.9	m
20	41.4	27.4	130.8e	m	119.7	53.3	32.7	65.3	102.8	96.5	34.2	m
21	40.1	27.5	130.3e	m	120.2	51.3	35.9	65.7	111.0	91.0	31.9	m
22	38.5	27.4	128.6e	m	121.5	47.7	39.0	67.6	110.4	86.5	30.6	m
23	37.0	39.7	123.4	m	122.0	45.1	41.1	71.1	103.1	84.4	30.1	m
24	35.9	59.2	115.4	m	122.2	43.3	43.8	77.3	99.6	84.3	29.6	m
25	35.4	64.1	102.4	m	120.6	42.5	44.7	85.9	96.8	86.7	28.2	m
26	34.8	62.8	88.8	m	114.0	42.0	43.4	90.2	94.0	88.6	26.5	m
27	34.1	59.4	82.5	m	106.8	41.5	39.6	92.5	91.8	97.1	25.3	m
28	33.0	55.0	74.8	m	101.5	41.4	36.0	97.0	89.4	107.6	24.1	m
29	32.2		70.4	m	96.9	42.2	33.3	104.1	87.2	113.5	23.0	m
30	31.4		67.3	m	93.3	41.4	33.3	108.6	86.1	104.8	22.3	m
31	30.5		65.2		91.3		33.5	115.1		97.3		m
Mean	49.7	33.5	94.6	-	-	60.6	38.9	60.6	101.1	97.4	43.2	-
Maximum	79.8	64.1	130.8	-	-	87.1	44.7	115.1	119.9	113.5	86.0	-
Minimum	30.5	24.0	38.2	-	-	41.4	32.7	34.6	86.1	82.9	22.3	-
Total	133	81	253	-	-	157	104	162	262	261	112	-

(Total flows in million cubic metres per month)

Annual statistics

Insufficient data for annual statistics

Data availability

Original values : 303
Estimated values (Flag e) : 9
Missing values (Flag m) : 53

Comments :

TABLE D.12

River Jubba at Lugh Ganana 1989

Daily mean flows (cubic metres per second)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	38.7	23.4	12.4	29.7	791.9	150.2	134.4	265.7	179.7e	300.6	506.9	229.7
2	37.5	23.3	11.9	56.2	832.0	138.6	126.7	250.3	188.9e	289.5	478.2	219.7
3	36.3	21.8	11.6	61.4	710.2	137.1	122.8	236.3	233.9	272.9	467.2	206.7
4	35.1	20.6	11.1	56.9	638.5	138.7	119.2	223.1	266.9	278.8	455.0	203.3e
5	34.0	21.2	10.4	53.4	713.0	139.2	114.6	215.8	289.8	293.9	408.1	194.4e
6	32.9	21.6	9.8	73.3	496.9	138.0	110.1	209.8	326.8	304.8	354.8	177.8e
7	32.1	21.0	9.6	104.7	413.6	130.7	108.7	210.3	330.3	343.6	334.0	170.2
8	30.7	19.4	9.1	197.1	368.9	121.7	108.1	201.4	328.0	392.9	309.5	174.0
9	29.6	17.9	9.1	222.7	373.4	113.3	105.3	189.7	331.2	472.3	294.8	170.5
10	28.8	16.9	8.8	416.5	332.8	107.3	102.4	174.7	351.9	652.4	283.4	173.5
11	28.0	16.0	8.7	385.7	287.4	103.0	112.1	164.3	350.5	513.8	272.8	170.8
12	27.3	15.4	8.4	190.4	270.6	98.7	138.3	155.5	344.8	473.0	263.1	171.1
13	26.5	14.9	8.2	168.2	244.2	93.4	142.4	150.8	347.9	448.7	272.2	179.9
14	25.8	14.1	7.9	227.8	228.3	99.2	146.1	160.8	431.7	305.8	299.6	213.3
15	25.0	13.5	7.8	354.8	208.6	172.7	157.6	180.4	474.0	261.3	294.4	284.3
16	24.2	13.0	7.6	350.3	225.2	211.7	167.8	185.1	502.7	255.3	255.9	361.5
17	23.3	13.0	7.5	303.3	226.4	224.7	179.5	167.1	471.8	354.8	243.7	338.3
18	22.8	13.5	7.2	242.5	215.4	209.1	186.4	165.8	438.8	388.7	253.1	306.9
19	21.9	15.1	7.1	195.0	235.0	214.3	218.2	173.1	418.9	543.8	290.5	281.9
20	21.4	20.3	6.8	174.6	257.5	230.9	228.3	177.8	357.5	604.7	246.2	265.1
21	20.8	21.1	6.5	196.2	282.1	232.4	222.7	176.3	348.0	655.1	237.4	256.4
22	20.1	19.2	6.3	158.1	277.4	214.3	216.3	173.5	338.6	683.9	228.7	227.0
23	19.6	17.5	6.2	142.4	267.2	199.9	203.3	163.9	325.9	715.4	216.0	218.7
24	18.8	15.9	6.2	171.9	260.2	196.5	189.5	166.2	314.3	850.6	205.1	212.4
25	18.3	14.9	7.2	192.9	230.1	201.8	179.0	174.2	303.4	893.7	222.4	202.7
26	17.9	14.1	7.5	248.4	194.4	189.5	187.6	182.6	291.5	893.2	421.4	193.2
27	17.5	13.5	12.4	368.4	174.7	175.7	246.1	197.7	274.5	847.8	229.6	192.8
28	17.3	13.0	31.6	769.1	161.7	162.6	264.1	207.5	265.8	730.4	248.3	196.6
29	17.3		26.8	957.9	155.6	149.5	295.7	210.7	253.9	633.7	228.9	191.9
30	17.6		21.4	922.9	150.6	140.9	283.1	200.8	254.8	574.4	236.8	187.0
31	20.5		18.7		152.2		275.5	192.6e		531.4		180.3
Mean	25.4	17.3	10.7	266.4	334.7	161.2	173.9	190.5	331.2	508.4	301.9	217.8
Maximum	38.7	23.4	31.6	957.9	832.0	232.4	295.7	265.7	502.7	893.7	506.9	361.5
Minimum	17.3	13.0	6.2	29.7	150.6	93.4	102.4	150.8	179.7	255.3	205.1	170.2
Total	68	42	29	691	896	418	466	510	859	1362	783	583

(Total flows in million cubic metres per month)

Annual statistics

Mean	: 212.6	(cubic metres per second)
Maximum	: 957.9	(cubic metres per second)
Minimum	: 6.2	(cubic metres per second)
Total	: 6706	(million cubic metres)

Data availability

Original values	: 359
Estimated values (Flag e)	: 6
Missing values (Flag m)	: 0

Comments : Substantial flood peaks in both the Gu and Der seasons

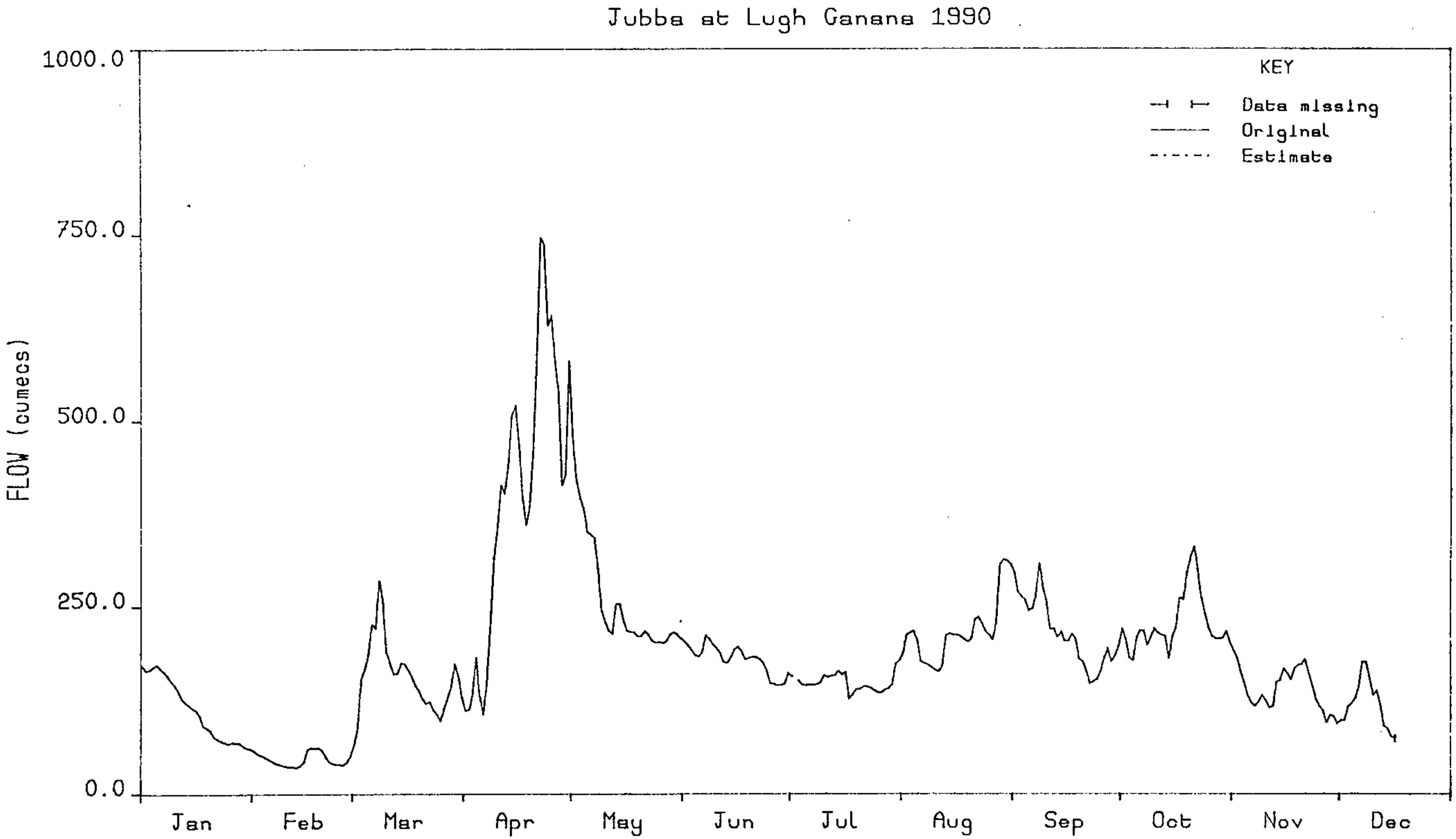

Figure D1

Department of Hydrology, Ministry of Agriculture

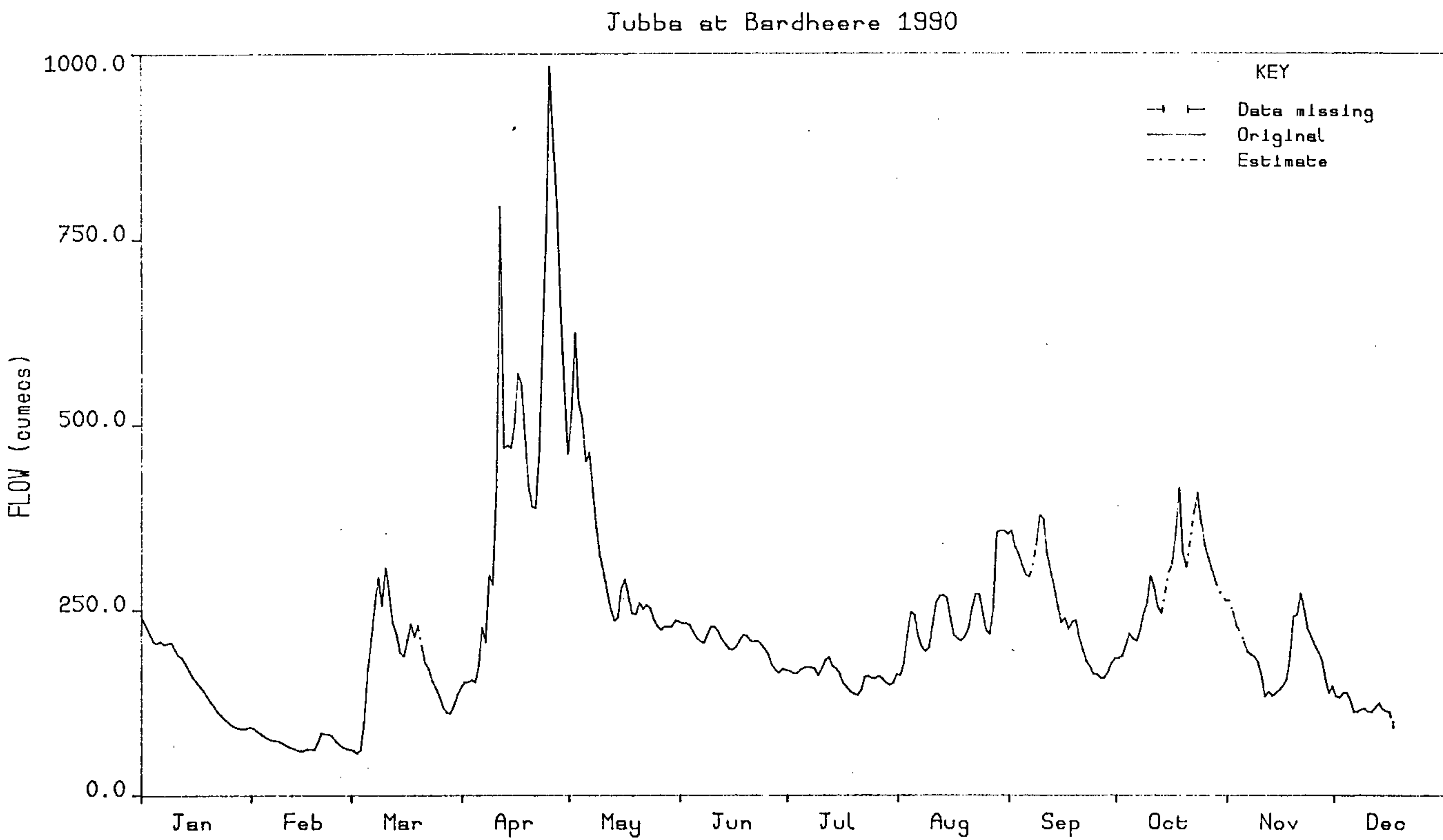

Figure D2

Department of Hydrology, Ministry of Agriculture

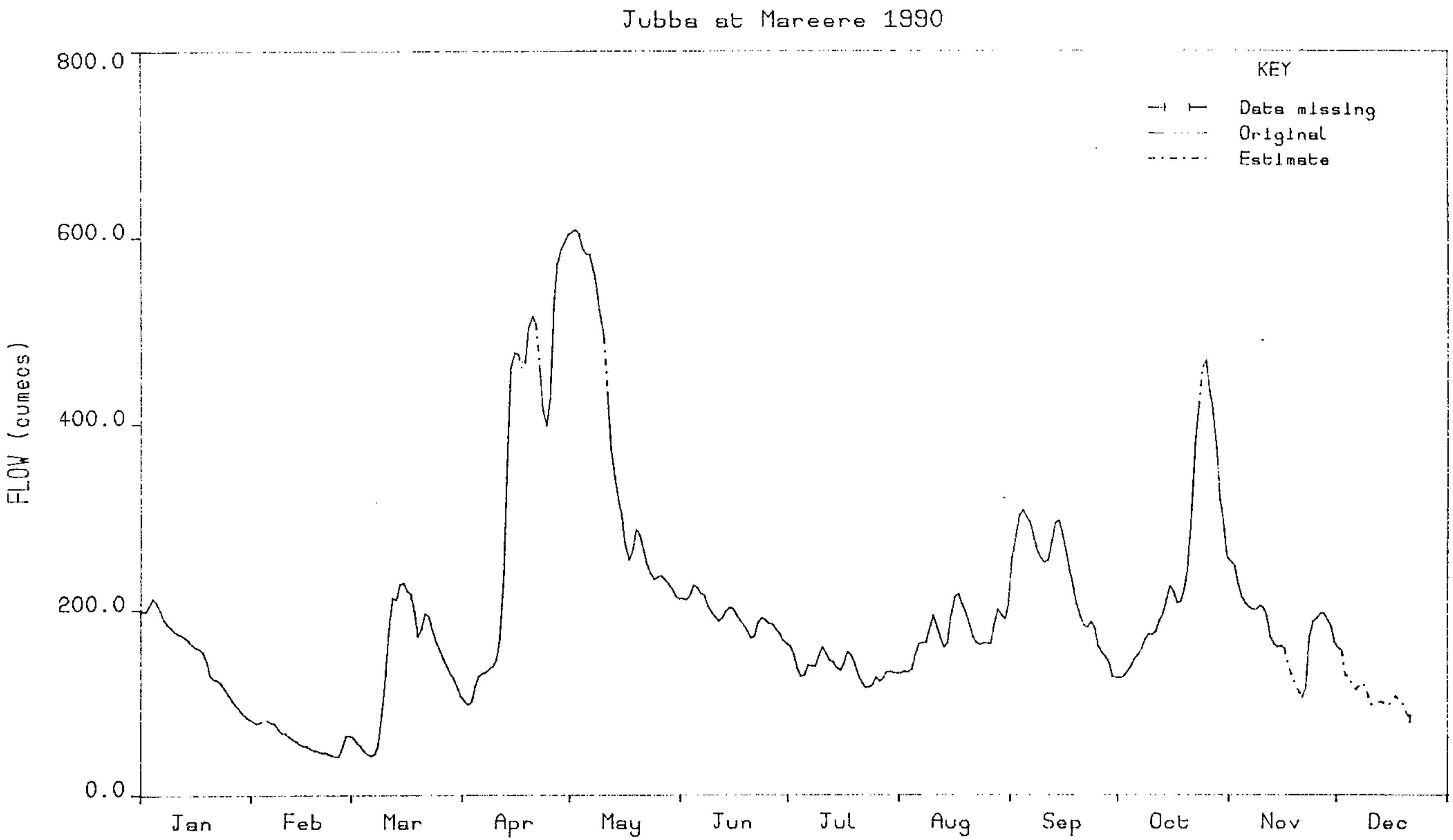

Figure D3

Department of Hydrology, Ministry of Agriculture

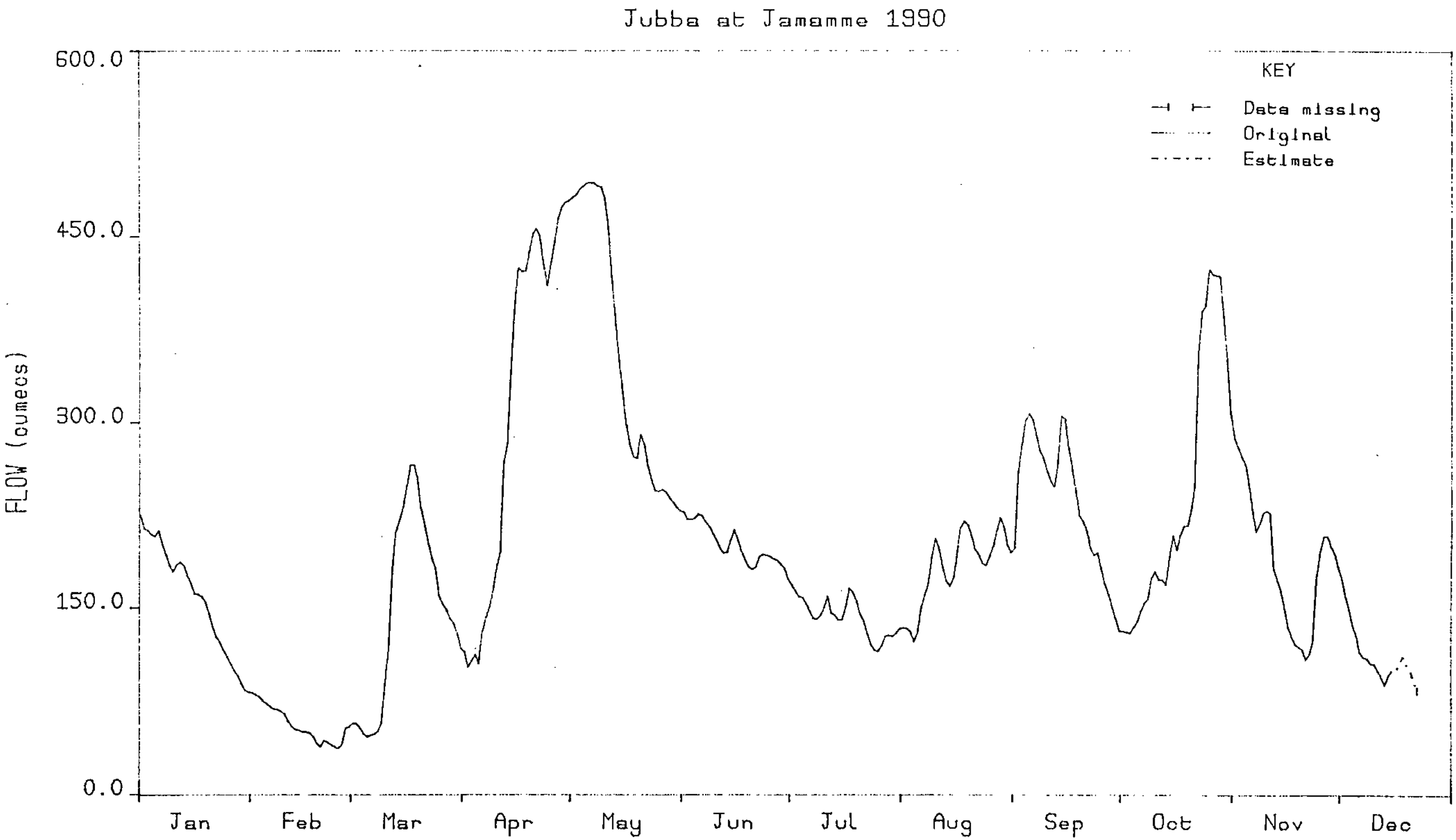

Figure D4

Department of Hydrology, Ministry of Agriculture

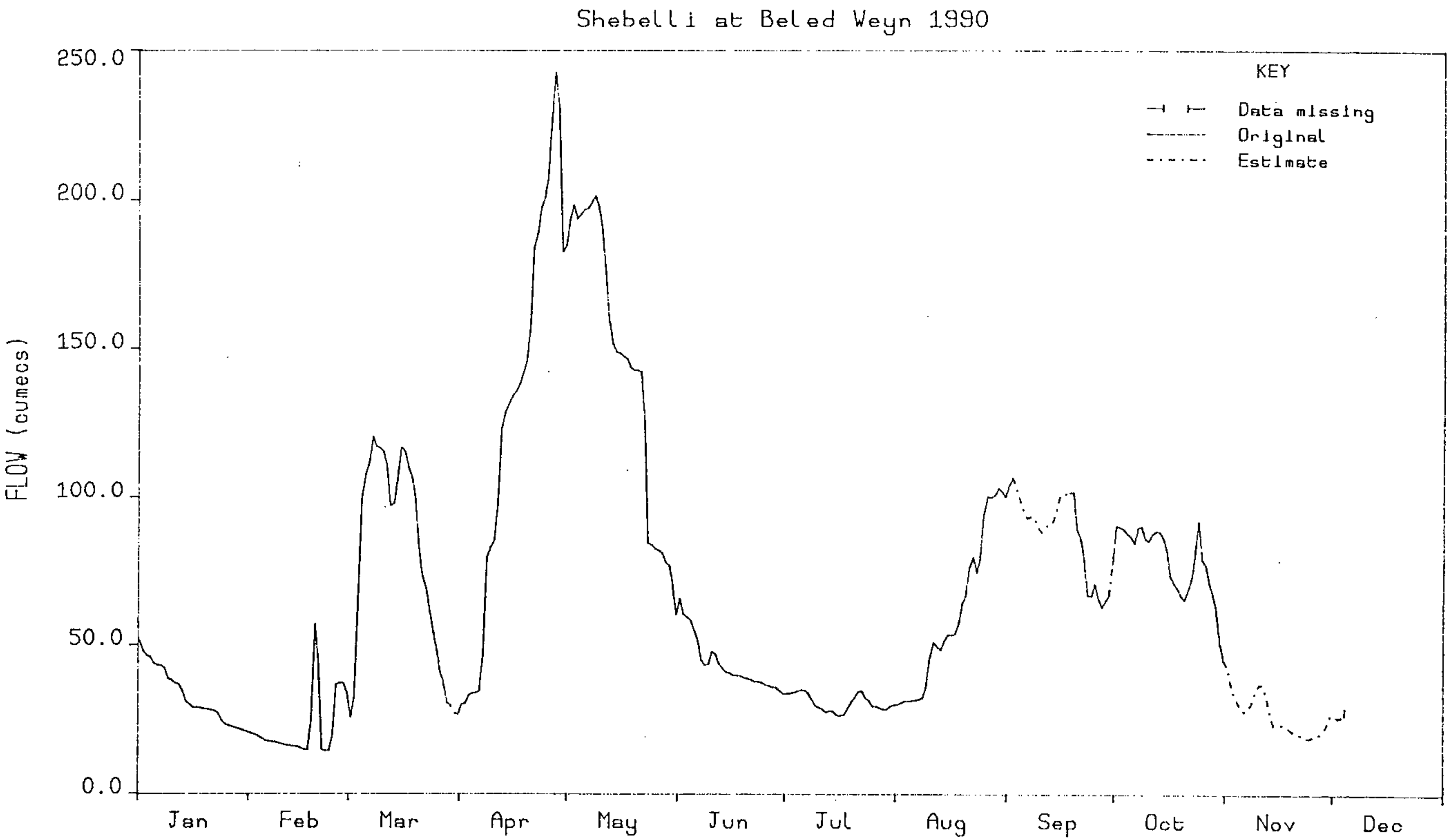

Figure D5

Department of Hydrology, Ministry of Agriculture

Shebelli at Bulo Burti 1990

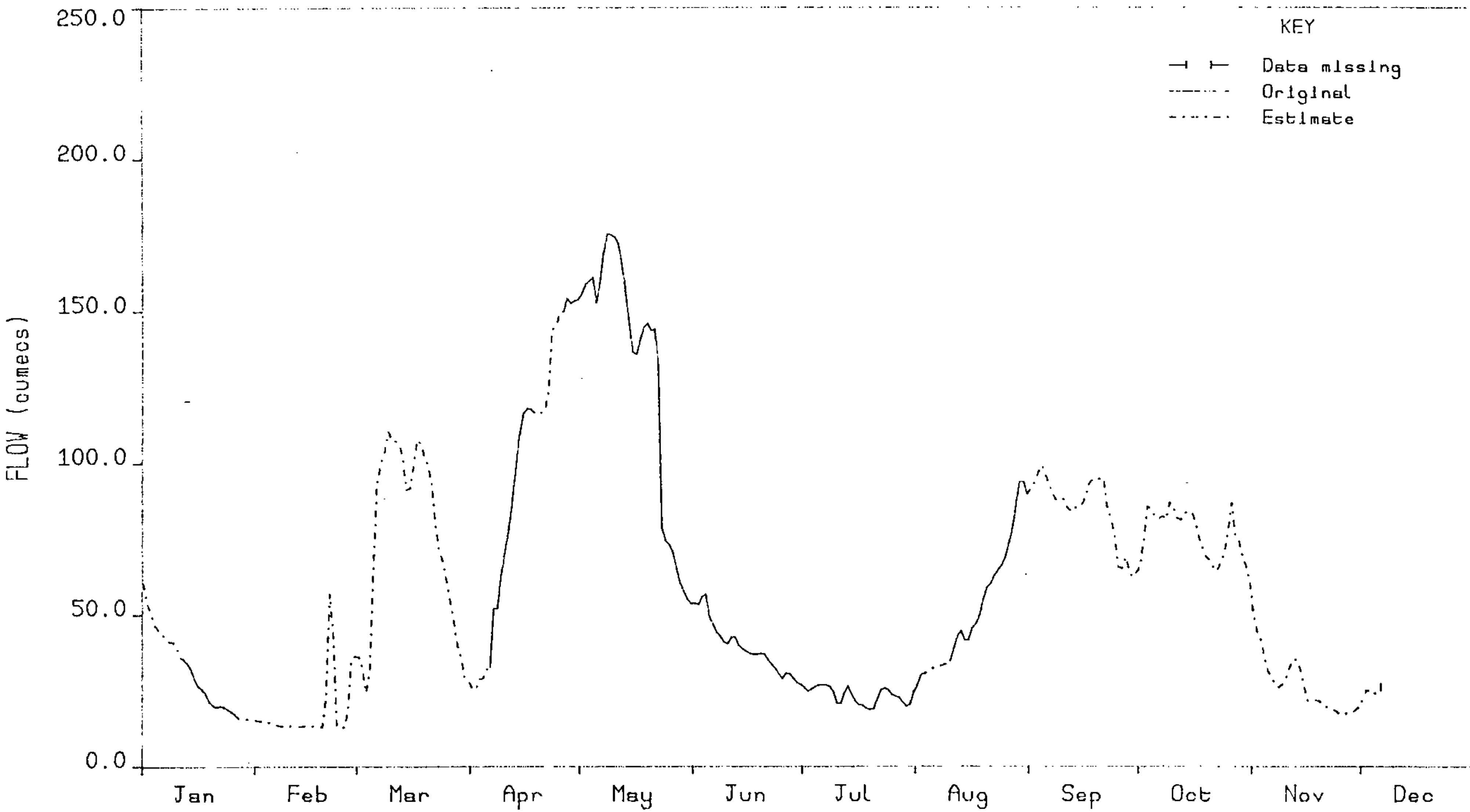

Figure D6

Department of Hydrology, Ministry of Agriculture

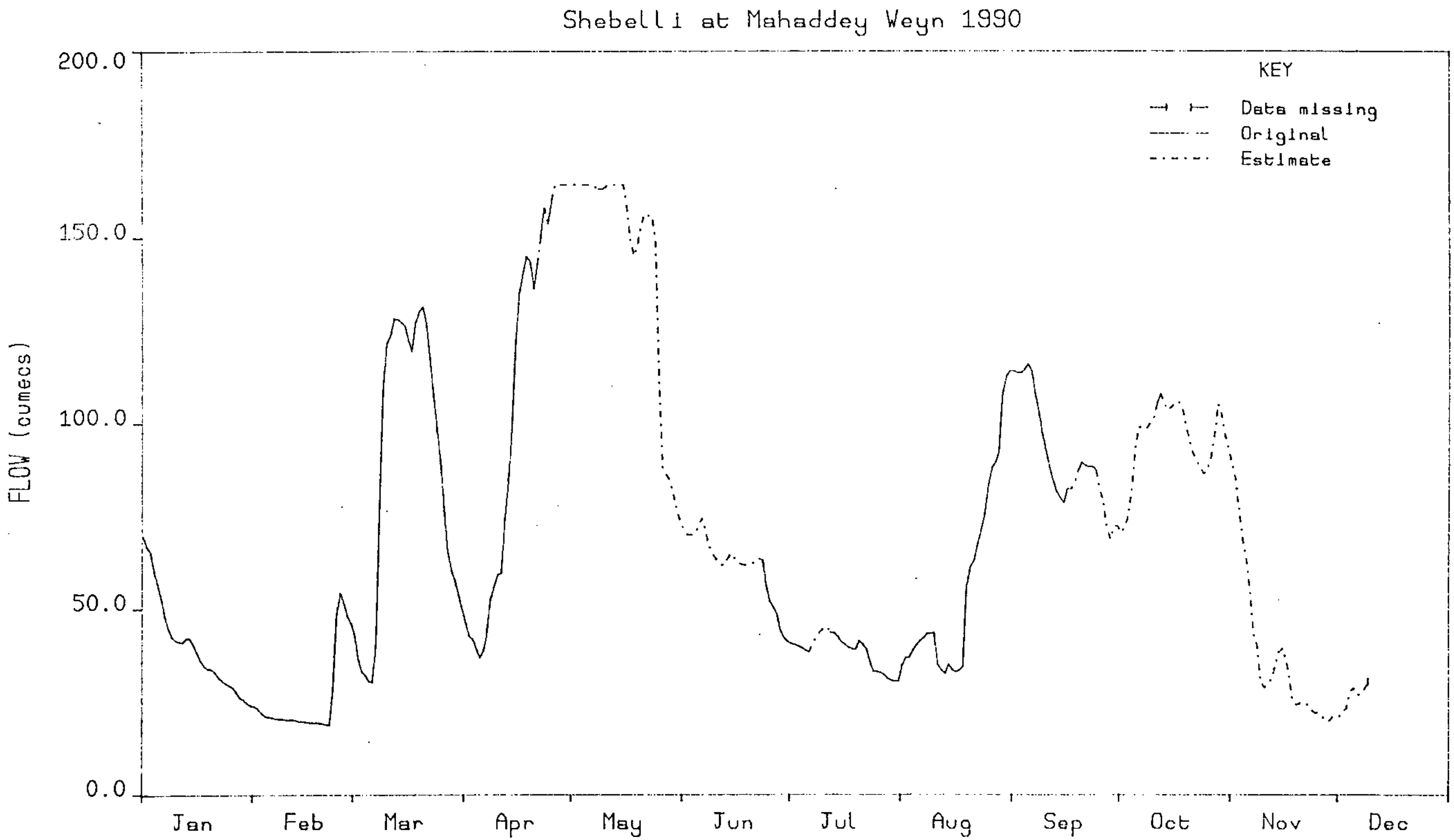

Figure D7

Department of Hydrology, Ministry of Agriculture

Shebelli at Afgoi 1990

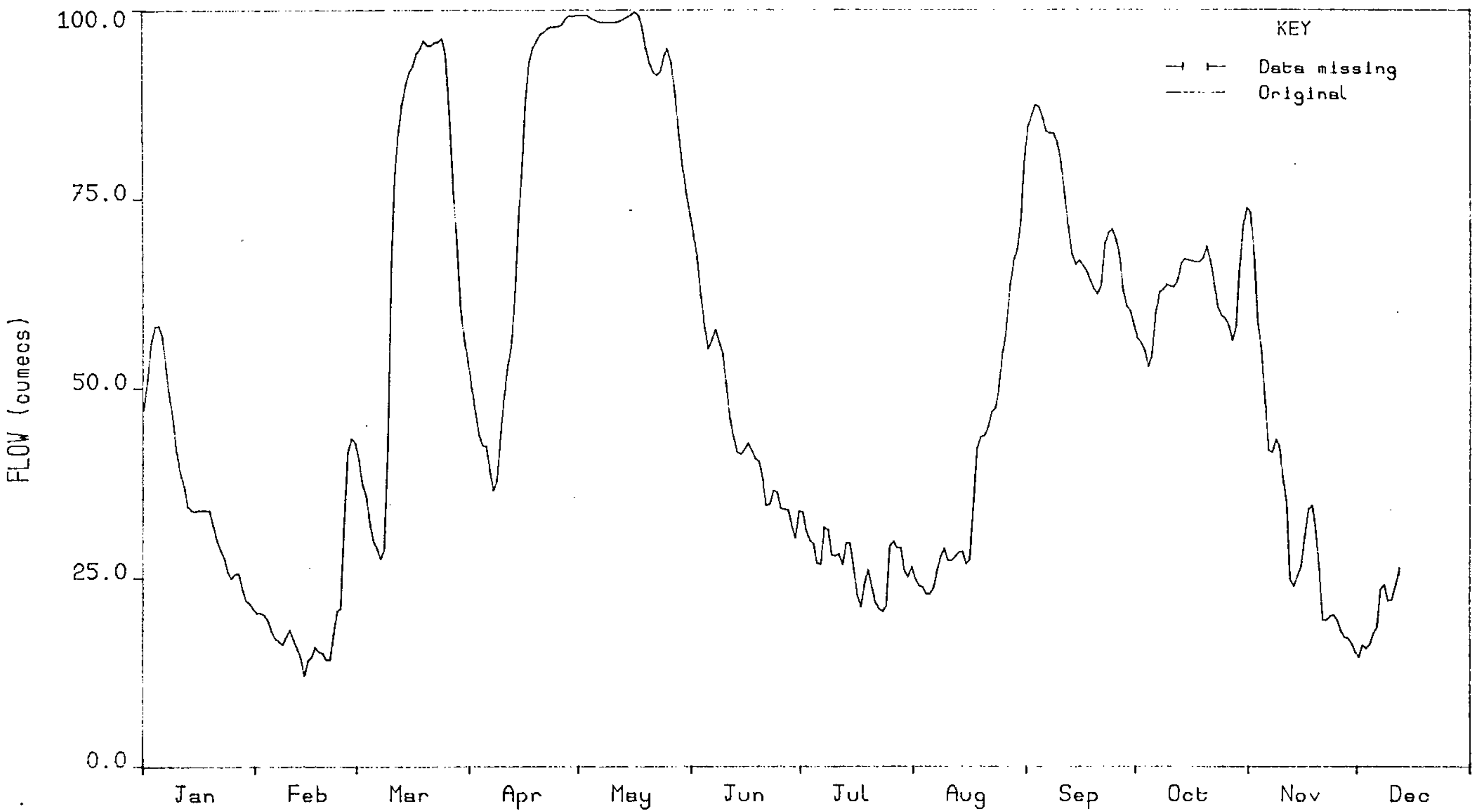

Figure D8

Department of Hydrology, Ministry of Agriculture

Shebelli at Audegle 1990

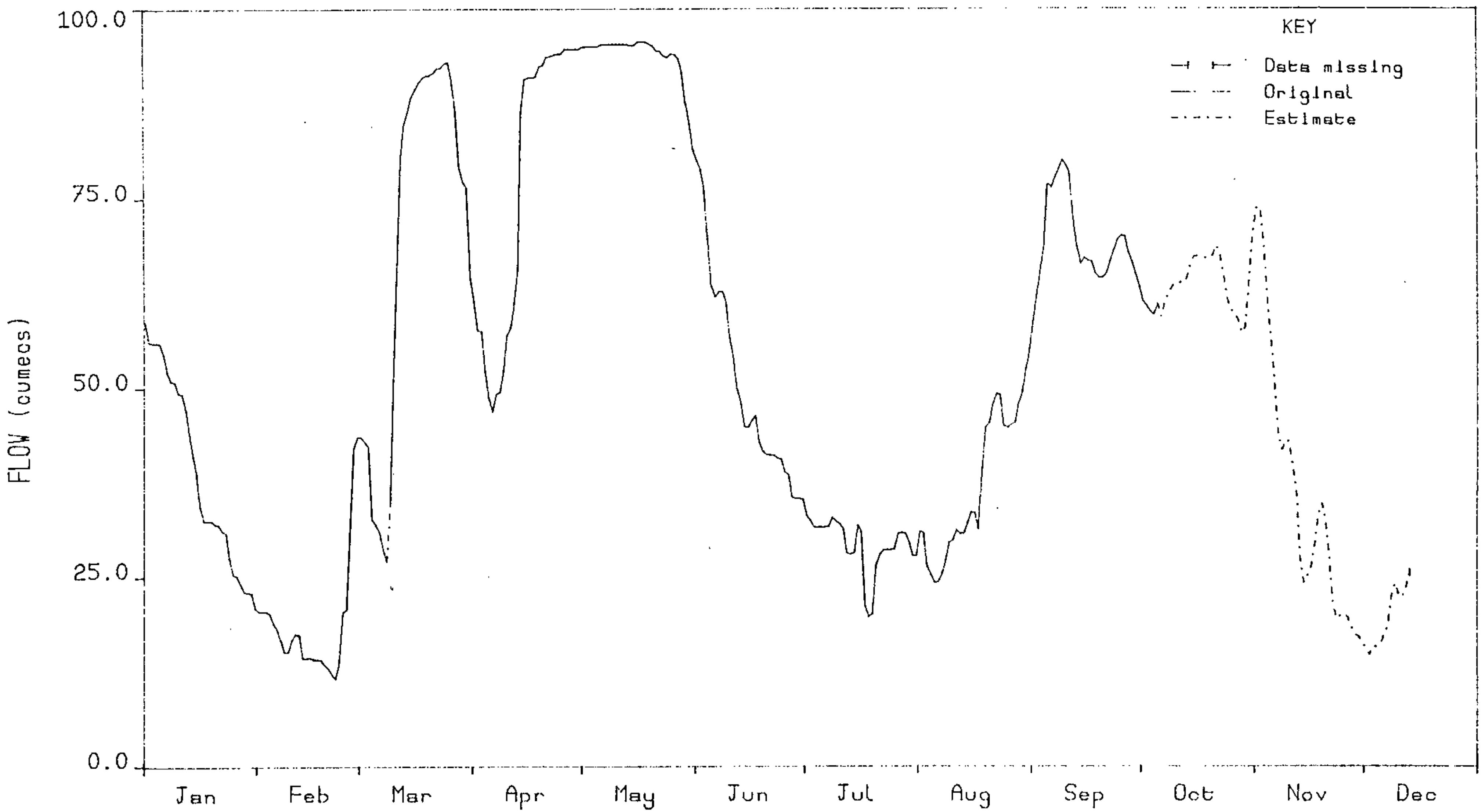

Figure D9

Department of Hydrology, Ministry of Agriculture

Jowhar Reservoir Storage 1989/90

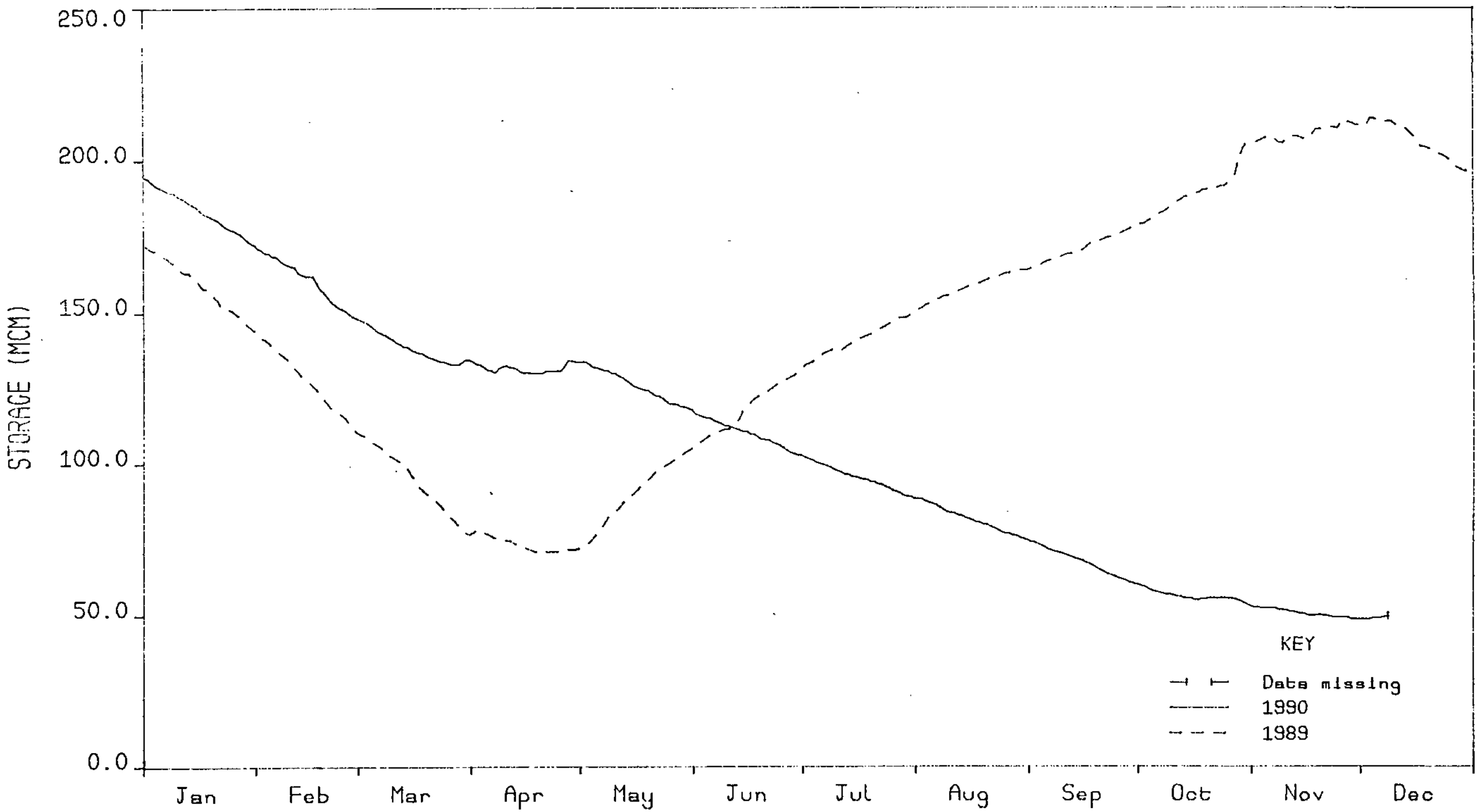

Figure D10

Department of Hydrology, Ministry of Agriculture

Shebelle d/s of outlet from JOSR

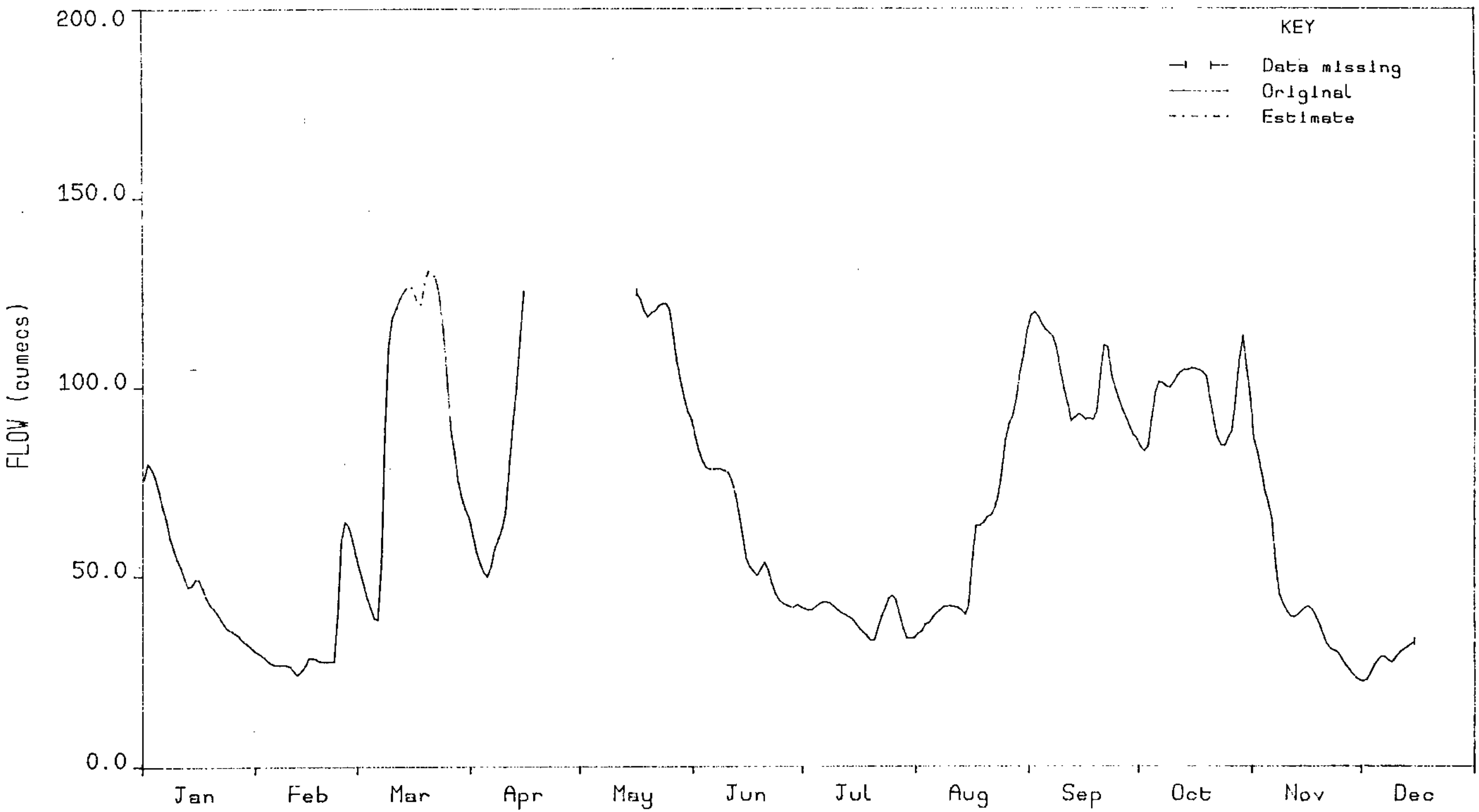

Figure D11

Department of Hydrology, Ministry of Agriculture

APPENDIX E

WATER QUALITY DATA

APPENDIX E

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(following page E-2)

LIST OF FIGURES

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APPENDIX E

WATER QUALITY DATA

E1 INTRODUCTION

Very little data is available concerning the quality of river water. This is regrettable because such information is of great importance to irrigation and to possible reservoir construction. The most comprehensive work in this field (groundwater as well as river water) was carried out by C. Faillace; reports of particular relevance are noted in the Bibliography and many others are listed in library catalogues published by the National Water Centre. This appendix makes no attempt to supersede Faillace's work, but does present some more recent data.

