(1) Rainfall data

There are 66 unevenly distributed rainfall gauging stations in and around the Study Area, where the rainfall data are available for more than 5 years. The rainfall depth has been recorded continuously over 50 years at several rainfall stations located in the plantation area. However, there are frequent interruptions of the records at most of the rainfall stations The available period of the rainfall data at these stations are shown in Fig. C.2.

In the Study Area, the coverage of the rainfall stations is fairly good in the Uluguru Mountains area and in the hilly land of Ngerengere in the northwestern part of the Study Area. However, only a few stations exist in the floodplain area, which is in the southeastern part of the Study Area.

Considering the data availability and the location, 19 stations were selected for the hydrological analysis. The daily rainfall data at these 19 stations were collected and the monthly rainfall data of these stations were checked and revised.

(2) Meteorological data

There are only 4 meteorological stations in the Study Area to observe the data other than the rainfall. In general, the data are not available for the entire period since its installation due to interruption of the observation. The continuity of data at these meteorological stations are shown in Fig. C.2.

3.2 Hydrological Data

MWEM is responsible for the collection of hydrological data in Tanzania. Discharge data for stations on the major rivers are available in the Hydrological Year-Book and unpublished water level and discharge measurement data can also be obtained from MWEM. Most of the hydrological stations in the Study Area were established after 1950. Besides, the runoff observation at most of these stations have only interrupted. The availability of the hydrological data at these stations is shown in Fig. C.2.

4. METEOROLOGY

4.1 Rainfall

The climate of the Study Area can be classified as the tropical savannah type. While rainfall occurs throughout the year in the Study Area, it is extremely variable and undependable. The mean monthly rainfall is higher during the period of November to May than that of June to October and these periods are generally referred to as the wet season and dry season, respectively. In the northeastern part of the Study Area, the mean monthly rainfall during March to May is higher than that of November to December. The monthly rainfall data are summarized in Table C.6 and seasonal rainfall pattern at the several rainfall stations is shown in Fig. C.3.

Based on the rainfall data in and around the Ruvu River basin, the isohyetal map of mean annual rainfall is drawn as shown in Fig. C.4. Annual rainfall at low land and hilly districts

varies from 800 to 1,000 mm, and at the foot of the Uluguru Mountains it varies widely from 1,000 to 2,000 mm. More than 2,000 mm of annual rainfall is observed in the high mountainous areas.

4.2 Other Parameters

The meteorological data other than the rainfall data in and around the Ruvu River basin are summarized in Table C.7 and Fig. C.5.

(1) Temperature

The average seasonal pattern of temperature in the Study Area is shown below:

(Unit : °C)

Month	Mean Maximum	Mean Minimum	Mean
Jan.	32.0	22.1	26.9
Feb.	32.0	23.0	27.4
Mar.	31.8	22.2	27.5
Apr.	29.9	21.2	25.7
May.	29.4	20.8	25.4
Jun.	28.1	18.1	23.5
Jul.	27.6	17.0	23.0
Aug.	28.3	16.9	23.3
Sep.	30.2	18.4	24.7
Oct.	31.3	19.3	25.9
Nov.	31.9	21.1	26.9
Dec.	31.3	21.7	27.0
Annual	30.3	20.1	25.6

In general, the mean monthly temperature in the Study Area is higher during the period from October to April than from May to September. The temperature at the middle area with an altitude of 70 m to 200 m is expected to be higher than that of the other areas in the Study Area. The mean temperature in the upper, middle and lower part of the basin was estimated at about 24.5° C, 27° C and 25° C, respectively.

(2) Relative humidity

The monthly average relative humidity (%) in the Study Area was estimated as shown below:

(Unit : %)

Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
63	62	68	70	66	64	56	55	52	59	59	63

The mean annual relative humidity was estimated at 62%. In general, the mean monthly relative humidity is higher during the period from December to June than from July to November. The relative humidity at the middle area with an altitude of around 100m is expected to be higher than that at the other areas in the basin. The mean relative humidity in the upper, middle and lower parts of the basin was estimated at about 50%, 70% and 60%, respectively.

(3) Sunshine

The monthly average of sunshine duration (h/day) in the Study Area is shown below:

(Unit : hour/day)

Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
7.1	8.7	6.6	5.4	5.8	6.7	6.6	6.6	7.0	7.9	8.0	7.3

The mean annual duration of sunshine was estimated at 7.0 h/day. In general, the mean monthly duration of sunshine is higher during period from September to February than from March to August. A clear regional difference of sunshine duration was not found.

The average monthly solar radiation (l/day) in the Study Area is estimated below:

(Unit : l/day)

Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
15.8	17.3	15.5	13.8	12.6	13.0	11.5	13.0	14.9	15.9	16.4	15.7

The mean annual solar radiation was estimated at 14.6 l/day.

(4) Wind velocity

The average monthly wind velocity (m/sec) in the Study Area is shown below:

(Unit : m/sec)

Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1.8	1.7	1.2	0.8	0.8	0.9	1.1	1.3	1.5	1.7	1.7	1.8

The mean annual wind velocity was estimated at 1.4 m/sec. In general, the wind velocity during the period from September to February is higher than that of March to August. The wind velocity in the upper part of the basin was estimated to be higher than the other parts.

(5) Evaporation

The annual mean monthly evaporation (mm/day) in the Study Area is shown below:

(Unit : mm/day)

Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
5.09	5.94	5.29	4.04	3.69	4.00	3.65	4.20	5.24	5.94	5.98	6.59

The mean annual evaporation in the basin was estimated at 4.97 mm/day. In general, the mean monthly evaporation is higher during the period of September to March than from April to August.

5. HYDROLOGY

5.1 River System

(1) Drainage system in Tanzania

The main drainage basins of Tanzania are as follows:

1. Indian Ocean Drainage
2. Internal Drainage to the Lake Eyasi, Bubu Depression, etc.
3. Internal Drainage to Lake Rukwa
4. Atlantic Ocean Drainage (Lake Tanganyika)
5. Mediterranean Drainage (Lake Victoria)

The Indian Ocean Drainage basin can be divided into the following five main river basins from north to south as shown in Fig. C.6.

Pangani River
Wami River
Ruvu River
Rufiji River
Ruvuma River

(2) The Ruvu River basin

The Ruvu River basin is located in the Coast and Morogoro Regions and lies between 6°-05' and 7°-45' South Latitude, and 37°- 15' and 39°- 00' East Longitude. The catchment area of the basin is approximately 18,000 km^2 and it can be divided into the following five main drainage systems as shown in Fig. C.7:

The Mgeta River basin including the Msoro River basin,
The Ngerengere River basin,
Upper Ruvu River basin,
Middle Ruvu River basin and
Lower Ruvu River basin

Most of the basin is a rolling area overlooked by the Uluguru Mountains with the highest altitude of 2,634 m at the Kimtiandu hill. The catchment areas of those basins are summarized in Table C.8.

a. Upper Ruvu River basin

The Ruvu River originates at Kinazi in the Uluguru North Forest Reserve, 7 km southeast of Morogoro municipality. The Ruvu River drains toward southeast direction, joining its tributaries such as the Mfizigo, Kiroka, Mvuha rivers. The upper reaches of Ruvu River flows into a fairly narrow valley before confluencing with the Chamazi and then it enters the Mgeta plain.