Currently the best regular records of river water quality are being kept by the Juba Sugar Project (JSP) for the Jubba at Mareere, for which results are contained below in Section E2. For a year up to the end of November 1990 the Hydrology Section was keeping records for the Shebelli at Afgoi, but in December it was considered unsafe to travel there and measurements have unfortunately been discontinued. The sediment and salinity results are contained in Chapter 3 of the main report. Because the scope of the analysis undertaken by the Section was severely limited by the lack of suitable laboratory facilities, the Director of Irrigation arranged for additional samples to be passed to a research scientist, Dr. Bashir, for supplementary analysis. Section E3 contains the results provided by Dr. Bashir.

E2 RIVER JUBBA AT MAREERE

Records of river level and salinity (EC) have been made on a daily basis almost continuously since 1977. This data has kindly been made available by the staff of JSP. All the daily salinity values are contained here in Tables E1 to E14, with a monthly summary in Table E15.

Figure E1 shows the "typical" conditions during the year, with the mean of the values for (eg) May 1st in each year plotted as the average EC reading for that date. This clearly demonstrates the typical pattern of steadily rising salinity during the jilaal recession, with a major peak occurring during the Gu flood season. The averaging process obviously smoothes out the fluctuations observed from day-to-day in each individual year; Figures E2 and E3 show the measurements for two sample years. Figure E4 plots the maximum and minimum values recorded for each date for the period to the end of 1989. This graph clearly shows that there is very little variation in salinity during the second half of the year, and particularly from early June to late September. There is usually a slight rise during the Der flood season, but there has never been a single value remotely as high as the peaks observed in the Jilaal and Gu seasons.

E3 RIVER SHEBELLI AT AFGOI

As indicated above, the Hydrology Section's water quality work on samples from the Shebelli at Afgoi is described in Chapter 3 of the main report. One or more additional samples were taken on each visit to Afgoi and these were passed to Dr. Bashir for further analysis. The main work which he did was to examine the distribution of the sediment between sand, silt and clay; he also determined total suspended sediment and EC, and these provide some check on the Section's results.

Dr. Bashir's results are contained in Table E16; these cover samples from the start of December 1989 to mid-October 1990, though no results were returned for some weeks in December/January. Unfortunately no details of his analysis procedures have been made available, despite repeated requests. Figure E5 compares his suspended sediment results to those of the Hydrology Section. In general there is reasonable agreement between the results, and in particular the sharp variations recorded by the Hydrology Section during the Gu flood season are closely followed by Dr. Bashir's results. At very low sediment loads there seems to be a consistent difference with Dr. Bashir's values somewhat higher; this may be due to differences in the analysis procedures adopted. There is also a noticeable difference towards the end of the period when Dr. Bashir's values for the last eight weeks look suspiciously similar to one another.

Figure E6 compares the respective results for salinity; there is close agreement from late May, but prior to that Dr. Bashir's results show two suspicious periods of constant values. There is also a sharp difference in the peak in February, but this was only one sample and either reading could be in error.

Figure E7 presents the weight distribution of the samples. Without details of the procedures it would be unwise to try to draw firm conclusions, but a few general observations may be made. The proportion of clay generally varies relatively little, but there are some sharp variations in the relative quantities of silt and sand. Usually silt comprises the major part of the sediment, through for many of the samples of high sediment load there was virtually no silt but a large amount of sand.

River Jubba at Mareere 1977

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	m	m	m	m	m	475	230e	m	250	245	285	m
2	m	m	m	m	m	448e	230	m	m	225	555	m
3	m	m	m	m	m	420	223e	m	m	340	550	m
4	m	m	m	m	m	m	215	100	230	295	500	m
5	m	m	m	m	m	m	205	110	205	225	410	650
6	m	m	m	m	m	510	190	105e	220	225	370	620e
7	m	m	m	m	m	388e	m	100	225	200	385	590
8	m	m	m	m	m	265	m	100	m	200	510	545
9	m	m	m	m	m	245	190	100	m	205	740	535
10	m	m	m	m	m	230e	120	110	m	205	885	545
11	m	m	m	m	m	215	190	100	190	220	840	530e
12	m	m	m	m	m	210	120	100	m	220	816	515
13	m	m	m	m	m	200	115	105e	m	220	800	535
14	m	m	m	m	m	205	115	110	m	220	800	490
15	m	m	m	m	m	236	m	110	295	235e	755	500
16	m	m	m	m	m	290	m	205	m	250	755	525
17	m	m	m	m	m	250	120	100	m	230	770	525
18	m	m	m	m	m	m	150	100	m	225e	m	545
19	m	m	m	m	m	m	120	100e	m	220	m	525
20	m	m	m	m	m	260	120	100	m	220	m	540
21	m	m	m	m	m	210	125	200	295	490	m	520
22	m	m	m	m	m	220e	110	200	295e	510	m	500
23	m	m	m	m	m	230	100	205	295	355	m	525
24	m	m	m	m	m	215	100	210	260e	320	m	525
25	m	m	m	m	m	m	100	225	225	285	m	515
26	m	m	m	m	m	m	100	m	265	495	m	515
27	m	m	m	m	m	m	100	m	290	310	m	515
28	m	m	m	m	m	m	100	m	220	260	m	530
29	m		m	m	m	m	105e	m	225	265	m	515
30	m		m	m	m	230	110	m	240	260	m	520
31	m		m		m		m	220		273e		505
Mean	-	-	-	-	-	-	-	-	-	273	-	-
Maximum	-	-	-	-	-	-	-	-	-	510	-	-
Minimum	-	-	-	-	-	-	-	-	-	200	-	-

Annual statistics

Insufficient data for annual statistics

Data availability

Original values	:	145
Estimated values (Flag e)	:	17
Missing values (Flag m)	:	203

River Jubba at Mareere 1978

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	515	795	820	425	560	335	365	150	180	250	175	345
2	505	740	780	415	745	320	335	170	170	230	275	355
3	505	710	820	400	580	300	340	180	190	255	365	310
4	505	730	840	405	565	345	320	195	195	180	360	325
5	540	735	860	375	565	480	300	175	190	195	435	290
6	490	740	910e	370	465	280	285	180	165	175	360	325
7	490	770	960	340	735	285	285	160	170	185	480	240
8	505	780	890	355	460	285	285	175	125	185	650	275
9	515	755	980	290	385	295	250	205	175	255	430	265
10	515	760	955e	280	385	285	250	180	185	210	390	295
11	525	760	930	270	335	255	240	200	170	265	405	220
12	525	735	800	270	370	250	250	185	160	230	365	315
13	595	800	515	270	380	295	270	180	160	170	450	255
14	545	710	390	275	375	270	250	180	155	170	395	310
15	560	695	340	295	365	280	220	170	160	170	380	295
16	580	705	270	300	340	290	240	175	165	190	485	280
17	580	700	270	340	295	270	215	180	175	725	345	280
18	580	705	260	435	275	275	205	200	165	685	385	330
19	590	705	250	1030	320	290	185	175	170	640	350	285
20	585	760	240	2015	385	290	190	205	160	280	345	385
21	620	730	295	955	675	290	280	170	175	250	305	405
22	610	825	1000	800	395	295	190	175	180	250	310	330
23	610	825	3665	1130	340	300	195	175	160	250	325	310
24	650	785	1920	805	295	310	180	175	170	260	330	315
25	650	800	850	565	290	310	190	175e	190	260	350	330
26	720	825	515	510	220	325	175	180e	180	225	370	320
27	720	830	390	890	250	345	180	180	175	230	335	325
28	665	750	385	660e	260	350	200	155	180	245	325	415
29	760		350	430	295	350	195	175	190	245	320	315
30	665		345	685	300	365	180	180	190	240	355	325
31	695		385		315		170	175		240		320
Mean	584	756	748	553	404	307	239	179	173	269	372	313
Maximum	760	830	3665	2015	745	480	365	205	195	725	650	415
Minimum	490	695	240	270	220	250	170	150	125	170	175	220

Annual statistics

Mean :	406	(micro Siemens)
Maximum :	3665	(micro Siemens)
Minimum :	125	(micro Siemens)

Data availability

Original values	:	360
Estimated values (Flag e)	:	5
Missing values (Flag m)	:	0

River Jubba at Mareere — 1979

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	335	530	445	755	175	150	215	245	180	180	234e	255
2	315	585	445	660	180	150	205	250	195	200	270	255
3	320	515	415	3930	220	150	200	250	190	190	255	265
4	325	510	405	960	320	180	215	255	185	190	190	300
5	315	500	380	710	330	160	210	245	195	200	200	275
6	310	420	355	785	1245	120	210	240	195	220	200	270
7	330	410	345	940	1010	120	210	240	190	225	250	280
8	320	395	330	665	823e	595	210	235	200	205	230	285
9	330	390	340	435	635	295	205	245	200	200	370	335
10	325	375	340	325	960	180	205	230	200	190	1000	310
11	345	375	345	450	785	280	210	210	205	175	1090	310
12	350	350	290	405	480	495	205	210	210	170	460	325
13	350	370	335	510	480	300	210	200	235	160	460	340
14	365	370	330	1415	400	250	200	195	240	170	325	345
15	375	365	350	785	380	250	210	190	240	155	270	345
16	380	320	370	890	410	180	210	195	255	160	265	365
17	370	355	370	435	200	150	210	200	260	155	225	375
18	405	310	380	400	190	150	200	200	270	160	195	370
19	400	285	380	400	190	150	195	205	285	190	375	375
20	400	270	415	440	200	120	200	190	285	180	310	380
21	415	270	455	435	200	195	200	195	275	160	250	415
22	415	274	450	390	200	200	210	200	270	160	240	425
23	420	280	460	860	295	200	210	200	240	175	265	430
24	430	285	475	1395	250	200	200	215	245	150	260	400
25	435	300	495	1415	220	210	200	215	250	150	230	400
26	465	310	495	520	180	200	215	220	230	170	210	405
27	460	310	510	450	180	210	230	200	230	180	345	420
28	455	380	595	270	180	205	235	200	210	290	290	425
29	460		585	265	180	195	240	180	200	190	295	435
30	480		535	178	150	195	240	165	190	190	265	460
31	435		580		150		240	160		207e		480
Mean	382	372	419	749	381	215	211	212	225	184	327	357
Maximum	480	585	595	3930	1245	595	240	255	285	290	1090	480
Minimum	310	270	290	178	150	120	195	160	180	150	190	255

Annual statistics

Mean : 335 (micro Siemens)
Maximum : 3930 (micro Siemens)
Minimum : 120 (micro Siemens)

Data availability

Original values : 362
Estimated values (Flag e) : 3
Missing values (Flag m) : 0

River Jubba at Mareere 1980

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	510	785	1270	1280	1780	610	305	165	245	189	175	285
2	510	805	1315	1330	1510	570	300	175	219	182	175	290
3	520	810	1355	1275	1850	530	290	170	213	190	185	460
4	495	820	1380	1280	990	560	310	180	207	195	190	290
5	520	810	1345	1290	1025	650	290	175	207	207	195	285
6	525	845	1380	1330	2055	650	295	175	200	181	200	300
7	520	855	1430	1360	1380	685	335	185	206	192	200	325
8	525	875	1440	1370	960	725	295	185	196	181	180	335
9	605	865	1375	1360	945	810	250	185	196	192	205	300
10	575	895	1420	1390	1385	745	250	195	192	198	195	375
11	560	900	1345	1450	4715	680	245	195	184	190	195	360
12	575	910	1380	1510	3020	665	220	195	219	198	180	370
13	580	930	1310	1485	1585	655	205	195e	196	198	175	385
14	615	950	1285	1570	1125	600	185	195	193	182	185	365
15	620	1045	1260	1560	840	540	185	205	192	179	180	385
16	630	1110	1215	1630	610	480	185	220	192	176	245	395
17	630	975	1205	1665	1010	450	175	200	196	132	235	390
18	645e	1255	1215	1755	1045	420	285	200	193	179	220	395
19	660	1045	1215	1665	835	430	190	195	192	160	240	385
20	675	1095	1150	1690	670	420	185	195	183	189	235	410
21	685	1115	1130	1815	750	485	170	190	181	167	260	395
22	685	1105	1120	1940	2110	325	170	186	202	176	230	405
23	680	1140	1120	1940	1310	335	170	176	190	176	275	415
24	660	1140	1110	2085	905	325	175	180	202	183	1150	415
25	700	1150	1125	1955	670	305	387	176	202	187	800	415
26	690	1160	1135	2150	630	305	190	158	192	183	400	405
27	720	1200	1155	2085	575	305	190	190	190	174	330	410
28	730	1250	1260	1815	675	300	175	195	202	173	290	405
29	735	1260	1155	1800	665	295	170	157	200	168	275	410
30	755		1250	2225	770	290	185	166	200	179	275	430
31	755		1310		665		170	347		185		425
Mean	622	1003	1263	1635	1260	505	230	191	199	182	276	375
Maximum	755	1260	1440	2225	4715	810	387	347	245	207	1150	460
Minimum	495	785	1110	1275	575	290	170	157	181	132	175	285

Annual statistics

Mean : 643 (micro Siemens)
Maximum : 4715 (micro Siemens)
Minimum : 132 (micro Siemens)

Data availability

Original values : 364
Estimated values (Flag e) : 2
Missing values (Flag m) : 0

River Jubba at Mareere 1981

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	472	960	1027	594	738	522	680	460e	192	186	199	276
2	495	960	1063	1295	707	538	680	415e	196	170	228	276
3	509	952	1037	904	707	529	630	391	182	176	240	283
4	523	1000	996	710	707	816	634	320	196	196	240	292
5	522	986	1008	912	707	524	643	299	196	157	230	323
6	570	1047	1018	1132	660	566	650	294	196	179	217	316
7	580	1015	990	1650	672	523	640	297	198	184	199	323
8	594	1047	1037	1320	672	538	630	310	210	182e	220	327
9	619	1047	979	786	657	538	650	280	190	179	201	342
10	634	1047	934	1037	666	544	617	306	190	198	201	362
11	641	1047	934	842	624	554	626	260	192	166	201	342
12	634	1112	925	1084	604	550	612	260	192	173	199	380
13	704	1132	979	1295	619	550	624	294	201	179	226	371
14	704	1084	961	1122	576	550	600	280	196	176	236	374
15	720	1092	943	857	576	560	590	280	192	179	660	384
16	714	1075	896	726	568	560	550	293	186	188	314	392
17	761	1132	879	685	577	550	540	240	190	186	238	374
18	769	952	856	622	577	550	510	230	178	182	244	377
19	816	1037	856	612	568	530	510	250	186	180	280	383
20	771	1480	848	490	587	530	490	240	188	177	276	398
21	810	1122	848	848	590	525	460	261	186	228	285	400
22	847	1122	840	726	594	550	460	250	200	209	283	405
23	851	1121	848	840	587	550	440	242	186	238	273	500
24	864	1121	816	1018	587	600	430	250	188	184	264	811
25	912	1152	846	848	554	564	440	214	182	188	266	624
26	904	1015	2640	768	541	584	450	200	168	180	282	519
27	902	1094	3650	758	518	565	460	210	183	190	277	518
28	870	1063	2564	707	499	555	490	210	182	186	251	504
29	904		1295	704	523	545	416	200	190	575	259	509
30	943		1110	768	504	550	470	203	192	273	250	504
31	943		560		495		495	205		238		514
Mean	726	1072	1135	889	605	557	552	272	190	203	258	410
Maximum	943	1480	3650	1650	738	816	680	460	210	575	660	811
Minimum	472	952	560	490	495	522	416	200	168	157	199	276

Annual statistics

Mean	:	569 (micro Siemens)
Maximum	:	3650 (micro Siemens)
Minimum	:	157 (micro Siemens)

Data availability

Original values	:	362
Estimated values (Flag e)	:	3
Missing values (Flag m)	:	0

TABLE E.6

River Jubba at Mareere 1982

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	518	854	943	1301	586	366	245	215	190	163	292	245
2	528	806	962	1298	389	336	240	231	190	163	283	250
3	571	826	979	1317	379	333	240	234	194	173	272	252
4	557	806	990	1399	463	294	226	234	194	162	290	255
5	561	800	1009	1315	837	294	240	231	186	157	281	259
6	571	783	1008	1259	405	307	212	224	166	170	315	680
7	598	792	1088	1110	672	309	236	215	166	226	368	377
8	613	806	1110	1043	336	258	230	196	170	192	374	315
9	629	847	1110	1179	384	288	210	188	186	173	325	287
10	616	915	1150	1027	374	298	206	184	200	1920	361	333
11	638	952	1132	998	449e	277e	206	170	170	614	274	330
12	645	960	1167	890	524	256e	210	160	163	1214	472	273
13	657	970	1202	907	355	236	207	200	179	333	849	286
14	662	1000	1237	912	352	243	206	200	170	274	934	236
15	685	962	1351	915	1467	235	186	202	178	417	693	213
16	670	960	1392	887	1344	230	196	194	180	272	564	194
17	682	934	1285	839	811	238	195	200	185	276	594	228
18	710	896	1322	839	499	250	191	190	185	236	575	220
19	717	866	1388	705	528	242	190	200	176	321	509	231
20	724	848	1480	785	774	245	196	200	194	386	472	241
21	724	839	1556	508	676	252	190	190	186	370	416	249
22	749	850	1603	377	734	251	193e	190	192	327	426	245
23	754	823	1666	346	441	255	196	202	186	385	416	248
24	762	841	1728	1037	470	250	196	204	189	415	333	241
25	771	850	1723	394	432	257	198	190	176	384	318	245
26	806	857	1888	874	384	253	190	200	152	257	267	243
27	806	879	1823	471	355	263	202	196	182	329	278	259
28	816	925	1805	1886	326	260	194	196	182	278	254	267
29	862		1714	546	336	260	204	200	192	275	250	271
30	849		1451	379	330	255	200	206	173	283	250	273
31	839		1351		345		210	190		278		267
Mean	687	873	1342	925	541	270	208	201	181	368	410	275
Maximum	862	1000	1888	1886	1467	366	245	234	200	1920	934	680
Minimum	518	783	943	346	326	230	186	160	152	157	250	194

Annual statistics

Mean :	521	(micro Siemens)
Maximum :	1920	(micro Siemens)
Minimum :	152	(micro Siemens)

Data availability

Original values :	361
Estimated values (Flag e) :	4
Missing values (Flag m) :	0

River Jubba at Mareere 1983

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	238	407	412	626	283	192	208	192	168	166	163	162
2	231	431	485	645	324	202	218	190	157	171	170	157
3	243	415	504	657	384	182	158	186	157	152	175	167
4	231	462	538	694	368	480	196	170	170	141	189	170
5	217	453	476	729	1756	277	215	182	164	141	189	166
6	217	453	444	745	1034	232	210	166	164	141	189	179
7	238	458e	416	785	2335	205	206	176	170	160	194	181
8	248	463	420	786	1226	232	203	166	182	148	185	188
9	248	463	472	816	786	202	196	160	163	180	194	158
10	250	486	495	846	509	193	190	158	163	167	204	194
11	256	490	462	852	420	193	196	163	164	176	218	158
12	268	499	463	881	292	193	245	149	163	151	205	200
13	268	515	463	908	283	186	255	160	166	148	163	204
14	288	544	481	943	292	174	240	160	163	148	272	207
15	256	537	499	980	307	186	220	168	163	148	218	198
16	305	509	522	998	295	195	220	157	163	151	222	207
17	292	546	530	998	336	176	215	168	155	148	204	224
18	318	555	551	998	333	176	211	166	163	145	231	224
19	264	566	555	952	336	183	230	166	174	148	199	211
20	410	599	553	980	538	188	215	150	163	148	185	226
21	336	580	580	1008	1542	190	217	160	163	156	190	226
22	346	546	550	1018	566	195	221	158	164	163	277	226
23	363	500	562	1074	432	195	213	176	157	183	176	231
24	379	495	544	1111	286	196	210	166	145	181	181	234
25	389	879	556	1242	259	206	173	188	148	157	175	240
26	370	424	576	941	235	188	176	186	152	181	175	231
27	389	415	555	624	207	210	182	178	153	178	172	243
28	392	412	571	466	194	202	176	176	163	190	175	245
29	396		578	377	192	206	186	165	157	185	172	255
30	416		587	327	211	200	192	170	164	185	185	250
31	415		620		200		193	168		172		262
Mean	306	504	517	834	541	208	206	169	162	162	195	207
Maximum	416	879	620	1242	2335	480	255	192	182	190	277	262
Minimum	217	407	412	327	192	174	158	149	145	141	163	157

Annual statistics

Mean	:	333	(micro Siemens)
Maximum	:	2335	(micro Siemens)
Minimum	:	141	(micro Siemens)

Data availability

Original values	:	364
Estimated values (Flag e)	:	1
Missing values (Flag m)	:	0

TABLE E.8

River Jubba at Mareere — 1984

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	264	378	671	962	1037	3200	306	275	176	173	209	330
2	264	421	660	971	662	2016	265	275	186	166	190	377
3	280	430	566	1073	557	931	275	270	190	170	189	336
4	278	440	678	1079	519	587	260	250	173	240	179	321
5	283	432	694	1110	594	548	260	255	150	236	179	283
6	308	428	698	1045	432	420	296	224	173	192	190	330
7	302	493	679	1008	394	400	296	210	180	192	190	292
8	318	467	733	1064	384	340	300	204	166	187	247	269
9	315	416	752	1043	451	340	300	194	176	179	377	321
10	315	500	758	1077	538	340	280	204	176	187	245	278
11	321	518	777	1027	624	323	260	194	180	186	285	296
12	330	528	786	1036	845	307	240	184	196	182	235	296
13	324	514	786	1064	1056	300	224	180	186	173	201	283
14	343	532	786	1110	981	290	245	180	192	144	282	330
15	336	518	786	1119	1224	347	235	180	192	155	601	321
16	362	527	802	1129	1165	306	200	180	182	141	405	201
17	370	537	805	1129	2643	320	220	184	163	173	415	336
18	368	556	805	1156	2350	250	200	184	157	141	282	339
19	387	547	830	1150	2154	290	250	180	157	148	280	292
20	378	547	830	1226	1056	300	236	190	147	167	330	373
21	356	566	864	1235	871	280	226	184	173	174	601	370
22	368	607	864	1320	672	250	240	250	173	163	339	370
23	370	590	858	1320	548	234	260	210	166	155	339	377
24	370	613	858	1314	472	230	260	230	186	160	321	361
25	379	613	896	1270	470	270	260	190	196	187	288	387
26	389	629	907	1424	461	215	250	180	182	179	660	407
27	387	629	916	1440	442	245	227	180	196	141	730	349
28	387	613	943	1507	432	230	245	208	211	189	282	396
29	392	638	944	1509	557	204	296	200	206	283	249	422
30	405		1008	1254	1958	245	296	200	202	245	242	432
31	362		1018		3072		275	176		235		424
Mean	342	525	805	1172	956	485	258	207	180	182	319	339
Maximum	405	638	1018	1509	3072	3200	306	275	211	283	730	432
Minimum	264	378	566	962	384	204	200	176	147	141	179	201

Annual statistics

Mean : 480 (micro Siemens)
Maximum : 3200 (micro Siemens)
Minimum : 141 (micro Siemens)

Data availability

Original values : 366
Estimated values (Flag e) : 0
Missing values (Flag m) : 0

River Jubba at Mareere 1985

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	424	691	1185	1848	528	190	143	163	175	173	214	547
2	424	701	1200	1924	538	190	117	186	172	167	200	326
3	415	740	1161	1825	870	196	122	186	168	165	214	326
4	420	786	1160	1943	967	193	122	174	169	161	188	281
5	352	803	1161	1756	1247	193	121	181	174	166	176	291
6	508	814	1203	1037	480	193	112	174	181	163	176	285
7	324	839	1224	786	432	240	110	181	173	183	176	286
8	472	858	1203	544	607	238	110	181	171	178	252	286
9	472	896	1249	550	644	238	110	199	175	171	302	291
10	472	847	1240	592	636	208	110	176	175	166	363	267
11	513	768	1286	849	480	198	91	181	169	165	333	291
12	528	786	1509	1371	762	200	120	165	190	161	238	291
13	546	776	1556	1400	789	198	110	170	183	155	213	286
14	524	796	1665	1536	424	198	110	165	184	153	202	286
15	528	833	1665	1401	408	200	110	165	194	173	238	286
16	546	842	1711	1371	387	200	110	176	195	165	238	286
17	518	833	1786	1451	355	202	121	302	197	216	214	310
18	564	886	1832	1392	302	202	102	211	202	169	238	310
19	560	896	1850	943	422	200	130	185	214	363	205	333
20	507	912	1850	960	432	200	122	180	192	494	713	343
21	509	886	1711	998	392	200	102	170	205	183	452	333
22	518	925	1679	2592	313	190	112	180	252	171	333	356
23	522	887	1745	1995	297	180	102	166	207	172	286	369
24	508	887	1775	2252	290	165	112	161	179	160	288	369
25	611	907	1780	1018	277	160	112	171	179	168	290	380
26	601	879	1821	1056	196	160	150	217	182	162	290	377
27	613	1466	1769	930	230	150	150	174	303	166	282	404
28	601	1588	1814	851	193	151	120	166	176	152	290	404
29	607		1850	613	192	143	159	172	168	223	333	428
30	707		1568	538	198	143	174	171	173	271	523	428
31	654		1665		200		162	170		224		356
Mean	518	883	1544	1277	467	191	121	181	189	192	282	336
Maximum	707	1588	1850	2592	1247	240	174	302	303	494	713	547
Minimum	324	691	1160	538	192	143	91	161	168	152	176	267

Annual statistics

Mean	:	513	(micro Siemens)
Maximum	:	2592	(micro Siemens)
Minimum	:	91	(micro Siemens)

Data availability

Original values	:	365
Estimated values (Flag e)	:	0
Missing values (Flag m)	:	0

River Jubba at Mareere 1986

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	443	808	1057	1451	613	288	305	210	200	157	509	302
2	443	823	1077	1633	849	326	294	202	193	166	358	345
3	443	823	1037	1537	802	355	264	200	202	166	330	389
4	432	855	1175	1649	566	302	265	210	200	170	472	379
5	435	903	1088	1633	509	346	245	214	235	163	324	324
6	469	903	1099	1678	443	288	300	210	210	152	245	327
7	380	820	1100	1728	405	278	224	199	202	160	283	481
8	404	820	1312	1728	409	352	224	220	192	157	231	452
9	475	833	1179	1758	405	343	164	205	192	157	218	444
10	475	833	1179	1804	400	784	224	200	192	160	200	361
11	475	841	1130	1582	371	554	218	204	200	163	200	364
12	444	868	1132	1509	422	441	215	200	211	178	204	364
13	475	887	1179	1374	682	313	240	204	203	178	190	372
14	475	901	1203	1315	532	294	220	204	206	174	208	458
15	504	883	1224	1156	442	267	228	225	210	176	217	387
16	475	920	1270	962	411	294	204	206	211	178	174	396
17	547	860	1238	862	330	390	204	206	240	181	231	416
18	552	930	1270	550	368	293	192	220	250	176	202	413
19	532	969	1270	651	336	300	192	210	211	163	217	400
20	522	969	1328	535	309	241	184	210	192	170	236	407
21	513	1021	1367	601	336	236	184	210	190	170	250	407
22	713	1021	1361	1603	336	217	192	225	176	200	250	435
23	713	989	1374	1296	355	300	192	200	171	200	236	416
24	713	1057	1388	1132	326	275	204	200	190	170	250	453
25	592	1037	1361	1405	355	260	200	210	180	160	245	472
26	750	1048	1361	2142	307	306	200	210	184	170	267	472
27	760	1067	1451	819	271	316	200	203	173	189	283	444
28	760	1048	1451	614	326	275	204	208	173	222	283	407
29	784		1451	768	277	250	208	215	190	1367	257	416
30	796		1451	571	335	197	204	196	170	1397	205	416
31	808		1508		413		224	200		833		426
Mean	558	919	1260	1268	427	323	220	208	198	272	259	405
Maximum	808	1067	1508	2142	849	784	305	225	250	1397	509	481
Minimum	380	808	1037	535	271	197	164	196	170	152	174	302

Annual statistics

Mean	:	523	(micro Siemens)
Maximum	:	2142	(micro Siemens)
Minimum	:	152	(micro Siemens)

Data availability

Original values	:	365
Estimated values (Flag e)	:	0
Missing values (Flag m)	:	0

River Jubba at Mareere 1987

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	412	720	1015	1611	340	971	360	292	337	259	183	218
2	397	743	1046	1617	486	840	334	315	446	257	183	223
3	377	754	1054	1827	273	813	360	315	420	232	198	278
4	363	754	1047	1678	430	735	341	315	379	227	216	297
5	370	787	1064	1719	298	750	386	318	360	236	216	273
6	370	802	1081	2103	360	670	394	289	341	232	347	297
7	377	816	1110	1934	350	643	367	309	341	232	224	248
8	370	854	1110	1448	357	603	367	334	278	236	892	273
9	389	858	1110	1289	383	603	367	295	253	223	2132	273
10	405	868	1170	783	354	662	394	322	232	232	935	273
11	420	860	1149	744	446	603	375	322	236	227	793	279
12	409	842	1191	793	1191	578	367	309	210	257	372	279
13	438	879	1193	778	620	578	352	334	214	236	297	279
14	472	879	1248	620	397	578	345	360	184	227	273	279
15	467	862	1287	595	322	536	325	360	202	257	273	309
16	472	905	1252	511	365	525	348	355	170	253	248	297
17	476	879	1214	471	360	499	315	375	179	227	238	292
18	524	924	1191	438	365	515	289	334	278	227	223	322
19	530	952	1338	545	372	509	289	375	257	196	213	347
20	538	934	1488	535	340	499	262	360	206	179	273	322
21	551	934	1488	496	972	446	251	394	236	197	228	340
22	576	941	1517	645	455	402	252	394	206	202	233	322
23	624	943	1467	464	778	402	252	394	232	206	233	354
24	619	959	1467	626	1213	402	283	367	210	223	233	354
25	634	980	1541	608	1492	402	289	371	206	183	208	389
26	636	960	1512	372	1312	367	257	367	253	208	218	389
27	643	1000	1556	322	798	367	252	375	257	193	208	347
28	660	962	1647	316	1338	367	289	367	257	193	203	322
29	670		1587	267	1081	348	289	420	232	178	206	347
30	707		1632	267	1049	348	283	367	253	193	218	365
31	714		1590		1049		292	402		183		438
Mean	504	877	1302	881	643	552	320	349	262	220	364	310
Maximum	714	1000	1647	2103	1492	971	394	420	446	259	2132	438
Minimum	363	720	1015	267	273	348	251	289	170	178	183	218

Annual statistics

Mean : 546 (micro Siemens)
Maximum : 2132 (micro Siemens)
Minimum : 170 (micro Siemens)

Data availability

Original values : 365
Estimated values (Flag e) : 0
Missing values (Flag m) : 0

TABLE E.12

River Jubba at Mareere 1988

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	421	744	1141	1653	1046	328	295	311	180	639	242	270
2	421	744	1091	1653	893	354	268	304	180	560	236	273
3	426	723	1091	1896	1041	360	268	250	174	435	235	288
4	413	694	1091	1750	1116	334	262	249	184	373	235	288
5	421	681	1112	1799	1592	309	262	255	158	311	253	288
6	421	669	1066	1487	1066	283	268	227	171	250	238	282
7	438	729	1112	1438	545	283	220	205	165	216	240	316
8	496	729	1091	1458	379	257	268	202	168	218	230	287
9	486	778	1118	1363	496	262	262	201	174	207	236	296
10	462	819	1181	1339	545	257	295	208	164	191	268	315
11	583	819	1181	1339	521	257	295	205	174	189	259	315
12	535	826	1205	1363	744	262	262	215	199	186	258	321
13	486	819	1215	1388	735	262	268	211	187	183	323	409
14	545	819	1191	1264	437	262	231	211	183	183	381	424
15	482	867	1191	1339	397	295	241	211	183	180	345	427
16	578	875	1215	910	404	283	241	218	192	173	259	444
17	583	875	1215	1094	422	341	322	218	193	173	253	455
18	626	900	1215	545	404	367	262	227	199	177	253	465
19	632	908	1215	632	404	371	244	211	204	182	264	475
20	632	900	1215	480	404	446	241	202	193	180	293	474
21	632	900	1361	669	404	482	214	196	185	188	381	495
22	632	927	1507	446	397	499	214	193	182	182	381	495
23	632	942	1542	595	404	566	214	199	171	316	259	495
24	694	1011	1653	1140	404	566	214	180	164	246	247	544
25	694	1016	1653	708	354	566	236	187	187	205	247	544
26	744	1041	1653	595	329	472	210	187	201	345	247	505
27	733	1041	1542	4214	354	499	210	177	193	288	252	544
28	849	1118	1604	1466	329	525	197	174	225	411	275	555
29	834	1091	1604	2033	329	430	210	171	498	460	259	594
30	834		1636	1735	379	322	214	174	1057	268	279	594
31	768		1586		329		322	177		245		605
Mean	585	862	1306	1326	568	370	249	211	223	270	271	422
Maximum	849	1118	1653	4214	1592	566	322	311	1057	639	381	605
Minimum	413	669	1066	446	329	257	197	171	158	173	230	270

Annual statistics

Mean :	554	(micro Siemens)
Maximum :	4214	(micro Siemens)
Minimum :	158	(micro Siemens)

Data availability

Original values :	366
Estimated values (Flag e) :	0
Missing values (Flag m) :	0

River Jubba at Mareere 1989

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	421	891	1747	2038	742	570	256	221	230	226	293	406
2	421	874	1844	2038	1485	840	240	248	226	203	316	437
3	426	891	1844	1456	1116	780	245	253	226	226	322	429
4	413	874	1795	1165	792	620	241	276	230	226	339	451
5	421	940	1795	1068	1534	650	245	268	226	226	339	451
6	421	970	1683	922	1138	650	243	310	230	226	332	451
7	438	1110	1683	1176	792	590	250	276	230	203	339	451
8	496	1110	1732	1225	728	592	255	271	234	226	339	420
9	486	1110	1336	1359	679	596	255	246	230	230	339	398
10	462	1089	1386	1359	679	620	259	266	253	226	368	497
11	583	1068	1456	1062	807	549	269	258	238	230	384	497
12	535	1110	1553	1116	959	544	264	230	271	230	361	497
13	486	1188	1553	1213	873	519	321	251	253	253	354	497
14	545	1188	1650	594	706	538	302	253	248	437	332	368
15	482	1188	1650	544	1165	528	296	248	239	271	354	552
16	578	1310	1747	792	1237	547	321	248	234	253	339	542
17	583	1310	1747	2911	610	566	321	230	234	226	298	553
18	626	1188	1747	1601	770	528	343	281	226	253	293	564
19	632	1312	1782	2353	670	519	339	276	226	226	293	591
20	632	1336	1915	2329	650	490	346	293	226	230	316	443
21	632	1336	2029	1732	670	443	324	239	234	226	339	451
22	632	1456	2078	1262	670	490	307	248	263	322	367	339
23	632	1553	2232	1116	600	547	304	305	258	745	700	288
24	694	1664	2276	1068	700	528	293	276	230	529	414	271
25	694	1644	2523	1019	640	392	311	253	234	429	384	271
26	744	1541	2375	1213	590	333	281	248	234	322	384	248
27	733	1584	2426	1019	700	288	271	253	226	310	361	271
28	849	1747	2620	757	560	269	305	271	230	880	971	271
29	834		1941	742	500	259	281	276	226	451	483	258
30	834		2038	757	630	245	256	253	230	316	483	253
31	768		1979		680		230	253		316		258
Mean	585	1235	1876	1300	809	521	283	261	236	312	385	409
Maximum	849	1747	2620	2911	1534	840	346	310	271	880	971	591
Minimum	413	874	1336	544	500	245	230	221	226	203	293	248

Annual statistics

Mean	:	681	(micro Siemens)
Maximum	:	2911	(micro Siemens)
Minimum	:	203	(micro Siemens)

Data availability

Original values	:	365
Estimated values (Flag e)	:	0
Missing values (Flag m)	:	0

TABLE E.14

River Jubba at Mareere 1990

Daily mean electrical conductivity (micro Siemens)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	253	361	642	310	496	632	366	271	293	361	332	288
2	226	361	587	288	752	376	268	265	338	310	391	265
3	722	414	620	443	797	361	253	293	221	248	414	271
4	276	398	642	384	835	443	304	293	226	221	354	258
5	299	406	664	487	752	587	293	271	226	248	443	230
6	316	406	620	384	752	465	276	293	265	265	443	243
7	293	398	487	632	542	496	281	265	226	265	451	248
8	293	451	587	686	487	361	474	288	221	248	428	221
9	271	451	496	406	487	332	281	322	243	248	414	226
10	271	420	487	443	542	332	253	293	226	271	428	m
11	253	474	542	443	542	310	451	243	205	265	428	m
12	276	474	542	664	575	288	243	310	226	271	414	m
13	338	451	542	722	542	251	242	226	221	243	406	m
14	316	474	310	797	575	276	268	243	226	265	391	m
15	316	451	542	384	708	310	328	221	221	221	406	m
16	338	496	542	487	575	310	328	226	226	226	474	m
17	276	506	542	531	542	310	293	221	208	221	686	m
18	271	496	496	587	542	310	265	243	205	265	575	m
19	276	587	664	664	597	342	288	221	221	338	496	m
20	271	542	587	632	451	288	265	226	205	782	474	m
21	298	542	542	642	451	797	288	221	205	304	443	m
22	299	542	496	465	383	293	248	226	199	281	451	m
23	316	587	310	376	398	317	293	265	199	253	474	m
24	293	575	265	465	398	243	265	271	234	414	487	m
25	313	587	288	398	542	375	230	288	203	306	474	m
26	316	597	361	361	384	266	256	226	226	1031	451	m
27	310	620	288	451	376	266	271	243	226	1505	474	m
28	361	620	310	708	361	686	271	271	221	1106	443	m
29	361		293	465	487	279	265	221	203	874	428	m
30	361		271	429	398	253	271	221	221	391	354	m
31	361		265		797		288	243		1106		m
Mean	314	489	478	504	551	372	289	256	226	431	444	-
Maximum	722	620	664	797	835	797	474	322	338	1505	686	-
Minimum	226	361	265	288	361	243	230	221	199	221	332	-

Annual statistics

Insufficient data for annual statistics

Data availability

Original values : 343
Estimated values (Flag e) : 0
Missing values (Flag m) : 22

Table E15

Average Monthly Electrical Conductivity - River Jubba at Mareere (microS/cm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	m	m	m	m	m	m	142	m	m	273	m	533
1978	584	756	748	553	404	307	239	179	173	269	372	313
1979	382	372	419	749	381	215	211	212	225	184	327	357
1980	622	1003	1263	1635	1260	505	230	191	199	182	276	375
1981	726	1072	1135	889	605	557	552	272	190	203	258	410
1982	687	873	1342	925	541	270	208	201	181	368	410	275
1983	306	504	517	834	541	208	206	169	162	162	195	207
1984	342	525	805	1172	956	485	258	207	180	182	319	339
1985	518	883	1544	1277	467	191	121	181	189	192	282	336
1986	558	919	1260	1268	427	323	220	208	198	272	259	405
1987	504	877	1302	881	643	552	320	349	262	220	364	310
1988	585	862	1306	1326	568	370	249	211	223	270	271	422
1989	585	1235	1876	1300	809	521	283	261	236	312	385	409
1990	314	489	478	504	551	372	289	256	226	431	444	m
Mean	516	798	1077	1024	627	375	252	223	203	251	320	361

Table E16

Sediment Results provided by Dr. Bashir
(Samples from River Shebelli at Afgoi)

Date	Sediment (g/l)	EC (microS/cm)	Percentage Distribution Sand	Silt	Clay
2/12/89	2.2	700	14	80	6
9/12/89	1.9	1000	20	69	11
16/12/89	2.4	1000	13	81	5
23/12/89	9.9	1400	89	2	9
30/12/89					
6/ 1/90	8.0	530	53	40	7
13/ 1/90					
20/ 1/90	3.0	700	14	83	3
27/ 1/90					
3/ 2/90	0.9	750	5	93	3
10/ 2/90	0.8	850	6	91	3
17/ 2/90	0.7	920	5	93	3
24/ 2/90	0.8	1700	5	93	2
3/ 3/90	2.9	740	27	70	3
10/ 3/90	3.3	500	27	68	5
17/ 3/90	2.5	560	13	84	4
24/ 3/90	2.4	480	15	78	8
31/ 3/90	2.4	520	42	53	5
7/ 4/90	2.3	600	22	74	3
14/ 4/90	2.4	600	23	75	2
21/ 4/90	10.6	600	91	0	9
30/ 4/90	7.0	600	64	30	6
5/ 5/90	12.1	900	91	0	9
12/ 5/90	11.3	900	89	2	9
19/ 5/90	4.8	900	42	53	4
26/ 5/90	9.9	900	88	6	7
2/ 6/90	8.3	800	68	25	7
9/ 6/90	2.8	700	22	70	8
16/ 6/90	1.9	700	16	78	5
23/ 6/90	1.6	650	13	82	5
30/ 6/90	1.6	600	12	83	5
7/ 7/90	1.4	600	14	81	5
14/ 7/90	1.6	700	14	80	6
21/ 7/90	1.4	720	10	86	4
30/ 7/90	1.4	700	9	87	4
5/ 8/90	1.5	720	10	90	0
16/ 8/90	1.5	690	10	86	4
22/ 8/90	2.0	600	12	83	5
27/ 8/90	2.0	550	13	82	5
1/ 9/90	3.3	400	25	70	5
8/ 9/90	3.2	460	24	72	4
15/ 9/90	3.1	400	20	76	5
22/ 9/90	3.5	420	26	69	5
29/ 9/90	3.5	500	25	70	5
6/10/90	3.3	400	24	72	4
13/10/90	3.3	450	24	72	4
23/10/90	3.3	400	25	70	5

Average Salinity (EC) at Mareere

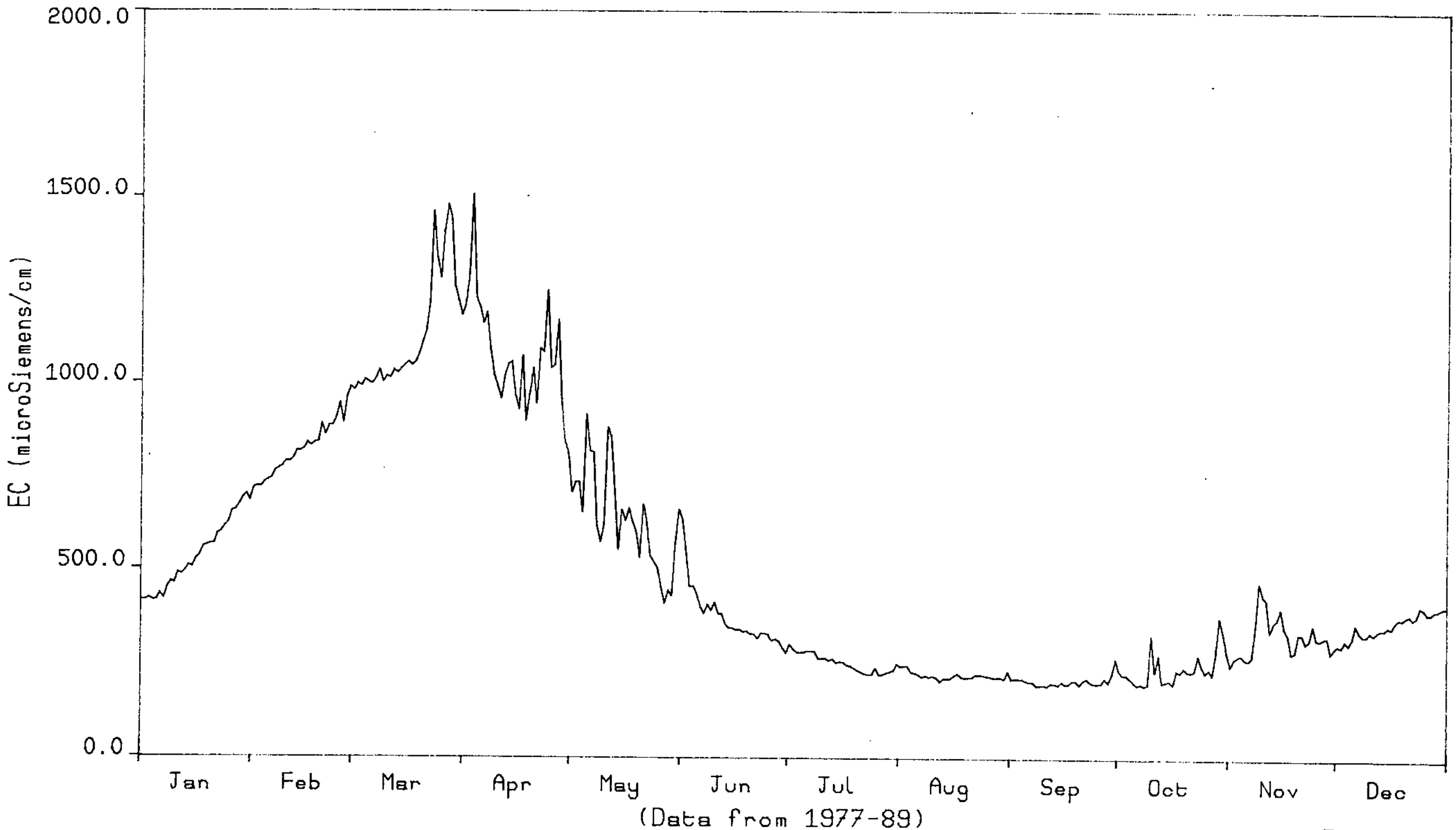

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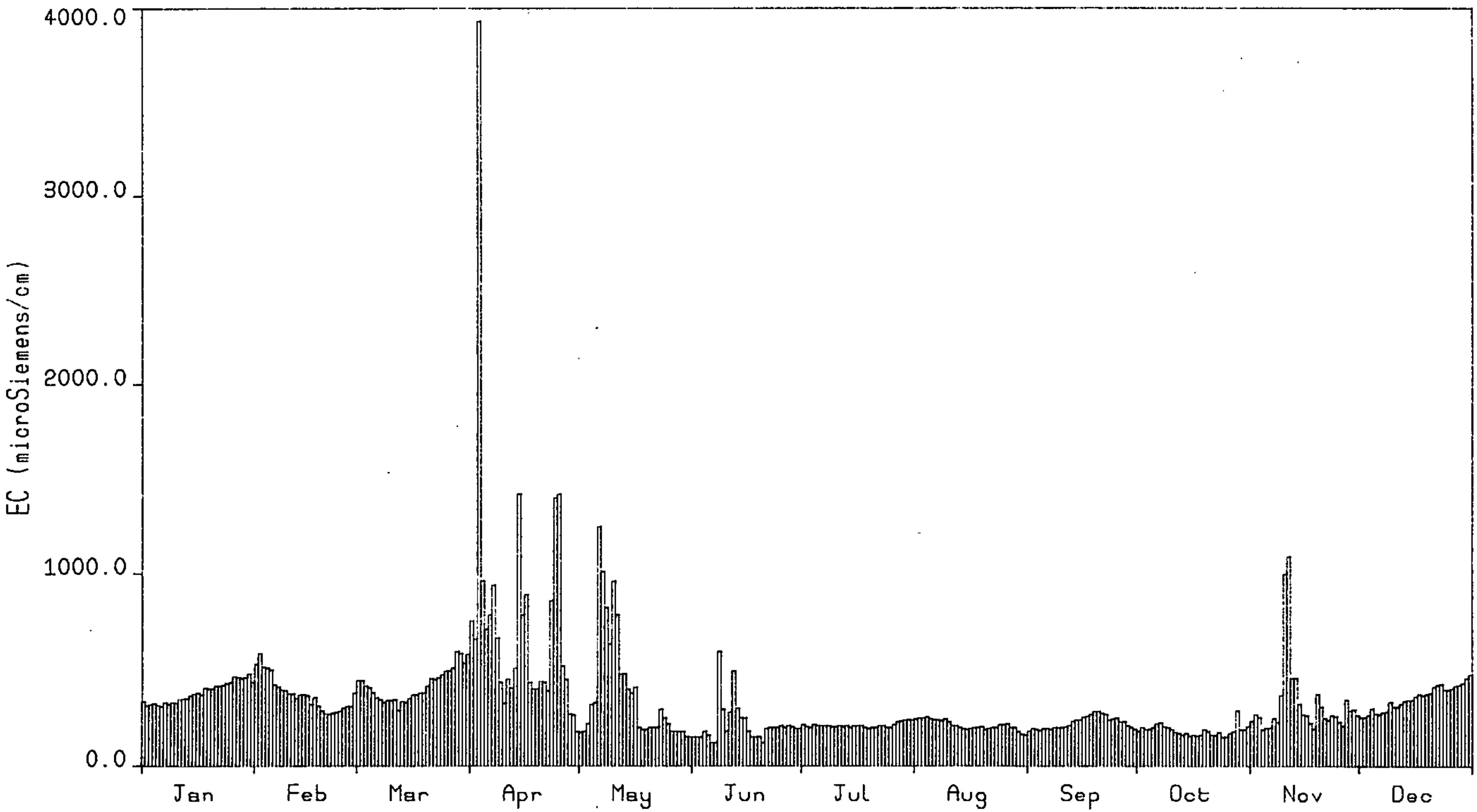
Figure E1

Salinity (EC) at Mareere 1979



Department of Hydrology, Ministry of Agriculture.

Figure E2

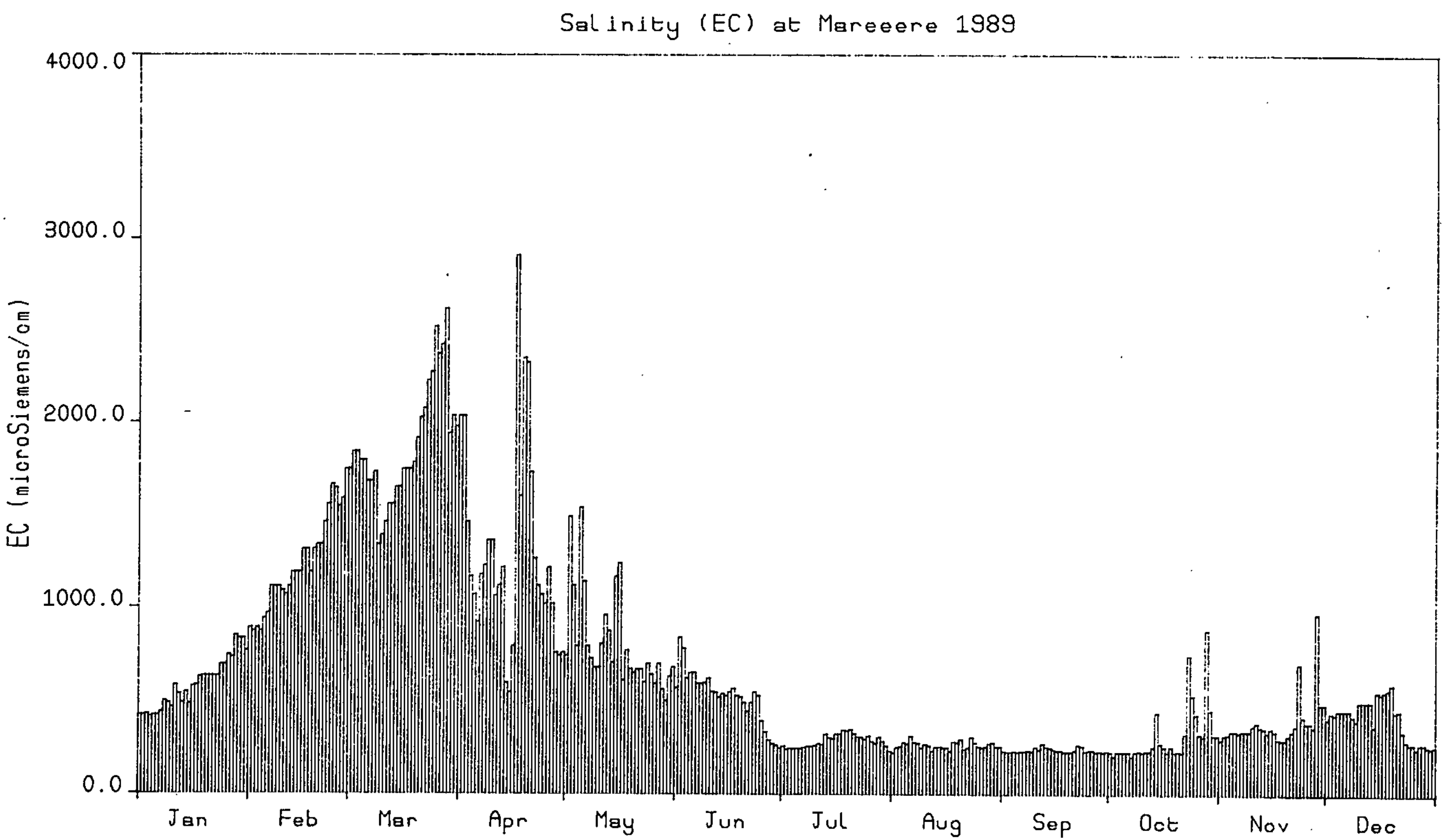


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Figure E3

Range of Salinity at Mareere

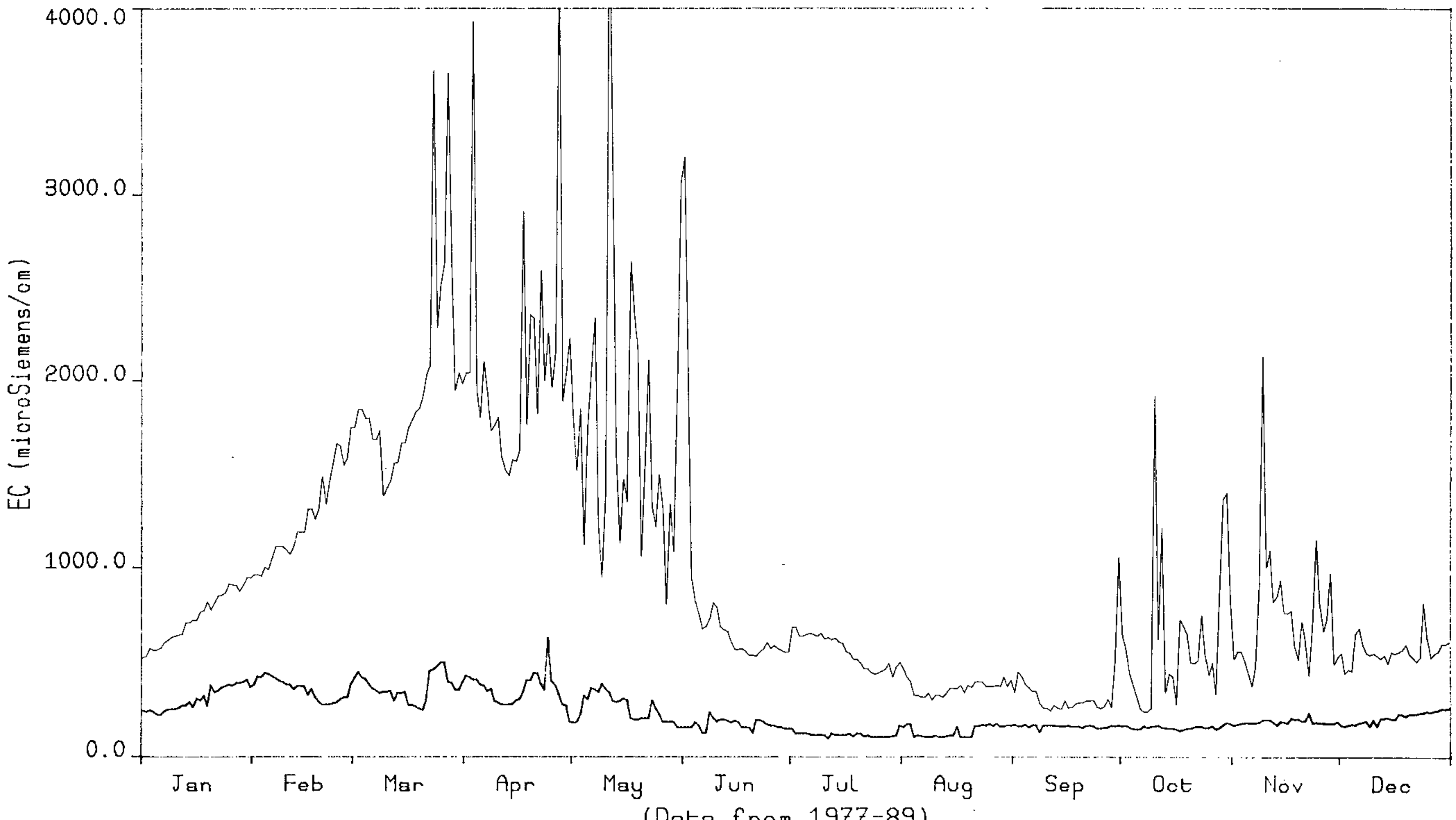

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Figure E4

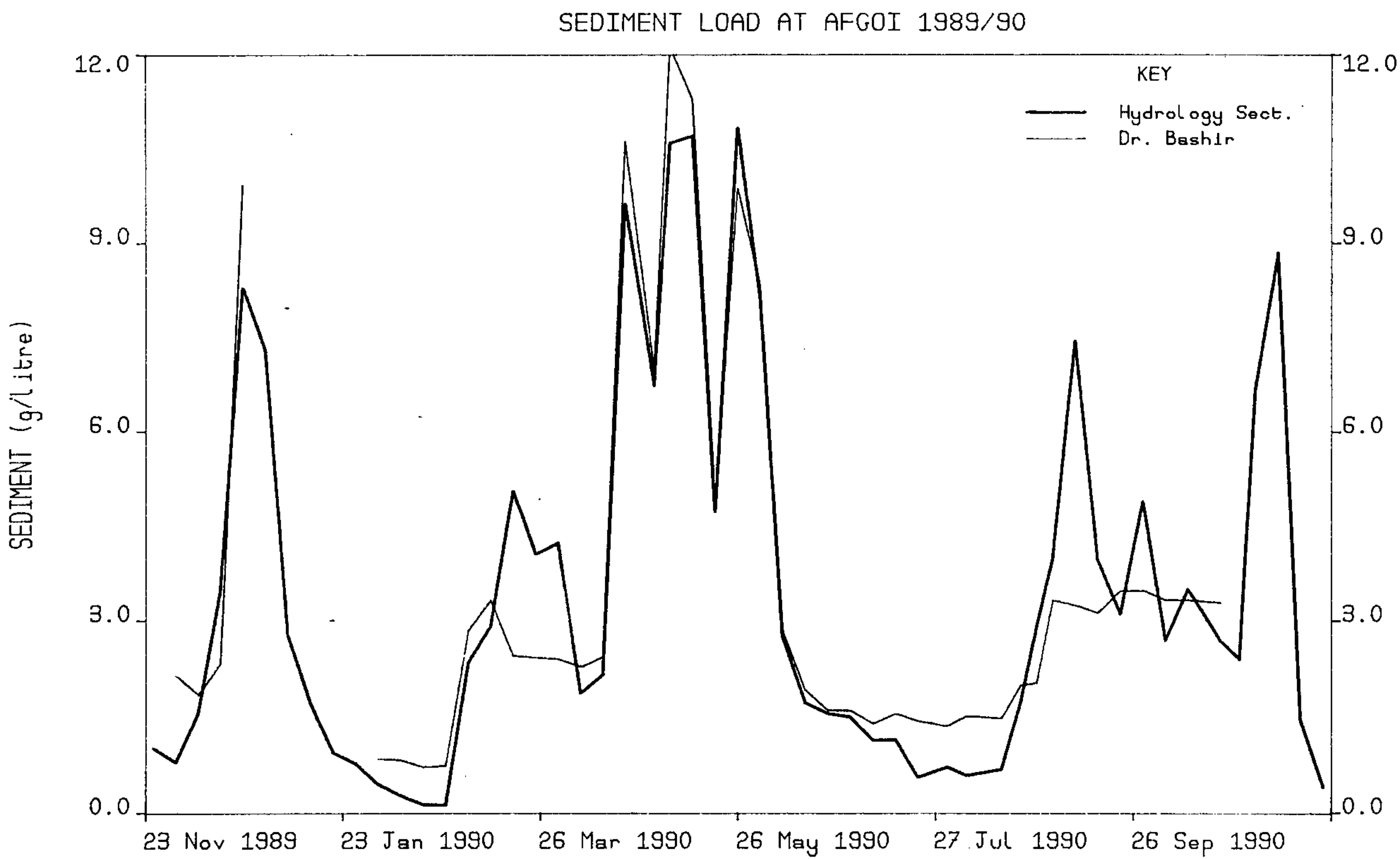

Figure E5

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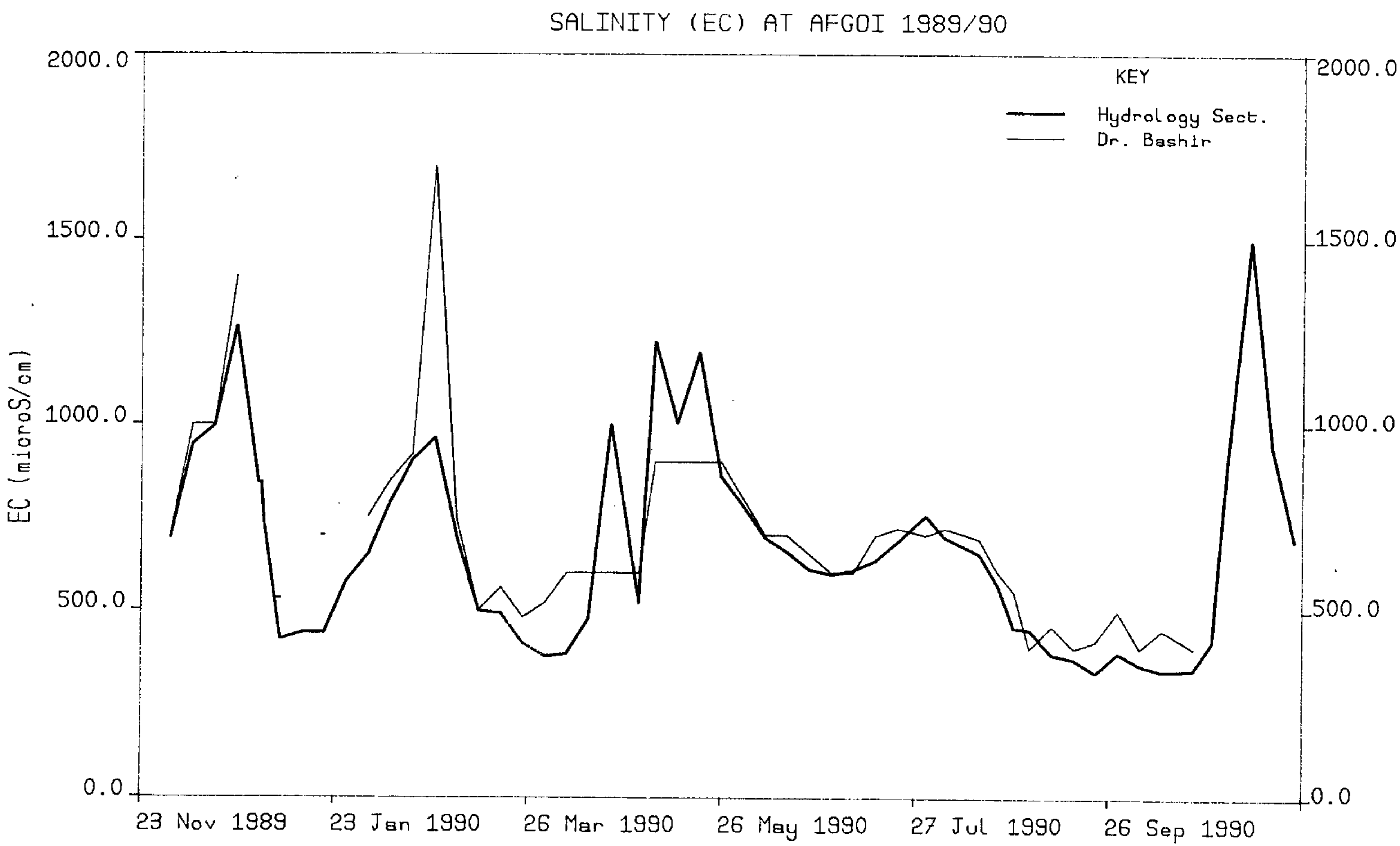

Figure E6

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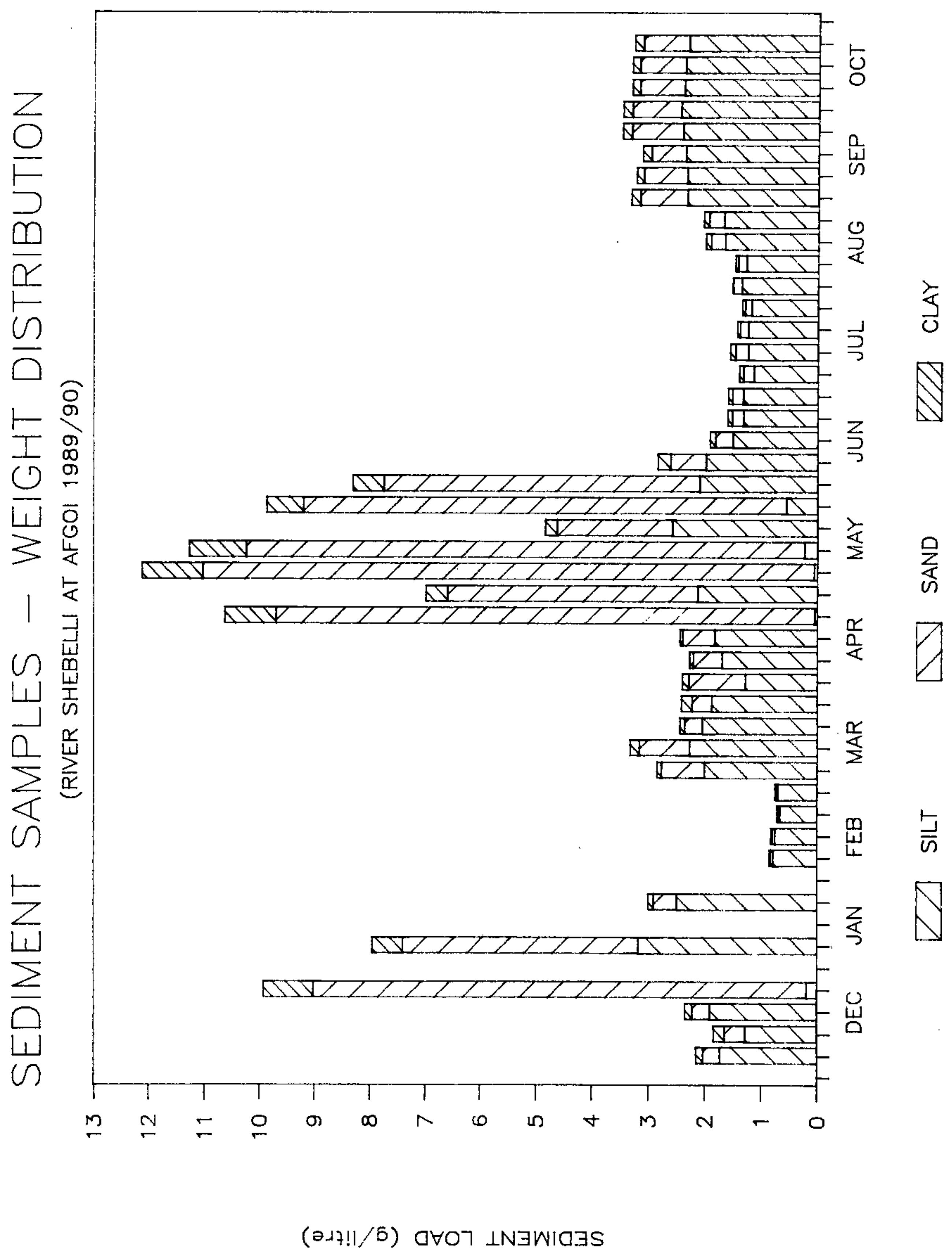
Figure E7


SEDIMENT SAMPLES — WEIGHT DISTRIBUTION
(RIVER SHEBELLI AT AFGOI 1989/90)
SEDIMENT LOAD (g/litre)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
SILT
SAND
CLAY

APPENDIX F

RATING CURVE DEVELOPMENT

APPENDIX F

TABLE OF CONTENTS

LIST OF FIGURES

APPENDIX F

STAGE-DISCHARGE RATING CURVE DEVELOPMENT

F1 INTRODUCTION

Stage-discharge rating equations were derived for the primary gauging stations during Stage 1 of the project. The Stage 1 Final Report contained listings of the available discharge measurements and the derived equations, together with graphs. The derivation of the equations was discussed in greater detail on a station-by-station basis in the Stage 2 Report, Appendix IV.1.

The computer software available at that time catered only for single-segment equations; it was noted that the suitability of multi-segment equations should be considered when the appropriate changes had been made to the derivation program. In addition to this, all equations also have to be reviewed periodically to see whether new measurements of discharge indicate any change in the stage-discharge relationship. The revised software was available towards the end of Stage 2 and the rating for Bardheere was reviewed using this facility, taking into consideration the many additional measurements from the cableway installed there in 1985. Other ratings have been examined during Phase 3.

This appendix gives details of this review of the ratings on a station-by-station basis. There is a full list of the equations used throughout the period of records. Table 3.1 in the main report shows all the discharge measurements which are additional to those contained in the Stage 1 report (Stage 2 report in the case of Bardheere).

Some general comments may be made concerning the reliability of the rating equations. It has usually been possible to use one rating for a considerable period - in some cases the entire period of record - but this apparent consistency may mask seasonal variations. The bed scouring and sediment deposition associated with major floods inevitably results in at least short-term changes in the stage-discharge relationship, but with the irregular and generally infrequent discharge measurements this cannot be covered by adjustments to the rating equation. It seems that ratings are generally fairly stable at high flows, but at low flows there may be substantial changes from year to year because of changes in the bed level. In Section F2.1 reference is made to the bed changes at Lugh Ganana and this is illustrated by various cross-sections.

Where there has been a clear change in the stage-discharge relationship, and different ratings have been applied to different periods of data, it was often very difficult to identify a suitable date for the transition to take place. This was largely due to the paucity of discharge measurements for extended periods, generally between foreign-funded projects.

F2 RIVER JUBBA

F2.1 Lugh Ganana

The Stage 1 review concluded that a single rating curve was adequate to cover the entire period of record; however, the fit was not particularly good at high flows and it was hoped that a multi-segment curve would provide an improved fit over the full range of measurements. The set of discharge measurements was therefore further examined to look for such a possible improvement, and also to check for possible shifts in the rating with time, particularly in the light of measurements made since the time of the initial analysis. For this purpose the measurements were divided into three sets as follows:

a) 1963-77 (no measurements
b) 1980-81 in 1978 or 1979)
c) 1982-89

For set (a) the measurements show some scatter about the derived rating (see Figure F1), but the overall fit is reasonable. Two and three part curves with various interception points were investigated, but there was no significant improvement in fit. Set (b) showed an extremely good fit to the rating curve (Figure F2) and there was no need to consider a multi-segment curve.

For set (c) most of the measurements were slightly below the rating curve, and it was concluded that a change in the rating would be appropriate for this period. Such a change could well have been caused by scouring and deposition during and after the big floods in 1981. For convenience the changeover in the rating was assumed to be at the beginning of 1982; the data around that time was either very bad or missing and therefore no "jump" would occur in the derived flow values. The mathematical best fit to these measurements produced an unrealistic zero flow intercept and a very high exponent, leading to excessive flow estimates at high flood levels. After further investigation of both single- and multi-segment curves it was decided that the exponent in the previous rating should be retained; the resulting best fit equation was as follows:

$$Q = 58.954\ (h - 0.752)^{1.867}$$

In addition to the 1982-89 measurements, earlier very high flood gaugings were included in the derivation process to assist in obtaining a fit over the entire range of river levels. Figure F3 shows the 1982-89 measurements, together with the rating curves; it can be seen that the slight shift in the rating from the original (full line) to the revised (dashed line) produces a substantial improvement to the fit.

It is clear from the discharge measurements made during Phase 3 that there is a considerable problem regarding scour and deposition at the gauging section at Lugh. Figure F4 shows the approximate bed profiles from four measurements in 1988 and 1989; the differences are very substantial, with a range in bed level of over four metres in places. It is therefore not surprising that discharge measurements show some scatter. Comparison of bed profiles for the 1981 and 1989 floods (Figure F5) lends some

Jubba at Lugh Ganana 1963-77

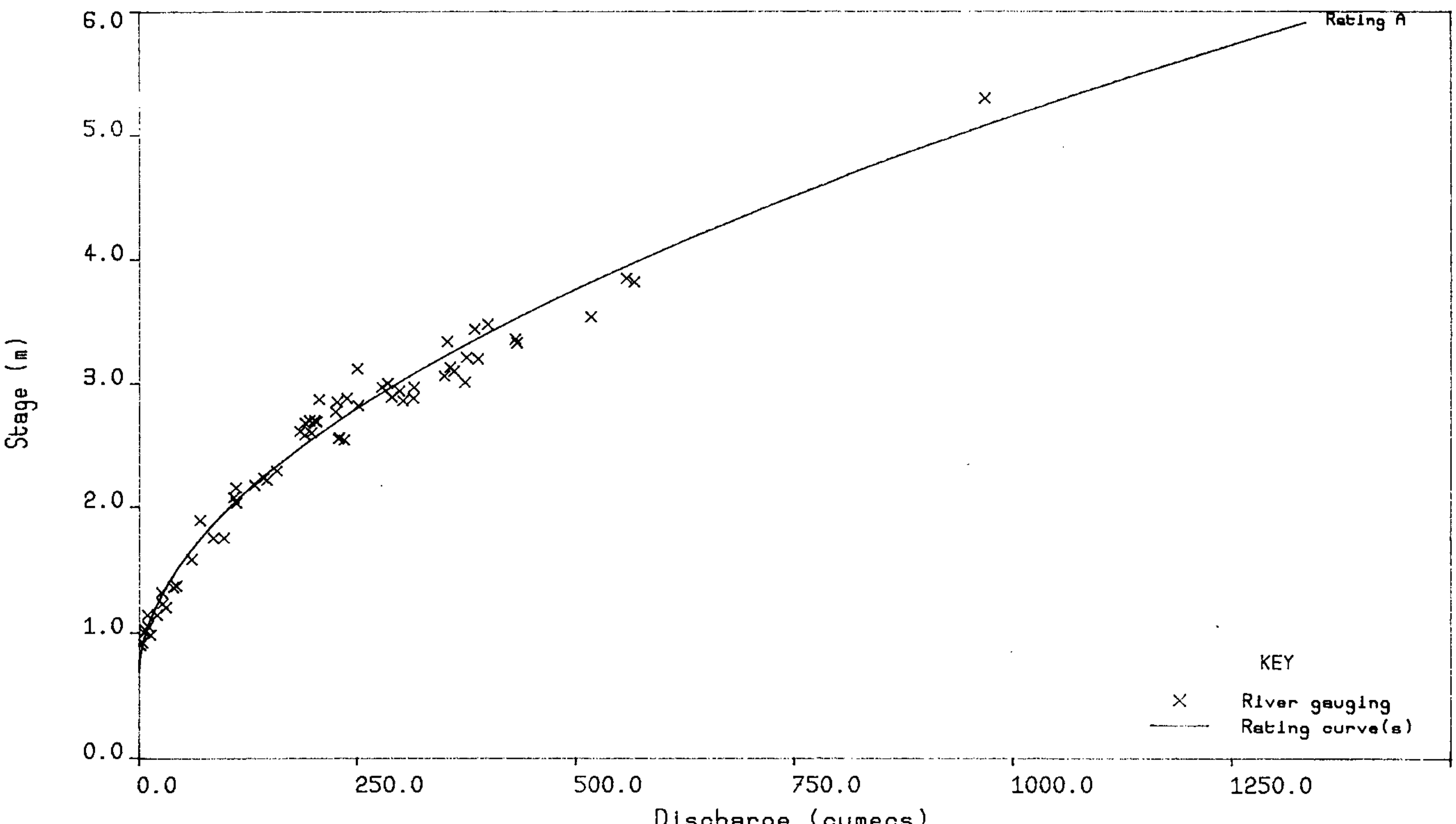


Figure F1

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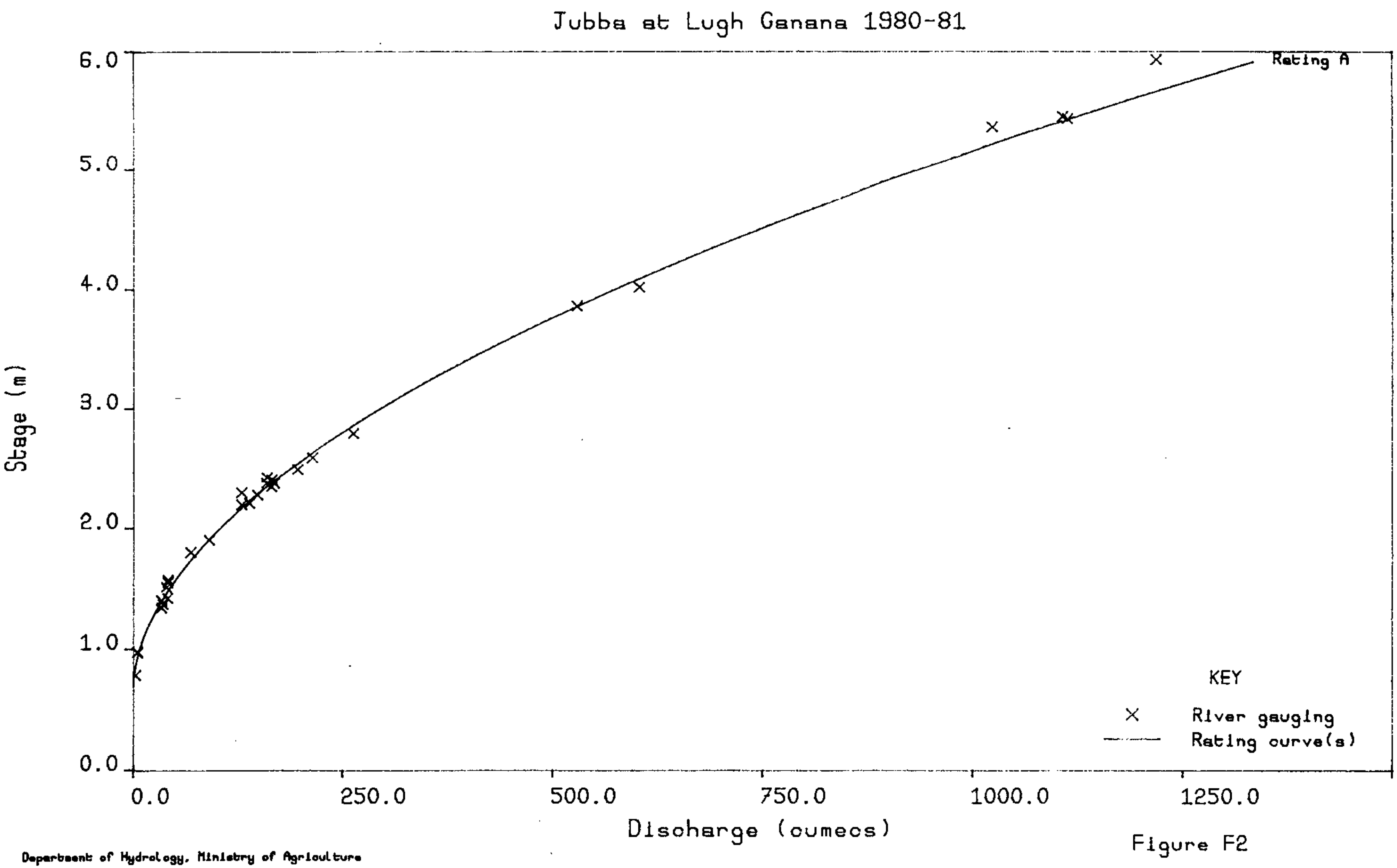
Jubba at Lugh Ganana 1980-81
Stage (m)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.0
250.0
500.0
750.0
1000.0
1250.0
Discharge (cumecs)
Rating A
KEY
River gauging
Rating curve(s)
Department of Hydrology, Ministry of Agriculture