b. The Mgeta basin

The Mgeta River originates at the center of the Uluguru Mountains, flows northward, turns to the west at Vinile, moves to the south at Yowe, and runs southward around the Uluguru Mountains to Kisaki joining with the Mbikana and other tributaries. Within this reach, the Mgeta River flows into a narrow valley with a steep slope on both banks, and it does not allow any important settlement. About 5 km from the confluence with the Mbakana, the Mgeta River enters into a vast flat plain lying at the south of Uluguru Mountains. The Msoro River originates at the Selous Game Reserve which is at the southwest corner of the Study Area. The Msoro River flows almost in parallel with Tazara Railway in the north eastward direction. The Msoro River collects flows of the Msogere and Rudete Rivers and other small streams from the left bank and confluences with the Mgeta River after Kisaki. After joining to the Mngazi, Msoro and Mgeta (Dutumi), the Mgeta River flows into the Ruvu at Mikula where the Mgeta plain is narrowed and the prospective Kidunda dam site is located.

c. The Middle Ruvu basin

The Ruvu River, after flowing towards Mikula and confluencing with the Mzenga River, enters into the floodplain. The low-lying right bank of the floodplain may be connected to the Rufiji basin in the event of extreme flooding therein and continue to the Selous Game Reserve area in the south.

d. The Ngerengere River basin

The Ngerengere River originates at the northern edge of the Uluguru Mountains and in the Uluguru North Forest Reserve located about 15 km south of Morogoro Municipality. The Ngerengere River enters into the Mindu Reservoir, after flowing a river course of about 11 km from its origin, where the Mkurenge River also joins the reservoir. The gentle flood plain spreads on the western and northern areas of Morogoro municipality. After joining to the Whaze, Labangolowe and other tributaries, the Ngerengere turns the direction towards southeast.

e. The Lower Ruvu River basin

Approximately 82 km long floodplain with some 10 km width extends along the lower Ruvu, downstream of the confluence with the Ngerengere River. There are two bottlenecks at the Railway Bridge and at the Morogoro Road Bridge and the upper river channels of these bottlenecks play a role of the storage function for flood during the rainy season. There are 8 tributaries with a catchment area of 100 to 200 km^2 on the right bank side of the Ruvu River and 6 tributaries with a catchment area of 300 to 900 km^2 on the left bank side. However, in general there are almost no flow in these tributaries in the dry season.

5.2 Rainfall Analysis

(1) Average rainfall in the Ruvu River basin

a. Total average rainfall in the Ruvu River basin

Correlation coefficient of monthly rainfall between the two stations was calculated. Each station has a correlation coefficient of more than 75 % with its neighboring stations. Especially a correlation coefficient of more than 95 % was found among the stations around Morogoro municipality and Ngerengere town.

Considering the location and data availability of stations, 19 stations were selected for the Study. Using mean monthly rainfall and the Thiessen Polygon method as shown in Fig. C.8, the total average rainfall in the Ruvu River basin was estimated as shown in Table C.9 and the seasonal rainfall pattern is shown in Fig. C.9.

b. Characteristic of rainfall in the subbasin

Using the same procedure as that mentioned above, the characteristics of rainfall in the subbasins mentioned in the foregoing Section 5.1 were analyzed as summarized in Table C.10 and Fig. C.10.

- Upper Ruvu River basin

The annual rainfall for the entire Upper Ruvu River basin is estimated to be approximately 1.5 times larger than that for the entire Ruvu River basin. Thus, this area is blessed with the large potential of water resources out of the Ruvu River basin and also the high rainfall in this area would be one of causes of the usual flood in the basin.

- Mgeta basin

The annual rainfall in the Mgeta River basin is almost same as the basin average rainfall for the entire Ruvu River basin. The mean monthly rainfall in the Mgeta River basin, especially during the dry season of September to October, is less than those in other subbasins and the same tendency is found in the rainy season of November to December. The rainfall in this area is one of the causes of the usual flood in the rainy season.

- Middle Ruvu River basin

The annual rainfall in the Middle Ruvu River basin is almost same as the basin average rainfall for the entire Ruvu River basin. The seasonal rainfall pattern in this area is slightly different from that of the other areas in view that the dry season starts in May, while the rainy season starts in October.

- Ngerengere basin

The annual rainfall in the Ngerengere basin is approximately 10 % less than the average rainfall in the entire Ruvu River basin. In the dry season, the amount of monthly rainfall of this area is almost same as that of the entire Ruvu River basin, while it is less than that of the entire Ruvu River basin during the rainy season.

- Lower Ruvu River basin

The annual rainfall in this area is almost same as that of the Ngerengere River basin. The mean monthly rainfall in this area in January and February is lower than that of the other months in the rainy season. Therefore, two rainy seasons and dry seasons are identifiable from the seasonal rainfall pattern in this area.

c. Rainfall in the unit basin

The Ruvu River basin was divided into 21 unit basins as shown in Fig. C.11 for understanding the runoff characteristics of the basin. The mean monthly rainfall in each of the unit basins was estimated using the aforesaid procedure as summarized in Table C.11.

d. Rainfall in the catchment area covered by hydrological station

The mean monthly rainfall in the catchment area covered by each of the hydrological stations was also estimated using the aforesaid procedure. The results are summarized in Table C.12 and Fig. C.12.

(2) Frequency Analysis

Based on the daily rainfall data at the 19 stations, the frequency analysis on the following items were carried out:

- Annual rainfall (probability of non-exceedance)
- Maximum 24hourr rainfall (probability of exceedance)
- Maximum 3 days rainfall (probability of exceedance)
- Consecutive non-rain days (less than 0.1 mm/day, probability of exceedance)
- Consecutive non-rain days (less than 0.5 mm/day, probability of exceedance)

The results are shown in Table C.13.

5.3 Runoff Analysis

(1) Calibration of rating curve

The stage-discharge rating curves (H-Q curve) at the selected 11 stream gauging stations were constructed based on the discharge measurement data and river cross section data. The results are shown in Table C.14.

It was confirmed that the discharge measurement data at 1H8 does not include the discharge flowing down through the existing 10 culverts which were installed on the right bank of the Morogoro Road Bridge. It means that the rating curve of 1H8 shows only discharge flowing down through the Ruvu Bridge. Therefore, in case of the high water level, it is necessary to consider the discharge flowing down through the culverts in the high river stage.

The report on conclusion on the culvert discharge, written by H.C.L. Moller, states that it was difficult to measure the culvert discharge since the flowing velocity inside the culvert was high. Furthermore, the culvert discharge varied depending on the difference of water head between upper and lower sides of the culvert, and there were no data on water level of the both sides.

The total culvert discharge was roughly estimated as shown Fig. C.13 using a few data and the section and elevation of the culverts, and the gauging height at 1H8. The equation used is shown below:

$Q = -8.23 + (H-6.00)^{154.34}$ (if $Q<0$ then $Q=0$)
where Q : Total culvert discharge (m^3/sec)
H : Stage height at 1H8 (m)

Using the above equation and mean daily gauging height, the river discharge for high flow was recalculated.

(2) Estimation of rating curve at new stream gauging stations

The Kidunda (1H3) and Utari Bridge (1HA1A) stations were moved to 20 m downstream of the previous sites. Besides, the Mafisi and Dutumi stations were newly installed. Therefore, it is necessary to estimate the new rating curves for these stations.