Figure F2

Jubba at Lugh Ganana 1982-89

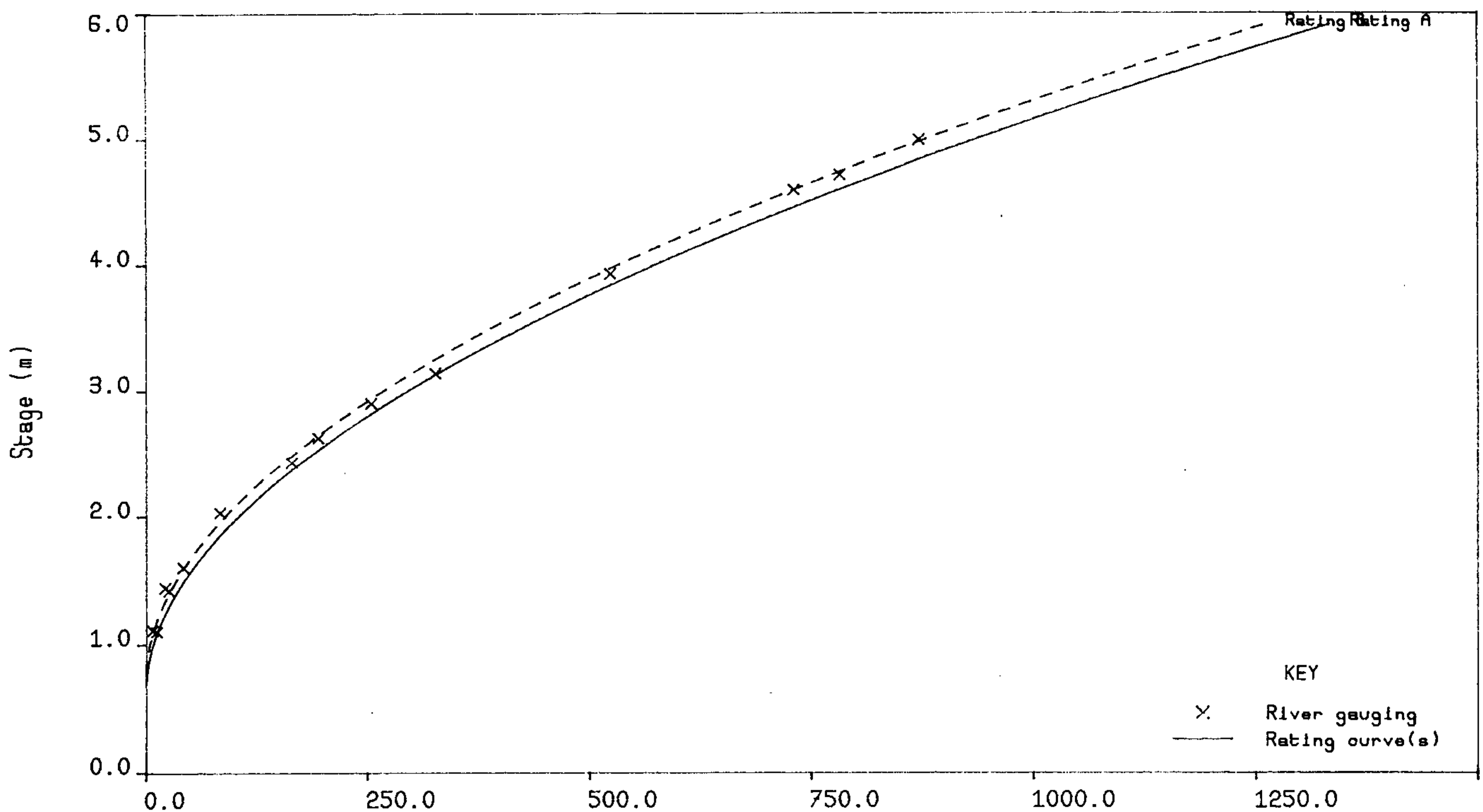

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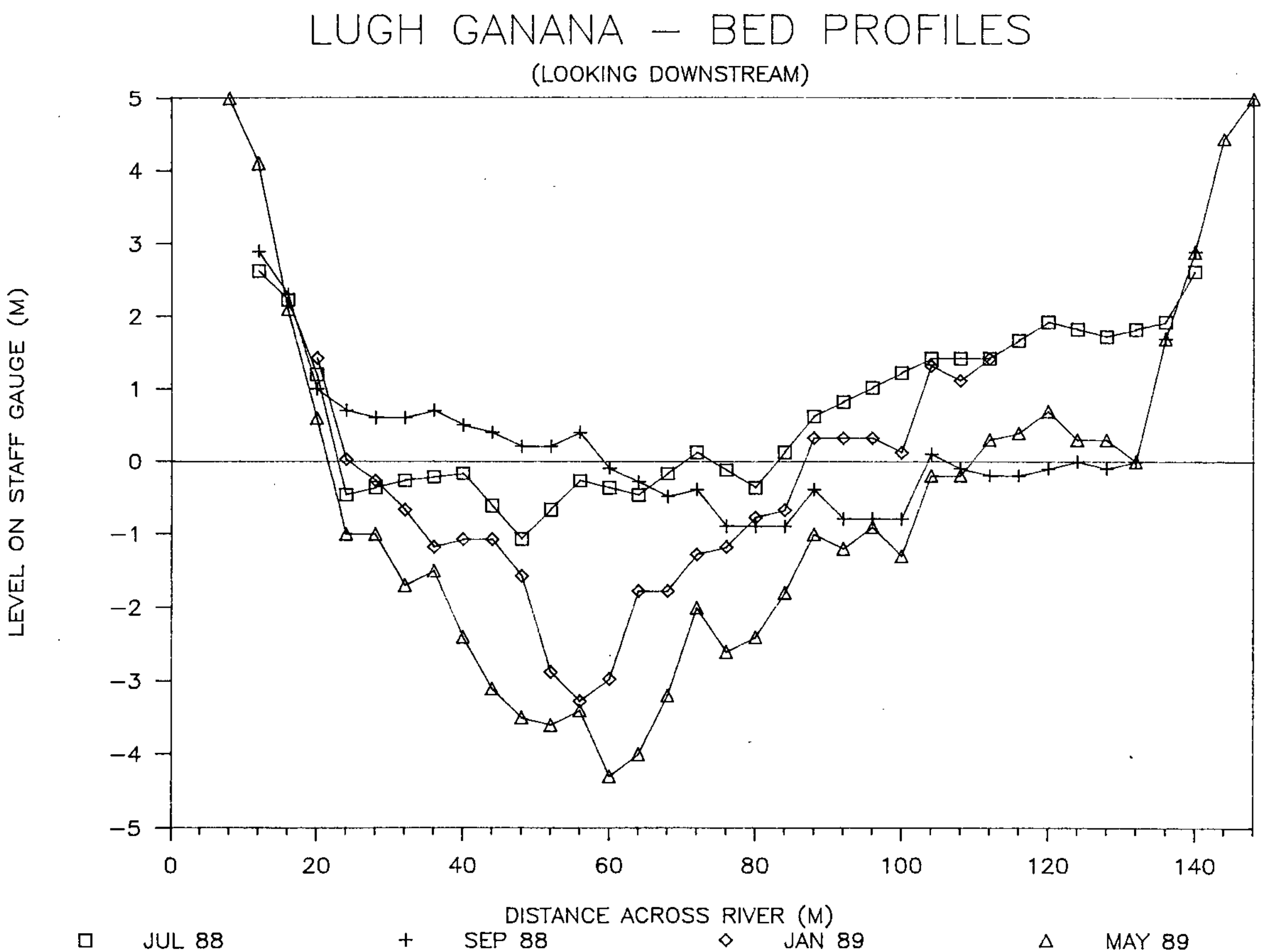
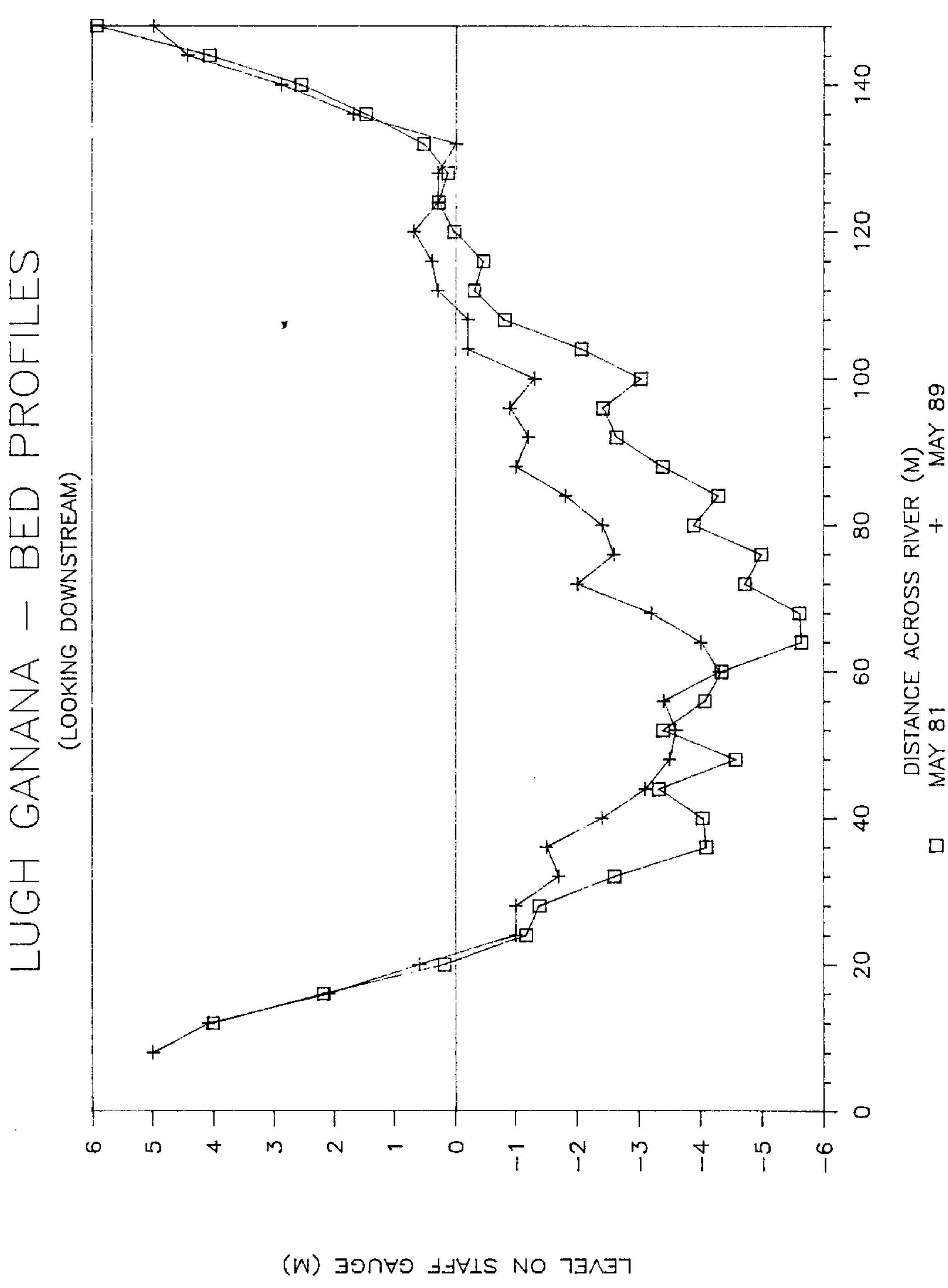
Figure F3

Figure F4



LUGH GANANA – BED PROFILES
(LOOKING DOWNSTREAM)
LEVEL ON STAFF GAUGE (M)
DISTANCE ACROSS RIVER (M)
JUL 88
SEP 88
JAN 89
MAY 89

Figure F5



LUGH GANANA — BED PROFILES
(LOOKING DOWNSTREAM)
LEVEL ON STAFF GAUGE (M)
DISTANCE ACROSS RIVER (M)
□ MAY 81
+ MAY 89

support to the change in rating noted above; the profile in 1989 (which is substantially the lowest of the four in Figure F4) is well above that for 1981, with a difference of 2-3 m over a large part of the section. In view of this reduction in cross-sectional area a drop in discharge for a given level is not surprising.

F2.2 Bardheere

The Bardheere rating was identified during Stage 1 as being in particular need of further consideration; this was done during Stage 2 when a substantial number of additional measurements were available from the cableway installed by the Bardheere Dam Project in 1985. One of the reasons for the previously inadequate rating was that measurements made from the bridge suffered from interference by the bridge pillars and from the bend immediately upstream which often results in reverse flow over a substantial portion of the section; the cableway provided much better data because it is situated some distance downstream from the bridge where the flow pattern is more uniform. This work was written up in the Stage 2 report.

Some additional measurements were made in 1988 and 1989 both by wading at low flow and by using the cableway. Unfortunately there appears to an error in the distance measuring apparatus on the cableway equipment and this is likely to result in significant errors in calculated discharges. These additional measurements are therefore of limited value.

F2.3 Kaitoi, Mareere and Kamsuma

Rating equations for these three stations were derived earlier during Phase 3 and the work was written up in the Second Progress Report. Since that time there have been some further measurements at Kamsuma, but no further measurements are available for Mareere. Kaitoi is no longer useful as a gauging station because of the backwater effect of the Fanoole barrage.

F2.4 Jamamme

The analysis during Stage 1 of the project found that the measurements showed very little scatter, and that no improvement could be expected with a multi-segment curve. It is physically a difficult place for making discharge measurements because the bridge is narrow and fairly busy, but technically it is an excellent site because there is no interference from bridge pillars and there is a long straight approach to the bridge. One measurement was made in 1989; this gave a discharge slightly below the rating curve, but one measurement is obviously insufficient evidence for any change in the equation.

F3 RIVER SHEBELLI

F3.1 Beled Weyn

Previous analysis indicated that a single part rating did not provide a good fit to the data over the whole range of river levels, there being a distinct kink at a discharge of around 100 cumecs. All measured discharges at gauge heights of above 2.50 m are lower than the values from the equation, confirming that a multi-segment curve would almost certainly provide a better fit to the measurements. An upper segment should fit much more closely to the data, and in addition the lower segment derived only from measurements at low river levels should fit more closely than that derived from the whole set of measurements.

It would be expected that the lower segment would have a higher exponent than the equation derived for the whole set, and the upper segment a lower exponent. The reduction in exponent at higher levels accords with the physical nature of the site where the bank slopes are shallow at low levels but nearly vertical at high levels so that at higher levels flow will increase relatively slowly with increasing water level.

The discharge measurements made between 1984 and 1989 all fit closely to the earlier measurements and confirm the earlier observation that a single rating curve should cover the complete time period. This is supported by examination of bed profiles. Figure F6 shows little difference in profile for four discharge measurements during Phase 3, and Figure F7 shows that the change from 1981 (the highest level at which the river has been gauged) is also relatively small.

After extensive trials of two-segment curves with various interception points, the following equations were derived as the best available fit to the data:

$$Q = 23.13\ (h + 0.27)^{1.879} \qquad \text{for h up to 2.22 m}$$

$$Q = 39.79\ (h + 0.27)^{1.285} \qquad \text{for h above 2.22 m}$$

Figure F8 shows the full set of measurements together with this two part rating (full line) and the original single part rating (dashed line). The improvement in the overall fit can be clearly seen.

Although there is a good fit to the measured discharges, it should be noted that the stage-discharge relationship is uncertain at high levels. The highest level at which the river has been gauged at Beled Weyn was 6.14 m in 1981; the measured discharge of 281 cumecs is substantially lower than some discharges measured at lower levels. The FAO Hydrologist, B. Gemmell, made estimates of the flow in a flood relief bypass canal and also over the floodplain; he estimated the total discharge to be well over 1000 cumecs. It is clear that the derived stage-discharge relationship does not apply at gauge heights above about 5.3 m, for which level the rated flow is about 360 cumecs. This inaccuracy of the rating should not be considered as a major problem because this level has only been exceeded on three occasions since 1963.

Figure F6

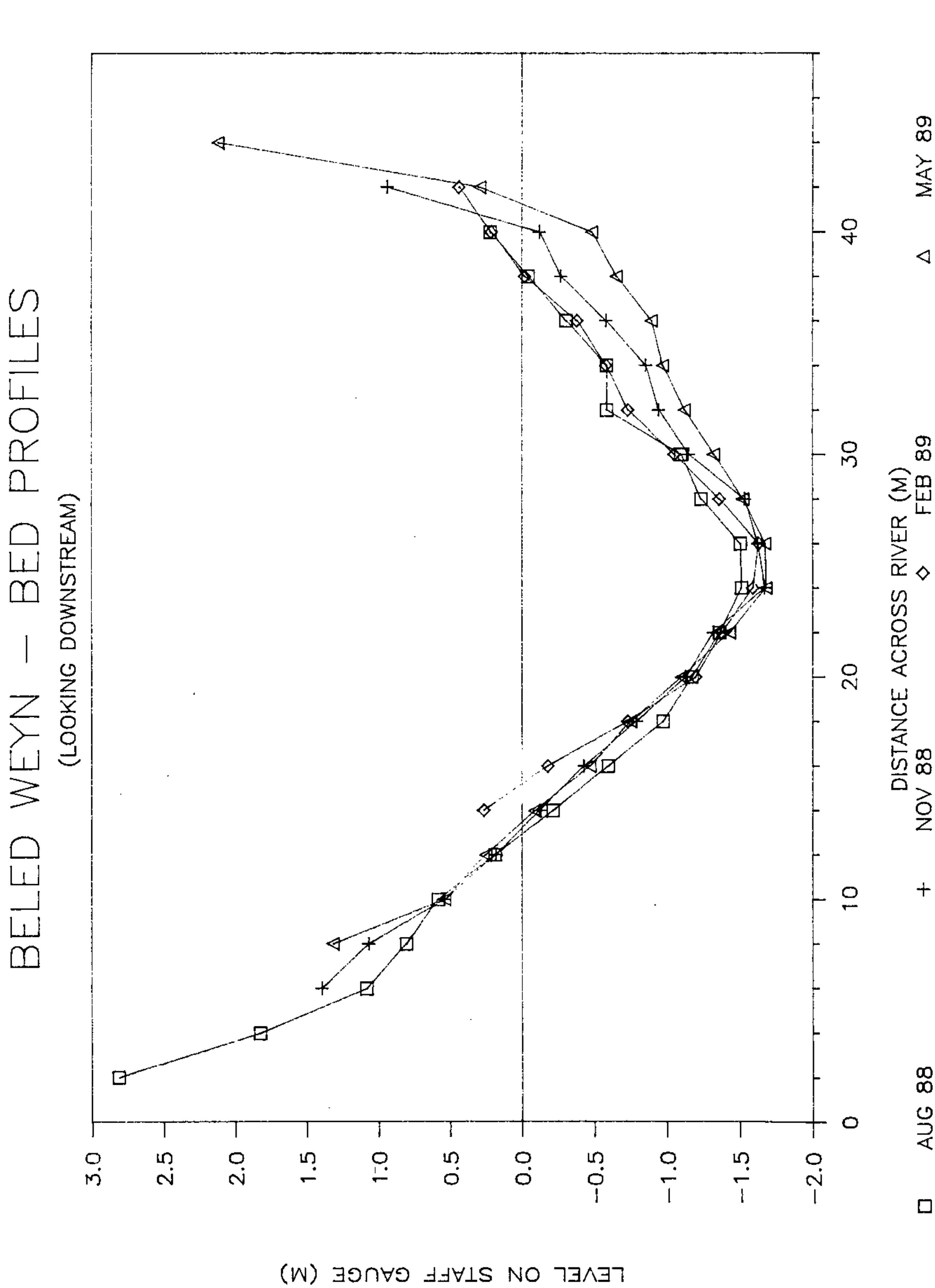
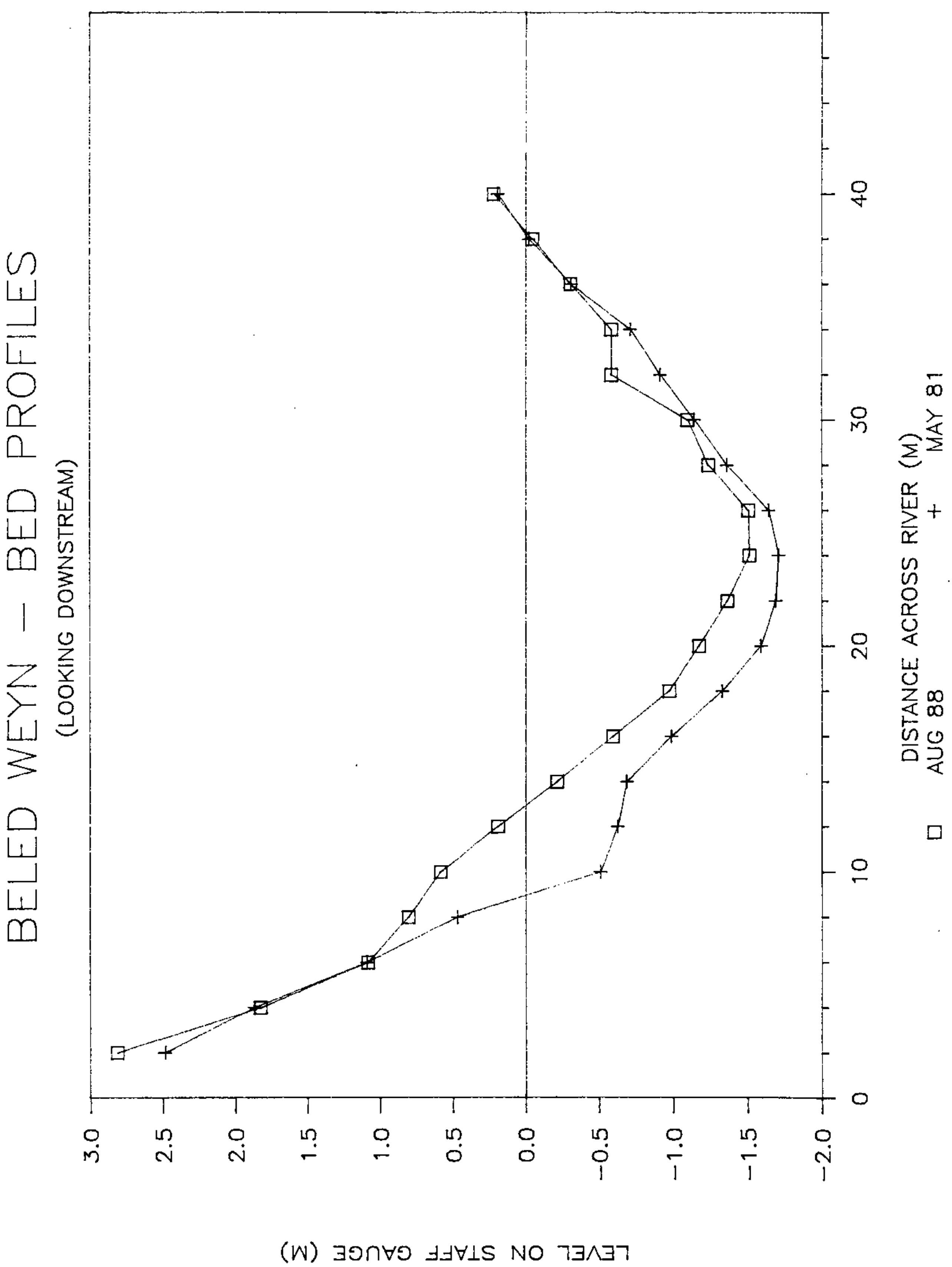

BELED WEYN - BED PROFILES
(LOOKING DOWNSTREAM)
LEVEL ON STAFF GAUGE (M)
DISTANCE ACROSS RIVER (M)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
0
10
20
30
40
AUG 88
NOV 88
FEB 89
MAY 89

Figure F7



BELED WEYN — BED PROFILES
(LOOKING DOWNSTREAM)
LEVEL ON STAFF GAUGE (M)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
0
10
20
30
40
DISTANCE ACROSS RIVER (M)
□ AUG 88
+ MAY 81

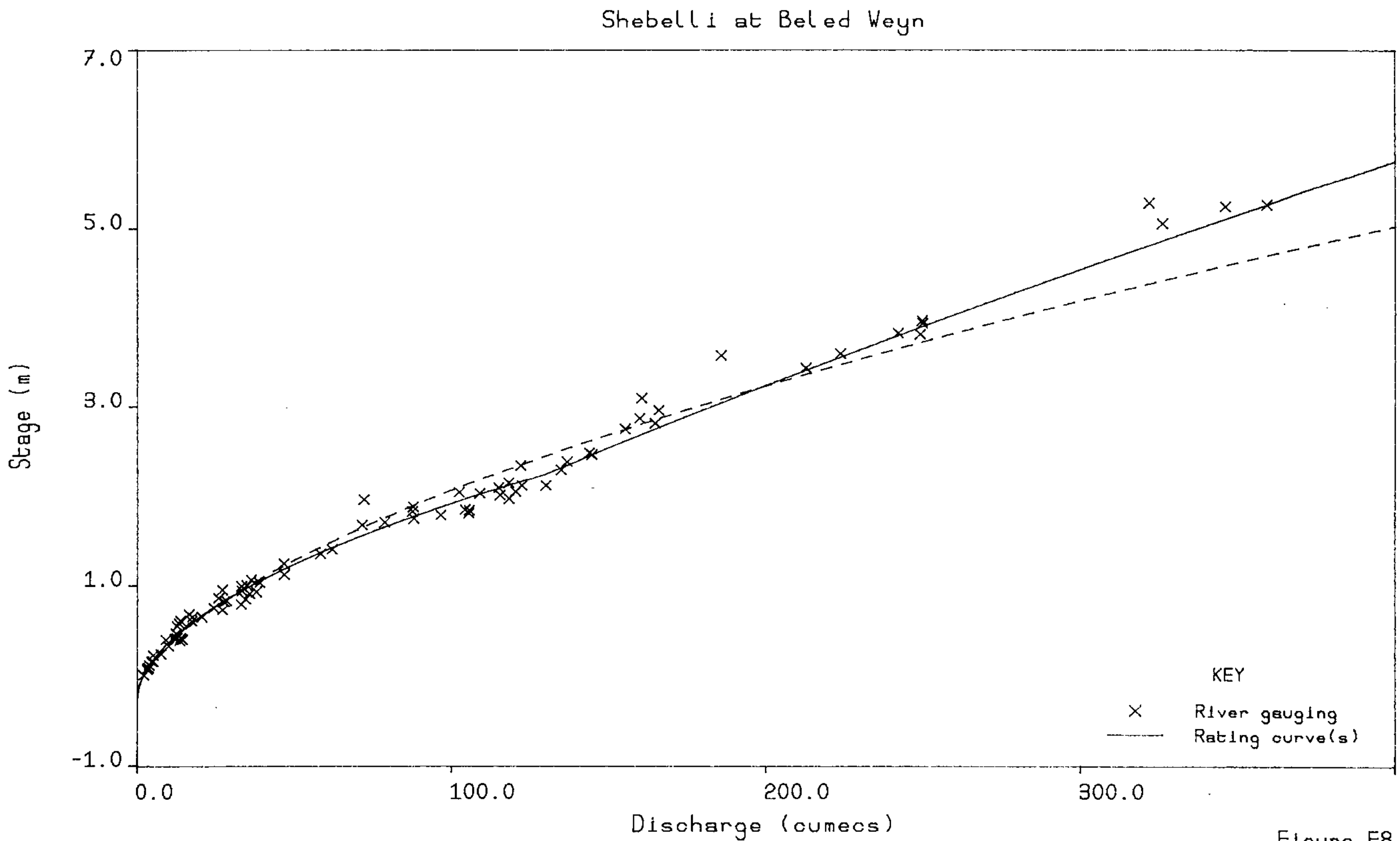


Figure F8

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F3.2 Bulo Burti

The Stage 1 study showed a clear shift in the rating at this station during the 1970's. Because of the dearth of discharge mesaurements at that time it was not possible to be accurate about the timing of the transition; the change was set at July 1st 1978, but since there was no reliable river level data available for that year the exact date is unimportant. The change may well have been caused by the large flood in late 1977.

The five measurements undertaken between 1984 and 1989 all showed discharges above the rating equation. Since they are few in number, and were all at fairly low levels, they do not necessarily indicate a change in the rating. However, if future measurements follow the same pattern it may later be necessary to make a back-dated change to the rating.

The five recent measurements were added to the 1978-83 measurements and a best fit equation derived as follows:

$$Q = 21.08\ (h - 0.631)^{1.468}$$

This is a minor change to the rating derived during Stage 1. Multi-segment curves were tried for both periods (before and after 1978), but there was no improvement to the fit.

F3.3 Mahaddey Weyn

The rating at Mahaddey has proved to be somewhat problematical. There was a definite shift around 1980, probably due to the construction of the Sabuun barrage some distance downstream, and measurements in the early 1980's showed rather more scatter than at other stations. Some of the discharge measurements made during Phase 3 were significantly below the rated flows, though within the scale of scatter of the earlier measurements. Comparison of the Mahaddey hydrographs for 1988 and 1989 with those for stations upstream and downstream also indicated that the existing equation may be overstating actual flows. However, best-fit analysis of the recent measurements did not produce a realistic new rating and it was decided to retain the existing equation until further measurements became available.

In 1990 the river level data has been intermittent because of the security situation, and the quality of the data is uncertain, but comparison with the hydrographs at other stations shows that the scale of the possible error has increased, and that there is therefore almost certainly a need to change the rating. Peak water levels at Mahaddey have got higher over the past few years, but there is no evidence that this is due to a greater discharge arriving from upstream. There has been some raising of the river bed since 1980, and it is possible that this is steadily continuing. For the purposes of the provisional 1990 flow data contained in Appendix D (and stored on the computer in Mogadishu) a crude adjustment has been made to the rating with effect from January 1st 1990. It is most important to note that this change in the rating, and the date from which it should apply, must be reviewed when further discharge measurements are available. The temporary equation is as follows:

$$Q = 5.30\ (h - 0.10)^{2.02}$$

If a change in the rating is subsequently determined to take effect before January 1990 then there would have to be some adjustments to the flow values already published in the Hydrometric Data Book.

The rating for the earlier period (to 1980) was also reviewed, but there was no improvement to the fit from a multi-segment curve.

F3.4 Balcad

A rating equation for this station was derived earlier in Phase 3 and presented in the Second Progress Report. The station is no longer operational because there is no clearly defined stage-discharge relationship as a result of its proximity to the barrage constructed a short distance downstream in 1979/80.

F3.5 Afgoi

The analysis during Stage 1 produced a satisfactory single-segment curve, with no indication of any change in the rating with time. It was noted that there was some unexplained scatter at gauge heights around 4.0 m, but there was no indication that a better fit would be obtained by using a two or three part equation.

All measurements from November 1981 onwards lie below the Stage 1 rating; those to mid 1984 were very close to it, but larger discrepancies occurred in 1988/89. It was therefore decided that a revised rating would be appropriate. 1st March 1985 was selected as the changeover point; the river was dry at that time. The zero flow intercept of 0.89 m seems to fit the recent measurements as well as those prior to 1984, but best fit analysis of the 1984-89 measurements produced an unrealistically high value; the existing intercept was therefore retained for the determination of the new equation, with the analysis program being used to derive the best fit of multiplier and exponent. This equation (Rating B) is as follows:

$$Q = 14.894\ (h - 0.89)^{1.22}$$

F3.6 Audegle

The Stage 1 analysis of discharge measurements resulted in two rating curves because of a clear change sometime during the 1970's. The first of these (1963-75) was considered to be acceptable even though there were relatively few measurements available, and no improvement could be expected from a multi-segment curve; however, the second (1976-) was derived from a small number of gaugings, mostly at low flows, and the derived rating did not produce a good fit.

One likely reason for the scatter of measured discharges is the effect of the bridge from which most measurements were made. By the late 1980's it was very clear that the progressive collapse of this bridge, and the resulting accumulation of debris, was significantly affecting the water levels; application of the existing equation produced flows which were too high compared to those at Afgoi. This effect is most noticeable at low levels when the debris creates a substantial backwater effect; at high levels the bridge structure provides less impedance to the flow. It is not possible to make discharge measurements from the new bridge using the gauging derrick, but one low flow measurement was made by handline suspension of the current meter; the measured flow was equivalent to the rated flow for a level about 50 cm lower.

In the absence of a range of flow measurements an empirical approach was adopted to produce a new rating equation. A shift of 50 cm was made to the gauge zero, the exponent of the previous equation was retained and the multiplier was set such that the bank-full flow would be slightly lower than previously. Comparison graphs for Afgoi and Audegle were examined in order to determine the appropriate date for this change to take effect . Substantial differences were first apparent in 1985 and for convenience 1st March 1985 was selected as the river was dry at that time and there would be no jump in flow values; this is also the same date as the change in the rating at Afgoi. The new equation (Rating C) is as follows:

$$Q = 13.744\ (h - 1.64)^{1.358}$$

It is important to note that this is a very crude adjustment to what was in any case a poor quality rating equation; resulting flow values are therefore less accurate than for most other stations.

F3.7 Jowhar Reservoir

The Jowhar reservoir system does not form part of the primary hydrometric network, but its data is of value in a hydrological study of the river Shebelli. Appendix A of the First Progress Report contained some comments on the rating equations and data for these stations. It was evident from the rate at which the reservoir filled that the original rating for the supply canal was overstating flows, probably because of siltation in the canal. A discharge measurement was carried out there in June 1989 and the measured discharge was found to be substantially lower than the rated value. In order to accurately determine a new rating equation a number of measurements would be required, and this should be done when safe access to the area is again possible. As an interim measure the zero flow intercept of the rating equation was raised (in accordance with the observation of a rise in the canal bed), but the multiplier and exponent were left unchanged; this certainly produces more realistic flow values. The revised equation, which was considered effective from the start of 1988, is as follows:

$$Q = 16.444\ (h - 0.00)^{2.072}$$

It must also be expected that the reservoir level/storage equation will require adjustment because of siltation over a decade of operation. There is no easy means of establishing a new equation, so it remains as determined at the design/construction stage. The amount of usable water stored in the reservoir is probably less than implied by the equation.

F4 FULL LIST OF RATING EQUATIONS

Jubba at Lugh Ganana

Rating A from 1 Jan 1951 $Q = 60.32 \; (h - 0.66)^{1.867}$ to 7.50 m

Rating B from 1 Jan 1982 $Q = 58.954 \; (h - 0.752)^{1.867}$ to 7.50 m

2 rating equations for this station

Jubba at Bardheere

Rating A from 29 May 1963 $Q = 47.204 \; (h + 0.379)^{1.897}$ to 7.00 m

1 rating equation for this station

Jubba at Kaitoi

Rating A from 1 Jan 1963 $Q = 35.115 \; (h + 0.29)^{1.614}$ to 7.00 m

1 rating equation for this station

Jubba at Mareere

Rating A from 1 Jul 1977 $Q = 17.87 \; (h - 4.55)^{1.903}$ to 12.00 m

1 rating equation for this station

Jubba at Kamsuma

Rating A from 11 Jul 1972 $Q = 45.759 \; (h - 2.33)^{1.405}$ to 9.00 m

Rating B from 13 Jun 1984 $Q = 35.018 \; (h - 0.50)^{1.521}$ to 9.00 m

2 rating equations for this station

Jubba at Jamamme

Rating A from 1 Jan 1963 $Q = 16.84 \; (h + 0.09)^{1.727}$ to 7.50 m

1 rating equation for this station

Shebelli at Beled Weyn

Rating A from 1 Jan 1951 $Q = 23.13 \; (h + 0.27)^{1.879}$ to 2.22 m
$Q = 39.79 \; (h + 0.27)^{1.285}$ to 7.00 m

1 rating equation for this station

Shebelli at Bulo Burti

Rating A from 1 Jan 1963 $Q = 12.76 \ (h - 0.61)^{1.772}$ to 10.00 m

Rating B from 1 Jul 1978 $Q = 21.079 \ (h - 0.631)^{1.468}$ to 10.00 m

2 rating equations for this station

Shebelli at Mahaddey Weyn

Rating A from 1 Jan 1963 $Q = 7.90 \ (h + 0.28)^{1.698}$ to 6.00 m

Rating B from 1 Jan 1980 $Q = 4.904 \ (h + 0.073)^{2.073}$ to 6.00 m

Rating C from 1 Jan 1990 $Q = 5.30 \ (h - 0.10)^{2.02}$ to 6.00 m

3 rating equations for this station

Shebelli at Balcad

Rating A from 20 Sep 1962 $Q = 10.083 \ (h + 0.10)^{1.329}$ to 8.00 m

1 rating equation for this station

Shebelli at Afgoi

Rating A from 1 Jan 1963 $Q = 17.606 \ (h - 0.89)^{1.175}$ to 7.00 m

Rating B from 1 Mar 1985 $Q = 14.894 \ (h - 0.89)^{1.22}$ to 7.00 m

2 rating equations for this station

Shebelli at Audgele

Rating A from 1 Jan 1963 $Q = 9.81 \ (h - 0.59)^{1.413}$ to 6.50 m

Rating B from 1 Jan 1971 $Q = 11.86 \ (h - 1.14)^{1.358}$ to 6.50 m

Rating C from 1 Mar 1985 $Q = 13.744 \ (h - 1.64)^{1.358}$ to 6.50 m

3 rating equations for this station

Jowhar Reservoir Head/Storage Curve

Rating A from 1 Jan 1980 $S = 21.082 \ (h - 0.87)^{1.903}$ to 5.00 m

1 rating equation for this station

Shebelli at Sabuun (downstream of JOSR offtake)

Rating A from 21 Nov 1979 $Q = 6.036 \ (h + 0.335)^{2.186}$ to 5.00 m

1 rating equation for this station

Jowhar Reservoir Supply Canal

Rating A from 10 Nov 1979 $Q = 16.444 \ (h + 0.20)^{2.072}$ to 3.00 m

Rating B from 1 Jan 1988 $Q = 16.444 \ (h - 0.00)^{2.072}$ to 3.00 m

2 rating equations for this station

Jowhar Reservoir Outlet Canal

Rating A from 1 Jan 1980 $Q = 4.16 \ (h + 0.37)^{2.00}$ to 2.00 m

1 rating equation for this station

Shebelli downstream of JOSR outlet

Rating A from 1 Jan 1980 $Q = 9.875 \ (h + 0.32)^{1.519}$ to 6.00 m

1 rating equation for this station

APPENDIX G

INVENTORY OF PROJECT EQUIPMENT

MMP

Sir M. MacDonald & Partners Limited

Consulting Engineers

Head Office

Demeter House
Station Road
Cambridge CB1 2RS
England

Telephone: 0223 66455
Cables: Screetan, Cambridge
Telex: 817260

Please reply to:

PO Box 996
Mogadishu
Somali Democratic Republic

Telephone 80307
Telex: 745 CROCESUD MOG
(for MacDonalds)

Date: 16th December 1990 Our Ref: 5015/1/1/890 Your Ref:

Omar Haji Dualeh,
The Director of Irrigation,
The Ministry of Agriculture,
Mogadishu.

Dear Omar Haji Dualeh,

Re: Handover of Hydrometry Project Equipment

My departure from Somalia today brings to an end the major expatriate input to the Hydrometry Project. The Overseas Development Administration has instructed me to hand over to you the computer and field equipment procured with ODA funds so that the important work of the Hydrology Section may continue.

The items of equipment concerned are listed in the attached inventory; all the equipment is in a satisfactory condition after making due allowance for wear and tear commensurate with its proper use during the Project. I would be grateful if you would sign and return the enclosed copy of this letter, and initial each page of the copy inventory.

All programs and data listed in the inventory are stored on the computer's hard disk, with back-up copies on floppy disk for security reasons. I am also carrying copies of the data disks to England in order to produce tables and graphs for the Final Report; in the unlikely event of loss of the data on both the hard disk and the floppy disk back-up it would be possible for the data to be retrieved from the disks taken to England.

As you are aware, the Project Land Rover was recently taken to the British Embassy compound for safe keeping when you and I agreed that it was too dangerous for the vehicle to be used. The Embassy will be contacting you shortly regarding this.

As indicated by Mr. Jackson of BDDEA, Nairobi during his visit to Mogadishu in November, ODA is hoping that it will be possible to arrange a short follow-up monitoring visit, probably in June 1991. MacDonald's cannot at this moment guarantee my availability for such a visit, but I very much hope that I will be able to return to provide some further assistance to the Hydrology Section.

I will be completing my Final Report on the Project in our Head Office in January, and this should be presented to you early in February. I would like to take this opportunity to thank both you and your predecessor for your assistance to me and to other Project staff over the course of the Hydrometry Project. We look forward to working with you again in the future.

Yours sincerely,

SIR M. MACDONALD & PARTNERS LTD

Peter F. Ede

P.F. Ede
Resident Hydrologist,
Somalia Hydrometry Project,
for Sir M. MacDonald and Partners Limited.

The Ministry of Agriculture acknowledges receipt of the equipment listed in the attached inventory.

....

Omar Haji Dualeh
Director of Irrigation
16/12/90

INVENTORY OF PROJECT EQUIPMENT

A. Equipment Procured During Phase III and Handed Over to the Ministry of Agriculture

Hydrology Field Equipment

Various current meter spares to supplement equipment from Stages 1 and 2 of the Project.
US DH-59 Depth-integrating sediment sampler for use with gauging derrick or by hand line.
US DH-48 Depth-integrating sediment sampler for use by wading.
Two pHOX 52E electrical conductivity meters (with spare probe).
30m bridge dipper.
10m bridge dipper.
(other bridge dippers obtained during Phase 3 have been distributed to the river level observers)
Supply of 1 m staff gauge plates, with various metre numbers.
Two pairs chest waders.

Computer Equipment - Hardware and Software

Hardware

IBM PS/2 Model 50 Computer (serial nr. EK55-0113188), with 20MB hard disk, 1.44 MB disk drive, keyboard and colour monitor (type 8513, serial nr. 55-A1875).
Logitech Mouse (serial nr. MAI119002293).
Epson FX1000 Dot matrix printer (serial nr. T0009775).
Hewlett Packard HP7475A pen plotter (serial nr. 2541L 48199).
Mains leads and connection cables.
Storage box for 3.5" disks.
Miscellaneous computer consumables (disks, paper, ribbons, pens etc.).

Software (programs and documentation)

DOS version 3.3.
Institute of Hydrology HYDATA hydrological database package.
Lotus-123 spreadsheet and graphics package.
Prospero PROFORTRAN 77 compiler/linker.
WORDMARC wordprocessing package.
Logitech Mouse software.
Various programs written by Project staff - listed in Hydrometry Project Final Report, Appendix I.

Laboratory Equipment

BDH AL500 Top-loading electronic balance (serial nr. 09144) - to weigh up to 500 g to accuracy 0.01 g.
Sartorius Analytic A200S electronic balance (serial nr. 37040275) - to weigh up to 200 g to accuracy 0.0001 g.
Unitemp Laboratory oven (serial nr. 74726/16).
Funnels, flasks, sieves, desiccators, oven dishes, filter papers, sample bottles etc.

General Office Equipment

Qualitair air conditioner
2 Casio fx-82c calculators.
Various Hydrology text books.
Miscellaneous office consumables (boxes, data cards, stationery etc.).

B. Other Equipment Available to the Hydrology Section

The Mission Report, Stage 2 contained a full inventory of equipment procured during Stages 1 and 2 of the Project and handed over to the Ministry of Agriculture at the end of Stage 2 in June 1986. A number of these items were either unavailable at the start of Phase 3 in 1988 or were in such a condition that they were of little or no value. The main items of note and still available for use are those connected with current metering. There are two Braystoke current meters, together with all necessary accessories for measuring discharge by wading, by hand-line suspension or by using the gauging reel and derrick.

C.α)

APPENDIX H

CIRCULATION LIST FOR HYDROMETRIC DATA BOOK

APPENDIX H

Circulation List for Hydrometric Data Book

The Director of Irrigation
The Minister of Agriculture
The Vice Minister of Agriculture
The Director General, MOA
The Director of Planning, MOA
The Director, FEWS
The Technical Supervisor, FEWS

Minister of National Planning and Jubba Valley Development
Minister of Commerce and Industry
Minister of Public Works
Minister of Mineral and Water Resources
Minister of Livestock, Forestry and Range

Water Development Agency
Settlement Development Agency
National Water Centre
National Range Agency

World Bank Mission
The Delegate, EEC
UNDP
UNHCR
GTZ
FAO
USAID Mission

Juba Sugar Project
Mogambo Irrigation Project
Fanoole Rice Farm
Farahaane Irrigation Rehabilitation Project
Farjano Refugee Resettlement Project
Bardheere Dam Project
LIBSOMA
Somalfruit
Euro Action Accord, Sablaale

British Embassy
US Embassy
German Embassy
Italian Embassy
French Embassy
Chinese Embassy
Kuwait Embassy
Saudi Arabian Embassy
United Arab Emirates Embassy

University Faculty of Agriculture
University Faculty of Engineering

APPENDIX I

COMPUTER PROGRAMS

APPENDIX I

COMPUTER PROGRAMS

A number of computer programs and packages are available in the Hydrology Section. Some are commercial packages and others are programs written or modified especially for the Project. The main software is listed and briefly described below:

HYDATA

The HYDATA package is a hydrological database designed for use on personal computers; it is the central part of the data processing and storage capability of the Hydrology Section. It is a commercial package produced by the Institute of Hydrology who regularly update and improve its features. Some of the initial development work was in fact carried out in the first part of the Somalia Hydrometry Project. A detailed manual is available.

A new updated version of HYDATA will be available shortly; it will have major enhancements, particularly to the graphics facilities. It is recommended that this updated version be obtained by the Hydrology Section in due course, but in view of the major nature of some of the changes it is probably preferable for this to be left until there is some further expatriate support to carry out the necessary training.

RIVERF

This is the River Forecasting model, operated by the batch command "RF". It is fully documented in the report presented in conjunction with this report.

RIVERI

This is the River Infilling model, operated by the batch command "RI". Its structure and operation was described in the Fourth Progress Report, Appendix C.

WORDMARC

WORDMARC is a word-processing package which can be used by staff of the Section to produce reports. It has full documentation as well as an on-screen help facility.

Lotus-123 and Printgraph

This Industry-standard spreadsheet and plotting package has already been widely used in the Section for data analysis and presentation. Full manuals are available.

ProFortran

Programs written in the Fortran programmimg language can be compiled using the ProFortran package which is probably the most complete version of Fortran for micro-computers.

Other programs

DISCHARG — This program is used for calculation of discharge measurement results; it prompts the user for the date of the measurement and the number of verticals, copies the required "shell" spreadsheet from a floppy disk, names it and invokes Lotus-123. The newly created file is retrieved automatically.

GETDATA — This is a program to read data from HYDATA files and output to file for analysis. The required type of daily data (eg Flow) is selected from a menu and then station number, years etc are entered in response to questions. Data may be output as daily values or as 10-day means, monthly means or annual means, and either sequences or specific items of data may be extracted.

GET10DAY — This modified version of GETDATA outputs to screen the 10-day mean flows for Lugh Ganana and Beled Weyn for the current and previous months. This permits easy determination of the values required for producing the 10 day bulletin.

GET10DAF — Similar to GET10DAY, but prints values for Afgoi.

APPENDIX J

HYDROLOGY SECTION GENERAL OPERATING INSTRUCTIONS

APPENDIX J

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APPENDIX J

HYDROLOGY SECTION OPERATING MANUALS AND INSTRUCTIONS

J1 ROUTINE OFFICE AND FIELDWORK PROGRAMME

J1.1 Office Work

Study all incoming data carefully. Try to detect any obvious mistakes before entering the data to the computer. After entering data, check it using the plotting facilities of the database to look for any unlikely changes which could have been due to mis-typing or other errors. Where possible use the Comparison Plot feature to compare data to that for an adjacent station, or use the Forecasting Model to compare the recent actual values to those forecast by the model.

Where corrections are made, or errors suspected, add comments to the observation sheet and to the database using the "Comment" facility. File the weekly cards and monthly sheets in their correct places.

Data should be printed out for visitors who require information, and every ten days the Bulletin should be prepared and taken to the FEWS Project office - see Section J2 for detailed instructions.

It is most important do do a back-up of the database files at least once a month, or more often if a substantial amount of data has been entered. There are two sets of back-up disks and these should be used alternately so that the most recent back-up is still available if something should go wrong during the back-up.

All fieldwork and any other specific items of work should be written up in the form used for the Progress Reports of the Hydrometry Project. This is particularly important because of the rapid turnover of staff in the Hydrology Section - if a staff member leaves for a training course a new member must be able to read and learn about his work. Reports can be prepared using the word processing package WORDMARC. Results of discharge and sediment measurements should be calculated first by hand, and then by using the appropriate computer programs - this is described separately.

J1.2 Fieldwork

For the immediate future fieldwork is likely to be restricted to weekly visits to Afgoi for sediment sampling; a discharge measurement should also be carried out about every two months. The main points to remember on each trip are as follows:

i) Collect data from the observer; supply more cards as necessary.

ii) Check the staff gauge level and/or bridge dip reading. If the value is significantly different from that reported by the observer it should be checked with him.

iii) Debris round the staff gauge should be cleared as necessary, and in the dry season it may be possible to repaint any gauges which are worn and difficult to read.

iv) Take the required number of sediment samples, following the standard procedures described in Section J4. Make sure all samples are properly labelled. The samples should be analysed in Mogadishu as soon as possible after the field trip.

v) When appropriate take a discharge measurement using the gauging derrick; at very low flows it might be better to use the wading equipment. Further details of discharge measurement procedures are given in Section J3.

If the conditions allow field visits to be made to other stations, the most important items of work are to collect data and carry out discharge measurements. Take a supply of data cards and books to give to the observers as required. It is very important to make careful notes of field observations, particularly if there is any problem with the station which requires repair work on a future visit.

J2 TEN DAY BULLETIN FOR FEWS PROJECT

The Hydrology Section's contribution to the FEWS Bulletin should be prepared as soon as possible after the end of the ten day period (eg on 11th, 21st or 1st). The procedure for updating the spreadsheet is as follows:

1) Type "GET10DAY" and press <ENTER> to get recent 10 day mean discharges for Beled Weyn and Lugh displayed on the screen. Similarly, "GET10DAF" gives figures for Afgoi.

2) Type "BULLETIN" and press <ENTER>. The spreadsheet is loaded automatically and the cursor (highlight block) should be on a square showing *B.W.*.

3) Check that this corresponds to the 10 day period just ended.

4) Type the average flow at Beled Weyn for the 10 days and press <ENTER>. If data is missing, hold down the <ALT> key and press E.

5) Hold down <ALT> and press A; the cursor should move to *LUGH*. Type the average flow at Lugh for the 10 days and press <ENTER>. If data is missing, hold down the <ALT> key and press E.

6) Hold down <ALT> and press A; the cursor should move to *AFGOI*. Type the average flow at Afgoi for the 10 days and press <ENTER>. If data is missing, hold down the <ALT> key and press E.

7) Check that the printer is ready (switched on and on-line); hold down <ALT> and press B. Wait for printing to be completed.

8) Check the printout very carefully. If there is any mistake you should repeat the entire process - i.e. type BULLETIN and press <ENTER>.

9) If all is correct, type UPDATE and press <ENTER>.

10) Write a short summary of the river conditions during the 10 day period (by hand or using WORDMARC - edit the existing file "BULLETIN.REP") and take this and the appropriate Bulletin printouts to the FEWS office. Only take the Afgoi printout as an alternative to that for Beled Weyn if the Beled Weyn data is unavailable.

11) If you need to enter or correct data for a previous period you should do the following:

    a) Use up-arrow key to move to the required place.

    b) Type value (10 day mean flow) and press <ENTER>

    c) Use down-arrow key to return to previous position.

J3 DISCHARGE MEASUREMENTS

J3.1 Field Measurements

Standard field equipment is as follows:

Derrick and gauging reel
Current meter, plus tail fin, counter unit and cables
Tape measure
Sinker weight
Observation sheets, plus position tables for .2, .6 and .8 depth.

At high flows the 25kg sinker weight must be used, but at low flows the 10kg weight is suitable and is easier to use. At very low flows the measurement should be done by wading; for this the wading rods replace the derrick, gauging reel and weight.

At the gauging site, choose a suitable interval between verticals - usually this should be such that about 20 verticals are measured across the whole section. At certain sites metre numbers are marked on the bridge deck, but at others the tape measure is required. At Afgoi a 2m interval is recommended.

On each vertical the velocity should be measured at 0.2 and 0.8 of the depth. This is the position of the current meter; the required position of the weight (as measured by the gauging reel counter) is shown in the tables at the end of the Appendix - see Table J1 for the 25 kg weight and Table J2 for the 10 kg weight. If the river is very shallow the 0.6 x depth position should be used. Measure the number of revolutions of the impellor in the standard time interval of 50 seconds.

It is most important to record the river level (staff gauge and/or bridge dip) both before and after the measurement, and to note the times of start and finish. Also, do not forget to note the meter/impellor numbers and the distance on the tape corresponding to each edge of the river (i.e. point of zero depth).

J3.2 Calculations

Discharge measurement calculations should first be done on the observation sheet using a calculator. Table J3 gives the velocities for the number of revolutions in 50 seconds. Afterwards they can be done by using a Lotus-123 spreadsheet. Spreadsheets can be accessed in the standard way by typing "123" and selecting the required spreadsheet, but to simplify the procedure there is a program called "DISCHARGE". Instructions are as follows:

1) Work out the number of the discharge measurement in the month - usually 1 with very limited opportunities for fieldwork.

2) Type DISCHARGE and press <ENTER>

3) Follow the instructions on the screen - enter the year and month and then the measurement number.

4) Count the number of verticals on the field observation sheet (count the zero depth points at each side of the river, but do not double count the point which appears at the bottom of one sheet and the top of the next sheet). Enter this number when prompted to do so.

5) Because of the different equipment used on the cableway at Bardheere a different worksheet is required for measurements there. Enter "B" (or "b") if the measurement was at Bardheere, or any other key if it was at another site using the Hydrology Section equipment.

6) You will now be asked to insert the floppy disk containing the 'blank' worksheets - there are two identical disks in the box.

7) If you have entered a number of verticals for which there is no worksheet available (eg 50), or if the number of the measurement has already been used, the program will stop and give an error message. Otherwise the required worksheet will be loaded automatically.

8) Proceed to enter the results as normal. You may then print a copy of the results - hold down <ALT> and press P.

9) To finish:

   To save: Hold down <ALT> and press S

   To quit: Hold down <ALT> and press Q

10) The final question asks you to confirm that you wish to save the worksheet. Enter "Y" (or "y") unless you have quit using ALT + Q.

11) If further corrections are needed you should type 123 and retrieve the named worksheet in the usual manner.

J4 SEDIMENT SAMPLING AND ANALYSIS

J4.1 Field Procedures

Sediment samples are taken using the USDH-59 sediment sampler from a handline or the gauging derrick, or the USDH-48 sampler for wading at low flows. Both of these are depth-integrating sediment samplers which are designed to produce representative samples of the water at the vertical where the sample is taken. By lowering and raising the sampler at constant rates the quantity of water drawn at a given depth is proportional to the flow velocity.

The USDH-59 sampler is shown in Figure J1; the USDH-48 sampler is smaller but is essentially of similar form. The sampler comprises a streamlined bronze casting which partially encloses a pint-sized plastic bottle. The sampler weighs approximately 10 kg and has a tail vane which orientates the intake nozzle into the direction of flow. The sample bottle is sealed against a gasket in the head cavity of the casting by a spring-loaded pull-rod assembly at the tail of the sampler. When the sampler enters the water, the sample enters the bottle via the nozzle, with the displaced air being ejected downstream via an air exhaust tube which is part of the sampler casting. Different sizes of nozzle are available to facilitate sampling in rivers of differing velocities and depths.

It is usual to first sample a river at a number of verticals across the section, and then for subsequent measurements to select one vertical which is representative of the whole section. Initial measurements at Afgoi indicated no substantial variation across the section, so later measurements have been taken near the middle of the channel where the flow is reasonably uniform.

The essential points to remember when taking sediment samples are as follows:

i) Note the river level (staff gauge and/or bridge dip); if the measurements take some considerable time, or if the river level is changing rapidly, record the level both before and after the measurements.

ii) Measure the river depth by lowering the sampler without a bottle.

iii) Take at least four samples; as soon as each sample has been taken the bottle should be capped and labelled clearly with the location, river level, date/time and sample number.

iv) The speed at which the sampler is lowered must be constant; on reaching the bed the sampler must be immediately raised, again at a constant rate. It is not essential for the speeds of lowering and raising to be equal, though it is usually easiest in practice if they are similar.

v) If the sample bottle is full or almost full the sample should be rejected and a new sample taken with a clean bottle. If the bottle is less than half full a further traverse to and from the bed may be made in order to double-up the sample.

J4.2 Analysis of Samples

On return to the office the samples should be stored in the cupboard overnight so that the sediment settles. The analysis should then be carried out as soon as possible. The procedure for determination of sediment concentration by filtration is summarised below:

1) Mark the filter papers (one per sample plus one) and place in the oven for about four hours. Transfer to the desiccator and leave overnight.

2) Write the filter paper identifications on the results sheet, together with the date, location and number of each sample.

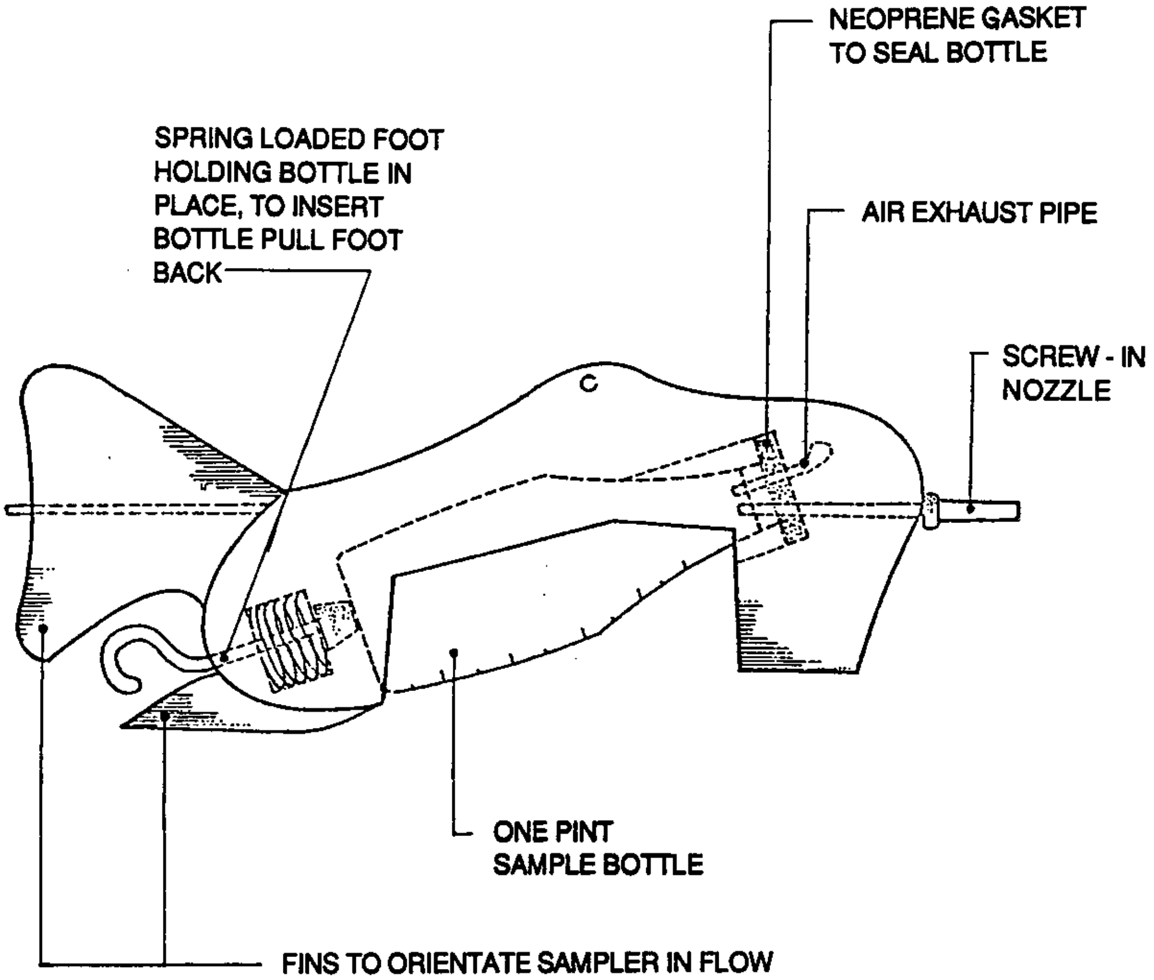
3) <u>For Each Sample:</u>

   a) Weigh the sample bottle on the 500g balance (to 2 decimal places).

   b) Weigh the filter paper on the 200g balance (to 4 decimal places). Since the weight is liable to rise as soon as it enters the moist atmosphere after being in the desiccator it is very important that this is carried out quickly. The filter paper should be moved to the balance and the reading recorded as soon as the character "e" appears on the display.

Figure J1

USDH - 59 Suspended Sediment Sampler



c) Carefully pour off the excess clean water into a spare clean bottle; it is very important not to pour off any of the sediment. This bottle will be used later to measure the EC.

4) Place the filter papers in the funnels and dampen slightly with distilled water so that the paper 'sticks' to the funnel.

5) Pour each sample into the filter paper a little at a time.

6) Fill the control filter paper with distilled water.

7) Use some distilled water (and the spray bottle) to ensure that all the sediment is washed out of the bottles.

8) Leave the empty sample bottles open to the air with the lids adjacent to them.

When filtration is complete:

9) Place each filter paper on a dish in the oven at Nr. 3 for at least four hours. This includes the unused filter paper.

10) Remove the filter papers with tweezers and place in the desiccator.

On the next day:

11) Using the 500g balance weigh the dry sample bottles (with lids) and record the weights on the sheet.

12) Weigh the filter papers (use the tweezers) and record the weights - method as in 3(b) above.

13) Measure the salinity (EC) of each sample using the conductivity meter; each sample should be measured both with and without temperature compensation, though it is the figure with compensation which should be stored in the database.

J4.3 Hand Calculation of Results

After entering the weights on the results sheet (copies of which may be obtained by printing the Lotus-123 file SEDBLANK.WK1), the weights of sample and sediment may be determined by subtraction, and the sediment concentration calculated.

The sediment concentration in mg/l (or parts per million - ppm) should be reported to the nearest whole number; decimals - and perhaps even units - are meaningless as the accuracy of the measurements does not justify them.

When expressed in g/l it is probably most appropriate to display to two significant figures (eg 3.6 or 0.48).

J4.4 Computer Calculation of Results

a) Change to the Lotus directory by typing "CD \123NEW"

b) Type "COPY SEDIMENT.WK1 SEDyymmx.WK1", where yy is the year (eg 90), mm is the month (eg 06 for June) and x is a letter indicating the number of the measurement in that month (A for first, B for second etc).

   Thus, for the third measurement in February 1991 the required file name would be SED9102C.WK1.

c) Type "123" and press <ENTER>.

d) Press "/" to get the menu.

   then File
   Retrieve
   then select the required file (SED9102C.WK1 in the above example)

e) Type in the weights and EC readings. The sediment concentration will be calculated automatically, and should be displayed to the accuracy recommended above. If not the format of that cell can be changed as required.

f) Hold down <ALT> and press S to save the file.

g) Hold down <ALT> and press P to print the file.

h) Hold down <ALT> and press Q to quit 123.

TABLE J1

Measurement Depths for Standard Positions using 25 kg weight

Depth of 25 kg weight = required depth of meter + 0.35 m
(eg 0.8 x depth of water + 0.35 m)

Depth for 0.6d	Water Depth	Depth for 0.8d	Depth for 0.2d
0.8	**0.8**	\)	
0.9	**0.9**	\)	
1.0	**1.0**	\)	
		\)	Too shallow for
1.0	**1.1**	\)	two point method
1.1	**1.2**	\)	
1.1	**1.3**	\)	
1.2	**1.4**	\)	
1.3	**1.5**	\)	
1.3	**1.6**	1.6	0.7
1.4	**1.7**	1.7	0.7
1.4	**1.8**	1.8	0.7
1.5	**1.9**	1.9	0.7
1.6	**2.0**	2.0	0.8
1.6	**2.1**	2.0	0.8
1.7	**2.2**	2.1	0.8
1.7	**2.3**	2.2	0.8
1.8	**2.4**	2.3	0.8
1.9	**2.5**	2.4	0.9
1.9	**2.6**	2.4	0.9
2.0	**2.7**	2.5	0.9
2.0	**2.8**	2.6	0.9
2.1	**2.9**	2.7	0.9
2.2	**3.0**	2.8	1.0
2.2	**3.1**	2.8	1.0
2.3	**3.2**	2.9	1.0
2.3	**3.3**	3.0	1.0
2.4	**3.4**	3.1	1.0
2.5	**3.5**	3.2	1.1
2.5	**3.6**	3.2	1.1
2.6	**3.7**	3.3	1.1

TABLE J1 (CONT.)

Measurement Depths for Standard Positions using 25 kg weight

Depth for 0.6d	Water Depth	Depth for 0.8d	Depth for 0.2d
2.6	**3.8**	3.4	1.1
2.7	**3.9**	3.5	1.1
2.8	**4.0**	3.6	1.2
2.8	**4.1**	3.6	1.2
2.9	**4.2**	3.7	1.2
2.9	**4.3**	3.8	1.2
3.0	**4.4**	3.9	1.2
3.1	**4.5**	4.0	1.3
3.1	**4.6**	4.0	1.3
3.2	**4.7**	4.1	1.3
3.2	**4.8**	4.2	1.3
3.3	**4.9**	4.3	1.3
3.4	**5.0**	4.4	1.4
3.4	**5.1**	4.4	1.4
3.5	**5.2**	4.5	1.4
3.5	**5.3**	4.6	1.4
3.6	**5.4**	4.7	1.4
3.7	**5.5**	4.8	1.5
3.7	**5.6**	4.8	1.5
3.8	**5.7**	4.9	1.5
3.8	**5.8**	5.0	1.5
3.9	**5.9**	5.1	1.5
4.0	**6.0**	5.2	1.6
4.0	**6.1**	5.2	1.6
4.1	**6.2**	5.3	1.6
4.1	**6.3**	5.4	1.6
4.2	**6.4**	5.5	1.6
4.3	**6.5**	5.6	1.7
4.3	**6.6**	5.6	1.7
4.4	**6.7**	5.7	1.7
4.4	**6.8**	5.8	1.7
4.5	**6.9**	5.9	1.7
4.6	**7.0**	6.0	1.8

TABLE J1 (CONT.)

Measurement Depths for Standard Positions using 25 kg weight

Depth for 0.6d	Water Depth	Depth for 0.8d	Depth for 0.2d
4.6	**7.1**	6.0	1.8
4.7	**7.2**	6.1	1.8
4.7	**7.3**	6.2	1.8
4.8	**7.4**	6.3	1.8
4.9	**7.5**	6.4	1.9
4.9	**7.6**	6.4	1.9
5.0	**7.7**	6.5	1.9
5.0	**7.8**	6.6	1.9
5.1	**7.9**	6.7	1.9
5.2	**8.0**	6.8	2.0
5.2	**8.1**	6.8	2.0
5.3	**8.2**	6.9	2.0
5.3	**8.3**	7.0	2.0
5.4	**8.4**	7.1	2.0
5.5	**8.5**	7.2	2.1
5.5	**8.6**	7.2	2.1
5.6	**8.7**	7.3	2.1
5.6	**8.8**	7.4	2.1
5.7	**8.9**	7.5	2.1
5.8	**9.0**	7.6	2.2
5.8	**9.1**	7.6	2.2
5.9	**9.2**	7.7	2.2
5.9	**9.3**	7.8	2.2
6.0	**9.4**	7.9	2.2
6.1	**9.5**	8.0	2.3
6.1	**9.6**	8.0	2.3
6.2	**9.7**	8.1	2.3
6.2	**9.8**	8.2	2.3
6.3	**9.9**	8.3	2.3
6.4	**10.0**	8.4	2.4

TABLE J2

Measurement Depths for Standard Positions using 10 kg weight

Depth of 10 kg weight = required depth of meter + 0.25 m
(eg 0.8 x depth of water + 0.25 m)

Depth for 0.6d	Water Depth	Depth for 0.8d	Depth for 0.2d
0.6	**0.6**	)	
0.7	**0.7**	)	
0.7	**0.8**	)	Too shallow for
0.8	**0.9**	)	two point method
0.9	**1.0**	)	
0.9	**1.1**	1.1	0.5
1.0	**1.2**	1.2	0.5
1.0	**1.3**	1.3	0.5
1.1	**1.4**	1.4	0.5
1.2	**1.5**	1.5	0.6
1.2	**1.6**	1.5	0.6
1.3	**1.7**	1.6	0.6
1.3	**1.8**	1.7	0.6
1.4	**1.9**	1.8	0.6
1.5	**2.0**	1.9	0.7
1.5	**2.1**	1.9	0.7
1.6	**2.2**	2.0	0.7
1.6	**2.3**	2.1	0.7
1.7	**2.4**	2.2	0.7
1.8	**2.5**	2.3	0.8
1.8	**2.6**	2.3	0.8
1.9	**2.7**	2.4	0.8
1.9	**2.8**	2.5	0.8
2.0	**2.9**	2.6	0.8
2.1	**3.0**	2.7	0.9
2.1	**3.1**	2.7	0.9
2.2	**3.2**	2.8	0.9
2.2	**3.3**	2.9	0.9
2.3	**3.4**	3.0	0.9
2.4	**3.5**	3.1	1.0
2.4	**3.6**	3.1	1.0

TABLE J2 (contd)

Measurement Depths for Standard Positions using 10 kg weight

Depth of 10 kg weight = required depth of meter + 0.25 m
(eg 0.8 x depth of water + 0.25 m)

Depth for 0.6d	Water Depth	Depth for 0.8d	Depth for 0.2d
2.5	**3.7**	3.2	1.0
2.5	**3.8**	3.3	1.0
2.6	**3.9**	3.4	1.0
2.7	**4.0**	3.5	1.1
2.7	**4.1**	3.5	1.1
2.8	**4.2**	3.6	1.1
2.8	**4.3**	3.7	1.1
2.9	**4.4**	3.8	1.1
3.0	**4.5**	3.9	1.2
3.0	**4.6**	3.9	1.2
3.1	**4.7**	4.0	1.2
3.1	**4.8**	4.1	1.2
3.2	**4.9**	4.2	1.2
3.3	**5.0**	4.3	1.3

Table J3

Velocity in m/s for number of revolutions in 50 seconds (8011 series propellors)

	0	1	2	3	4	5	6	7	8	9
0	0.000	0.009	0.017	0.026	0.033	0.038	0.043	0.048	0.053	0.058
10	0.063	0.068	0.073	0.078	0.083	0.088	0.093	0.099	0.104	0.109
20	0.115	0.120	0.125	0.131	0.136	0.141	0.147	0.152	0.157	0.163
30	0.168	0.173	0.179	0.184	0.189	0.195	0.200	0.205	0.211	0.216
40	0.221	0.227	0.232	0.237	0.243	0.248	0.253	0.259	0.264	0.269
50	0.275	0.280	0.285	0.291	0.296	0.301	0.307	0.312	0.317	0.323
60	0.328	0.333	0.339	0.344	0.349	0.355	0.360	0.365	0.371	0.376
70	0.381	0.387	0.392	0.397	0.403	0.408	0.413	0.419	0.424	0.429
80	0.435	0.440	0.445	0.451	0.456	0.461	0.467	0.472	0.477	0.483
90	0.488	0.493	0.499	0.504	0.509	0.515	0.520	0.525	0.531	0.536
100	0.541	0.547	0.552	0.557	0.563	0.568	0.573	0.579	0.584	0.589
110	0.595	0.600	0.605	0.611	0.616	0.621	0.627	0.632	0.637	0.643
120	0.648	0.653	0.659	0.664	0.669	0.675	0.680	0.685	0.691	0.696
130	0.701	0.707	0.712	0.717	0.723	0.728	0.733	0.739	0.744	0.749
140	0.755	0.760	0.765	0.771	0.776	0.781	0.787	0.792	0.797	0.803
150	0.808	0.813	0.819	0.824	0.829	0.835	0.840	0.845	0.851	0.856
160	0.861	0.867	0.872	0.877	0.883	0.888	0.893	0.899	0.904	0.909
170	0.915	0.920	0.925	0.931	0.936	0.941	0.947	0.952	0.957	0.963
180	0.968	0.973	0.979	0.984	0.989	0.995	1.000	1.005	1.011	1.016
190	1.021	1.027	1.032	1.037	1.043	1.048	1.053	1.059	1.064	1.069
200	1.075	1.080	1.085	1.091	1.096	1.101	1.107	1.112	1.117	1.123
210	1.128	1.133	1.139	1.144	1.149	1.155	1.160	1.165	1.171	1.176
220	1.181	1.187	1.192	1.197	1.203	1.208	1.213	1.219	1.224	1.229
230	1.235	1.240	1.245	1.251	1.256	1.261	1.267	1.272	1.277	1.283
240	1.288	1.293	1.299	1.304	1.309	1.315	1.320	1.325	1.331	1.336
250	1.342	1.347	1.352	1.358	1.363	1.368	1.374	1.379	1.384	1.390
260	1.395	1.400	1.406	1.411	1.416	1.422	1.427	1.432	1.438	1.443
270	1.448	1.454	1.459	1.464	1.470	1.475	1.480	1.486	1.491	1.496
280	1.502	1.507	1.512	1.518	1.523	1.528	1.534	1.539	1.544	1.550
290	1.555	1.560	1.566	1.571	1.576	1.582	1.587	1.592	1.598	1.603
300	1.608	1.614	1.619	1.624	1.630	1.635	1.640	1.646	1.651	1.656
310	1.662	1.667	1.672	1.678	1.683	1.688	1.694	1.699	1.704	1.710
320	1.715	1.720	1.726	1.731	1.736	1.742	1.747	1.752	1.758	1.763
330	1.768	1.774	1.779	1.784	1.790	1.795	1.800	1.806	1.811	1.816
340	1.822	1.827	1.832	1.838	1.843	1.848	1.854	1.859	1.864	1.870
350	1.875	1.880	1.886	1.891	1.896	1.902	1.907	1.912	1.918	1.923
360	1.928	1.934	1.939	1.944	1.950	1.955	1.960	1.966	1.971	1.976
370	1.982	1.987	1.992	1.998	2.003	2.008	2.014	2.019	2.024	2.030
380	2.035	2.040	2.046	2.051	2.056	2.062	2.067	2.072	2.078	2.083
390	2.088	2.094	2.099	2.104	2.110	2.115	2.120	2.126	2.131	2.136
400	2.142	2.147	2.152	2.158	2.163	2.168	2.174	2.179	2.184	2.190
410	2.195	2.200	2.206	2.211	2.216	2.222	2.227	2.232	2.238	2.243
420	2.248	2.254	2.259	2.264	2.270	2.275	2.280	2.286	2.291	2.296
430	2.302	2.307	2.312	2.318	2.323	2.328	2.334	2.339	2.344	2.350
440	2.355	2.360	2.366	2.371	2.376	2.382	2.387	2.392	2.398	2.403
450	2.408	2.414	2.419	2.424	2.430	2.435	2.440	2.446	2.451	2.456
460	2.462	2.467	2.472	2.478	2.483	2.488	2.494	2.499	2.504	2.510
470	2.515	2.520	2.526	2.531	2.536	2.542	2.547	2.552	2.558	2.563
480	2.568	2.574	2.579	2.584	2.590	2.595	2.600	2.606	2.611	2.616
490	2.622	2.627	2.632	2.638	2.643	2.648	2.654	2.659	2.664	2.670

APPENDIX K

DETAILS OF CURRENT GAUGING STATIONS

APPENDIX K

DETAILS OF CURRENT GAUGING STATIONS

Station	Staff Gauge range (m)	Bridge dip	Gauge zero
River Jubba			
Lugh Ganana	0-2 and 2-7	EGH 9.59	141.42
Bardheere	0-7	EGH 7.99	88.98
Mareere	(Covers 14-22)	no bridge	0.00
Kamsuma	-	EGH 9.96	?
Mogambo	6-13.5	no bridge	0.00
Jamamme	-	EGH 11.04	0.00
River Shebelli			
Beled Weyn	0-2 and 1.5-6.5	EGH 7.58	176.11
Bulo Burti	1-3, 3-5 and 5-7	EGH 10.11	133.39
Mahaddey Weyn	0-2, 2-4 and 4-6	EGH 7.52	104.57
Afgoi	0-1 and 1-6	EGH 7.42	77.42
Audegle	1-3 and 3-5	EGH 7.20	70.05
Kurten Waarey	1-4 and 4-6	no bridge	55.40

Notes:

Lugh Ganana: Bridge dip point on bridge deck at 32 m mark from left bank on downstream face.

Bardheere: Part or all of the 0-2 m staff gauge has been reported broken. Bridge dip point marked on bridge girder next to box containing automatic water level recorder.

Mareere: The station is operated by JSP who keep records of the zero level of each gauge and provide levels corrected to mean sea level. Levels stored on the computer in Mogadishu are referenced to a datum of 10 m (i.e. all values reduced by 10.00) because HYDATA would not accept a zero correction of more than 9.99 m for rating equations.

Kamsuma: Bridge dip point marked "MB" on bridge deck at 32 m point on downstream face.

Jamamme: Bridge dip point is arrow painted on bridge deck near centre of upstream face. Locating arrow marked on cross beam.

Beled Weyn: Part or all of the 0-2 m staff gauge has been reported broken. Bridge dip point on downstream face - hacksaw mark on top rung of railings, by fifth vertical from right bank.

Bulo Burti: Bridge dip point marked on top of handrail on downstream face, near to centre of bridge. Actual EGH is 10.14 m, but slope correction of 0.03 m to staff gauges gives effective EGH of 10.11 m.

Mahaddey Weyn: The 0-2 m staff gauge is very badly worn and is difficult to read. Bridge dip is marked on concrete ledge just below bridge deck on upstream face near centre of bridge.

Afgoi: Bridge dip point marked on old bridge directly above staff gauges.

Audegle: 5-6 m staff gauge was previously attached above 3-5 m gauge; extension of stand is still in place. Bridge dip point marked by arrow shaped hacksaw cut on the downstream edge of the bridge deck near to the centre of the bridge. EGH allows for approximate slope correction.

APPENDIX L

EXAMPLE 10-DAY BULLETIN FROM FOOD EARLY WARNING SYSTEM PROJECT

Hydrometry

SOMALI DEMOCRATIC REPUBLIC
WASAARADDA BEERAHA
MINISTRY OF AGRICULTURE
FOOD EARLY WARNING DEPARTMENT

FOOD EARLY WARNING SYSTEM

TEN DAY EARLY WARNING INFORMATION BULLETIN for 1st DECADE (1-10) NOVEMBER 1990

RAINFALL SITUATION

Only partial data could be collected this decade. Afgoi reported 29.8mm of rain during the first five days of the month; Dusa Mareb reported 20.0mm on the first of November; Dudunle reported 19.4mm on the 4th. Elsewhere, only slight rains were reported, with 5.5mm at Jowhar, 1.5mm at Balad (during the first 5 days), 0.4mm at Mogadishu and 2.2mm at Jamame.

In the Lower Juba region, at Jamame, the rainfall in October amounted to 146.7mm, which is 431.5% above normal and the second highest monthly rainfall record for a reporting period of 16 years.

RIVER FLOWS

Both rivers dropped sharply during this period. The Juba at Lugh fell from about 200 cumecs to just over 120 cumecs; the Shebelli at Afgoi fell from over 70 cumecs to under 40.

The attached graphs clearly show that the Der flood season has been both shorter and lower than normal on both rivers.

AGRICULTURAL SITUATION

Crops: Cereal crops are at the vegetative stage. The condition of the crop is reported to be good in most regions. Dudunle (northern part of the district of Jowhar) reports a poor crop's condition since rainfall in this region has been poor during the last decade of October and the first decade of November. Although information is scarce, very poor growing conditions are believed to persist in the Hiran region. Rainfall cereal plantings in Lugh and Geed Weyn are likely to fail as rainfall has been extremely scarce since the 17th of October.

Sesame plantings have started in the southern regions, especially in the Lower Shebelli and Lower Juba regions, as in the district of Balad and Jilib where above normal rains have been recently received.

Range: Rangelands conditions are below normal in the Hiran, the Galgadud, the Mudug and large parts in the northern regions (Bari, Sool, Togdheer). In the south, good range conditions prevail.

PRICES SITUATION

The price of maize decreased or remained unchanged on most markets, except in Jowhar and Lugh ; the highest maize prices were reported in Lugh (1485 SoShs/kg). Sorghum prices decreased on all markets, with even a 20% price decrease reported in Mogadishu; only in Jowhar sorghum prices were still slightly increasing. The highest prices were once more reported from Lugh, with prices up to 1309 SoShs/kg, but prices were decreasing towards the end of the decade. Cowpea prices increased on most markets, reflecting the still unfavourable supply situation. In Baidoa, the price increase reached even 66.7%, cowpeas being sold at 2520 SoShs/kg, which is 20% over the Mogadishu price. Sesame seed prices remained stable or decreased slightly. Sesame oil prices also remained relatively stable; in Baidoa however sesame oil was selling at 7000 SoShs/ltr, an increase of 16.7% over the previous decade, reflecting poor local imports.

Wheat flour prices remained stable or increased slightly, except in Baidoa, where prices jumped from 1500 to 2000 SoShs/kg. Rice prices increased on most markets with highest prices reported from Jowhar (2500 SoShs/kg on the 10th) and Baidoa. In the aftermath of high price rises for imported edible oil reported in Mogadishu last month, several markets continued to report important edible oil price rises; the highest price being reported from Baidoa, with oil selling at 4800 SoShs/ltr. Sugar prices continued to remain stable; however above average sugar prices were reported in Lugh and in the Hiran region.

In Borama (Awdal region), very high price rises were recently reported, rice selling at 4000 SoShs/kg and sugar at 6000 SoShs/kg.

FEWS PROJECT

DECADAL RAINFALL REPORT

for

First Decade November 1990

STATION	1	2	3	4	5	6	7	8	9	10	Ten day Total	Cumulative totals 1990	1989	Normal	1990 0 Normal 0
Jilib	.	.	.	.	.	.	.	.	.	.	.	.	525.4	503.6	.
Boale	.	.	.	.	.	.	.	.	.	.	.	.	604.3	458.4	.
Dinsor	.	.	.	.	.	.	.	.	.	.	.	.	698.2	375.9	.
Bardera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	548.9	436.5	307.9	178.3
Jowhar	2.0	0.0	0.9	2.6	0.0	0.0	0.0	0.0	.	.	.	.	325.3	449.1	.
Balad	0.0	0.0	1.5	0.0	0.0	.	.	.	.	.	.	.	506.7	370.9	.
Afgoi	0.0	0.0	0.0	21.5	8.3	.	.	.	.	.	.	.	484.7	401.2	.
Lafoole	.	.	.	.	.	.	.	.	.	.	.	.	359.7	389.9	.
Mogadishu	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	333.7	321.6	385.6	86.5
Lugh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	208.5	249.6	257.7	80.9
Baidoa	.	.	.	.	.	.	.	.	.	.	.	.	531.4	557.5	.
Bulo Berti	.	.	.	.	.	.	.	.	.	.	.	.	437.3	298.1	.
Hoddur	.	.	.	.	.	.	.	.	.	.	.	.	487.9	332.8	.
Belet Weyne	.	.	.	.	.	.	.	.	.	.	.	.	383.4	295.9	.
Dusamareb	20.0	.	.	.	.	.	.	.	.	.	.	.	193.0	.	.
Galcaio	.	.	.	.	.	.	.	.	.	.	.	.	282.9	181.4	.

NOTES: Rainfall in Millimetres Dots (.) indicate missing values

DEPARTMENT OF IRRIGATION AND LAND USE

HYDROMETRY PROJECT

RIVER FLOW REPORT 12-Nov-90

RIVER JUBBA AT LUGH GANANA

10 Day period	10 day mean discharges (cumecs)					Cumulative Water Volume (MCM)				
	Normal	1988	1989	1990	1990 as % normal	Normal	1988	1989	1990	1990 as % normal
JAN I	35	36	34	162	466	30	31	29	140	466
II	29	34	25	109	376	55	61	50	234	425
III	22	25	19	67	304	76	84	68	291	384
FEB I	21	21	21	45	215	94	102	86	330	352
II	16	16	15	48	305	107	116	99	371	346
III	12	11	16	42	340	116	124	110	407	351
MAR I	10	10	10	184	1766	125	133	119	566	453
II	11	14	8	156	1435	134	144	126	701	522
III	11	11	14	127	1132	145	155	139	811	559
APR I	25	6	127	184	731	167	160	249	970	581
II	120	64	259	434	362	270	215	473	1345	497
III	148	131	413	544	367	398	328	830	1814	456
MAY I	196	155	567	348	177	568	462	1320	2115	373
II	240	125	240	223	93	775	570	1527	2308	298
III	237	133	210	208	88	1000	702	1726	2487	249
JUN I	200	77	131	195	98	1174	768	1840	2656	226
II	166	74	166	183	110	1317	833	1983	2814	214
III	153	120	186	158	104	1449	936	2144	2951	204
JUL I	182	98	115	148	81	1607	1020	2243	3078	192
II	173	163	168	145	84	1756	1161	2388	3204	182
III	207	316	233	146	71	1953	1461	2610	3330	171
AUG I	205	300	218	188	92	2130	1720	2798	3493	164
II	226	383	168	201	89	2325	2051	2943	3666	158
III	265	297	186	254	96	2577	2333	3104	3885	151
SEP I	283	231	283	268	95	2821	2532	3348	4116	146
II	273	234	414	203	75	3057	2735	3706	4292	140
III	276	290	297	170	62	3295	2985	3962	4439	135
OCT I	290	302	360	205	71	3545	3246	4273	4616	130
II	415	477	415	237	57	3904	3659	4632	4821	123
III	396	697	728	236	60	4280	4321	5324	5025	117
NOV I	340	346	389	142	42	4574	4620	5660	5148	113
II	228	181	269			4771	4777	5893		
III	163	117	247			4912	4878	6107		
DEC I	107	78	192			5004	4945	6273		
II	73	57	257			5067	4995	6495		
III	51	47	205			5115	5040	6690		

Notes:

(1) Normal is the median from the period 1963-1989 (revised after extensive checks)

(2) 1990 flow values are provisional; all other values are now final.

(3) Any use of this data should acknowledge the source to be the Hydrology Section, Department of Irrigation and Land Use, Ministry of Agriculture.