The rating curve for each of the new stations was estimated as shown in Fig. C.14, considering the river section and estimated river slope and using the uniform flow calculation formula. The discharge measurement data in 1993 are plotted in the Figure. The equation and the estimated basic dimensions are summarized below:

Dutumi station — estimated roughness, n=0.04; estimated river slope, I=1/550

$Q=9.068 \times (H+0.30)^{1.962}$
where, Q : River discharge (m^3/sec)
H : Gauging height (m)

Utari Bridge station — estimated roughness, n=0.04; estimated river slope, I=1/2500

$Q=0.746 \times (H+0.27)^{2.622}$

Kidunda station — estimated roughness, n=0.04; estimated river slope, I=1/4000

$Q=4.931 \times (H+0.37)^{2.518}$

Mafisi station

estimated roughness, n=0.04

estimated river slope, I=1/8000

$Q=2.126 \times (H+0.69)^{2.659}$

Concerning the above equations, the discharge measurement data of high flow applied to construction thereof are insufficient at all. Therefore, in the next study stage it is necessary to carry out the discharge measurement during the flood in order to accurately estimate discharge at the high river stages.

(3) Estimation of long-term runoff

The daily water levels were converted into discharge using the stage-discharge rating curve. The results are shown in Table C.15 and Fig. C.15. They are summarized below:

Station No.	Catchment Area (km^2)	Mean Discharge (m^3/sec)	Annual Runoff Depth (mm/year)	Annual Rainfall (mm/year)	Runoff Coefficient (%)
1H2	12,488	74.7	189	1,132	16.7
1H3	6,697	57.8	272	1,291	21.1
1H5	420	18.5	1,388	2,620	53.0
1H8	15,190	61.1	127	1,099	11.5
(1H8*)	15,190	65.1	135	1,099	12.3
1H10	5,870	50.2	269	1,342	20.1
1HA1A	2,840	4.3	48	970	5.0
1HA15	2,370	4.7	63	974	6.5
1HB1	963	6.3	207	1,080	19.2
1HB2	101	2.5	768	1,333	57.6
1HC2	251	9.0	1,131	2,057	55.0

Note : * ; Include the culvert discharge.

The relationship between catchment area and runoff is shown in Fig. C.16.

(4) Characteristics of runoff in the Ruvu River basin

The runoff coefficient at the selected stream gauging stations was estimated based on the mean monthly rainfall and discharge as shown in Table C.16. The relationship between catchment area and annual runoff ratio is shown in Fig. C.16.

Since the rainfall amount in March and April is higher than that in May, the amount of runoff also becomes higher during the period. In the Lower Ruvu basin, though the amount of the rainfall in June is less than 30% of that in May, the amount of runoff in June is more than 30% of that in May. When the rainy season starts in November, the runoff also occurs immediately after the rainfall. In general, there is a big storage function in the Ruvu River basin for large amount of rainfall.

The average runoff coefficient in the entire Ruvu River basin was estimated at 12%, which comes to approximately 2,100 million m^3 in annual yield of water in the basin .

- Upper Ruvu and Mgeta basin

Considering the conditions of rainfall, vegetation, topography and others in the basin, approximately 50 % of annual rainfall is expected to result in runoff in the mountain side. However, it appears that a large amount of water loss, due to evaporation, infiltration and others, takes place in the floodplain with an area of more than 1,500 km^2, extending in an altitude of 100 m to 200 m a.s.l in the lower part of these basins. Therefore, the runoff coefficient would be less than 20 %, which is equivalent to annual yield of 1,600 million m^3.

- Middle Ruvu basin

In the upper part of the confluence with the Mkulazi River, the runoff ratio is not so different as that for the entire runoff coefficient of the Upper Ruvu and Mgeta basin. The annual yield at Mikula would be 1,600 million m^3. However, as there is floodplain in lower part of this basin some amount of water loss may be expected.

- Ngerengere basin

There is also floodplain in the middle part of the Ngerengere basin. As the river length is comparatively large with gentle slope, large amount of water loss would take place. Furthermore, around 5% of runoff coefficient is estimated for annual rainfall of less than 1,000 mm. Only 140 million is expected as annual yield of water.

- Lower Ruvu basin

The hydrologic conditions of the tributaries in the Lower Ruvu basin are quite similar to the condition of the Ngerengere River basin. Around 5% of runoff coefficient was estimated for annual rainfall of around 950 mm. Though a total catchment area of these tributaries is more than 6,000 km^2, only around 250 million m^3 is expectable as the annual water yield. Especially in the dry season, no water flow was observed in those rivers except the Ruvu mainstream.

In the Ruvu River, there are two bottlenecks at the Railway Bridge and Morogoro Road Bridge which are the main control points for streamflow of the Ruvu. Approximately 20 km long floodplain with about 10 km width extends along the Ruvu River between these bottlenecks. In the rainy season, the peak of the flood is cut through the storage function in the upper part of these bottlenecks. In the dry season, however, more than 20 % of water loss would take place. The annual yields at the Railway Bridge and Morogoro Road Bridge were estimated to be 2,300 million m^3 and 1,900 million m^3, respectively. Therefore, approximately 15% of annual water loss is estimated to take place between these bottlenecks.

Based on the complete discharge data, The mean daily discharges of 90% and 95% firmness at the stream gauging stations 1H8, 1H10 and 1HA1A were estimated by the series method as shown below:

Station Code No.	90% firmness (m^3/sec)	95% firmness (m^3/sec)	Years of complete data
1H8	11.00	9.06	21
1H10	10.37	8.60	8
1HA1A	0.067	0.021	7

(5) Frequency Analysis

Based on the long-term runoff data at the aforesaid stream gauging stations, the frequency analysis was carried out for the following items. The results are shown in Table C.17.

- Annual mean discharge (probability of non-exceedance)
- Annual minimum discharge (probability of non-exceedance)
- Annual maximum discharge ((probability of exceedance)

(6) Low flow analysis

a. Low flow analysis model

Based on the monthly rainfall and discharge and using the Tank model method, the low flow analysis models for the steam gauging stations 1H5, 1H8, 1H10 and 1HA1A were constructed as shown in Table C.18 and Fig. C.17. The comparison between the observed discharge and the simulated discharge is shown in Fig. C.18.

b. Low flow analysis for promising dam sites

Applying the monthly rainfall and actual discharge data to the Tank mode, the monthly runoff at the following dam sites were estimated for 40 years of 1950 to 1989. The results are shown in Table C.19.

	Name	Catchment Area (km^2)	Used Model
1.	Rudete	246.8	Tank model for 1H5
2.	Ngerengere	2,809.3	Tank model for 1HA1A
3.	Mkombezi	602.9	Tank model for 1HA1A
4.	Mgeta	938.7	Tank model for 1H5
5.	Kidunda	5,760.9	Tank model for 1H10

(7) High flow analysis

The Ruvu River basin was divided into 21 unit basins for the establishment of high flow analysis model as shown Fig. C.11. The daily rainfall of 21 unit basins was estimated using the Thiessen polygon method as shown in Fig. C.8.

A high flow analysis model was made using the storage function model and daily rainfall data as shown in Fig. C.19. The coefficients were determined based on the actual floods in 1968, 1973 and 1974. (The flood in 1979 was the biggest flood at 1H8 in the observation period. However, the rainfall and discharge data were not available for the analysis.) The comparison between the observed discharge and simulated discharge is shown in Fig. C.20 and the determined coefficients are shown in Table C.20.