DEPARTMENT OF IRRIGATION AND LAND USE

HYDROMETRY PROJECT

RIVER FLOW REPORT 12-Nov-90

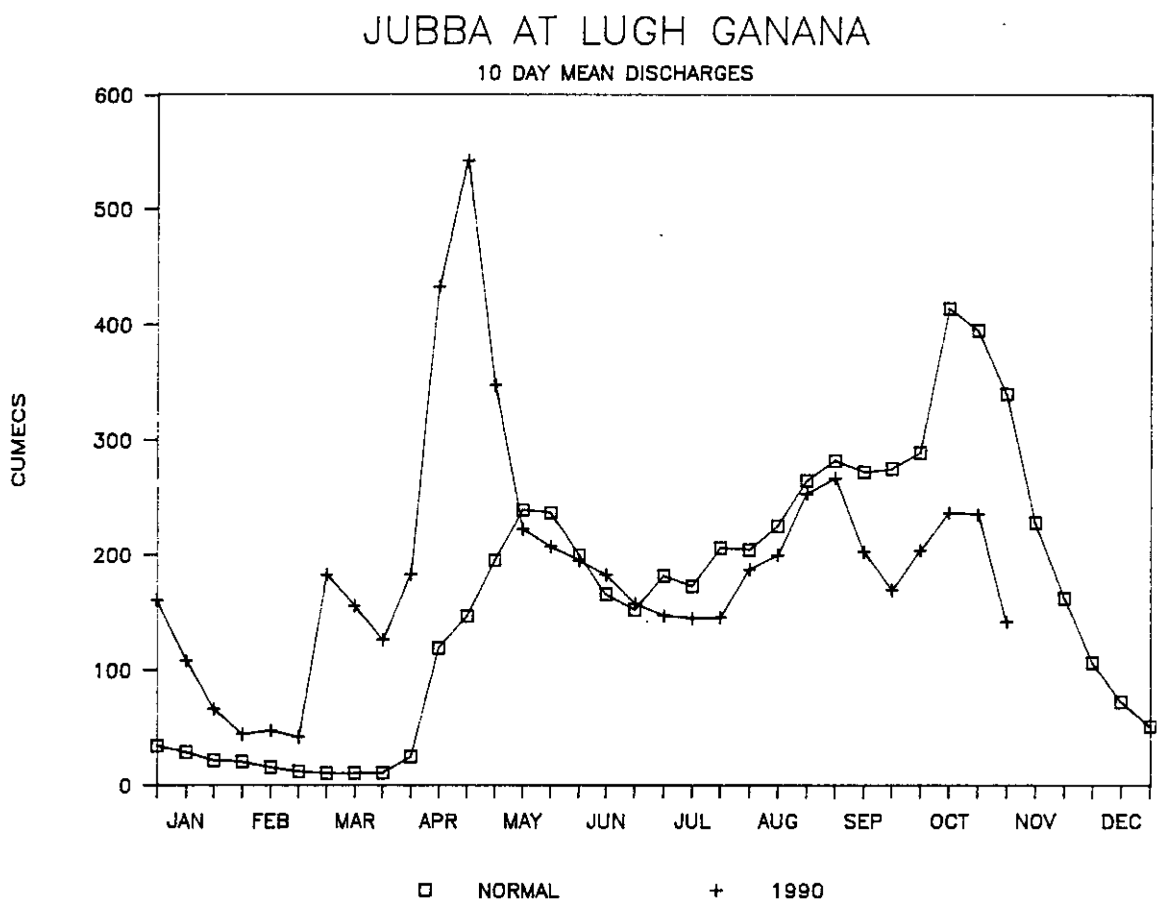
RIVER SHEBELLI AT AFGOI

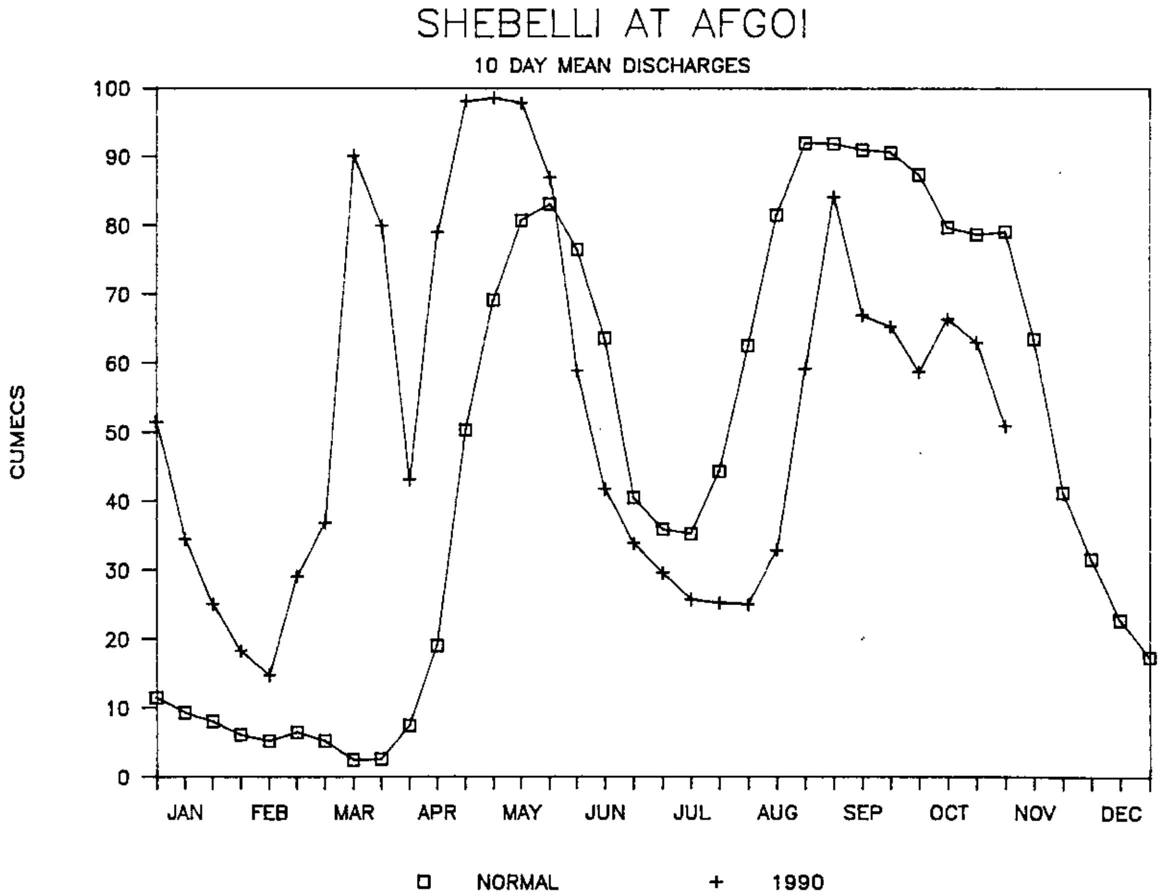
10 Day period	10 day mean discharges (cumecs)					Cumulative Water Volume (MCM)				
	Normal	1988	1989	1990	1990 as % normal	Normal	1988	1989	1990	1990 as % normal
JAN I	12	10	13	52	445	10	9	11	45	445
II	9	10	13	34	367	18	18	22	74	410
III	8	11	11	25	309	26	28	33	96	372
FEB I	6	10	12	18	299	31	36	43	112	359
II	5	11	11	15	283	36	46	52	125	350
III	7	8	11	29	448	40	51	60	150	372
MAR I	5	6	15	37	709	45	57	73	182	406
II	3	2	11	90	3609	47	59	83	260	553
III	3	1	12	80	3074	49	60	94	329	666
APR I	8	0	28	43	575	56	60	118	366	655
II	19	2	79	79	414	72	62	186	434	600
III	50	32	86	98	195	116	89	260	519	448
MAY I	69	77	90	99	143	176	155	338	604	344
II	81	63	94	98	121	245	210	420	689	281
III	83	24	96	87	105	325	233	511	764	235
JUN I	77	22	77	59	77	391	253	577	815	209
II	64	13	42	42	66	446	264	613	851	191
III	41	13	28	34	84	481	275	638	880	183
JUL I	36	19	25	30	82	512	291	659	905	177
II	35	17	18	26	73	542	306	674	928	171
III	44	25	17	25	57	584	330	690	949	163
AUG I	63	30	33	25	40	638	356	719	971	152
II	82	65	47	33	40	709	412	759	1000	141
III	92	84	25	59	64	796	492	781	1051	132
SEP I	92	83	40	84	92	876	564	816	1124	128
II	91	82	79	67	74	954	634	884	1181	124
III	91	81	72	65	72	1033	704	947	1238	120
OCT I	87	79	61	59	67	1108	772	999	1288	116
II	80	80	77	66	83	1177	841	1066	1346	114
III	79	79	76	63	80	1252	916	1138	1400	112
NOV I	79	82	75	51	64	1320	987	1202	1444	109
II	64	77	50			1375	1053	1245		
III	41	41	37			1411	1088	1277		
DEC I	32	24	38			1438	1109	1310		
II	23	18	34			1458	1124	1340		
III	18	16	44			1474	1139	1382		

Notes: (1) Normal is the median from the period 1963-1989 (revised after extensive checks)

(2) 1990 flow values are provisional; all other values are now final.

(3) Any use of this data should acknowledge the source to be the Hydrology Section, Department of Irrigation and Land Use, Ministry of Agriculture.


JUBBA AT LUGH GANANA
10 DAY MEAN DISCHARGES
CUMECS
0
100
200
300
400
500
600
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
NORMAL
1990


SHEBELLI AT AFGOI
10 DAY MEAN DISCHARGES
CUMECS
0
10
20
30
40
50
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80
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100
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
NORMAL
1990

FEWS PROJECT

RETAIL PRICES
for
First Decade November 1990

STATION	Maize		Sorghum		Wheat Flour		Rice		Sesame Seed		Cowpeas		Imported Oil		Sesame Oil		Sugar	
	SoSh/kg	%	SoSh/kg	%	SoSh/kg	%	SoSh/kg	%	SoSh/kg	%	SoSh/kg	%	SoSh/ltr	%	SoSh/ltr	%	SoSh/kg	%
Jilib	1088.1	2.9	N.A.	N.A.	1810.0	0.6	2000.0	0.0	2047.0	0.4	1843.2	-7.0	3650.0	-6.2	6000.0	0.0	2000.0	-0.5
Boale	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Dinsor	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Bardera	1216.0	N.A.	704.0	N.A.	1900.0	N.A.	2100.0	N.A.	N.A.	N.A.	1982.5	N.A.	4000.0	N.A.	5000.0	N.A.	2200.0	N.A.
Balad	1046.3	-8.3	900.0	-5.4	1600.0	0.0	2167.0	8.4	N.A.	N.A.	1941.4	12.7	3900.0	30.0	4410.0	-11.0	2000.0	0.0
Mogadishu	1107.0	-5.2	938.3	-20.1	1610.0	-3.6	2170.0	13.0	2349.6	-5.7	2099.2	7.2	3850.0	-6.7	4810.0	-6.6	1990.0	0.5
Jowhar	1350.0	9.6	1147.5	5.4	2000.0	9.6	2440.0	1.7	1850.0	-0.5	1989.0	5.4	3900.0	8.0	4990.0	3.8	2000.0	14.3
Lugh	1455.0	17.6	1219.5	-4.4	1166.7	10.1	2040.0	10.0	N.A.	N.A.	N.A.	N.A.	3040.0	1.6	N.A.	N.A.	2744.4	2.3
Baidoa	1310.0	0.0	917.0	-7.7	2000.0	25.0	2200.0	10.0	N.A.	N.A.	2520.0	66.7	4800.0	37.1	7000.0	16.7	2000.0	0.0
Bulo Berti	1060.0	N.A.	1060.0	N.A.	1800.0	N.A.	2000.0	N.A.	N.A.	N.A.	N.A.	N.A.	4000.0	N.A.	5000.0	N.A.	2800.0	N.A.
Hoddur	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Belet weyn	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Dusa mareb	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Galcaio	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Hargeisa	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Note: % = % change from last decade.
Prices for white maize, red sorghum
(except Hargeisa: white sorghum)
Prices for imported rice, imported sugar
Nominal prices

APPENDIX M

SUMMARY DATA TABLES

APPENDIX M

SUMMARY DATA TABLES

This appendix contains some summary data tables which supplement the tables of daily and monthly flows presented in the Hydrometric Data Book. An intermediate interval is probably of more interest for irrigation purposes, and in Somalia 10-day or decadal data is widely used. Each month is divided into three periods, with the third varying in length from 8 to 11 days depending on the length of the month.

Tables M1 to M12 present 10-day mean flows for each of the twelve stations for which data was published in the Hydrometric Data Book; the relatively unreliable data for Lugh Ganana and Beled Weyn between 1951 and 1962 is omitted from these tables, as is the limited amount of 1990 data which has not yet been validated.

Tables M13 and M14 contain the results of some analysis of the 10-day data for two example stations on each river - one at the upstream end and one downstream. On the Shebelli Afgoi is used in preference to the most downstream station in the network (Audegle) because the data at Afgoi is much more reliable. Table M15 contains some similar figures for monthly data. Some of the data in these analysis tables is presented graphically in Chapter 2 of the main report.

Tables M13 to M15 contain exceedance values for certain percentage probabilities. The 80 % exceedance values indicate the flows which are exceeded on average in four years out of five. As noted in Chapter 2, these values are of particular interest in assessing reliable water availability for the design of irrigation schemes.

List of Tables

River Jubba at Lugh Ganana 10 Day Mean Discharges (cumecs) Table M1

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	m	m	21.8e	16.6e	15.7e	12.3e	16.8e	14.5e	11.2e	16.2e	420.6e	496.5e	549.7	576.2	343.6	239.6	228.5	186.5
1964	110.4e	91.3e	61.2e	40.4e	29.9e	24.2e	17.5e	14.0e	10.6e	35.4e	144.9e	147.9e	85.5	190.5	117.9	187.4	166.1	88.6
1965	230.2	98.5e	56.6e	42.1e	34.8e	24.4e	13.6e	8.1	6.0	5.5	15.1	28.2	116.4	53.0	24.8	33.2	33.2	29.1
1966	50.1	33.5	24.8	27.5	34.0	33.5	38.9	47.9e	73.6e	52.4e	51.7	353.4	342.4	159.7	191.3	178.3	153.8	152.6
1967	30.4	18.0	10.2	6.0e	5.9e	5.8e	5.7e	5.6e	5.6e	25.2e	68.7e	144.0e	231.5e	292.5e	205.4e	133.6e	95.4	116.3
1968	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
1969	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
1970	20.8	9.6	19.4	15.2	0.7	0.0	0.0	2.5	172.5	117.9e	147.2	457.5	344.9	402.5	275.6	210.7	197.7	191.9
1971	35.8	28.2	20.3e	17.2e	12.6e	9.5e	7.2e	5.2e	3.8e	11.5e	59.4	99.4	126.3	260.6	245.1	169.9	185.0	152.0e
1972	79.9	63.4	50.0	36.3	51.4	74.7	41.1	37.9	32.1	39.4	77.8	251.7	371.0	247.2	372.6	342.5	214.2	153.2
1973	63.1	49.7	37.4	30.0	20.1	12.7	11.9	10.9	6.4	4.7	4.4	23.2	75.6	32.0	125.4	106.2	76.0	100.9
1974	30.9	27.9	21.8	18.4	10.2	9.2	8.0	8.3	22.0	197.6	119.9	74.8	41.4	160.8	147.5	308.2	174.5e	97.2e
1975	21.7	15.2	10.8	9.0	7.2	5.4	5.0	2.8	1.6	0.9	63.5	123.1	121.7	73.1	158.3	200.4	105.5	135.9
1976	32.7	26.1	20.6	13.6	10.9	10.0	8.3	8.3	6.1	4.5	60.0	64.3	189.5	556.7	660.5	360.7	195.1	180.5
1977	52.9	50.4	47.1	61.4	59.5	47.0	27.9	26.5	17.3	247.1	415.4	144.2	413.0	309.1	282.5	470.2	344.9	279.5
1978	91.2	75.5	61.9	47.4	34.2	33.2	238.8	208.5	158.7	140.8	139.2	138.9	196.3	384.7	232.1	144.9	97.7	125.7
1979	74.0	54.0	70.6	96.1	68.2	79.1	67.8e	52.8e	104.3e	194.3e	173.3e	197.3e	169.0e	216.7e	237.2e	253.4e	233.6e	205.5e
1980	28.6	23.2	16.0e	12.0e	11.0e	11.0e	8.0e	6.5e	5.8	5.3	13.0	35.9	56.2	183.2	108.6	88.7	80.1	86.5
1981	13.3e	7.4	5.9	4.1	2.1	1.6	2.8	77.2	285.0	448.4	715.1	1219.3	1078.4	472.6	274.1	146.5	129.3	98.9
1982	30.9e	29.5e	27.1e	26.1e	21.5e	18.1e	15.6e	16.2e	19.8e	18.8e	170.3e	245.1e	240.1e	407.0e	486.0e	540.4e	348.9e	294.2e
1983	136.6e	90.1e	67.7e	92.5e	75.3e	59.2e	49.7e	38.4e	32.7e	31.2e	42.6e	147.9e	247.0e	294.2e	514.3e	483.6e	319.2e	225.9e
1984	60.7	49.6	34.0	22.6	16.6	14.7	11.2e	8.2e	6.8	7.8e	8.0e	19.3	21.4e	46.3	83.2	77.1e	105.6e	78.0
1985	19.1	12.2	8.3	6.3	5.7	2.6	1.2	1.2	2.3	20.3e	191.8	374.8	494.2	589.8	410.5	210.5e	150.9	194.8e
1986	22.0	16.0	11.0	6.7	5.3	5.5	6.4	14.1	10.5	19.5	195.5	191.4	261.2	189.1	394.7	328.3e	279.9	280.4e
1987	26.3	18.0	14.1	9.9	6.8	6.0	5.2	8.1	34.7	42.7	149.7	166.0	118.0	237.1	1042.5e	819.5	455.5	256.3
1988	35.8	34.5	24.7	20.7	16.1	11.5	9.7	13.9	10.6	6.1	64.3	130.6	154.6	125.3	138.7	76.9	74.4	119.7
1989	33.6	24.6	18.7	20.7	14.9	16.1	10.4	7.7	13.7	127.2	259.3	412.8	567.1	239.9	209.7	131.5	165.8	186.3
Mean	55.5	39.4	30.5	28.0	22.8	21.1	25.1	25.8	42.1	72.8	150.8	227.5	264.5	268.0	291.3	249.7	184.4	160.7
Maximum	230.2	98.5	70.6	96.1	75.3	79.1	238.8	208.5	285.0	448.4	715.1	1219.3	1078.4	589.8	1042.5	819.5	455.5	294.2
Minimum	13.3	7.4	5.9	4.1	0.7	0.0	0.0	1.2	1.6	0.9	4.4	19.3	21.4	32.0	24.8	33.2	33.2	29.1

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Jubba at Lugh Ganana 10 Day Mean Discharges (cumecs) Table M1 (continued)

	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	182.3	171.7	188.2	196.0	166.2	220.0	223.7	172.5	128.0	247.3	249.1	175.6	151.8	233.4	294.6	306.1	340.0e	164.1e
1964	127.9e	130.5e	126.7	254.2	347.0	343.6	247.3	235.7	302.9	379.2	560.9	606.8	363.4	192.4e	132.6e	112.0e	128.4e	231.5e
1965	44.5	68.6e	65.6e	98.5e	84.0e	144.9	140.0	128.4	148.4	232.0	848.4	676.6	336.2	571.3	401.3	194.5	108.8	80.7
1966	102.9	143.7	182.3	193.7	141.4	306.3	385.5	384.9	293.3	169.1	132.2	358.0	340.4	203.0	193.9	112.4	67.6	43.3
1967	202.9	169.4	265.7	448.2	411.9	308.8	300.6	433.4	312.2	526.9	m	m	m	m	m	m	m	m
1968	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
1969	m	m	m	m	m	m	m	m	m	201.0e	273.0e	277.5	253.9	193.7	92.8	80.9	54.2	33.5
1970	187.8	177.5	187.8	167.5	225.7	351.9	356.4	363.8	414.6	464.9	545.7	826.4	951.7	381.4	184.7	106.7	72.7	51.0
1971	213.6	279.1	250.9	195.4	231.3	265.4	286.1	272.6	246.6	404.9	671.1	742.2	607.1	382.6	378.3	216.1	140.6	89.9
1972	195.2	306.4	222.1	234.1	287.9	324.0	287.2	271.2	225.0	332.1	337.1	341.4	389.4	443.7	369.9	221.0e	128.8e	88.7e
1973	88.1	80.0	206.6	198.6	292.9	402.3	337.8e	288.0e	292.9e	334.2	500.6	445.2	315.9	221.7	162.7	101.0e	62.6	40.7
1974	112.4	275.1e	213.9	190.1	253.2	185.9	367.6	370.4	275.6	277.5	204.6	156.7	242.9	177.0	91.4	62.2	42.4	30.8
1975	203.2	165.5	229.4	363.9	398.4	377.4	356.7	363.5	265.1	275.8	442.6	395.6	283.3	228.1	160.9	95.2	63.4	47.4
1976	200.8	234.4	257.4	227.9	213.0	203.3	219.2	264.6	213.6	209.1	245.7	249.2	453.0	394.6	232.7	134.2	86.2	62.7
1977	219.5	251.4	260.4	245.7	286.0	371.8	322.5	394.9	451.2	320.9	630.5	869.3	1583.4	998.5	657.3	419.5	228.8	141.6
1978	267.6	375.7	409.1	342.5	417.7	331.9	319.9	305.8	225.4	391.6	699.4	766.6	464.0	261.2	253.7	249.6	119.7	107.0
1979	170.3e	142.4e	127.6e	172.7e	161.1e	165.7e	94.3e	101.2e	108.3e	160.2e	126.7e	243.2e	245.9e	164.5e	98.2e	68.1e	49.1e	41.2e
1980	160.6	173.4	122.3	108.3	143.0	115.2	157.6	115.9	116.6	208.1	167.4	161.7	151.5	91.4	65.8	51.6e	31.7e	19.5e
1981	108.9	102.8	153.0	205.0	247.6	292.2	317.7	388.9	502.1	368.7	500.1	418.8	256.9	171.7	105.2	76.9	53.4	36.2
1982	262.7e	245.0	239.2	235.6	204.9	237.6	218.5	222.3	201.0	225.8	760.3	598.4e	464.5e	332.2e	286.4e	286.1e	218.2e	208.6e
1983	306.9e	255.5e	215.6e	254.1e	216.3e	389.6e	400.7e	390.1e	410.7e	508.9e	543.1e	578.3e	610.0e	481.1e	419.6e	226.5e	147.0e	96.5e
1984	80.7	55.1	99.6	136.4	152.4e	187.1	158.5	247.4	422.8	315.3	210.6e	199.7	133.8	100.9e	79.2e	52.3	39.9	29.2e
1985	173.2	175.1	196.0	258.6	299.9	241.0	159.2	172.5	184.0	222.9	294.4	212.3	148.9	124.9	117.7e	72.1	45.0	31.7
1986	273.0e	226.4	177.7	159.9	162.4e	230.4	155.3	281.6	378.0	271.7	279.3	272.8e	203.3	128.6	86.4	74.5	57.4e	42.3e
1987	208.2	226.3	158.2	141.0	101.8	121.0	199.2	127.3	127.3	188.3	391.1	327.2	382.6	285.7	145.1	98.9	77.7	53.9
1988	97.6	163.1	316.0	299.5	382.8	296.6	230.8	234.2	289.8	302.4	477.1	697.3	346.2	181.4	116.7	78.2	57.3	46.9
1989	115.2	167.7	233.0	217.7	168.1	186.0e	282.7e	413.9	297.1	360.2	415.0	728.2	389.2	269.1	247.5	192.0e	257.3	205.4
Mean	172.2	190.5	204.2	221.8	239.9	264.0	261.0	277.8	273.3	303.8	420.2	453.0	402.8	288.6	215.0	147.5	107.1	81.0
Maximum	306.9	375.7	409.1	448.2	417.7	402.3	400.7	433.4	502.1	526.9	848.4	869.3	1583.4	998.5	657.3	419.5	340.0	231.5
Minimum	44.5	55.1	65.6	98.5	84.0	115.2	94.3	101.2	108.3	160.2	126.7	156.7	133.8	91.4	65.8	51.6	31.7	19.5

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Jubba at Bardheere   10 Day Mean Discharges (cumecs)   Table M2

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	m	m	m	18.8e	17.9e	14.4e	17.6e	16.0e	13.9e	13.1e	303.5e	507.1e	536.0e	576.2e	372.0e	200.1e	193.3	147.8
1964	119.4	98.9	68.9	45.5	33.5	27.2	20.5	15.5	13.2	26.7	106.4	181.8	101.3	148.6	145.1	140.1	188.2	107.7
1965	215.6e	89.9e	62.2	46.8	40.1	34.5	25.2	18.1	14.7	15.9	31.1	34.0	113.0	84.3	40.6	37.5	44.2	44.9
1966	72.1	52.0	38.2	30.3	25.4	41.0	39.4	59.9	76.0	55.9	81.8	252.2	397.6e	173.5	194.1	202.9	178.9	177.5e
1967	45.8	33.4	24.9	20.4e	20.1e	20.0e	19.9e	19.8e	19.7e	25.5	59.4	135.4	203.5	287.2	234.7	123.9e	72.7e	69.7e
1968	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
1969	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
1970	21.7	11.9	13.3e	61.6	34.3	12.9	7.9e	8.9e	135.1e	129.4	131.5	321.1	329.6	349.1	263.2	171.7	172.9	155.1
1971	39.1e	30.4e	22.5e	19.3e	14.8e	11.7e	9.3e	7.4e	5.9e	7.9e	52.3	112.7	78.5	249.2	218.5	167.8	161.5	128.4
1972	59.1	51.0	39.8	30.0	27.0	60.5	36.6	31.2	20.7	45.9	26.5e	224.3e	456.5e	228.8	297.0	366.4e	242.7e	160.8e
1973	54.3	37.7	32.0	23.2	16.5e	14.1e	12.5e	10.9e	8.5e	5.8e	5.9e	22.6e	83.8e	35.8e	104.4e	130.3e	82.2e	102.1e
1974	23.3e	25.9e	24.2e	26.6e	21.4e	16.3	9.1	7.7	10.8e	178.9e	139.2e	90.0e	47.3e	130.6e	164.5e	269.9e	214.1e	110.2e
1975	30.7e	23.7e	19.1e	17.0e	15.3e	13.4e	12.8e	11.1e	9.6e	8.8e	47.5e	113.7e	139.9e	75.1e	131.1e	224.9e	123.9e	118.3e
1976	41.9e	33.7e	29.8e	22.2e	18.9e	17.8e	16.0e	15.9e	14.5e	12.0e	43.5e	78.7e	88.9e	480.2e	695.0e	434.7e	206.3e	152.5e
1977	46.2e	48.1e	49.3e	63.5e	70.1e	56.6e	38.2e	33.4e	26.1e	152.2e	456.7e	175.0e	280.2e	407.9e	254.5e	442.9e	373.8e	281.9e
1978	100.7e	83.0e	69.3e	58.6e	43.0e	35.8e	189.8e	230.1e	156.9e	149.5e	156.3e	133.8e	156.8e	372.7e	272.3e	157.7e	107.3e	119.0e
1979	84.6e	63.2e	73.4e	93.6e	80.8e	82.3e	75.8e	55.5e	76.7e	205.2e	164.4e	205.7e	147.1e	232.1e	214.1e	284.9e	232.4e	214.0e
1980	33.7e	28.5e	20.1e	14.1e	11.2e	11.0e	7.1e	4.1e	3.5e	3.3	2.9	23.2	37.3	220.6	131.9	80.4	80.8	65.7
1981	16.4	13.2	9.7	6.4	3.5	1.9	1.1	24.2	445.1	517.1	675.2	1226.1	1319.7	724.1	409.9	241.6	167.0	130.6
1982	24.2e	19.6e	16.9e	17.1e	15.4e	14.2e	12.7e	15.6e	20.4e	20.1e	140.1e	237.7	247.0	314.9e	533.0e	515.2e	401.3	314.8
1983	153.6e	100.0e	71.2e	96.5e	72.2e	67.6e	53.0e	43.6e	34.6e	31.7e	36.4e	99.6e	272.5e	244.6e	498.0e	500.3e	360.3e	237.3e
1984	85.0e	72.4e	55.4e	45.6e	37.5e	31.8e	25.9e	20.9e	19.1e	24.6	30.0	37.5	70.8	219.3	89.0	93.0	128.7	92.2
1985	36.4	27.1	20.2	16.2	14.5	12.7	8.6e	5.6e	11.1e	24.8	194.9	389.9	600.3	711.9	512.2	237.2	192.5	228.6e
1986	31.1e	26.1e	20.5e	13.9e	12.7e	10.8e	10.7e	13.9	20.7	21.7	198.7	275.0	274.9	196.3	396.5	352.1	330.9	290.5
1987	42.1	31.1	25.0	19.3	15.9	13.7	10.6	13.7	31.2	48.3	125.6	201.8	149.3	232.8	1033.9	1040.0	585.6e	334.7e
1988	51.4	43.7	36.4	27.6	22.9	16.8	14.5	16.6	22.8	15.9	123.0	183.1	220.7	160.3	157.4	114.8	82.0	147.6
1989	47.6	37.0	29.2	28.5	24.2	23.9	19.9	15.5	46.6	142.6	334.3	332.9	876.2	319.6	269.3	159.5	156.1	226.0
Mean	61.5	45.1	36.3	34.5	28.4	26.5	27.8	28.6	50.3	75.3	146.7	223.8	289.1	287.0	305.3	267.6	203.2	166.3
Maximum	215.6	100.0	73.4	96.5	80.8	82.3	189.8	230.1	445.1	517.1	675.2	1226.1	1319.7	724.1	1033.9	1040.0	585.6	334.7
Minimum	16.4	11.9	9.7	6.4	3.5	1.9	1.1	4.1	3.5	3.3	2.9	22.6	37.3	35.8	40.6	37.5	44.2	44.9

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Jubba at Bardheere 10 Day Mean Discharges (cumecs) Table M2 (continued)

	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	163.7	141.0	168.7	186.2	161.9	195.0	203.4	190.8	113.3	196.0	240.7	183.0	135.3	225.4	303.8	282.0	342.3	179.1
1964	131.7	137.7	132.2	212.2	320.3	359.4	249.9	228.0	273.4	329.1	537.3	619.3	409.2	232.9	144.6	114.0	125.4	189.3
1965	40.6	73.0	70.9	105.1	99.9	117.9	146.0	128.3	141.3	203.8	761.0	781.1	396.3	677.9	508.0	247.6	141.4	105.3
1966	118.7e	119.3e	187.0e	200.6e	147.9e	263.2e	383.9e	374.1e	311.3e	219.9	162.0	354.7	372.7	270.2	214.3	154.1	90.3	61.7
1967	160.8e	140.5e	185.2	348.7	387.9	257.4	247.8	360.2	260.1	337.6e	m	m	m	m	m	m	m	m
1968	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
1969	m	m	m	m	m	m	m	m	m	m	256.5	245.8	245.7e	219.8e	113.1e	71.5e	50.0	35.3
1970	159.4	165.3	153.6	147.9	186.5e	275.2e	333.7	318.8	396.1	440.9	469.6	710.8	957.8	455.3	202.6	117.4	77.8	54.1
1971	172.1	222.4	226.0e	161.9	179.9	204.3e	245.7	224.2	209.1	293.7	611.5e	623.6e	705.6	370.6	379.1	212.8	133.2	77.7
1972	164.3	282.1	182.4	197.2	247.6	273.4	251.7	242.7	187.4	293.5	353.7	257.8e	413.5e	433.5e	388.0e	260.3e	145.8e	86.3e
1973	94.7e	87.6e	167.0e	211.0e	241.6e	400.7e	354.9e	314.3e	274.0e	327.2e	441.5e	474.0e	346.8e	232.1e	180.2e	101.9e	59.4	34.7
1974	110.5e	223.4e	247.4e	187.9e	239.9e	180.2e	244.6	371.2e	262.9e	289.3e	221.6e	159.3e	221.1e	210.0e	106.2e	74.4e	52.2e	39.9e
1975	202.0e	177.0e	207.4e	320.2e	404.2e	382.3e	339.5e	374.3e	281.5e	253.5e	423.4e	387.2e	319.1e	238.5e	183.8e	110.2e	74.6e	56.7e
1976	164.8	182.9	237.8	190.1	186.0e	178.2e	176.2	228.2	194.1	174.5	194.8	221.5e	385.0e	372.5	230.6	116.1	84.2	52.7
1977	238.6e	234.5e	260.4e	248.3e	257.0e	383.8e	312.9e	371.9e	449.3e	316.5e	543.2e	801.0e	1362.9e	1231.8e	628.8e	493.5e	250.4e	165.4e
1978	203.5e	384.4e	400.3e	345.1e	411.0e	345.1e	304.5e	320.2e	234.7e	337.9e	600.7e	772.9e	527.6e	297.0e	224.9e	285.5e	138.9e	117.1e
1979	178.1e	154.4e	128.7e	167.8e	154.6e	181.7e	104.6e	95.1e	110.8e	151.8e	128.4e	215.2e	272.7e	181.4e	111.5e	74.6e	54.4e	45.1e
1980	134.3	162.9	129.9	91.8	125.0	113.2	145.6	112.2	117.1	195.1	152.9	137.6	155.6	97.8	67.5	49.0	36.8	23.1
1981	117.3	129.4	160.4	220.1	272.9	334.5	314.5	440.6	572.6	378.0	522.0	503.0	330.6	154.2	100.3	71.6	50.4	33.6
1982	309.1	307.3	336.6	327.1	269.4e	271.8	320.9	256.0	258.3e	321.9	963.9	770.7e	510.3	328.1	309.0	285.0e	240.5e	212.3e
1983	277.9e	295.2e	206.1e	254.8e	219.4e	354.7e	421.3e	391.2e	402.3e	484.9e	543.7e	560.3e	651.3e	476.7e	460.9e	259.2e	168.6e	116.3e
1984	107.2	70.9	98.4	150.5	154.2	233.5	175.6	249.3	448.8	373.4	246.6	254.0	167.1	160.9	112.5	73.1	58.4	43.4
1985	202.5	185.3	215.5	279.1	320.4	281.8	194.7	180.2	192.5	264.1	308.6	280.1	192.8	163.4	133.1e	104.1	71.4e	46.0e
1986	314.4	261.6	196.5	181.8	166.7	219.7	155.8	269.8	458.8	294.5	298.3	305.2	242.5	132.6	110.2	87.2	69.0	62.6
1987	225.3	260.5	185.9	175.8	127.4	125.1	244.7	166.6	138.6	159.0	443.3	409.4	447.1	374.4	191.0	127.2	94.0	73.6
1988	113.3	190.9	339.3	305.1	450.2	345.4	273.4	268.1	310.1	319.5	476.7	829.7	460.0	236.7	141.2	98.6	75.8	64.4
1989	147.4	166.6	254.5	269.4	193.8	205.8	273.1	442.0	354.0	505.7	500.2	780.6	517.9	367.4	313.4	258.6	291.6	264.8
Mean	170.1	190.3	203.1	219.4	237.0	259.3	256.7	276.7	278.1	298.4	416.1	465.5	429.9	325.7	234.3	165.2	119.1	89.6
Maximum	314.4	384.4	400.3	348.7	450.2	400.7	421.3	442.0	572.6	505.7	963.9	829.7	1362.9	1231.8	628.8	493.5	342.3	264.8
Minimum	40.6	70.9	70.9	91.8	99.9	113.2	104.6	95.1	110.8	151.8	128.4	137.6	135.3	97.8	67.5	49.0	36.8	23.1

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Jubba at Kaitoi 10 Day Mean Discharges (cumecs) Table M3

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	m	m	m	27.0	24.4	22.0e	22.2e	23.0	22.1	18.1	142.3e	531.1	551.2	646.2	516.2	253.7	196.1e	171.5e
1964	145.8	111.4	81.2	54.7	43.0	35.0	30.2	24.9	22.3	23.0	68.9	161.4	116.7	102.4	179.8	91.4	216.2	124.6
1972	67.6e	60.4e	49.7e	39.2e	34.0e	56.5e	52.1e	36.6e	30.3e	47.6e	34.9e	138.8e	416.0e	340.3e	226.1e	401.5e	301.7e	178.6e
1973	75.7	55.5	43.5	32.5	26.8	19.5	14.0	11.5	9.5	6.5	5.4	15.3	41.3	64.7	38.9	116.7	77.7	70.7
1974	38.9	31.5	28.4	21.2	13.9	9.8	5.7	4.4	5.8	70.6	150.6	93.8	63.8	89.0	160.6	170.2	241.1	112.4
1975	26.6	18.7	12.5	14.6	7.5	4.8	3.3	1.6	1.6	0.3	1.8	57.5	104.5	168.0	95.8	161.4	132.9	80.2
1976	52.6e	42.2e	38.3e	31.2e	26.9e	24.9e	20.9	21.8	20.5	21.4e	28.3e	81.5e	71.1	342.7e	583.3e	508.4	239.9	169.9
1977	52.4e	52.3e	52.2e	60.6e	72.3	69.0	63.6	43.1	41.0	67.7	465.4	243.5	247.7	443.6	198.5	374.0	381.5	266.0
1978	190.7	129.5	103.1	97.1	84.4	71.0	88.8	245.7	181.9e	183.7e	222.7	162.9	151.4e	316.8e	329.1	186.7e	125.1e	116.4e
1979	121.9	93.5	79.1	94.3	117.9	88.0	91.6	60.9	64.7	193.5	168.4	210.8	175.9	217.6	222.9	287.0	235.1	233.4
1980	42.5	36.2	28.4	20.8	17.3	16.4	13.4	9.6	7.5	6.5	8.8	13.0	31.8	136.7	164.1	88.0	88.1	70.8
Mean	81.5	63.1	51.6	44.9	42.6	37.9	36.9	43.9	37.0	58.1	118.0	155.4	179.2	260.7	246.8	239.9	203.2	145.0
Maximum	190.7	129.5	103.1	97.1	117.9	88.0	91.6	245.7	181.9	193.5	465.4	531.1	551.2	646.2	583.3	508.4	381.5	266.0
Minimum	26.6	18.7	12.5	14.6	7.5	4.8	3.3	1.6	1.6	0.3	1.8	13.0	31.8	64.7	38.9	88.0	77.7	70.7

	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	162.9	152.0	169.7	187.9e	176.7	189.5	214.2	220.7	133.9	161.8e	260.6	226.0	154.3	198.3	333.9	304.7	359.8	253.7
1964	104.5	135.8	129.4	142.5	297.0	378.1	295.8e	237.1e	244.5e	315.3e	496.0e	617.8e	465.8e	305.6e	165.7e	125.7e	120.8e	149.6e
1972	163.7e	269.9e	215.5	203.6	230.9	275.6	279.3	256.5	213.8	217.5	400.7	286.2	426.4	472.3	399.3	306.3	162.0	101.6
1973	92.8	89.5	128.1	225.0	205.8	324.1	352.5	341.4	278.5	312.5	345.8	515.5	368.6	238.2	178.2	127.8	78.0	53.2
1974	77.2	105.5	275.0	151.8	164.5	208.6	185.2	383.8	270.9	248.5	210.0	138.9	157.1	217.5	117.3	69.0	51.1	39.4
1975	145.9	164.7	145.3	229.3	378.6	357.8	316.6	329.8	280.9	224.7	329.3	370.8	334.3	223.5	188.8e	114.2e	77.6e	64.7e
1976	158.2e	178.7e	232.9e	203.5	207.2	186.5	174.2	219.6	227.5	180.9	206.1	214.3	364.8	391.4	318.2e	139.6e	103.0e	64.7e
1977	233.2	178.5	218.8	222.8	211.3	304.9	300.9	311.7	390.0	331.8	417.8	557.6	589.3	742.3	700.6	628.6	388.0	279.2
1978	179.0	384.5	427.6	341.5	385.5	358.0	300.9	320.3	244.7	218.2	461.9	607.6	615.0	554.6	315.0	288.5	203.1	146.0
1979	198.3	170.6	135.9	159.3	169.5	187.7	131.0	97.0	112.3	134.1	153.0	168.5	301.2	215.7	138.9	87.6	66.3	52.5
1980	98.5	145.8	153.7	98.3	106.8	126.2	109.6	134.9	98.8	124.8	163.7	146.9	155.2	136.3	78.6	60.4	47.7	34.9
Mean	146.7	179.6	202.9	196.9	230.3	263.4	241.8	259.3	226.9	224.6	313.2	350.0	357.5	336.0	266.8	204.8	150.7	112.7
Maximum	233.2	384.5	427.6	341.5	385.5	378.1	352.5	383.8	390.0	331.8	496.0	617.8	615.0	742.3	700.6	628.6	388.0	279.2
Minimum	77.2	89.5	128.1	98.3	106.8	126.2	109.6	97.0	98.8	124.8	153.0	138.9	154.3	136.3	78.6	60.4	47.7	34.9

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Jubba at Mareere   10 Day Mean Discharges (cumecs)   Table M4

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1977	34.8e	34.4e	35.0e	41.2e	48.8e	49.4e	44.2e	28.4e	26.0e	36.8e	466.2e	252.9e	218.3e	463.0e	181.5e	362.2e	397.2e	260.8e
1978	148.9e	95.5e	68.5	55.4e	39.2	33.8e	41.0e	222.2	175.8	152.7	191.7	139.7	149.0	299.7	343.0	186.6	121.0	86.6
1979	96.9	69.7	54.4	65.1	83.3	59.5	65.7	43.7	44.8	134.4	130.0	132.7	132.7	192.8	202.7	253.5	236.4	229.5
1980	26.5	20.2	16.4	12.2	9.5	7.7	6.1	3.7	2.7e	2.5e	2.9e	3.7	17.3	103.2	155.4	69.8	63.0	50.8
1981	11.9	8.3	5.0	2.7	2.0e	0.2e	0.0e	0.4e	190.1e	516.1	509.7	604.9	665.3	759.4	604.2	293.9	183.7	142.3
1982	36.0	27.8	22.7	18.7	17.1	13.2	9.7	9.0	10.0	10.8	35.5	203.7	211.3	263.5	511.6	488.5	514.0e	324.4e
1983	168.4	99.9e	65.5	74.8	56.8	62.9	41.4	37.4	20.3	21.5	21.4	47.1	191.3	195.5	387.6	478.4	409.6	244.3
1984	79.0	62.9	46.2	35.8	26.7	20.8	15.8	13.7	12.9	6.6	8.2	21.6	25.1	52.9	71.4	80.7	102.7	99.4
1985	31.0	25.9	21.1	12.2	7.9	4.8	5.6	3.8	3.1	25.8	67.5	272.4	559.8	544.6	557.7	297.3	167.6	181.9
1986	34.0e	23.6	15.8	10.6	8.5	7.1	6.3	4.8	4.7	8.4	82.6	218.3	219.8	228.6	281.8	390.8	306.0	250.9
1987	37.7	24.8e	15.5	12.3e	9.4	8.5	5.2e	5.3e	13.4e	31.8e	37.4e	134.9	153.5	94.5	502.7	619.0	644.0	561.1e
1988	53.8	33.7	33.5	23.8	21.9	19.8	14.4e	15.9	15.6	23.5	111.0	185.2	193.6	139.2	121.5	123.3	62.9	85.5
1989	44.2e	31.4e	21.9	8.1	6.9	4.0	2.5	1.2	6.9	9.6	259.8	232.7	486.4	487.1	304.5	179.6	121.4	196.9
Mean	61.8	42.9	32.4	28.7	26.0	22.4	19.8	30.0	40.5	75.4	148.0	188.5	247.9	294.1	325.1	294.1	256.1	208.8
Maximum	168.4	99.9	68.5	74.8	83.3	62.9	65.7	222.2	190.1	516.1	509.7	604.9	665.3	759.4	604.2	619.0	644.0	561.1
Minimum	11.9	8.3	5.0	2.7	2.0	0.2	0.0	0.4	2.7	2.5	2.9	3.7	17.3	52.9	71.4	69.8	62.9	50.8

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Jubba at Mareere . 10 Day Mean Discharges (cumecs) Table M4 (continued)

	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1977	232.9e	181.7	209.9	211.0	206.1	291.8e	273.8e	306.1e	404.0	356.7	406.7e	533.1	561.3	594.2e	637.0e	624.0e	496.2	259.0e
1978	120.1	381.6	396.7	361.5	392.0	385.4	296.0	330.0	258.3	202.3e	459.4e	577.6	589.9	483.5	258.8	300.4	213.7	122.1
1979	167.4	153.3	107.4	125.4	143.6	145.1	108.8	68.5	80.9	93.4	144.9	149.7	303.8	223.4	120.1	67.3	46.6	33.1
1980	66.0	117.4	130.5	76.1	77.0e	99.1	78.8	106.2	69.4	92.8	154.6	122.5	128.9	118.2	61.2	44.9	31.2	19.4
1981	109.1	121.8	109.2	161.3	215.1	279.6	263.1	360.2	427.0	445.7	392.5	508.9	348.2	224.9	152.1	94.1	69.9	48.2
1982	313.0e	291.0	243.6	251.5	220.0	195.2	286.2	197.2	187.6	218.1	481.1	614.2	624.9	460.0	378.0	255.5	261.0	184.9
1983	202.3	315.8	184.8	216.9	221.8	258.3	381.4	360.6	351.4	422.0	494.7	510.2	582.4	491.0	457.3	319.4	174.0	112.8
1984	88.8	72.3	54.1	120.3	131.6	178.1	149.9	174.5e	349.7	390.8	314.4	205.7	172.8	158.5	119.7	77.5	52.6	36.9
1985	216.6	179.7e	175.3e	248.2e	281.1e	291.9e	211.6	159.3	170.4	197.7	239.0e	300.3	178.1	162.2	125.5	106.8	64.9	48.4
1986	301.9	260.8e	191.3	152.7	149.2	166.7e	154.3	143.6	360.8	324.8	264.6	281.4	238.4	144.5	96.7	76.8	57.8	52.1e
1987	283.1e	266.3	207.0	172.5	141.0	113.7	184.8	190.0	120.2	124.5	257.6e	425.4	336.6	429.3	241.2	135.3	93.9	75.2
1988	105.5	105.7	229.4	275.3	353.6	343.8	274.9	224.7	231.4	261.1	362.5	503.7	513.1	352.4e	195.9e	105.2e	71.1e	56.2e
1989	156.7	118.8	192.3	257.1	190.6	164.4	187.4	339.5	397.9	331.0	506.5	503.5	589.2	484.3e	366.4	327.9	252.5	291.3
Mean	181.8	197.4	187.0	202.3	209.4	224.1	219.3	227.7	262.2	266.2	344.5	402.8	397.5	332.8	246.9	195.0	145.0	103.1
Maximum	313.0	381.6	396.7	361.5	392.0	385.4	381.4	360.6	427.0	445.7	506.5	614.2	624.9	594.2	637.0	624.0	496.2	291.3
Minimum	66.0	72.3	54.1	76.1	77.0	99.1	78.8	68.5	69.4	92.8	144.9	122.5	128.9	118.2	61.2	44.9	31.2	19.4