Based on the daily rainfall pattern in 1974, the flood pattern of return period of 5, 10, 20, 50, 100 and 200-year at 1H10 and 1H8 were estimated as shown in Fig. C.21.

The flood pattern in case of its peak cut utilizing the surcharge volume of the reservoir of Kidunda dam was analyzed for the 5-year probabile flood at 1H8 as shown in Fig. C.22 and its results are summarized below:

	Maximum Spill Out Discharge (m^3/sec)	Total Surcharge Volume (Million m^3)	Peak Discharge at 1H8 (m^3/sec)	Remark
Case 1	-	-	610	(without Dam)
Case 2	100	483	250	(with Dam)
Case 3	150	308	300	(- do -)
Case 4	200	203	350	(- do -)

The peak flood discharge of 5, 10, 20, 50 100 and 200-year return period at the dam sites were estimated based on the results of the storage function model analysis. The results are shown in Table C.21.

The hydrograph of 20, 50 and 100-year return period at the dam sites was also estimated as shown in Fig. C.23.

5.4 Sediment Analysis

Based on the suspended sediment data, relation between mean daily discharge and suspended sediment were analyzed as shown Fig. C.24. The equations derived through the analysis are shown below:

No.	Name of River/Location	Catchment Area (km^2)	Rating Formula of Suspended Sediment Load
1	Ruvu (1H8, Morogoro Road bridge)	15,190.0	$Qs = 33.06 \times Q^{1.424}$
2	Ruvu (1H10, Mikuda)	5,870.0	$Qs = 61.30 \times Q^{1.281}$
3	Kikundi	4.4	$Qs = 232.65 \times Q^{2.066}$

Note: Variables in above rating formula of suspended load
Qs : Daily yield of Suspended load in ton/day
Q : Mean daily discharge in m3/sec

Using these equations, the daily sediment transport was estimated based on mean daily discharge data at 1H8 and 1H10. The results are summarized in Table C. 22. The sediment

yields at 1H8 and 1H10 were estimated at about 200 and 400 $m^3/km^2/year$, respectively. However, the sampling periods of these sediment data are a little bit old and the number of the data is insufficient. Considering these conditions as well as the change of the hydrologic condition in the basin, it is necessary to carry out more intensive water sampling for suspended load analysis in the next study stage.

6. RECOMMENDATION

6.1 Improvement of Data Observation System

(1) Installation of meteorological station

There are a few meteorological stations in and around the Ruvu River basin. For further detail study in future, it is recommended to install new meteorological stations in the basin. Considering the location of the existing stations, the new stations should be installed around Dutumi, Kidunda, Mafisi, Chalinze and Bagamoyo.

(2) Continuous observation of river water level

As there are many missing water level data at the key stations in the Ruvu River basin after 1980, it is recommended to observe the river water level at the key stations continuously. Considering the future development of water resources in the Ruvu River basin, the following stations should be given the priority:

No.1	1H8	Morogoro Road Bridge
No.2	1H3	Mikula
No.3	-	Mafisi
No.4	-	Dutumi
No.5	1H5	Kibungo
No.6	1H10	Kidunda
No.7	1HA1A	Utari Bridge

The automatic water level recorders were installed in 1993 at all the above stations except 1H10. The continuous maintenance for those stations is required at least once every three months.

(3) Continuous discharge measurement at the key stations

It is recommended to measure the river discharge at the key stations in the rainy and dry seasons every year for checking the accuracy of the existing H-Q rating curve or modification thereof if necessary.

(4) Sampling of sediment data

It is recommended to make the intensive sediment sampling when the discharge measurement is carried out for further detail analysis in the next study stage.

(5) Discharge measurement for the culverts at 1H8

Regarding existing stream gauging station 1H8, it is recommended to measure the discharge flowing down through the culverts which exist on the right bank of the Morogoro Road Bridge. However, the discharge measurement at the culverts is very difficult since the flow velocity in the culvert is so high. One way to estimate the culvert discharge is to carry out the hydraulic analysis based on the difference of water head between upper and lower sides of culvert. Therefore, the water level of both sides of the culvert and gauging height should be observed at flood time. Using these data, the relation between the gauging height at 1H8 and culvert discharge can be estimated more accurately.

6.2 Renewal of Simple Data Base

It is recommended to store the additional meteo-hydrological data in the data base after collection of new data. In this Study, approximately 40 Mb of memory was used for the simple data base and still 160 Mb of user memory is usable. Therefore the meteo-hydrological data in the Ruvu River basin for more than 50 years can be stored therein.

APPENDIX-C

TABLES

Table C.1 LIST OF RAINFALL GAUGING STATIONS

Ser. No.	CODE No.	LATITUDE	LONGITUDE	ALTITUDE (m)	NAME OF STATION	PERIOD OF DATA COLLECTED	
1	9637000	6°51'S	37°40'E	500	Morogoro Agri. Station	1905	1990
2	9637002	6°46'S	37°42'E	500	Tungi Sisal Estate	1932	1989
3	9637011	6°45'S	37°48'E	460	Kingolwira Prison Farm	1935	1989
4	9637012	6°47'S	37°49'E	460	Pangawe Sisal Estate	1938	1970
5	9637015	6°45'S	37°46'E	460	Kingolwira Sisal Estate	1938	1989
6	9637017	6°58'S	37°31'E	580	Melela	1938	1966
7	9637020	6°57'S	37°43'E	990	Tegetero Mission	1938	1984
8	9637025	6°56'S	37°36'E	640	Tangeni Mission	1940	1988
9	9637041	6°57'S	37°49'E	370	Mkuyuni	1952	1989
10	9637045	6°57'S	37°38'E	1,120	Mondo	1954	1989
11	9637046	6°54'S	37°40'E	1,450	Morningside Farm	1954	1989
12	9637047	6°59'S	37°34'E	740	Hobwe	1954	1990
13	9637048	6°55'S	37°38'E	880	Luhungo	1954	1989
14	9637049	6°58'S	37°35'E	880	Kwandewa Masa	1954	1989
15	9637051	6°58'S	37°20'E	590	Mlali	1956	1989
16	9637052	6°49'S	37°39'E	510	Morogoro Water Department	1956	1989
17	9637053	6°54'S	37°59'E	520	Mfumbwe	1957	1974
18	9637054	6°57'S	37°33'E	610	Mlali Irrigation Scheme	1957	1976
19	9637062	6°50'S	37°42'E	610	Morogoro Tecnical T.C.	1964	1973
20	9637069	6°50'S	37°38'E	500	Mafiga Sisal Estate	1967	1978
21	9637070	6°46'S	37°39'E	580	Kihonda Sisal Estate	1967	1989
22	9637076	6°50'S	37°39'E	530	Morogoro Meteo. Station	1970	1989
23	9638000	6°25'S	38°55'E	3	Bagamoyo Agri. Station	1892	1989
24	9638001	6°47'S	38°07'E	210	Ngerengere Agri. Campany	1921	1988
25	9638002	6°48'S	38°43'E	250	Ruvu Sisal Estate	1922	1969
26	9638003	6°50'S	38°52'E	160	Alavi Sisal Estate	1922	1989
27	9638005	6°28'S	38°19'E	240	Lugoba Mission	1933	1990
28	9638008	6°47'S	38°10'E	210	Athina Sisal Estate	1934	1990
29	9638010	6°47'S	38°14'E	230	Fatemi Sisal Estate	1934	1976
30	9638013	6°47'S	38°08'E	210	Mgudeni Sisal Estate	1938	1967
31	9638017	6°48'S	38°06'E	210	Kiwege Sisal Estate	1938	1967
32	9638018	6°15'S	38°51'E	3	Utondwe Salt Works	1943	1987
33	9638019	6°45'S	38°01'E	270	Kinoko Sisal Estate	1950	1965
34	9638020	6°25'S	38°51'E	3	Bagamoyo Salt Works	1949	1990
35	9638022	6°54'S	38°18'E	150	Kikondeni Sisal Estate	1951	1979
36	9638023	6°35'S	38°55'E	60	Chambezi Coast A. Company	1953	1990
37	9638027	6°50'S	38°58'E	150	Kibaha Farmers	1964	1985
38	9638028	6°37'S	38°05'E	300	Ubena Prison Camp	1965	1985
39	9638031	6°38'S	38°09'E	250	Kate Sisal Estate	1966	1973
40	9638033	6°37'S	38°10'E	250	Ubena Zomozi	1966	1989
41	9638034	6°38'S	38°20'E	220	Chalinze Catholic Mission	1967	1990
42	9638035	6°14'S	38°42'E	3	Wami Railway Station	1964	1984
43	9638036	6°47'S	38°49'E	100	Zegereni State Farm	1970	1985
44	9638038	6°45'S	38°45'E	250	Ruvu National Farm	1967	1990
45	9737000	7°23'S	37°48'E	90	Duthumi Estate	1931	1986
46	9737005	7°15'S	37°43'E	460	Singiza Catholic Mission	1935	1989
47	9737006	7°05'S	37°46'E	390	Motombo Mission	1938	1989
48	9737008	7°28'S	37°36'E	180	Kisaki	1899	1980
49	9737009	7°03'S	37°58'E	170	Tununguo Mission	1938	1967
50	9737011	7°13'S	37°33'E	610	Kikeo Mission	1941	1976
51	9737013	7°07'S	37°36'E	1,680	Kienzema Mission	1950	1983
52	9737014	7°12'S	37°51'E	130	Mvuha	1950	1989
53	9737015	7°02'S	37°37'E	1,280	Bunduki	1907	1989
54	9737016	7°04'S	37°35'E	1,100	Mizungu Megeta	1951	1986
55	9737017	7°04'S	37°46'E	320	Mtamba	1951	1987
56	9737019	7°16'S	37°44'E	340	Bwakira Jun	1952	1981
57	9737021	7°48'S	37°55'E	100	Stiegler's Gorge	1961	1989
58	9737024	7°04'S	37°41'E	980	Kibungo Mission	1957	1976
59	9737025	7°06'S	37°33'E	1,500	Kibuko Coffee Plot	1959	1987
60	9737026	7°01'S	37°48'E	270	Kibungo	1956	1990
61	9737027	7°27'S	37°45'E	150	Bwakira Estate	1956	1989
62	9737028	7°02'S	37°44'E	460	Tawa Helth Center	1963	1989
63	9738002	7°12'S	38°47'E	360	Maneromango U. P. School	1936	1990
64	9738008	7°16'S	38°18'E	90	Kidunda Village	1956	1969
65	9738009	7°01'S	38°19'E	90	Ng'hesse	1956	1990
66	9738014	7°03'S	38°58'E	300	Sungwi Primary School	1965	1971

Table C.2 LIST OF METEOROLOGICAL STATIONS

Ser. No.	CODE	LATITUDE	LONGITUDE	ALTITUDE (m)	NAME OF STATION	PERIOD OF DATA COLLECTED		OBSERVATED METEO-PARAMETER							
								Tmx	Tmn	Tm	Rh	Sh	Ra	Wv	Ep
1	9637076	6° 50'	37° 39'	530	Morogoro Mete-Station	1971	1992	●	●		●	●	●	●	●
2	9638027	6° 50'	38° 58'	150	Kibaha Farmers	1974	1992	●	●		●	●	●	●	●
3	9000064	7° 15'	38° 15'	80	Mikura	1970	1973			●	●	●	●	●	●
4	-	6° 25'	38° 53'	5	Experimental Farm (JICA)	1990	1992	●	●	●	●	●	●	●	

Note : Tmx - Max. Temperature Sh - Sun Shine
Tmn - Min. Temperature Ra - Solar Radiation
Tm - Mean Temperature Wv - Wind Velocity
Rh - Relative Humidity Ev - Evaporation

Table C.3 LIST OF HYDROLOGICAL STATIONS

Ser. No.	River Name	Station Code	Location			Altitude (m)	Catchment Area (km2)	Obsevation Period	
			Name	Latitude	Longitude			Established	Closed
1	Ruvu	1H2 *	Ruvu Sisal Estate	6° 48'S	38° 39'E	27	12,488	Aug. 1950	Jun. 1959
2	Ruvu	1H3 *	Kidunda	7° 16'S	38° 18'E	76	6,697	Aug. 1951	Oct. 1963
3	Ruvu	1H5 *	Kibungo	7° 1'S	37° 48'E	473	420	Oct. 1952	Cont.
4	Ruvu	1H8 *	Ruvu Bridge	6° 41'S	38° 41'E	15	15,190	Nov. 1958	Cont.
5	Ruvu	1H10*	Mikula	7° 18'S	38° 10'E	80	5,870	Nov. 1965	Cont.
6	Ngerengere	1HA1A*	Utari Bridge	7° 2'S	38° 22'E	90	2,840	Oct. 1950	Cont.
7	Ngerengere	1HA3	Kingolwira	6° 45'S	37° 48'E	425	690	Sep. 1950	Oct. 1963
8	Ngerengere	1HA4	Kilimanjero	6° 46'S	37° 42'E	457	630	Apr. 1953	Oct. 1959
9	Ngerengere	1HA5*	Kiluwa	6° 44'S	38° 6'E	198	1,646	Nov. 1953	Aug. 1967
10	Ngerengere	1HA6	Kihonda	6° 47'S	37° 39'E	466	461	Sep. 1950	Oct. 1963
11	Mlali	1HA7	Mlali	6° 58'S	37° 32'E	518	18.1	Oct. 1953	Oct. 1963
12	Morogoro	1HA8	Morogoro	6° 51'S	37° 40'E	543	23.3	Mar. 1954	Cont.
13	Ngerengere	1HA9	Konga	6° 54'S	37° 37'E	530	20.5	Apr. 1954	Mar. 1960
14	Ngerengere	1HA9A	Konga	6° 54'S	37° 37'E	530	20.5	Nov. 1962	Cont.
15	Ngerengere	1HA10	Mgera	6° 56'S	37° 34'E	518	15.4	Apr. 1954	Oct. 1963
16	Ngerengere	1HA15*	Mgude	6° 48'S	38° 9'E	95	2,370	Oct. 1968	Dec. 1975
17	Msoro	1HB1*	Kisaki	7° 28'S	37° 42'E	152	963	Nov. 1950	Dec. 1962
18	Mgeta	1HB2*	Mgeta	7° 2'S	37° 34'E	975	101	Jun. 1954	Cont.
19	Mgeta	1HB3	Bunduki	7° 2'S	37° 37'E	1,220	46.0	Jun. 1954	1962
20	Mgeta	1HB4	Luhuela	7° 1'S	37° 38'E	1,493	5.0	Dec. 1954	1963
21	Mvuha	1HC2*	Mvuha	7° 12'S	37° 51'E	274	251	Apr. 1954	Cont.