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Jubba at Kamsuma | 10 Day Mean Discharges (cumecs) | Table M5

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1972	79.7e	70.2e	57.4e	44.6e	38.1e	59.1e	62.7e	40.5e	35.3e	49.7e	41.8e	126.2e	398.9e	384.5e	234.5e	409.9e	330.5e	204.1e
1973	91.0	68.6	50.3	37.4	29.7	21.7	14.2	10.0	7.6	3.7	3.1	7.7	31.3	84.7	34.8	126.0	97.4	79.3
1974	44.0	33.5	30.1	23.1	14.2	8.5	4.4	1.3	5.1	43.9	170.1	117.6	78.9	77.6	163.8	165.9	269.3	143.1
1975	32.3	23.0	14.0	13.1	9.4	3.5	1.8	0.1	0.3	0.1	0.0	52.6	112.2	175.7	130.1	169.1	175.0	101.6
1976	49.3	35.8	20.7	13.0	9.7	4.4	0.0	0.0	0.0	0.0	0.0	48.3	62.6	273.9	520.7	506.1e	276.8e	191.8e
1988	64.6e	40.4e	40.1e	28.1e	26.1e	23.4e	16.8e	18.7e	18.3e	28.0e	126.1e	208.7e	216.0e	154.3e	142.9e	147.0e	75.8e	104.4e
1989	44.2	27.7	17.6	13.1	9.7	6.4	3.3	1.4	6.1	19.4	253.9	246.5	434.6	472.2	307.7	183.6	125.9	190.1
Mean	57.9	42.7	32.9	24.6	19.5	18.1	14.8	10.3	10.4	20.7	85.0	115.4	190.6	231.9	219.2	243.9	193.0	144.9
Maximum	91.0	70.2	57.4	44.6	38.1	59.1	62.7	40.5	35.3	49.7	253.9	246.5	434.6	472.2	520.7	506.1	330.5	204.1
Minimum	32.3	23.0	14.0	13.0	9.4	3.5	0.0	0.0	0.0	0.0	0.0	7.7	31.3	77.6	34.8	126.0	75.8	79.3

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1972	181.8e	273.6e	243.2e	218.9e	237.6e	288.7	305.8	276.4	241.8	226.5	406.8	319.4	421.1	482.8	428.1	341.0	192.9	124.8
1973	104.3	104.8	123.5	247.0	220.8	327.8	383.4	361.7	304.4	333.0	344.6	508.4	401.8	273.8	206.3	150.2	95.6	64.3
1974	93.2	114.3	282.0	172.0	172.7	223.2	172.4	395.1	302.5	260.7	234.6	164.9	157.1	235.5	146.4	84.5	58.6	46.4
1975	134.8	186.5	163.3	232.6	382.8	376.2	343.3	352.4	294.2	227.5	314.2	395.2	347.5	227.2	209.1	145.6	90.2	60.8
1976	172.1e	199.7e	246.2e	225.0e	223.1e	207.1e	192.7e	230.3e	250.4e	198.5e	219.6e	234.3e	356.9e	407.6e	352.9e	170.0e	123.8e	76.7e
1988	127.2e	127.6e	234.5e	296.0e	359.8e	343.6e	277.4e	243.6e	250.6e	276.2e	364.0e	480.6e	485.5	354.2	180.1	109.9	71.4	56.8
1989	165.6	115.3	193.9	255.2	198.6	164.7	188.8	339.5e	391.8e	356.9e	450.4e	462.8e	489.1e	468.9e	410.9e	332.2e	256.0e	302.3e
Mean	139.9	160.3	212.3	235.2	256.5	275.9	266.2	314.2	290.8	268.5	333.5	366.5	379.9	350.0	276.2	190.5	126.9	104.6
Maximum	181.8	273.6	282.0	296.0	382.8	376.2	383.4	395.1	391.8	356.9	450.4	508.4	489.1	482.8	428.1	341.0	256.0	302.3
Minimum	93.2	104.8	123.5	172.0	172.7	164.7	172.4	230.3	241.8	198.5	219.6	164.9	157.1	227.2	146.4	84.5	58.6	46.4

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Jubba at Jamame — 10 Day Mean Discharges (cumecs) — Table M6

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	m	m	m	20.4e	16.7e	15.0e	13.3e	16.3e	14.5e	10.4e	59.6e	454.8e	436.9	451.7	406.5	245.8	204.9	173.7
1964	133.3	93.7	72.2	46.2	31.5	20.7	16.2	11.6	8.7	8.0	31.4	140.4	104.3	73.4	155.5	84.5	170.5	116.6
1965	210.6	117.4	61.8	39.2	26.8	22.8	17.9	11.9	7.2	4.2	3.4	15.2	21.0	88.2	44.8	21.6	24.5	24.7
1966	81.3	53.7	38.5	26.9	20.7	16.6	35.2e	45.7e	54.8e	58.3e	64.2e	101.6e	385.4e	255.6e	165.8e	181.0e	181.9e	167.3e
1967	44.0e	31.7e	21.0e	14.3e	12.8e	12.7e	12.6e	12.5e	12.4e	14.7e	28.6e	84.6e	130.6e	254.5e	269.1e	159.5e	87.4e	53.8e
1968	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
1969	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
1970	21.0e	9.0e	2.1e	33.2e	43.2e	15.5e	2.4e	1.0e	55.6e	156.1	168.5	216.9	399.6	364.4	323.0e	180.4e	164.0e	142.8e
1971	37.9e	26.0e	19.1e	13.2e	9.8e	6.2e	3.5e	1.3e	0.1e	0.0e	17.8e	63.9e	101.2e	155.6e	207.9e	195.2e	144.8e	136.0e
1972	79.5	66.1	49.5	35.6	27.2	26.5	51.4	27.8	26.1	24.2	33.6	82.2	315.1	375.7	257.3	375.1	307.7	173.4
1973	78.3	59.1	43.1	32.4	24.6	19.1	13.5	8.7	7.2	3.9	3.3	6.4	20.9	74.7	25.3	105.2	90.8	68.9
1974	34.8	27.6	26.1	21.9	15.2	9.1	6.3	3.5	3.5	19.7	166.2	105.9	69.4	63.3	166.6	140.1	259.6	141.9
1975	26.2	18.7	9.2	7.3	7.7	2.4	0.5e	0.0e	0.0e	0.0e	0.0e	37.8	88.4	143.6	132.6	149.3	156.9	88.7
1976	31.9e	23.9e	19.0e	10.7e	7.2e	2.9e	0.0e	0.0e	0.0e	0.0e	0.0e	33.6e	57.7e	241.6e	468.0	468.5	309.5	203.1
1977	35.8e	34.1e	35.8e	41.5e	47.4e	52.7e	45.5e	29.7e	25.8e	25.5e	411.2e	285.0e	205.0e	439.1e	201.1e	324.2e	395.5e	271.9e
1978	206.9	138.9	98.9	58.4e	41.2e	33.9e	37.1e	210.8e	191.3e	160.4e	198.3e	152.6e	152.6e	272.6e	347.4e	203.5e	133.8e	90.7e
1979	104.5e	74.4e	56.4e	66.9e	85.0e	63.6e	68.0e	46.4e	43.2e	131.6e	135.1e	138.8e	144.9e	184.3e	208.0e	250.3e	238.2e	239.8e
1980	27.2e	19.6e	15.6e	10.8e	7.8e	5.7e	4.0e	1.3e	0.2e	0.1e	0.9e	2.0e	12.7	111.7	167.4	69.6	63.9	49.2
1981	6.5	3.4	0.9	0.0	0.0	0.0	0.0e	0.0e	152.8e	468.0	482.4	486.3	484.5	483.1	479.9	313.3	203.6	157.6
1982	51.6e	40.6e	32.9e	26.1e	23.0e	16.9e	11.7e	8.4e	8.1e	9.9e	22.7e	192.9e	228.6e	249.1e	448.3e	441.6e	462.9e	323.2e
1983	185.7e	109.9e	70.4e	74.2e	59.8e	66.7e	44.4e	38.3e	20.6e	20.1e	20.2e	42.9e	178.0	198.8e	343.9e	457.1e	406.4e	257.7e
1984	84.4e	66.4e	49.4e	35.9e	27.8e	20.2e	15.3e	12.5e	12.1e	5.1e	6.2e	17.0e	27.4e	41.1e	79.7e	85.0e	95.1e	97.4
1985	30.8e	26.4e	20.7e	12.1e	6.4e	3.3e	3.7e	2.2e	0.9e	23.7e	42.2e	256.4e	469.3e	477.0e	477.0e	318.8e	180.0e	185.1e
1986	36.1e	23.8e	14.9e	9.9e	7.0e	5.5e	4.7e	3.0e	2.9e	5.9e	68.5e	219.5e	213.2e	246.0e	251.6e	396.3e	301.5e	255.8e
1987	39.5e	26.3e	14.5e	11.6e	7.6e	7.6e	3.7e	3.0e	9.8e	31.7e	35.5e	134.3e	158.2e	96.6e	411.6e	477.0e	477.0e	468.9e
1988	57.9e	35.6e	32.1e	26.1e	20.5e	19.5e	13.3e	14.6e	14.7e	22.5e	88.5e	202.7e	197.4e	149.6e	125.4e	134.5e	69.5e	82.7e
1989	46.6e	32.4e	22.8e	6.8e	5.4e	2.7e	0.7e	0.0e	3.0e	11.0e	232.8e	244.9e	408.2e	453.6e	306.2e	194.9e	127.6	187.9
Mean	70.5	48.3	34.5	27.3	23.3	18.7	17.0	20.4	27.0	48.6	92.9	148.7	200.4	237.8	258.8	238.9	210.3	166.4
Maximum	210.6	138.9	98.9	74.2	85.0	66.7	68.0	210.8	191.3	468.0	482.4	486.3	484.5	483.1	479.9	477.0	477.0	468.9
Minimum	6.5	3.4	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	12.7	41.1	25.3	21.6	24.5	24.7

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Jubba at Jamame 10 Day Mean Discharges (cumecs) Table M6 (continued)

	JULY 1	JULY 2	JULY 3	AUGUST 1	AUGUST 2	AUGUST 3	SEPTEMBER 1	SEPTEMBER 2	SEPTEMBER 3	OCTOBER 1	OCTOBER 2	OCTOBER 3	NOVEMBER 1	NOVEMBER 2	NOVEMBER 3	DECEMBER 1	DECEMBER 2	DECEMBER 3
1963	157.5	135.6	151.2	165.3	147.9	162.3	184.3	194.2	107.0	142.1	220.5	189.4	120.7	142.4e	267.6e	251.2	303.9	245.3
1964	76.8	110.9	103.1	95.5	236.8	340.7	287.8	208.1	196.8	273.1	402.5	466.9	444.3	310.2	161.2	111.0	96.1	102.8
1965	22.8	24.5	46.5	54.9	74.6	60.0	115.5	104.7	93.8	120.4	319.4	451.7	456.3	444.1	474.1	422.4	211.5	115.9
1966	140.9e	93.9e	160.3e	176.9e	162.1e	169.3e	333.1e	352.8e	344.3e	260.9e	160.9e	200.7e	398.9e	313.5e	211.8e	188.6e	106.4e	63.9e
1967	96.0e	155.5e	125.8e	248.5e	403.2e	273.6e	245.8e	261.8e	326.4e	245.4e	409.3e	m	m	m	m	m	m	m
1968	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
1969	m	m	m	m	m	m	m	m	m	m	199.3e	255.8e	231.6e	236.7e	153.6e	75.3e	51.6e	33.7e
1970	156.7e	153.3e	135.2e	153.0e	182.3e	247.8	367.7	310.8e	346.7e	400.9e	407.2e	471.1e	471.4e	468.8e	269.3e	145.5e	83.2e	55.7e
1971	130.3e	175.9e	239.4e	170.8e	151.1e	179.8e	210.1e	234.9e	210.5e	192.2e	407.3e	474.1e	473.1e	422.1e	376.1e	270.3e	166.1e	109.4e
1972	156.3	254.4	234.8	199.0	214.2	275.3	297.0e	261.8e	229.5e	204.0	388.4	308.2	391.1	449.9	411.9	334.0	179.5	111.1
1973	92.6	95.5	103.6	234.2	205.1	312.6	374.2	352.6	291.5	320.5	332.3	470.6	413.8	292.7	194.7	132.6	82.6	48.4
1974	82.4	93.9	256.3	165.1	155.2	207.6	154.7	356.8	294.0	257.5	221.7	157.4	140.3	225.7	139.3	75.2	49.7	38.1
1975	123.0	178.9	160.3	223.4	366.0e	375.7	331.0	341.3e	301.6	234.4	302.6	386.2	362.5	237.8e	201.4	132.1	78.0	44.0
1976	202.9	204.7	235.3	231.2	216.4	199.5	195.1	211.8	243.1	186.8	174.4	204.8	324.8e	404.9e	347.2e	160.5e	108.6e	67.2e
1977	238.8e	190.9e	216.1e	218.4e	211.6e	276.7e	284.3e	290.8e	378.6e	366.3e	366.5e	478.1e	461.1e	506.2	527.5	503.2	496.0	342.5
1978	121.4e	345.4e	381.3e	358.7e	364.2e	382.5e	298.0e	323.0e	266.6e	204.4e	403.9e	477.0e	477.0e	450.2e	270.6e	289.7e	232.5e	132.2e
1979	180.6e	163.7e	115.2e	123.6e	155.2e	152.1e	121.0e	71.2e	83.3e	90.9e	154.4e	150.9e	291.3e	239.8e	133.1e	73.1e	49.5e	33.5e
1980	61.1	124.7	142.8	82.1	77.6e	106.4	79.0	116.9	71.9	90.7	170.1	133.3	153.2	111.0e	69.0	46.8	32.3	14.2
1981	118.9	131.5	114.8	172.0	228.0	284.4	302.6	354.7	381.6	455.5	395.9	484.0	390.2	238.2	174.1	123.1	95.4	66.4
1982	311.1e	290.0e	253.7e	246.7e	230.9e	202.1e	282.4e	208.0e	193.8e	225.9e	393.0e	477.0e	477.0e	430.4e	369.0e	263.9e	266.7e	190.9e
1983	210.1e	292.4e	202.7	226.2	235.8	269.7	396.0	364.1	386.5	423.3	461.6	485.0	483.7	451.4e	442.3e	342.7e	190.1e	123.5e
1984	75.7	75.2	56.7e	113.0	133.7	171.0	153.3e	155.7e	321.1e	367.2e	296.4	218.3e	178.5e	159.0e	119.8e	83.4e	56.3e	37.9e
1985	224.4e	191.6e	179.0e	243.1e	280.0e	289.9e	227.1e	167.0e	180.5e	197.2e	234.5e	304.6e	192.0e	171.5e	137.0e	114.7e	69.7e	50.6e
1986	296.5e	264.0e	204.9e	164.3e	156.9e	169.2e	169.6e	143.0e	328.2e	337.4e	262.4e	282.7e	244.5e	160.5e	103.2e	81.9e	61.3e	54.0e
1987	295.9e	265.4e	219.5e	182.1e	153.6e	120.1e	176.7e	206.9e	128.6e	130.9e	235.8e	407.1e	326.0e	416.1e	260.2e	147.6e	102.4e	78.8e
1988	113.8e	105.4e	214.9e	282.8e	332.4e	341.6e	279.5e	229.0e	234.4e	258.9e	337.4e	461.0e	474.5e	360.3e	214.2e	117.0e	75.8e	58.7e
1989	172.1	112.3	191.3	256.9	202.8	164.9	185.0	323.9	392.6	329.5	430.1	429.4	449.6e	437.5	389.7	327.7	240.2	295.7
Mean	154.3	169.2	177.8	191.5	211.1	229.4	242.0	245.8	253.3	252.6	311.1	353.0	353.1	323.2	256.7	192.5	139.4	100.6
Maximum	311.1	345.4	381.3	358.7	403.2	382.5	396.0	364.1	392.6	455.5	461.6	485.0	483.7	506.2	527.5	503.2	496.0	342.5
Minimum	22.8	24.5	46.5	54.9	74.6	60.0	79.0	71.2	71.9	90.7	154.4	133.3	120.7	111.0	69.0	46.8	32.3	14.2

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Beled Weyn 10 Day Mean Discharges (cumecs) Table H7

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	26.7e	23.7e	22.6e	20.9e	19.3e	18.2e	17.4e	17.1e	16.3e	15.5e	26.1e	131.1e	265.8	336.7	337.0	236.8	67.6	42.7
1964	39.0	39.0	30.4	20.9	15.3	12.2	10.4	8.0	6.2	5.4	32.6	34.1	45.7	27.5	22.5e	16.6	20.9	21.1
1965	81.8	38.2	21.6	14.1	8.4e	7.8e	6.9e	6.0e	5.0e	4.2e	4.3e	21.2e	77.9	38.9e	15.9e	13.3e	11.1e	7.6e
1966	6.7e	4.6e	3.3e	3.2	3.1	13.6	22.0	35.7	16.9	13.6	26.4	66.9	127.6	81.0	47.3	38.1	30.5	36.3
1967	2.4	1.8	2.5	2.5	2.1	1.3	1.1	0.8	0.5	25.6	69.9	47.8	79.4	122.2	206.6	113.3	44.0	13.0
1968	34.5	25.8	19.3	15.4	13.4	18.6	56.1	101.0	71.3	40.0	78.8	178.0	272.6	332.1	303.6	191.0	131.4	115.8
1969	19.8	20.9	20.3	17.6	21.8	33.0	80.5	135.8	150.5	123.4	119.3	83.7	74.5	156.3	185.4	56.0	36.6	30.4
1970	9.1	8.7	9.2	30.3	18.1	10.6	23.7	60.6	107.3	114.9	76.9	127.1	203.5	182.8	110.7	39.5	22.9	16.7
1971	11.2	9.7	9.1	8.0	7.2	6.3	6.3	6.2	5.7	18.4	49.4	73.3	79.2	115.0	93.7	60.4	34.9	61.6
1972	12.5	12.4	9.9	8.0	13.5	46.1	18.4	17.6	10.8	28.4	22.7	103.3	180.8	211.4	152.3	117.4	45.4	31.6
1973	10.8	8.6	7.5	6.7	5.9	5.4	4.9	4.4	3.5	3.1	3.0	15.3	44.6	36.3	75.3	41.5	19.1	13.4
1974	3.6	2.8e	2.3e	2.0e	1.6e	1.3e	0.9e	0.6e	0.2e	86.4	87.3	33.2	22.8	67.9	96.4	73.1	77.8	59.5
1975	4.5	2.4e	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.9	61.1	52.1	64.3	115.1	84.8	22.9	19.7
1976	4.3	1.1e	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	95.6	177.8	90.4	179.2	324.2e	342.2	155.0	71.6
1977	15.0e	13.5e	12.2e	14.5e	17.3e	18.1e	19.9e	11.5e	11.9e	25.4	143.9	139.6e	220.6	256.6	132.7	74.1	71.2	33.8
1978	31.9	25.2	18.2	14.7	12.0	10.8	59.2	108.5	64.8	38.2	46.9	62.1	68.6	115.8	78.1	39.0	28.6	20.0
1979	20.3	17.9	21.6	83.8	51.9	47.5	39.6	20.6	81.1	70.2	66.1	71.3	41.4	80.0	123.1	143.6	102.1	63.3
1980	8.6	8.7	6.7	5.5	5.2	5.0	4.2	3.5e	2.8e	3.0	4.1	29.5	65.2	129.6	88.2	20.2	14.7	11.4
1981	3.0	2.5	2.1	1.9e	1.9e	2.0e	2.7e	36.5	175.0	274.6	367.1	398.1	450.6	378.9	143.2	66.9	39.9	30.9
1982	12.0	11.1	11.7	10.5	9.2	7.4	10.6	10.4	12.9	16.6	89.3	122.3	128.9	135.9	172.6	181.9	72.7	38.7e
1983	46.4	30.9	22.2	18.1	26.5	22.9	21.1	19.1	11.7	10.5	32.5	96.9	127.5	92.8	108.7	166.1	223.4	142.0
1984	25.2	22.5	19.3	17.4	15.6	13.9	12.0e	11.0e	10.1e	9.6	9.2e	15.3e	11.8e	17.9	77.9	78.3	60.1	30.2e
1985	9.9	7.5	6.1	5.5	5.1	5.0	4.0	3.0	3.6	51.5	72.8	158.9	210.8	257.8	325.6e	215.5	71.0	43.7e
1986	7.9	7.0	6.1	5.3	4.8	4.8	4.4	6.8	6.7	4.6	56.3	131.3	141.0	79.4	134.8	150.1	100.9	68.6
1987	8.1	6.6	5.4	5.0	4.7	4.4	3.7	4.6	25.7	36.5	103.3	109.1	69.5	127.2e	206.8e	323.4	397.8	200.1
1988	6.6	5.7	5.0	4.2	3.5	3.2	2.7	2.6	2.5	5.2	19.8	124.4	129.3	47.2	29.8	20.5	9.9	19.4
1989	17.9	15.3	14.6	13.9e	13.9	19.5	13.8	12.1	19.7	93.6	155.4	203.4	223.4	267.9	178.9	68.2	45.0e	44.0
Mean	17.8	13.8	11.5	13.0	11.2	12.5	16.5	23.8	30.5	41.4	69.5	104.3	129.8	145.9	143.9	110.1	72.5	47.7
Maximum	81.8	39.0	30.4	83.8	51.9	47.5	80.5	135.8	175.0	274.6	367.1	398.1	450.6	378.9	337.0	342.2	397.8	200.1
Minimum	2.4	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	15.3	11.8	17.9	15.9	13.3	9.9	7.6

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Beled Weyn 10 Day Mean Discharges (cumecs) Table M7 (continued)

	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	44.7	50.6	66.2	86.4	123.2	136.6e	175.3	200.4	170.1	107.1	132.2	73.7	43.0	41.8	65.5	80.1	84.4	65.6
1964	24.8	29.1	53.6	65.8	111.8	186.6	190.4	158.9	200.0	218.6	143.1	184.3	187.6	60.7	31.0	23.5	18.1	33.4
1965	7.0e	5.2e	4.7e	11.9	24.5	55.3	60.1	73.3	58.9	50.3	91.3	168.9	158.3	80.7	149.1	48.2	23.6	11.6e
1966	38.3	24.2	41.4	44.9e	55.5e	80.8	97.4	135.5	174.1	166.4	79.7	69.7	122.6	48.9	18.4	11.9	11.3	7.8
1967	5.8	19.6	58.7	80.5	111.4	173.3	187.9	202.0	222.4	239.8	213.1	243.0	243.7	87.3	155.2	240.5	187.1	62.5
1968	78.8	80.9	92.2	99.1	137.3	173.5	196.7	145.5	119.9	140.3	126.4	105.1	67.3	35.3	58.4	85.3	50.3	28.6
1969	41.7	60.4	62.4	90.3	142.0	174.0	168.5	163.3	152.3	112.8	77.4	55.3	48.6	48.8	21.3	17.1	15.8	11.6
1970	15.6	14.2	42.8	85.5	116.1	176.6	216.1	225.5	209.9	194.7	167.7	169.1	167.1	88.1	35.1	21.4	15.5	12.1
1971	73.9	77.4	95.7	96.3	108.8	131.3	161.1	164.9	145.8	87.7	114.2	126.4	86.2	41.3	88.6	47.2	26.4	17.3
1972	44.8	83.3	118.9	116.8	126.2	138.3	159.6	162.9	140.9	116.8	133.9	91.1	98.4	83.0	33.3	24.1	17.2	12.7
1973	11.9	15.9	50.7	61.8	87.9	119.4	149.0	140.4	126.5	85.2	104.8	114.7	43.8	19.7	11.5	8.2e	5.8	4.4
1974	42.4	89.9	86.4	97.3	112.8	119.2	131.0	154.6	130.4	134.0	73.2	35.4	22.4	21.6	13.0	8.2	6.6	6.4
1975	37.4	52.5	103.2	120.0	132.1	156.1	193.6	218.3	229.5	195.7	105.1	85.4	40.0e	33.0	19.2	13.6	9.9	6.0
1976	52.9	76.4	103.0	104.6e	121.6e	143.7e	145.2e	150.5e	135.4e	114.0e	91.3e	63.0e	71.1e	92.4e	84.8e	41.0e	25.0e	17.7e
1977	43.4	83.2	107.7	103.2	126.8	142.8	147.5	153.0	160.8	169.1	154.2	185.6	214.4	267.4	340.7	248.7	95.3	44.0
1978	17.2	59.5	106.4	129.6	147.2	176.5	195.1	201.9	171.2	153.4	159.2	211.2	218.8	76.3	42.7	40.6	28.8	19.7
1979	51.1	57.0	67.4	84.6	112.5	121.1	62.9	72.1	64.4	71.5	52.6	95.0	92.9	44.1	23.7	17.2	13.1	9.7
1980	10.2	23.7	31.9	79.6	84.5	74.8	92.0	77.4	59.7	55.6	56.6	38.9	25.7	14.1	9.7	7.1e	6.0	4.3
1981	23.5e	17.1	26.4	65.4	127.2	141.9	159.1	207.4	272.8	313.9	237.8	151.4	66.1	44.2e	26.7e	18.0	15.4	13.5
1982	30.9e	47.8e	58.6	82.7	114.6	135.3	141.5	131.0e	120.8e	92.5e	178.0e	194.4e	235.3	198.9	174.0	104.9	58.4e	93.9
1983	77.6	63.3	71.5	128.4	150.8	216.7	266.1	333.6e	346.5	350.3	312.2	235.0	178.4	120.3	99.9	58.9	36.9e	31.1
1984	62.1e	45.1e	52.6e	92.7	118.7e	109.3e	81.5	127.9	157.0	138.6	60.9	42.8	24.0e	18.8e	15.7	12.7e	9.8e	8.9e
1985	40.3e	32.4e	62.0e	109.1e	128.3	133.7	113.5	104.0	98.6	94.9	66.3	42.5e	34.4	19.9	17.7	13.3	11.3	9.6
1986	125.2	94.3	98.8	108.7	123.8	139.1e	112.7e	96.4	132.4	87.1	81.4	65.2e	50.7e	21.8e	12.6e	11.8e	11.4e	11.0e
1987	74.1	60.2	53.7	50.7	32.5	31.2	37.9	77.9	80.0	99.0	74.4	74.4	90.1	36.4	16.5	11.2	9.2	7.8
1988	20.4	31.1	52.2	77.6	132.3	160.1	183.8	181.9	173.4	188.5	179.9	190.2	199.2	63.6	32.1	25.7	19.9	18.9
1989	36.4	32.5	41.1	73.0	42.3	49.8e	85.1	110.2	77.3e	121.0	121.5	132.0e	61.8	38.4e	29.9e	42.0e	35.7	58.4
Mean	41.9	49.1	67.0	86.9	109.4	133.2	144.8	154.5	153.0	144.4	125.5	120.1	107.1	64.7	60.2	47.5	31.4	23.3
Maximum	125.2	94.3	118.9	129.6	150.8	216.7	266.1	333.6	346.5	350.3	312.2	243.0	243.7	267.4	340.7	248.7	187.1	93.9
Minimum	5.8	5.2	4.7	11.9	24.5	31.2	37.9	72.1	58.9	50.3	52.6	35.4	22.4	14.1	9.7	7.1	5.8	4.3

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Bulo Burti 10 Day Mean Discharges (cumecs) Table M8

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	26.1e	22.4e	21.2e	19.7e	17.8e	16.9e	15.4e	15.9e	14.6e	13.7e	19.0e	97.4e	243.5e	264.8	287.8	300.6	84.7	46.8
1964	36.4	33.3	29.3	20.8e	15.4e	12.2e	10.7e	8.8e	7.5	7.0	26.8	41.4	47.8	29.5	21.5	13.7	18.4	18.9
1965	77.7	41.3	20.3	13.8	10.0	9.2	7.9	6.6	5.1	4.2	4.3	12.1	69.9	47.1	17.1	13.0	11.5	8.0
1966	11.3	8.0	5.3	4.3	3.9	7.4	16.4	34.7	18.1	15.9	18.0	63.7	97.6	103.0	43.1	37.9	28.7	33.5
1967	2.4	1.5	0.8	0.3	0.0	0.0	0.0	0.0	0.0	3.1	60.2	50.2	79.3	98.6	178.0	117.2	45.9	23.1
1968	36.7	29.1	22.4	17.6	14.3	18.1	48.0	90.2	73.4	41.1	67.2	143.2	226.5	268.0	293.5	229.4	116.1	107.5
1969	18.8	18.2	18.1	15.1	19.0	21.3	73.7	114.4	136.4e	110.1e	117.7e	88.2e	65.5e	124.2e	172.1e	69.7e	35.5	28.6
1970	7.4	6.2	6.3	22.8	16.2	9.3	12.2	50.6	86.7	108.9	72.6	108.8	180.9	175.8	113.0	40.6	20.2	14.0
1971	9.9	8.5	7.9	6.7	6.0	5.5	4.9	3.9	3.3	10.8	39.2	72.5	72.4	97.6	94.5	60.2	35.6	51.8
1972	10.1	9.9	8.0	6.0	5.3	43.7	17.7	13.3	9.1	22.0	14.9	87.7	164.7	198.9	162.2e	124.5	50.4	32.3
1973	8.3	7.1	5.9	4.9	4.3	3.6	3.0	2.4	1.9	1.4	1.3	7.0	56.3	31.3	67.2	48.0	16.8	12.4
1974	3.2	2.8	2.8	1.7e	0.7e	0.0e	0.0e	0.0e	0.0e	59.4e	83.0	37.1	19.0e	48.7	94.9e	51.2e	80.6e	58.4e
1975	3.4e	1.6e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	8.3e	54.2e	51.5e	55.7e	103.7e	92.0e	27.5e	19.0e
1976	3.0e	0.7e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	55.8e	167.7e	87.4e	144.0e	235.7	275.4	199.6	72.3e
1977	13.4e	12.1e	10.6e	11.7e	15.6e	13.7e	20.3e	11.2e	8.8e	15.7e	123.7e	144.1	185.2	262.0	193.4e	72.8e	79.2e	42.3e
1978	32.3e	25.6e	18.0e	13.9e	11.1e	9.5e	36.1e	104.1e	69.8e	39.4e	45.7e	52.1e	69.2e	97.1e	86.1e	42.8e	28.3e	20.8e
1979	18.9e	16.8e	15.9e	69.0e	61.2e	40.4e	45.3e	22.7e	64.8e	69.3e	62.8e	68.5	49.0	55.0	110.0	139.8	107.1	71.0
1980	8.2e	9.6e	7.3e	6.1e	5.4e	6.0e	4.5e	3.7e	3.0e	3.3e	3.5e	32.3e	60.9e	136.9e	107.1e	28.9e	17.3e	14.9e
1981	2.4e	1.4e	0.6e	0.0	0.0	0.0	0.3	18.2	181.5	235.2	266.4	303.3	350.0	448.9	357.6	115.8	54.3	40.3
1982	11.1e	8.5e	8.9e	7.9e	6.6e	4.6e	6.1e	9.6e	10.3e	5.9e	80.1e	124.0	135.6	137.9	161.7	187.5	88.6	43.7e
1983	52.9e	31.8e	22.4e	16.8e	24.7e	22.1e	19.8e	19.4e	11.0e	9.4e	21.3e	79.3e	118.9	99.3e	95.8e	137.6e	191.4e	150.1e
1984	24.2	19.1	15.8	13.5e	11.4e	10.5	8.4	6.9	6.0e	5.0	4.8	9.7	10.2	8.8	88.4	81.1	67.3	31.9
1985	8.5e	6.3e	4.7e	4.1e	3.6e	3.5e	2.8e	1.6e	1.5e	48.1e	63.4	146.9	194.4e	247.3e	280.9e	257.4e	90.4	51.0
1986	6.8e	5.7e	4.7e	4.0e	3.3e	3.3e	2.9e	4.8e	5.6e	3.1e	28.8e	123.6	133.7	97.8	114.4	150.3	102.2	77.9
1987	7.3e	5.4e	4.0e	3.6e	3.2e	3.0e	2.2e	2.8e	14.5e	36.9	87.9	107.2	84.1	108.8	188.7e	264.6e	312.5e	250.3e
1988	5.3e	4.4e	3.6e	2.8e	2.0e	1.7e	1.2e	1.0e	1.0e	0.3e	10.2e	103.8	122.9	59.9	28.1	17.5	9.5	13.7
1989	14.4	13.5	11.3	10.4	10.1	14.9	10.9	8.5	10.2	76.9	130.3	179.3	196.6	229.7	179.2	76.6	43.4	41.8
Mean	17.1	13.0	10.2	11.0	10.0	10.4	13.7	20.6	27.6	35.0	56.2	92.8	117.5	136.2	143.5	112.8	72.7	51.0
Maximum	77.7	41.3	29.3	69.0	61.2	43.7	73.7	114.4	181.5	235.2	266.4	303.3	350.0	448.9	357.6	300.6	312.5	250.3
Minimum	2.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	7.0	10.2	8.8	17.1	13.0	9.5	8.0

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Bulo Burti 10 Day Mean Discharges (cumecs) Table M8 (continued)

	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	47.0	51.3	60.9	83.4	110.7	120.9	155.9	174.2	156.1	89.8	116.5	68.6	43.0	42.4	58.4	69.6	77.7	59.8
1964	23.1	24.9	48.3	64.1	92.4	146.9	170.5	133.1	160.5	191.5	131.1	147.5	176.6	68.3	32.3	22.3	16.6	23.4
1965	6.9	5.4	4.6	7.1	15.6	40.9	59.7	70.6	62.3	47.8e	85.7e	132.5e	165.6e	74.3	117.9	49.3e	17.3e	13.5e
1966	36.0	21.8	36.5	42.8	49.7	73.2	88.4	113.4	145.1e	146.2e	71.4	60.8	104.7	54.1	19.8	12.3	10.3	6.0
1967	14.6	19.5	49.2	70.9	88.9e	127.6	146.1	164.7	179.2	195.7	181.7	197.5	222.5	88.7	119.4e	204.2e	182.9e	77.7e
1968	76.9	75.6	83.5	87.7	111.5	146.8	174.1	135.3	102.6	120.3	109.9	107.6	71.0	41.7	48.9	79.9	54.8	28.8
1969	32.0	56.7	57.8	79.9	115.2	155.6	148.4	149.3	132.0	122.5	76.1	57.6	41.2	52.5	19.8	13.2	12.3	9.3
1970	13.3	9.6	29.0	75.9	98.0	147.6	193.4	207.9	192.7	178.6e	159.0	138.8	156.4	88.9	35.9	22.3	15.8	12.2
1971	72.7	70.7	87.1	88.3	96.7	113.3	141.9	151.0	138.0	84.5	96.4	115.6	88.4	42.1	75.0	50.3	24.3	14.9
1972	38.5	73.3	103.2	107.9	108.8	122.3	142.1	151.1	131.6	104.0	120.9	93.9	84.3	84.8	35.6e	22.0	15.8	10.5
1973	8.8	12.6	40.9	63.4	78.5	104.8	134.9	128.5	115.9	88.6	88.3	108.8	51.9	19.5e	11.0	7.3	5.3e	4.1e
1974	39.2e	68.1e	89.7e	83.4e	99.5e	106.0	116.1e	136.0e	124.8e	123.1e	83.2e	39.6e	23.2e	21.8e	14.3e	8.7e	6.7e	6.3e
1975	30.7e	45.8e	90.2e	108.0e	117.6e	134.6e	167.2e	188.5e	202.5e	185.1e	111.0e	82.5e	46.3e	34.0e	19.3e	13.1e	9.3e	5.1e
1976	52.8e	63.3e	95.7e	96.9e	107.3e	127.9e	133.4e	135.2e	128.8e	108.6e	90.6e	64.9e	64.6e	85.5e	84.1e	47.0e	25.5e	17.0e
1977	49.1e	79.0e	112.8e	113.3e	129.5e	147.3e	155.3e	167.2e	176.9	187.1	177.7	201.0	239.1	254.8	287.4	328.6	153.6e	47.5e
1978	15.7e	46.4e	91.5e	115.8e	129.4e	152.8e	171.2e	179.2e	159.9e	138.2e	141.0e	173.3e	208.7e	89.6e	45.0e	39.7e	31.1e	19.6e
1979	45.7	47.2e	66.8e	76.6e	98.0e	117.4e	66.5e	66.6e	64.6e	69.1e	53.5e	79.3e	94.1	42.1	27.1	19.9e	14.3e	9.4e
1980	13.5e	25.2e	39.8e	74.2e	93.0e	77.6e	111.7e	83.8e	74.8e	62.1e	65.9e	48.0	33.5	20.8	12.0	7.5e	6.1e	4.2e
1981	30.1	24.1	28.8	55.4	129.6	141.2	156.9	186.0	214.3	250.7	281.8	192.9	74.6	64.4	31.8	21.2	16.0	14.1
1982	30.6e	41.8e	56.8e	72.6e	113.3	134.8	142.4	127.3	117.6	80.6	153.1	174.1	216.2e	179.3e	164.6e	105.9e	65.9e	82.8e
1983	77.6e	65.8e	62.3e	113.6e	129.2e	180.3e	227.5	244.8	277.5	303.5	315.0	279.2	203.6	133.8e	116.2e	75.4e	43.3e	31.7
1984	67.0	57.2	46.5	96.8	118.9e	110.3	68.8	117.0	150.6e	154.0e	99.9	54.6	22.6e	17.9e	12.7e	8.3e	6.5e	6.4e
1985	40.7	33.1	55.9	96.5	120.3	126.4	110.6	100.7	96.9	97.0	70.1	49.8	35.3	19.7	15.9	10.7e	10.0e	8.5e
1986	109.4	95.9	93.7	98.3	111.2	126.4	104.3	96.4	116.8	91.9	80.9	63.8	53.2	23.9	11.6e	10.5e	10.1e	9.7e
1987	78.9	63.6	56.0	50.7	35.6	27.7	39.0e	72.2e	82.3e	88.5e	74.7e	74.5e	81.2e	44.3e	15.3e	8.6e	6.8e	6.4e
1988	14.8	26.4	51.7	63.6	118.0	142.9	165.5	166.7	153.7	165.6	163.4	160.6	185.1e	74.7e	38.2	24.7	17.5	15.2
1989	33.4	29.2	36.4	65.2	43.2	42.9	72.9	103.3	78.1	98.1e	112.1e	123.9e	71.3e	39.2e	30.8e	41.5e	24.1e	60.7e
Mean	40.7	45.7	62.1	79.7	98.5	118.4	132.0	138.9	138.4	132.3	122.6	114.5	105.9	66.8	55.6	49.0	32.6	22.4
Maximum	109.4	95.9	112.8	115.8	129.6	180.3	227.5	244.8	277.5	303.5	315.0	279.2	239.1	254.8	287.4	328.6	182.9	82.8
Minimum	6.9	5.4	4.6	7.1	15.6	27.7	39.0	66.6	62.3	47.8	53.5	39.6	22.6	17.9	11.0	7.3	5.3	4.1

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Mahaddey Weyn 10 Day Mean Discharges (cumecs)

Table M9

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	30.5	26.0	24.4	23.2	21.1	20.2	18.4	19.0	17.7	16.8	20.6e	94.4e	131.5	130.5	129.2	128.2	103.2	52.7
1964	37.9	32.9	31.7	20.1	14.8	11.2	9.5	7.6	5.7	4.8	13.6	41.1	43.2	34.0	22.6	16.7	14.2	19.6
1965	63.9	57.4	27.8	19.1	13.8	11.8	9.8	7.3	5.3	4.4	4.6	10.9	52.2	59.9	24.7	15.6	14.8	9.5
1966	13.8	10.4	8.1	6.5	5.1	4.2	17.8	34.7	24.7	22.4	16.8	59.3	87.7	116.1	52.4	48.1	37.5	39.1
1967	8.0	4.6	2.9	2.3	1.9	1.6	1.4	1.1	0.7	2.5	51.0	46.6	75.2	94.0	132.9	129.4	60.7	32.6
1968	49.4	33.8	24.8	20.0	16.2	16.6	31.9	85.0	81.7	50.9	58.8	118.9	143.8	145.3	138.3	132.8	118.9	106.5
1969	28.3	25.7	24.7	21.0	23.4	22.1	60.7	110.3	125.7	115.6	122.6	93.0	80.5	117.6	145.0	98.1	45.8	37.1
1970	9.8	8.6	5.8	20.8	24.6	13.3	10.0e	46.4e	82.8e	116.2	87.1	104.1	142.3	145.1	133.7	64.9	35.1	22.6
1971	15.3	12.2	10.9	9.8	8.7	8.1	6.7	5.3	4.6	4.0	23.5	75.9	84.2	93.9	104.5	70.2e	45.8e	44.2e
1972	14.2e	12.9e	11.9e	9.5e	8.3e	39.8e	26.6e	15.8e	14.3e	22.3e	19.5e	65.3e	137.4e	140.0e	137.6e	135.2e	64.6e	37.4e
1973	11.9e	10.7e	9.3e	8.3e	7.6e	6.9e	6.3e	5.7e	5.1e	4.6e	4.5e	4.3e	54.4e	36.8e	62.8e	65.6e	22.4e	17.3e
1974	6.5e	6.0e	6.1e	5.1e	4.1e	3.2e	2.4e	1.6e	0.7e	38.8e	95.6e	50.7e	21.9e	39.4	107.2	54.3	95.0	67.6
1975	7.8	5.7	4.6	4.1	3.2	2.5	2.1	1.7	0.6e	0.0e	4.5e	51.6e	48.7	53.0e	97.4e	105.1e	45.1e	23.0e
1976	6.0e	3.3e	1.2e	0.5e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	26.4e	130.7	104.4	131.1	145.5	147.3	146.2	107.2e
1977	16.7e	15.5e	13.6e	13.4e	18.3e	16.4e	23.6e	16.0e	11.0e	19.4e	75.6e	137.3	136.4	148.7	140.2	77.5e	83.9e	53.5e
1978	38.0e	31.2e	23.1e	17.7e	15.0e	13.1e	19.2e	107.2e	84.3e	48.6e	48.0e	47.7e	73.9e	91.5e	102.2e	53.2e	33.8e	26.8e
1979	22.2e	20.4e	18.5e	53.6e	79.7e	42.1e	52.3e	30.8e	53.7e	75.6e	70.4e	79.5e	54.1e	44.4e	114.3e	130.2e	118.4e	80.0e
1980	10.3e	9.9e	7.5e	5.1e	3.5e	3.5e	3.1e	2.3e	1.8e	1.5e	1.5e	15.6e	40.9e	119.8e	116.0e	40.6e	17.1e	12.8e
1981	3.1	1.7	0.4	0.1	0.1	0.0	0.0	0.5	128.6	160.2	162.0	159.7	158.9	158.8	159.4	122.9	68.5	43.8
1982	15.7	13.3	11.8	8.8	8.0	7.8	7.1e	10.8e	11.1e	11.1	45.0	108.6	114.7	112.8	134.2	151.8	108.0	53.8
1983	75.4	38.8	27.9	22.6	25.8	32.7e	24.0e	24.0	18.1	12.3	10.9	64.3	120.5	108.9	99.4	137.1	153.2	147.5
1984	27.9	24.4	23.3	22.7	21.3	19.8	18.2	15.9	13.8	12.9	12.2	15.2	18.2	20.8	72.7	75.3	76.5	39.4
1985	8.8e	8.0e	6.6e	5.8e	5.0e	5.0e	4.5e	3.8e	3.4e	34.1e	46.8e	144.1	162.7	162.8	165.3	163.4	120.8	60.6
1986	15.3	14.1	12.8e	11.6	8.9	7.3	6.8	6.6	7.9	6.8	5.3e	127.9	144.1	124.8	115.0	149.6	126.2	88.6e
1987	9.3	7.2	6.5	5.8	5.0	5.3	4.9	4.1	4.5	37.9	73.3	117.4	95.7	100.4	160.7	162.1	160.8	161.4
1988	8.3	7.2	6.2	5.1	4.0	3.5	2.9	2.5	2.2	2.2	8.6	82.8	157.4	81.9	34.4e	30.0	17.5	21.6
1989	19.8	19.0	16.2	15.1	14.1	17.3	18.5	13.8	12.5	62.8	137.5	159.1	165.5	168.5	167.4	104.4	57.1	48.2
Mean	21.3	17.1	13.7	13.3	13.4	12.4	14.4	21.5	26.8	32.9	46.2	81.7	98.2	103.0	111.7	96.7	73.7	53.9
Maximum	75.4	57.4	31.7	53.6	79.7	42.1	60.7	110.3	128.6	160.2	162.0	159.7	165.5	168.5	167.4	163.4	160.8	161.4
Minimum	3.1	1.7	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.5	4.3	18.2	20.8	22.6	15.6	14.2	9.5