Note * : Stations selected for the Study

Table C.4 LIST OF WATER LEVEL MEASUREMENT STATIONS WITH NEWLY INSTALLED WATER LEVEL RECORDERS

Ser. No.	River Name	Station Number	Location			Altitude (m)	Catchment Area (km2)	Remark
			Name	Latitude	Longitude			
R-1	Ruvu	1H8	Ruvu Bridge	6° 41'S	38° 41'E	15	15,190	Re-installed by MWEM
A-1	Ruvu	-	Mafisi	6° 59'S	38° 33'E	40	11,407	Newly installed by JICA
A-2	Ruvu	1H3	Kidunda	7° 16'S	38° 18'E	76	6,697	Newly installed by JICA
A-3	Ngerengere	1HA1A	Utari Bridge	7° 2'S	38° 22'E	90	2,840	Newly installed by JICA
A-4	Mgeta	-	Dutumi	7° 24'S	37° 46'E	160	3,201	Newly installed by JICA
R-2	Ruvu	1H5	Kibungo	7° 16'S	38° 18'E	473	420	Re-installed by JICA

Table C.5 RESULT OF DISCHARGE MEASUREMENT

Station Code	Site	Date			Gaug. H (m)	Area (m2)	Mean V (m2/s)	Discharge (m3/s)
		Year	Month	Day				
1H5	Kibungo	93	5	26	1.11	31.078	0.755	23.462
		93	5	27	1.04	22.983	0.775	17.812
		93	10	23	0.51	15.439	0.296	4.574
		93	10	25	0.51	15.635	0.293	4.584
1H8	Ruvu Bridge	93	5	8	6.85	427.565	0.976	417.303
		93	5	9	6.74	423.350	0.831	351.804
		93	5	10	6.64	406.700	0.860	349.762
		93	5	12	6.72	436.250	0.799	348.564
		93	5	13	6.65	411.950	0.821	338.211
		93	5	14	6.55	374.225	0.804	300.877
1H3A	Kidunda	93	7	19	1.28	55.540	0.422	23.438
		93	7	18	1.28	56.945	0.431	24.543
		93	10	27	0.74	22.439	0.269	6.039
		93	10	28	0.73	22.631	0.247	5.583
-	Mafisi	93	7	22	1.62	65.910	0.352	23.200
		93	7	23	1.62	65.750	0.374	24.591
		93	11	3	1.03	40.810	0.248	10.138
		93	11	5	1.00	41.522	0.227	9.436
1HA1B	Utari Bridge	93	6	7	1.97	10.512	0.585	6.150
		93	6	8	1.94	10.790	0.565	6.096
		93	10	26	0.47	1.223	0.275	0.336
		93	10	28	0.47	1.198	0.275	0.329
1HB2	Mgeta	93	5	28	0.49	5.565	0.599	3.333
		93	5	29	0.49	5.728	0.568	3.254
-	Dutumi	93	5	2	2.70	72.525	1.047	75.934
		93	5	3	3.46	113.355	1.106	125.371
		93	10	23	0.30	4.913	0.441	2.168
		93	10	25	0.30	5.264	0.391	2.059
1HC2	Mvuha	93	5	29	0.72	21.010	0.575	12.081
		93	5	30	0.68	21.210	0.547	11.602

Table C.6 SUMMARY OF RAINFALL DATA

No.	CODE No.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
1	9637000	100	90	152	214	101	24	14	11	16	32	63	105	900
2	9637002	124	84	123	136	56	18	14	10	14	41	46	107	772
3	9637011	122	108	140	144	60	17	14	10	19	40	68	87	835
4	9637012	112	118	148	169	76	26	24	26	24	58	91	116	1,004
5	9637015	115	95	132	127	65	18	17	17	21	43	70	101	830
6	9637017	90	108	156	192	53	5	1	3	10	22	40	56	738
7	9637020	210	185	346	557	298	117	104	100	119	154	225	239	2,704
8	9637025	133	110	182	354	182	23	18	13	27	58	111	98	1,305
9	9637041	185	154	244	321	149	45	43	36	46	90	134	192	1,669
10	9637045	184	170	321	622	350	101	73	83	112	188	276	217	2,693
11	9637046	149	135	255	506	307	101	83	79	92	143	195	191	2,298
12	9637047	125	120	179	248	104	16	10	7	21	48	85	106	1,091
13	9637048	88	78	139	234	119	27	14	18	22	104	81	99	1,054
14	9637049	142	131	177	277	103	24	13	14	29	59	103	104	1,187
15	9637051	121	99	151	220	67	20	13	3	17	36	70	99	885
16	9637052	98	86	109	183	61	14	12	6	11	28	56	100	752
17	9637053	166	173	250	304	124	48	68	46	80	100	186	230	1,661
18	9637054	98	84	131	215	50	6	10	3	10	27	63	68	777
19	9637062	92	114	160	247	119	26	37	21	45	47	94	132	1,101
20	9637069	102	68	101	185	78	12	32	9	24	14	60	121	768
21	9637070	118	80	123	141	63	11	10	6	12	26	66	117	730
22	9637076	116	80	130	179	94	19	15	8	13	33	72	123	877
23	9638000	78	66	103	236	184	43	31	29	28	50	84	108	1,031
24	9638001	78	83	131	174	80	16	13	15	28	60	70	82	847
25	9638002	66	83	152	221	112	24	15	14	27	68	101	74	972
26	9638003	72	79	175	263	116	21	13	14	24	55	108	113	1,069
27	9638005	92	82	139	186	130	23	23	20	35	68	104	99	1,019
28	9638008	101	84	154	196	99	22	12	19	38	61	92	95	970
29	9638010	99	83	136	208	101	18	15	21	30	60	93	91	956
30	9638013	88	105	151	186	100	14	9	16	24	58	80	84	919
31	9638017	104	90	150	199	94	20	13	17	25	61	88	91	952
32	9638018	60	59	85	156	124	25	27	16	31	69	99	143	915
33	9638019	97	113	119	178	85	13	8	12	14	100	105	218	1,083
34	9638020	70	55	83	189	171	39	29	29	24	59	83	117	951
35	9638022	116	92	151	223	99	21	14	15	36	60	97	94	1,010
36	9638023	77	67	123	274	176	40	31	23	34	70	110	115	1,135
37	9638027	57	69	150	223	127	28	24	17	27	68	94	105	992
38	9638028	117	89	190	205	98	34	19	15	49	100	133	119	1,074
39	9638031	109	79	130	194	117	26	13	15	41	34	67	112	887
40	9638033	85	69	141	164	103	28	10	21	31	36	122	105	920
41	9638034	81	56	131	162	96	21	10	15	30	59	105	94	867
42	9638035	88	45	108	168	104	39	32	22	31	63	61	157	883
43	9638036	92	64	141	218	119	17	13	16	19	59	84	105	957
44	9638038	94	62	167	219	124	28	13	8	31	80	107	110	1,005
45	9737000	129	121	206	258	112	28	13	9	20	33	84	100	1,117
46	9737005	159	158	286	429	189	42	24	17	32	46	120	143	1,632
47	9737006	216	187	311	312	160	62	63	63	67	101	172	218	1,940
48	9737008	117	88	192	262	172	31	12	19	16	27	62	60	1,052
49	9737009	162	139	263	330	166	25	25	28	125	73	106	157	1,580
50	9737011	154	158	234	329	137	24	12	8	11	27	86	133	1,325
51	9737013	171	160	213	318	117	35	20	8	23	41	111	174	1,400
52	9737014	142	132	214	247	102	23	16	25	37	54	88	114	1,216
53	9737015	175	152	281	368	146	33	24	41	80	165	295	264	2,075
54	9737016	119	137	167	258	58	9	8	7	22	47	92	127	1,052
55	9737017	176	174	426	300	147	52	56	40	56	121	131	221	1,958
56	9737019	128	147	236	362	133	50	29	31	27	40	87	122	1,319
57	9737021	114	94	144	182	84	21	10	7	12	31	54	120	952
58	9737024	275	189	309	370	139	44	58	76	130	235	327	378	2,513
59	9737025	171	183	226	300	127	25	17	5	29	39	103	168	1,495
60	9737026	208	168	260	331	128	53	36	32	45	96	140	214	1,736
61	9737027	114	113	187	241	107	36	31	13	26	51	89	84	1,077
62	9737028	168	164	281	384	179	70	73	91	95	139	207	219	2,043
63	9738002	94	88	156	214	100	21	11	13	21	58	104	97	915
64	9738008	116	102	155	217	61	25	8	19	23	81	92	113	973
65	9738009	74	68	117	157	89	16	7	11	21	65	92	91	818
66	9738014	79	93	157	311	143	28	49	21	71	67	205	94	1,348

Table C.7 SUMMARY OF METEOROLOGICAL DATA

MONTH	TMAX. ℃	TMIN. ℃	TMEAN ℃	RH %	SUNH hr/day	RAD l/day	WINDV m/s	EVAP mm/day
Morogoro Agromet. Station				ALTITUDE	506 m			
JAN.	31.7	21.0	26.4	54.1	7.3	16.8	2.5	5.68
FEB.	32.1	21.2	26.6	52.1	7.9	18.4	2.3	6.70
MAR.	31.6	21.2	26.4	56.8	6.9	15.5	1.7	5.50
APR.	29.5	20.6	25.1	67.8	5.4	13.9	1.0	3.96
MAY	28.4	18.8	23.6	67.3	5.8	12.6	0.9	3.13
JUN.	27.6	16.0	21.8	55.9	6.6	12.8	1.0	3.06
JUL.	27.2	15.1	21.2	50.8	6.3	12.7	1.4	3.38
AUG.	27.8	15.3	21.5	45.6	6.5	12.9	1.8	4.03
SEP.	29.9	16.7	23.3	42.5	6.9	15.1	2.2	5.59
OCT.	31.5	18.1	24.8	42.0	7.9	15.9	2.5	6.38
NOV.	32.0	20.0	26.0	47.2	7.8	17.5	2.6	6.73
DEC.	31.8	20.6	26.2	50.2	7.7	16.8	2.8	6.18
ANNUAL	30.1	18.7	24.4	52.7	6.9	15.1	1.9	5.03
Kibaha Agromet. Station				ALTITUDE	150 m			
JAN.	32.5	23.1	26.2	60.5	7.0	16.1	1.6	4.00
FEB.	32.5	25.4	27.7	60.4	9.6	18.3	1.9	5.90
MAR.	32.3	22.8	27.5	66.0	6.2	15.4	1.1	4.70
APR.	30.4	21.4	25.9	73.6	5.4	14.6	0.9	3.85
MAY	29.3	21.0	25.2	69.3	5.8	14.6	1.0	4.10
JUN.	28.8	19.4	24.2	64.8	6.9	14.5	0.9	-
JUL.	29.0	18.8	24.1	55.7	6.8	13.0	1.3	-
AUG.	29.2	18.6	24.0	58.0	6.8	13.5	1.3	-
SEP.	29.9	19.5	24.8	54.8	7.1	15.7	1.4	5.45
OCT.	31.0	20.2	25.7	55.5	8.0	16.8	1.5	6.03
NOV.	31.1	22.0	25.9	62.0	8.3	17.1	1.3	4.67
DEC.	30.2	22.1	26.1	62.4	6.9	16.0	1.1	4.10
ANNUAL	30.5	21.2	25.6	61.9	7.1	15.5	1.3	-
Mikura Agtomet. Station				ALTITUDE	80.0 m			
JAN.	-	-	28.1	71.3	-	15.6	1.2	5.60
FEB.	-	-	28.3	72.7	-	16.3	1.0	5.21
MAR.	-	-	28.8	80.6	-	16.7	0.8	5.68
APR.	-	-	26.9	76.4	-	13.9	0.5	4.30
MAY	-	-	26.2	74.3	-	13.9	0.6	3.84
JUN.	-	-	25.3	77.6	-	14.5	0.7	4.93
JUL.	-	-	25.0	59.7	-	12.1	0.7	3.91
AUG.	-	-	25.4	58.1	-	13.2	0.9	4.36
SEP.	-	-	25.9	60.0	-	14.8	1.0	4.68
OCT.	-	-	27.2	60.0	-	15.7	1.0	5.39
NOV.	-	-	28.5	57.1	-	16.9	1.3	6.55
DEC.	-	-	28.6	70.7	-	16.7	1.3	7.00
ANNUAL	-	-	27.0	68.2	-	15.0	0.9	5.12
JICA Experimental Farm				ALTITUDE		5.0 m		
JAN.	31.9	22.2	27.0	66.9	12.6	14.8	-	-
FEB.	31.3	22.3	26.8	64.2	12.4	16.3	-	-
MAR.	31.5	22.6	27.3	69.3	12.3	14.6	-	-
APR.	29.7	21.6	24.8	61.2	12.4	12.6	-	-
MAY	30.6	22.6	26.6	54.7	12.2	9.4	-	-
JUN.	28.0	18.8	22.9	59.1	11.9	10.1	-	-
JUL.	26.6	17.1	21.7	59.5	13.3	8.2	-	-
AUG.	27.8	16.7	22.1	57.1	13.0	12.4	-	-
SEP.	30.8	19.0	24.8	49.6	12.5	14.1	-	-
OCT.	31.3	19.5	25.9	77.8	12.7	15.4	-	-
NOV.	32.4	21.4	27.2	71.1	12.7	14.1	-	-
DEC.	31.9	22.3	27.2	70.0	12.7	13.4	-	-
ANNUAL	30.3	20.5	25.3	63.4	12.6	12.9	-	-