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Mahaddey Weyn 10 Day Mean Discharges (cumecs) Table M9 (continued)

	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	43.0	47.9	53.5	75.4	100.2	115.7	131.7	132.9	134.0	96.4	109.8	75.0	40.8	38.8	52.9	78.0	89.0	71.3
1964	21.7	24.3	37.7	58.1	80.8	124.6	133.0	129.4	132.0	135.4	128.8	127.2	136.2	86.7	43.8	29.3	23.2	22.0
1965	6.7	6.1	4.2	4.6	13.9	29.8	57.7	64.6	61.5	48.7	79.1	111.8	132.1	82.9	110.8	82.7	36.3	22.3
1966	43.6	30.9	38.0	48.4	53.1	74.1	91.2	107.5	130.6	140.4	95.2	66.7	103.0	71.4e	25.1e	20.9e	16.1	12.5
1967	22.0	16.5	41.3	64.0	89.4	129.8	138.4	139.0	138.0	134.8	134.1	134.1	135.6	118.8	104.0	132.9	133.9	101.9
1968	82.7	77.3	83.6	89.2	93.6	132.2	143.8	138.0	111.3	120.1	116.4	116.8	93.9	57.2	49.3	84.7	74.8	42.7
1969	32.3	56.3	61.9	81.0	113.0	140.6	138.6	138.7	134.1	129.7	90.5	75.4	46.6	64.8	32.3	20.4	14.0	11.2
1970	18.7	15.6	21.9e	74.3e	97.4e	132.1	143.8	142.6	141.9	141.5	143.4	139.6	144.4	113.3	44.2	29.9	22.9	18.8
1971	77.8e	73.1e	89.4e	92.3e	98.7e	113.8e	135.9e	140.0e	139.7e	99.8e	91.8e	119.0e	105.1e	55.7e	64.5e	68.0e	31.1e	20.1e
1972	36.7e	69.8e	102.3e	115.8e	109.3e	125.0e	138.6e	140.0e	138.5e	114.7e	120.6e	106.9e	84.2e	98.2e	48.2e	26.7e	21.1e	14.6e
1973	11.7e	15.7e	31.2e	72.8e	73.7e	104.2e	132.1e	136.1e	125.1e	101.6e	84.4e	116.0e	72.3e	26.7e	15.8e	11.2e	8.9e	7.5e
1974	50.2	64.0	99.5	83.3	104.3	113.6	113.8	123.6	126.5	118.4	95.3	53.5	32.3	27.5	24.0	14.0	10.7	8.6
1975	29.3e	42.6e	86.6e	110.0e	120.3e	134.5e	140.0e	140.0e	140.0e	140.0e	126.0e	88.5e	62.1e	38.9e	25.2e	17.7e	13.7e	9.2e
1976	87.2	75.1	96.2	99.8	106.5	129.0	139.3	137.8	138.7	116.6	99.9	73.8	64.7	85.2	90.5	61.8e	31.4e	21.5e
1977	48.3e	70.8e	116.3e	120.2e	127.0e	138.0e	138.0e	138.0e	138.0e	138.0e	138.5e	141.0	143.9	148.0	150.7	150.4	143.6	102.6
1978	19.3e	36.9e	87.7e	117.6e	131.4e	139.9e	140.0e	140.0e	140.0e	140.0e	140.0e	140.0e	140.0e	112.9e	52.6e	42.7e	39.2e	24.7e
1979	58.7e	51.5e	69.7e	76.9e	96.0e	122.9e	82.1e	67.6e	71.5e	72.6e	64.1e	69.7e	111.6e	59.8e	33.1e	21.5e	16.6e	13.0e
1980	8.9	12.8	33.3	60.2	88.6	75.6e	98.0e	69.7e	70.9	48.0	55.3	48.7	29.1	18.7	9.7	7.5	5.3	4.3
1981	34.6	28.6	30.1	46.9	114.1	127.7	141.5	153.2	155.4	156.1	155.3	153.8	94.5	70.6	41.0	28.7	22.3	18.5
1982	37.8	39.5	59.9	69.2	107.3	117.9	134.3	128.7	121.6	93.1	131.6	145.4	154.8e	155.0e	153.6e	106.1e	76.7e	79.0e
1983	92.7	81.3	57.2	118.5	141.4	154.2	153.5	151.5	148.9	148.1	147.9	150.4	151.3	134.7	113.4	85.2	56.1	41.9
1984	57.6	63.3	41.0	93.3	113.9	116.3	79.8	115.9	135.9	140.4	102.6	67.1	31.9	22.6	18.0e	13.5e	10.9e	9.5e
1985	48.5	41.0	53.4e	95.2	133.5	135.9	123.9	112.9	101.4	109.3	78.6	66.7	43.9e	27.8	24.4	20.5	17.5	16.4
1986	114.1	111.9	99.4e	108.8	118.8	140.6	120.3	107.1	120.3	111.0	89.2	76.0	70.8	34.2	20.7e	14.4e	11.1e	9.2
1987	113.6	68.3	62.3	53.7	43.0	31.0	41.2	66.4	82.6	89.6	87.4	86.3	108.1	59.8e	21.8e	17.0e	12.4	9.6
1988	22.1	24.2	48.8	65.0	122.0	149.3	159.6	164.8	165.7	166.8	166.6	162.9	170.9	112.5	50.7	33.3	25.8	21.5
1989	44.4	38.6	37.7	70.9	62.6	46.8	70.7	118.4	96.7	108.9	137.3	151.6	105.1	53.5	41.2	47.3	30.5	63.6
Mean	46.8	47.6	60.9	80.2	98.3	114.6	120.8	123.9	123.7	117.0	111.5	106.1	96.6	73.2	54.1	46.9	36.9	29.6
Maximum	114.1	111.9	116.3	120.2	141.4	154.2	159.6	164.8	165.7	166.8	166.6	162.9	170.9	155.0	153.6	150.4	143.6	102.6
Minimum	6.7	6.1	4.2	4.6	13.9	29.8	41.2	64.6	61.5	48.0	55.3	48.7	29.1	18.7	9.7	7.5	5.3	4.3

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Balcad 10 Day Mean Discharges (cumecs) Table M10

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	20.1e	14.9e	12.7e	11.7e	9.4e	8.4e	6.8e	6.9e	5.7e	4.9e	7.5e	55.8	90.3	89.3	86.0	83.3	75.1	49.1
1964	38.9	30.5	29.7	18.1	11.2	7.6	5.5	3.3	1.6	2.6	5.5	39.8	38.3	34.5	20.2	17.0	9.7	15.6
1965	48.4	58.2	26.0	16.6	10.1	6.5	5.1	2.2	0.6e	0.5e	1.4e	6.3	39.9	61.6	23.2	9.8	10.7	4.6
1966	10.3	6.5	3.8	1.5e	0.9e	0.5e	12.5e	28.1e	23.7e	20.1e	12.9e	45.4e	66.8e	92.1e	51.5e	44.1e	35.9e	35.3e
1967	7.4	2.2	0.3	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	33.7e	47.6e	56.4e	78.2e	90.0	93.7	67.2	36.6
1968	44.1	29.0	19.6	15.4	11.4	10.4	22.0	69.9	78.7	49.6	48.1	88.5	95.0	95.1	93.0	87.2	82.7	77.3
1969	26.9	20.8	20.5	17.5	18.2	19.5	40.8	81.7	95.8	95.2	93.9	85.7	65.7	92.0	96.1	90.6	50.0	37.6
1970	6.5e	5.4e	2.5e	12.3e	24.7e	11.2e	6.9e	32.9e	64.3e	92.3e	75.8e	77.9e	95.0e	95.0e	94.8e	63.6e	34.9e	21.5e
1971	12.1	9.2	7.5	6.0	3.9	2.7	2.5e	2.9e	4.3e	5.2	19.7	57.3	61.0	72.6	83.1	62.5	48.3	35.8e
1972	12.2	7.9	6.3	4.2	1.2	27.4	33.8	11.7	10.4	10.8	18.4	35.7	86.2	94.3	98.1	98.7	72.8	39.8
1973	9.9	6.5	3.6	1.6	0.7e	1.0e	2.0e	1.0e	1.6	0.5e	0.0e	0.0e	28.3e	34.1	46.3	57.8	23.2	17.4
1974	3.0e	2.5e	2.4e	1.7e	0.5e	0.0e	0.0e	0.0e	0.0e	19.3e	77.0	48.1	19.6	21.9	78.3	41.2	71.2	53.2
1975	4.7e	2.4e	1.0e	0.5e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	38.9e	46.0e	46.6e	72.3e	86.6e	50.7e	20.1e
1976	2.8e	0.6e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	9.1e	80.0	68.5	83.1	92.0	91.1	88.9	70.4
1977	13.7e	12.2e	10.2e	8.8e	15.0e	14.1e	18.9e	14.0e	7.3e	14.4e	56.4e	95.7e	97.2e	98.1e	98.2	66.7	63.2	42.7e
1978	37.3e	29.7e	22.4e	17.8e	16.4e	15.5e	21.1	69.6	72.6	45.1	42.1	45.3	68.1	82.7	89.9	50.1	31.3	21.4
1979	22.9	19.5	16.3	38.2	69.6	38.6	46.3	29.9	38.5	72.8	67.5	65.6	56.2	40.2	91.8	99.1	98.2	81.3
Mean	18.9	15.2	10.9	10.1	11.4	9.6	13.2	20.8	23.8	25.5	33.5	53.8	63.4	71.3	76.7	67.2	53.8	38.8
Maximum	48.4	58.2	29.7	38.2	69.6	38.6	46.3	81.7	95.8	95.2	93.9	95.7	97.2	98.1	98.2	99.1	98.2	81.3
Minimum	2.8	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.6	21.9	20.2	9.8	9.7	4.6

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Balcad 10 Day Mean Discharges (cumecs) Table M10 (continued)

	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	40.2	43.3	46.4	64.0	84.0	90.7	90.8	90.7	90.0	79.6	84.6	73.0	41.6	35.0	45.6	68.8	78.9	72.1
1964	15.9	21.1	31.7	52.7	67.7	88.5	89.6	88.5	88.1	88.7	88.5	87.8	88.4	79.2	48.2	28.6	23.8	20.3
1965	1.6	3.0	1.1	0.3e	8.3e	25.1	54.6	57.6	65.2	48.3	68.7	86.7	90.4	80.3	87.7	79.5	36.6	20.5
1966	40.5e	30.8e	31.2e	43.3e	46.4e	59.5e	73.9e	84.5e	95.0e	95.0e	82.2e	53.1e	81.0e	72.2e	29.7e	24.0	14.7	11.1
1967	23.3	17.3e	33.4e	50.9e	68.4e	87.5e	93.3	92.7	90.5	88.2	86.9	87.6	88.2	86.3	79.8	86.7	86.4	77.5
1968	73.2e	68.7e	71.9e	74.9e	77.5e	92.0e	94.5	93.2	89.5	89.6	90.6	90.6	81.6	56.8	45.8	73.8	71.4	42.5
1969	30.0	52.3e	60.1e	69.4e	89.1e	96.1	95.4	95.6	94.4	93.1	82.8	69.1	45.7e	54.7e	33.4e	18.6e	11.8e	8.0e
1970	16.0e	12.7e	14.5e	56.8e	77.1e	93.2e	95.0e	95.0e	95.0e	95.0e	95.0e	95.0e	95.0e	91.2e	45.5e	29.7e	20.3e	16.4e
1971	67.6	63.8	75.7	80.4	84.7	92.6	96.3	97.1	96.6	86.1	75.7	95.3	88.2	55.4	49.0	70.5	33.8	21.2
1972	33.0	54.0	82.5	96.7	92.9	98.3	98.8	98.7	97.6	92.3	90.9	91.6	77.2	90.3	56.6	34.1	25.0	16.0
1973	11.2	10.3	17.3	57.7	55.9	80.1	87.9	88.5	87.6	80.6	67.4	91.7	69.6e	28.4e	13.8e	8.3e	5.8e	4.1e
1974	40.7	42.2	81.6	65.9e	84.4e	92.0e	90.9e	95.0e	95.0e	94.0e	83.4e	51.8e	32.0e	24.8e	22.4e	11.8e	7.7e	5.1e
1975	23.9e	37.8e	65.1e	87.8e	94.8e	95.0e	95.0e	95.0e	95.0e	95.0e	94.3e	74.4e	61.4e	37.5e	23.8e	15.8e	11.0e	6.5e
1976	52.4	44.4	73.4	79.5	86.7	95.3e	96.6	96.6	94.7	91.2	70.0	46.7	39.2	66.6	72.2	56.0	31.0e	19.6e
1977	40.7e	54.9e	91.5e	92.8	87.6	97.2	97.5e	97.5e	96.5e	89.3	92.4	94.3	94.7	93.2	96.2	99.2	97.9	61.6
1978	18.1e	24.4e	67.0	92.2	98.6	99.9	98.8	96.1	95.2	93.6	94.8	96.4	99.7	96.5	58.9	45.1	41.3	27.5
1979	54.4	38.0	54.4	68.0	85.9	98.8	78.1	49.3	55.2	58.7	54.8	54.8	83.5	45.1	24.6e	15.1e	11.7e	9.5e
Mean	34.3	36.4	52.9	66.7	75.9	87.2	89.8	88.9	89.5	85.8	82.5	78.8	74.0	64.3	49.0	45.0	35.8	25.8
Maximum	73.2	68.7	91.5	96.7	98.6	99.9	98.8	98.7	97.6	95.0	95.0	96.4	99.7	96.5	96.2	99.2	97.9	77.5
Minimum	1.6	3.0	1.1	0.3	8.3	25.1	54.6	49.3	55.2	48.3	54.8	46.7	32.0	24.8	13.8	8.3	5.8	4.1

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Afgoi 10 Day Mean Discharges (cumecs) Table M11

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	12.4e	7.4e	5.2e	4.6e	2.8e	1.9e	0.8e	1.1e	0.4e	0.2e	0.8e	46.9e	91.6e	93.1	90.6	86.6	80.3	53.3
1964	42.7	30.2	29.0	19.3	11.4	7.1	5.2	2.7	0.7	1.8	2.2	37.1	34.4	34.5	19.6	18.5	8.9	14.9
1965	39.7	60.0	28.0	18.4	11.3	6.5	4.7	1.6	0.1	0.0	0.4	4.7	29.9	60.7	24.9	9.3	9.4	4.1
1966	11.6	6.2	3.6	0.9	0.0	0.0	9.1	29.2	21.3	15.9	11.6	35.3	60.6	82.4	52.7	37.5	30.0	28.6
1967	2.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.4	47.6	59.9	77.5	86.6	91.4	68.4	40.5
1968	47.4	30.7	21.4	16.0	11.2	9.1	18.1	64.2	81.1	51.3	42.7	85.9	96.3	97.7	97.7	92.5	88.4	81.5
1969	26.9	19.7	19.0	16.2	14.9	17.6	36.9	78.4	95.1	97.0	96.6	92.4	76.3	88.2	96.4	92.7	49.8	36.4
1970	6.1	4.4	2.5	5.4	23.3	11.3	5.4	20.9	58.4	87.7	88.3	81.4	97.0	98.3	97.9e	74.4	39.5	25.4
1971	12.1	7.7	5.8	4.4	2.0	0.7	0.5	0.2	0.0	0.0	12.1	51.3	60.3	72.4	83.2	62.9	48.7	31.9
1972	11.4	6.7	5.9	2.9	0.2	11.3	31.2	11.1	9.4	2.8	16.7	28.3	83.6	94.4	98.9	100.6	79.0	37.3
1973	8.1e	4.4e	1.3e	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	18.8	37.0	42.0	57.9	24.0	13.8
1974	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	73.0	50.4	20.9	16.8	74.0	46.3	67.6	52.6
1975	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.2	36.6	33.8	59.8	71.5	44.9	14.6
1976	1.2e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	2.8e	75.9	73.5	81.9	97.1	97.7	94.6	76.3
1977	12.3	10.4	8.1	6.7	12.2	13.0	16.4	13.0	5.1e	11.3	48.8	99.2	103.2	102.8	100.8	74.5	63.6	49.2
1978	38.6e	29.8e	22.1e	16.9e	15.3e	14.2e	16.4e	66.6e	77.0e	47.6e	41.2e	45.3e	65.9e	78.5	82.5	63.7	38.0	19.8
1979	21.3e	17.4e	15.2e	39.2	74.1e	40.9e	45.3e	31.8e	33.0e	80.8	73.8	75.6	69.2	44.6	93.2	105.8	108.8	93.5
1980	6.7e	6.5e	5.3e	3.0e	1.7	0.2e	0.2e	0.0e	0.0	0.0	0.0	5.3	26.2	80.8	82.1	39.0	18.2	15.4
1981	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.3	74.5	77.3	85.3	87.7	88.6	87.2	84.1	56.8	42.3
1982	24.7	17.3	15.5	14.5	12.8	11.8	9.6	16.1	18.0	16.6	24.3	81.8	93.0	86.5	91.9	94.8	85.9	54.8
1983	73.6	45.0	36.7	33.1	31.4	35.8e	26.0e	26.4e	22.8	18.2	19.1	43.8	84.2	93.7	75.4	90.1	95.4	94.0
1984	33.3e	29.3	26.5	21.5	22.7	22.3	22.0	22.0	22.8	18.1	14.7	15.7	16.4	20.2	39.8	62.3	65.9	43.4
1985	8.8	10.3	8.1	7.8	0.8	0.0	0.0	2.0	0.0	7.5	35.8	58.9	66.4	68.0	76.2	76.5	71.1	47.9
1986	5.1	4.2	7.4	5.7	4.7	4.9	1.8	1.8	2.6	2.1	1.2	56.1	85.0	83.7	71.8	87.6	86.1	67.3
1987	10.7	9.4	8.4	6.1	5.2	3.7	2.3	0.4	0.1	20.0	34.9	65.7	61.3	61.8	85.4	90.2	90.8	91.8
1988	10.4	10.2	10.6	9.6	11.1	7.9	6.1	2.5	1.0e	0.3	2.1	31.6	76.9	63.2e	24.4	22.5	12.8	13.2
1989	12.5	13.3	10.7	12.1	10.6	11.2	15.2	10.9	11.6	27.7	79.2	85.6	90.5	94.3	95.9	76.5	42.2	28.0
Mean	17.8	14.1	11.0	9.8	10.4	8.6	10.1	14.9	18.7	21.6	30.6	52.1	65.4	71.7	75.1	70.6	58.1	43.4
Maximum	73.6	60.0	36.7	39.2	74.1	40.9	45.3	78.4	95.1	97.0	96.6	99.2	103.2	102.8	100.8	105.8	108.8	94.0
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.4	16.8	19.6	9.3	8.9	4.1

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Afgoi 10 Day Mean Discharges (cumecs) Table M11 (continued)

	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	41.0	42.1	44.4	61.3	83.0	92.3	93.4	93.7	94.5	88.1	81.9	77.2	45.0	35.1	41.9	68.8	79.8	75.9
1964	14.3	19.3	27.2	49.9	62.8	87.3	91.4	91.0	90.5	90.7	90.8	89.9	90.7	83.4	54.3	31.6	26.4	20.0
1965	0.7	1.2	0.3	0.0	4.3	17.0	45.6	48.9	58.4	43.0	57.8	81.0	86.9	80.0	82.2	80.7	37.6	20.8
1966	34.0	26.9	23.8	36.5	40.0	52.9	71.0	78.3	82.2	83.1	78.2	53.1	80.3	79.6	33.6	17.8	11.1	5.6
1967	24.5	16.4	31.4	61.6	80.9	94.8	98.1	97.4	94.9	93.1	92.5	92.6	93.5	92.8	85.9	91.0	91.8	84.2
1968	71.3	65.8	69.7	74.3	88.1	96.5	97.3	96.4	93.9	91.8	93.2	94.5	87.8	59.9	44.8	73.0	76.4	44.3
1969	27.8	42.3	54.3	64.1	84.4	95.1	96.4	95.2	95.1	94.9	86.4	71.4	52.5	55.6	35.1	19.1	14.6	9.9
1970	17.7	17.3	14.5e	53.2	81.4	95.9	98.9	98.9	98.1	97.9	97.7	98.0	98.1	97.3	60.6	32.4	21.2	15.7
1971	63.6	62.1	73.9	81.1	84.7	92.6	97.3	99.0	99.3	92.5	76.4	91.5	92.7	59.0	45.8	70.5	34.7	20.9
1972	31.2e	50.8	82.7e	97.1e	97.5	101.8	103.6	103.7	102.0	97.8	94.1	97.3	79.1	92.6	65.9	35.9	26.8	17.5e
1973	8.7	6.8e	12.1e	54.6e	53.5e	79.9e	89.4e	91.0e	90.6e	84.5	67.0	93.6	75.1	34.5	18.1	9.0	1.4	0.0
1974	42.4	39.9	84.1	64.7	86.5	92.5	88.8	89.1	91.3	87.4	81.1	48.9	28.9	20.3	16.3	7.1	0.7	0.0
1975	16.1	30.0	53.8	88.4	95.1	97.3	98.4	97.2	96.9	96.7	91.3	65.3	48.8	16.3	13.3	8.5	4.7e	3.5e
1976	56.0	42.4	74.1	83.7	87.2	96.7	99.4	99.6	98.5	96.9	74.5	46.4	40.3	63.9	75.1	60.9	31.6	18.9
1977	35.9	48.6	79.4	96.2e	95.9e	98.2e	96.9	95.3	93.3	93.3	95.1	96.5	96.8	98.2	103.5	105.5e	102.0e	67.6e
1978	13.6	16.5	70.3	88.8	95.3	95.3	96.8	97.9	100.4	100.8	104.2	103.8	105.5	99.8	76.1	52.4	37.7	29.9
1979	65.3	45.0	59.8	74.0	98.0	108.0	94.7	49.8	51.3	58.8	59.4e	51.7e	87.5e	64.1e	35.2e	19.0e	13.7e	9.5e
1980	8.6	4.9	25.9	44.4	74.4	54.5	68.5	53.7	66.9	45.7	44.4	44.6	30.6	20.6e	10.7	2.1	0.0	0.0
1981	39.5	35.2	34.2	42.3	71.2	88.9	88.9	88.7	87.3	87.0	86.3	87.0	75.0	62.5	41.1	29.5	22.8	25.2
1982	39.1	34.8	51.9	55.8	81.6	89.6	94.4	93.0	85.3	72.5	79.7	85.9	91.8	94.0	94.0	93.7	84.0e	59.1e
1983	86.2	73.9	54.6	79.8	93.3	92.0	91.9	95.5	94.6	95.0	94.0	94.7	93.6	93.6	91.4	72.5	54.3	43.6
1984	38.6	57.8	39.6e	62.6	81.4	87.6	73.2	75.3	82.0	83.4	74.1	64.1	37.4	27.8	21.9	15.7	9.9	6.3
1985	38.1	33.6	38.8e	63.0	79.8	80.4	77.2	73.7	70.5	67.0	57.5	50.0	35.5	24.5	19.7	14.8	10.2	6.4
1986	60.1	82.7	66.8	71.9	82.7	84.0	82.0	71.8	68.4	70.3	56.9	54.3e	45.9	29.9	17.4	12.1	11.6	13.1
1987	82.9	45.1	37.7	30.2	29.2	23.8	27.9	44.9	65.4	68.3	72.1	68.3	72.7	63.5	25.1	17.4	13.8	10.8
1988	18.9	17.4	25.1	30.1	64.5	84.0	83.2	81.7	80.8	79.2	79.6	78.7	81.7	76.8	41.2	23.7	17.8	15.7
1989	24.8	17.6e	16.8	33.0	47.3	24.8	40.4	79.2	72.1	61.3	76.6	76.0	74.5	50.0	36.6	38.3	34.5	44.1
Mean	37.1	36.2	46.2	60.8	75.0	81.6	84.6	84.4	85.4	82.3	79.4	76.2	71.4	62.0	47.7	40.8	32.2	24.8
Maximum	86.2	82.7	84.1	97.1	98.0	108.0	103.6	103.7	102.0	100.8	104.2	103.8	105.5	99.8	103.5	105.5	102.0	84.2
Minimum	0.7	1.2	0.3	0.0	4.3	17.0	27.9	44.9	51.3	43.0	44.4	44.6	28.9	16.3	10.7	2.1	0.0	0.0

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Audegle　　10 Day Mean Discharges (cumecs)　　Table M12

	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	4.6	1.8	2.2	2.1	0.0	0.0e	0.0e	0.4e	0.0e	0.0e	0.1e	35.9e	73.5e	73.8e	73.3	70.1	68.2	48.0
1964	42.2	29.6	28.9	19.4	11.7	8.3	6.5	4.3	3.1	1.9	0.7	31.1	31.7e	34.2	20.0	19.6	10.6	14.5
1965	33.0	57.7	26.9	16.4	10.2	6.5	5.1	3.0	1.4	0.0	1.0	4.2	22.2	56.7	25.6	10.6	10.4	6.4
1966	11.2	8.6	5.3	3.5	0.7	0.0	7.0e	27.8e	24.5e	17.5e	14.7e	29.2e	54.8	69.6	52.5e	35.4e	28.7e	26.1e
1967	3.7	1.0	0.0	0.0	0.0	0.0	0.0e	0.0e	0.0e	0.0e	20.0e	50.5e	54.3e	73.9e	74.0e	74.0e	66.5e	42.6e
1968	51.4e	29.5e	20.2	15.5e	11.6e	9.6e	16.5e	58.2e	73.3e	50.6	38.0	69.5	74.1	74.5	74.3	73.7	72.7	69.6
1969	28.9e	20.6e	19.8e	17.4e	15.3e	18.8e	31.5e	70.5e	74.0e	74.0e	74.0e	74.0e	73.1e	74.0e	74.0e	74.0e	53.9e	37.9e
1970	7.1e	5.6e	3.7e	3.8e	24.3e	13.5e	6.9e	17.6e	54.8e	73.8e	74.0e	72.6e	74.0e	74.0e	74.0e	70.5e	42.7e	27.5e
1971	13.1e	8.9e	6.8e	5.5e	3.1e	1.8e	1.3e	1.2e	0.9e	0.9e	10.0e	46.9e	59.0e	71.8e	81.9e	65.4e	51.3e	32.3e
1972	13.1e	7.9e	7.0e	4.1e	1.3e	6.5e	34.4e	13.3e	10.4e	3.2e	16.9e	22.9e	78.4e	82.0e	82.0e	82.0e	76.4e	40.3e
1973	9.5e	5.6e	2.5e	0.6e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	13.0e	40.9e	38.8e	59.6e	27.7e	14.9e
1974	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	64.4e	54.4e	23.3e	15.4e	66.0e	52.6e	62.3e	52.6e
1975	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	13.4e	39.0e	33.7e	56.2e	71.8e	51.4e	16.4e
1976	2.4e	0.4e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.0e	0.3e	68.7e	68.9	71.4	83.8	85.3	83.3	74.5
1977	14.4	10.1	7.6	6.0	11.7	13.3	16.1	16.6	8.5	10.1	29.1	83.4	90.2	90.0	86.5	76.1	68.2	55.7
1978	46.9	37.3	29.5	24.6e	20.8e	17.7e	16.2e	60.0e	79.0e	50.7e	40.6e	45.5e	64.6e	73.6e	81.7e	65.5e	41.8e	22.1e
1979	24.7	22.4	18.3	34.9	74.4	44.6e	43.6e	35.7e	28.5e	80.7e	73.8e	74.6e	72.5e	47.0e	76.6e	86.0e	86.0e	86.0e
1980	1.8e	2.5e	2.8e	1.7e	1.1e	0.2e	0.1e	0.0e	0.0e	0.0e	0.0e	1.2e	23.4e	72.7e	79.0e	45.7	18.5	24.6
1981	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.1	73.8	76.6	83.3	84.7	85.3	85.5	83.0	62.5	46.0
1982	21.7	18.4	17.7	17.1	16.7	15.2	12.9	17.5	18.8	18.6	20.4	79.7	88.8	85.3	87.8	89.3	84.7	62.2
1983	77.6	49.5	39.4	37.0	35.6	46.6	38.5	34.6	27.8	23.0	22.2	42.9	79.4	88.5	75.3e	87.7	90.2	88.2
1984	35.5	33.5	30.2	26.7	24.7	26.6	26.1	27.3	26.1	18.1	15.9	17.2	19.5	21.7	35.1	65.5	68.6	49.9
1985	8.3	8.7	9.4	6.4	2.8	0.2e	0.0	0.5e	0.0	0.4	38.3	65.0	72.9e	73.6e	79.2e	79.7e	73.9e	56.3
1986	0.6	0.7	5.0	3.8	1.7	1.6	0.2	0.0	0.0	0.0	0.0	49.0	86.9	88.0	75.8	88.1	87.4e	70.4e
1987	3.5e	2.8e	2.6e	1.9e	0.5e	1.6e	0.4e	0.0e	0.0e	18.4e	31.7e	65.3e	62.0e	63.1e	85.8	86.8	86.7	85.5
1988	11.1e	8.1e	8.5e	2.6	2.6	5.1	2.3	2.3e	0.0e	0.0e	0.8e	24.6e	80.0e	74.5e	28.3e	26.1e	15.3	12.7e
1989	11.4	12.6	10.9	11.8	11.5	10.4	15.7	11.3	10.6	22.8	86.0	89.8	90.3	92.9	93.4	87.1	50.7	31.9
Mean	17.7	14.2	11.3	9.7	10.4	9.2	10.4	14.9	17.7	19.9	27.7	47.9	61.3	66.7	68.4	67.1	57.1	44.3
Maximum	77.6	57.7	39.4	37.0	74.4	46.6	43.6	70.5	79.0	80.7	86.0	89.8	90.3	92.9	93.4	89.3	90.2	88.2
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.0	15.4	20.0	10.6	10.4	6.4

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

River Shebelli at Audegle   10 Day Mean Discharges (cumecs)   Table M12 (continued)

	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1963	37.3	37.9	40.4	53.5	69.0	73.9	74.2	73.4	73.8	72.0	70.4	67.0	41.8	32.7	38.1	58.4	70.2	72.8
1964	14.0	19.3	24.5	45.9	56.7	73.1	75.2	75.0	74.0	73.5	73.5	74.0	74.3	72.9	51.8	29.4	23.9	17.7
1965	2.8	2.1	2.4	0.4	3.8	15.0	41.3	46.0	55.0	43.0	56.0	70.4	74.4	75.2	73.4	74.3	39.3	21.0
1966	31.8e	27.2e	21.1e	35.3e	38.1	45.0	62.4	69.2	69.1	69.4	68.4e	45.7e	66.8e	69.1	33.9e	16.0e	10.1e	6.4
1967	26.7e	17.6e	28.1e	59.6e	73.3e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e
1968	68.5e	65.6e	69.2e	72.8e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	62.4e	45.5e	67.3e	73.1e	47.5e
1969	29.3e	40.0e	54.1e	61.6e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	70.6e	55.4e	54.3e	39.0e	21.0e	15.6e	11.3e
1970	18.7e	18.1e	15.3e	46.9e	73.1e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	74.0e	62.9e	34.9e	22.7e	17.1e
1971	60.6e	62.9e	73.2e	79.2	80.0	82.1	82.7	83.3	82.2	79.2	73.4	79.4	80.7e	63.7e	42.6e	72.7e	37.7e	22.7e
1972	32.5e	46.6e	76.6e	82.0e	82.0e	82.0e	82.0e	82.0e	82.0e	82.0e	82.0e	82.0e	77.0e	82.0e	69.4e	38.1e	28.7e	19.1e
1973	10.4e	7.2e	11.2e	50.8e	52.5e	77.4e	82.0e	82.0e	82.0e	81.8e	66.8e	81.7e	75.2e	38.1e	20.2e	10.8e	2.9e	0.0e
1974	44.4e	36.3e	77.1e	64.6e	80.4e	81.1e	81.1e	81.1e	81.1e	81.1e	78.6e	51.3e	30.1e	20.6e	16.8e	8.2e	1.0e	0.0e
1975	14.8e	30.5e	48.8e	81.4e	82.0e	82.0e	82.0e	82.0e	82.0e	82.0e	82.0e	68.2e	51.3e	19.3e	15.1e	9.8e	5.7e	4.5e
1976	58.4	44.3	70.9	82.3	81.2	84.8	84.6	83.1	80.7	79.7	73.2	48.7	42.3	58.7	74.5	64.8	35.6	22.0
1977	41.7e	52.9e	78.3e	89.6	88.3	89.7	88.6	83.6	81.4	78.8	81.0	81.7	85.3	85.6	89.2	91.7	92.2	76.9
1978	14.6e	21.4e	76.4e	87.3e	88.1e	88.6e	89.1e	89.6e	90.2e	90.7e	91.2e	91.7e	92.6	93.5	71.0	45.7	44.3	32.7
1979	68.2e	47.5e	57.4e	70.1e	86.0e	86.0e	83.7e	53.2e	50.2e	57.3e	59.8e	51.9e	81.3e	55.4e	26.8e	14.1e	8.6e	4.3e
1980	7.8	5.2e	27.9e	41.6	77.7	57.7e	72.1	57.4	71.5	53.1e	46.5e	46.9e	33.3e	21.7e	11.6e	2.3	0.0	0.0
1981	44.7	39.0	34.7	47.5	70.5	84.7	83.5	82.4	82.6	83.6	82.1	82.5e	76.7	63.5	41.6	28.8	23.0	23.4
1982	43.6	38.1	57.5	60.8	80.5	86.0	87.4	84.2	78.6	71.3	75.9	81.2e	85.2	87.3	89.1	89.6	83.4	62.4
1983	80.0	74.0	58.0	76.0	88.7	87.2	85.4	84.9	83.9	82.5	82.6	83.3	84.6	84.8	82.0	76.5	57.7	43.4
1984	41.7	63.1	45.8	60.3	76.5	79.6	74.5	64.5	74.3	75.0	71.0	64.1	42.9	30.1	23.7	17.6	9.1	5.3
1985	44.4	41.1	39.4e	61.8e	80.2e	80.5e	76.7e	71.5e	69.5	68.3	62.0	57.1e	49.0	36.2	20.2	18.0	12.6	5.7
1986	58.1e	87.2e	67.5e	72.0e	87.0e	83.6e	81.8	73.4	68.1	71.1	60.3	54.8	48.9e	29.2	11.6	6.8	4.4	8.0
1987	83.7	50.2e	38.4e	30.9e	30.1e	24.7e	26.8e	47.6e	69.9	71.6	72.7	69.7	71.3	68.3	28.1e	18.5e	13.1e	10.4e
1988	24.8e	24.6e	32.8e	37.7e	71.2	89.3	86.5	81.8	79.0	78.8	80.1	80.9	85.1	84.7	50.2	26.5	21.6	16.1
1989	27.0	17.0	16.0	33.8	51.9	28.3	44.4	75.7	75.8e	64.2	77.6	72.5	72.9	53.5	39.2	42.9	44.1	47.7
Mean	38.2	37.7	46.0	58.7	70.2	72.5	75.0	74.2	75.3	73.6	72.7	69.6	66.7	58.9	46.0	39.2	31.6	24.9
Maximum	83.7	87.2	78.3	89.6	88.7	89.7	89.1	89.6	90.2	90.7	91.2	91.7	92.6	93.5	89.2	91.7	92.2	76.9
Minimum	2.8	2.1	2.4	0.4	3.8	15.0	26.8	46.0	50.2	43.0	46.5	45.7	30.1	19.3	11.6	2.3	0.0	0.0

Note : Flag m - more than 2 daily values missing; Flag e - one or more daily values estimated or missing

10 Day Exceedance Flows - River Jubba Table M13

10 Day period		Lugh Ganana 80%	Lugh Ganana 50%	Lugh Ganana 20%	Jamamme 80%	Jamamme 50%	Jamamme 20%
	1	23.0	34.7	78.6	31.1	45.3	100.0
JAN	2	16.5	28.9	61.3	23.9	33.2	72.6
	3	12.3	21.9	53.8	15.1	29.1	54.8
	1	9.4	20.7	41.4	10.7	26.1	40.5
FEB	2	6.3	15.7	34.5	7.3	20.5	37.0
	3	5.6	12.3	33.4	4.3	15.5	25.0
	1	5.4	10.4	34.2	2.9	12.6	36.3
MAR	2	6.0	10.9	38.2	1.2	8.7	28.9
	3	5.8	11.2	57.1	1.7	9.8	35.9
	1	5.7	25.2	135.0	4.0	14.7	47.0
APR	2	46.5	119.9	193.9	4.6	35.5	167.5
	3	68.7	147.9	365.7	35.4	134.3	234.1
	1	98.6	196.3	395.2	62.7	158.2	393.6
MAY	2	139.9	239.9	405.0	91.8	241.6	412.2
	3	131.1	237.2	403.8	142.3	251.6	409.4
	1	116.9	200.4	353.0	117.7	195.2	387.3
JUN	2	96.4	166.1	260.2	92.6	180.0	308.7
	3	97.9	152.6	217.3	85.2	157.6	249.0
	1	105.5	182.3	217.0	86.7	140.9	218.3
JUL	2	135.6	173.4	253.7	99.7	155.5	259.9
	3	138.4	206.6	254.7	115.0	179.0	235.1
	1	163.1	205.0	256.7	136.1	182.1	245.2
AUG	2	156.1	225.7	327.0	152.2	205.1	261.7
	3	185.9	265.4	348.4	163.4	207.6	303.0
	1	158.8	282.7	348.5	161.0	245.8	318.9
SEP	2	172.5	272.6	387.2	160.5	234.9	347.8
	3	163.5	275.6	396.8	150.7	266.6	345.7
	1	208.7	290.0	383.8	161.1	245.4	354.0
OCT	2	225.5	415.0	600.9	212.5	325.9	405.1
	3	225.4	395.6	715.0	202.4	407.1	475.8
	1	220.1	340.4	464.3	208.8	391.1	472.4
NOV	2	167.6	228.1	389.5	194.5	313.5	447.5
	3	95.0	162.7	337.9	138.0	214.2	383.9
	1	73.1	106.7	224.2	82.6	145.5	311.5
DEC	2	50.9	72.7	144.3	58.4	96.1	223.6
	3	34.6	51.1	126.9	40.6	66.4	128.5

Flow values in cubic metres per second (cumecs)

10 Day Exceedance Flows - River Shebelli

Table M14

10 Day period		Beled Weyn 80%	Beled Weyn 50%	Beled Weyn 20%	Afgoi 80%	Afgoi 50%	Afgoi 20%
JAN	1	6.2	11.2	27.6	4.7	11.6	34.2
	2	4.3	9.7	23.9	3.5	9.4	29.4
	3	3.2	9.2	20.5	1.1	8.1	21.6
FEB	1	3.1	8.0	17.7	0.0	6.1	17.2
	2	2.9	8.4	17.4	0.0	5.2	15.0
	3	2.9	7.8	18.8	0.0	6.5	13.2
MAR	1	2.7	10.4	22.3	0.0	5.2	18.8
	2	2.9	10.4	35.8	0.0	2.5	26.9
	3	2.7	10.8	66.0	0.0	2.6	35.1
APR	1	4.5	18.4	73.0	0.0	7.5	48.3
	2	19.3	56.3	97.0	1.1	19.1	73.2
	3	33.9	96.9	143.0	26.7	50.4	82.4
MAY	1	51.0	90.4	212.5	33.6	69.2	90.7
	2	61.3	122.2	256.8	43.3	80.8	93.8
	3	77.4	123.1	206.6	50.9	83.2	96.5
JUN	1	38.8	74.1	183.5	45.0	76.5	92.6
	2	22.6	45.0	101.1	29.0	63.6	86.5
	3	19.0	33.8	64.2	15.3	40.5	68.9
JUL	1	16.9	40.3	64.2	15.8	35.9	60.7
	2	23.0	50.6	78.0	17.2	35.2	52.1
	3	42.6	62.0	99.6	24.8	44.4	70.9
AUG	1	65.7	86.4	108.8	41.3	62.6	81.5
	2	87.3	118.7	132.2	61.1	81.6	93.6
	3	104.3	138.3	173.6	75.5	92.0	96.5
SEP	1	90.8	149.0	191.0	72.8	91.9	97.5
	2	102.7	153.0	201.9	73.4	91.0	97.5
	3	95.4	145.8	201.7	70.1	90.6	97.1
OCT	1	87.6	121.0	194.8	68.1	87.4	95.3
	2	74.2	114.2	169.5	65.7	79.7	93.3
	3	61.6	105.1	186.4	52.8	78.7	94.5
NOV	1	42.5	86.2	189.7	44.2	79.1	92.8
	2	21.8	44.2	87.4	29.5	63.5	92.9
	3	16.4	31.0	90.5	19.4	41.2	77.1
DEC	1	11.9	23.5	62.6	14.3	31.6	72.6
	2	9.9	17.2	39.2	10.1	22.8	58.1
	3	7.8	12.7	35.2	6.2	17.5	44.1

Flow values in cubic metres per second (cumecs)

Monthly Exceedance Flow Values Table M15

River Jubba

	Lugh Ganana			Jamamme		
	80%	50%	20%	80%	50%	20%
January	17.2	28.5	65.8	24.7	34.4	75.1
February	6.5	16.3	36.8	7.6	21.8	32.6
March	7.0	13.0	48.1	2.0	12.2	34.4
April	48.8	123.0	221.7	11.8	74.7	167.2
May	118.2	269.8	435.2	106.4	237.4	341.1
June	103.2	169.0	274.6	97.5	176.7	323.1
July	135.1	196.2	242.8	115.3	151.9	226.3
August	174.6	231.8	310.6	154.2	215.2	263.5
September	173.1	271.6	352.1	179.6	247.6	333.1
October	228.9	372.1	569.9	208.0	306.2	394.3
November	169.9	233.4	421.3	172.6	308.1	424.8
December	53.5	76.0	158.6	61.4	103.3	229.0

River Shebelli

	Beled Weyn			Afgoi		
	80%	50%	20%	80%	50%	20%
January	4.5	10.0	24.4	3.7	9.0	29.7
February	3.4	9.2	19.7	0.0	5.1	13.8
March	3.3	11.3	51.2	0.1	3.1	25.8
April	25.6	57.6	99.6	13.3	26.2	60.7
May	66.8	118.9	205.5	43.0	75.1	91.8
June	26.1	56.2	111.1	32.0	59.7	81.6
July	28.7	54.2	78.4	20.3	41.9	57.0
August	88.7	123.4	129.2	59.9	79.3	90.1
September	102.8	153.8	192.0	72.3	90.9	97.7
October	79.5	110.0	177.8	68.1	82.1	93.5
November	27.8	53.6	115.6	30.7	62.2	86.3
December	10.2	17.8	47.2	10.5	25.8	57.7

All values in cubic metres per second (cumecs)