Table C.8 RUVU RIVER SYSTEM

Sub Basin	Main River and Tributaries		Catchment Area (km2) Unit Basin	Sub-Total	Total	River Length(km)
Mgeta	Mgeta		762			135.5
	Mbakana		357			50.0
	Mngazi		223	1,342		34.5
	Msoro	Msoro	289			72.0
		Rudete	249			61.8
		Msagere	466			44.8
		Tributary	433	1,437		27.5
	Mgeta		1,049			64.5
	Mgeta(Dutumi)		75	1,124		31.2
Mget at Ruvu Confluence					3,903	200.0
Upper Ruvu	Ruvu		1,075			198.9
	Mfizigo		589			29.6
	Kiroka		150			25.0
	Mvuha		525	2,339		54.6
Ruvu at Mgeta Confluence					6,242	102.5
Middle Ruvu	Ruvu		1,366			96.4
	Mkulazi		416			37.0
	R/01		75	1,857		24.1
Ruvu at Ngrengre Confluence					8,099	198.9
Ngerengere	Ngerengere		2081			229.1
	Mkurunge		49			25.3
	Whazi		84			21.2
	Kwazi		257			41.8
	R3		74			27.6
	R2		68			23.0
	R1		243	2,856		32.0
Ruvu at Ngrengre Confluence					10955	198.9
Lower Ruvu	Ruvu		1768			171.2
	R/02		207			38.6
	R/03		81			21.3
	Ngurungru		187			48.3
	Dudangulu		172			37.5
	Pangani		196			66.7
	Mlandizi		178			35.0
	Chatota		187			39.0
	Lugongwe		91			18.0
	Kigogo		672			47.5
	Msua		899			75.6
	Mbiki		885			128.0
	Mkombezi		885			114.5
	Usingwa		287			66.0
	Vianzi		324	7,019		37.6
Ruvu at River Mouse					17,974	370.1

Table C.9 AVERAGE RAINFALL IN THE RUVU RIVER BASIN

unit : mm

CODE No.	NAME OF STATION	AREA	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	Annual
9637000	Morogoro Agri. Station	978	100	90	152	214	101	24	14	11	16	32	63	105	900
9637020	Tegetero Mission	420	210	185	346	557	298	117	104	100	119	154	225	239	2,704
9637047	Hobwe	426	125	120	179	248	104	16	10	7	21	48	85	106	1,091
9638005	Lugoba Mission	939	92	82	139	186	130	23	23	20	35	68	104	99	1,019
9638008	Athina Sisal Estate	988	101	84	154	196	99	22	12	19	38	61	92	95	970
9638020	Bagamoyo Salt Works	701	70	55	83	189	171	39	29	29	24	59	83	117	951
9638022	Kikondeni Sisal Estate	699	116	92	151	223	99	21	14	15	36	60	97	94	1,010
9638023	Chambezi Coast Agri. Company	293	77	67	123	274	176	40	31	23	34	70	110	115	1,135
9638033	Ubena Zomozi	1,127	85	69	141	164	103	28	10	21	31	36	122	105	920
9638034	Chalinze Catholic Mission	916	81	56	131	162	96	21	10	15	30	59	105	94	867
9638038	Ruvu National Service Farm	1,463	94	62	167	219	124	28	13	8	31	80	107	110	1,005
9737000	Duthumi Estate	1,042	129	121	206	258	112	28	13	9	20	33	84	100	1,117
9737008	Kisaki	1,563	117	88	192	262	172	31	12	19	16	27	62	60	1,052
9737011	Kikeo Mission	1,077	154	158	234	329	137	24	12	8	11	27	86	133	1,326
9737014	Mvuha	980	142	132	214	247	102	23	16	25	37	54	88	114	1,218
9737026	Kibungo	785	208	168	260	331	128	53	36	32	45	96	140	214	1,736
9738002	Maneromango Upper School	1,141	94	88	156	214	100	21	11	13	21	58	104	97	915
9738008	Kidunda Village	1,276	116	102	155	217	61	25	8	19	23	81	92	113	973
9738009	Ng'hesse	1,159	74	68	117	157	89	16	7	11	21	65	92	91	818
	Total Average	17,974	112	96	171	232	119	28	16	18	29	58	97	109	1,081

Note : Area unit in km2

Table C.10 AVERAGE RAINFALL IN THE SUB-BASIN

unit : mm

Sub-Basin	Area (km)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Upper Ruve	2,339	173	154	245	314	141	49	39	39	51	85	128	168	1,609
Megeta	3,903	135	116	208	280	137	28	11	14	17	31	77	95	1,148
Middle Ruvu	1,857	120	93	146	242	72	22	8	18	24	76	90	107	1,047
Ngrengre	2,856	101	90	153	205	103	25	14	16	28	50	90	104	976
Lower R. Right	3,067	85	71	145	209	123	27	16	13	30	69	101	107	955
Lower R. Left	3,952	88	71	137	178	116	26	16	16	34	62	114	104	965
Total	17,974	112	96	171	232	119	28	16	18	29	58	97	109	1,081

Table C.11 AVERAGE RAINFALL IN THE UNIT BASIN

unit : mm

Unit Basin No.	Area (km)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1	1,342	153	139	226	306	132	26	10	11	14	28	83	120	1,246
2	1,437	122	95	197	269	167	30	12	18	16	27	65	68	1,081
3	1,124	127	115	199	264	106	28	12	14	23	39	87	99	1,115
4	1,023	194	171	275	385	186	71	58	55	70	108	162	203	1,959
5	1,316	157	141	221	259	107	32	24	27	37	66	101	140	1,336
6	1,857	120	93	146	242	72	22	8	18	24	76	90	107	1,047
7	526	116	109	175	248	111	25	17	14	24	46	82	114	1,084
8	1,387	96	86	155	195	104	28	14	15	28	42	90	107	951
9	943	99	86	137	195	97	20	14	18	32	63	95	95	954
10	511	90	80	140	202	96	20	10	13	22	59	98	95	890
11	672	102	82	139	196	95	20	12	16	33	64	95	95	951
12	924	89	78	149	207	105	22	11	11	26	63	101	100	918
13	899	86	65	149	170	102	26	10	13	37	59	105	106	931
14	700	80	66	162	198	124	27	13	8	35	76	106	113	957
15	885	85	66	147	164	104	26	11	14	37	57	111	106	936
16	171	82	71	162	206	123	26	13	8	32	73	105	111	955
17	885	89	77	139	180	128	25	21	18	34	66	145	100	1,032
18	287	84	71	117	186	146	30	26	22	31	67	129	105	1,019
19	497	85	66	144	247	160	35	27	15	38	82	107	119	1,099
20	324	72	55	82	185	169	39	30	28	24	63	83	117	941
21	263	73	55	84	193	172	40	31	27	25	65	82	118	956

Table C.12 AVERAGE RAINFALL IN THE CATCHMENT AREA OF THE HYDROLOGICAL STATIONS

unit : mm

Station Code.	Area(km2)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1H2	12,488	123	108	185	249	117	29	16	19	28	55	94	111	1,132
1H3	6,697	143	127	215	288	137	34	20	22	29	52	95	120	1,291
1H5	420	207	182	338	540	287	111	99	95	113	148	217	234	2,620
1H8	15,190	117	101	179	240	116	28	15	18	28	57	96	110	1,099
1H10	5,870	149	132	225	300	146	36	22	23	30	49	95	122	1,342
1HA1A	2,840	101	88	154	206	103	24	13	16	28	48	89	103	970
1HA5	1,646	103	91	159	215	107	26	15	16	25	41	86	108	986
1HA15	2,370	102	89	155	209	105	25	14	16	27	45	88	105	974
1HB1	963	121	96	197	269	168	30	12	18	16	27	65	68	1,080
1HB2	101	131	128	190	265	111	61	54	52	62	82	85	112	1,333
1HC2	251	166	146	270	432	229	89	79	76	91	119	174	187	2,057

Table C.13 RESULT OF PROBABILITY ANALYSIS ON THE RAINFALL DATA (1/3)

Station Code	Return Period	F[%]	Annual Rainfall (mm/year)	24hr Max. Rainfall (mm/day)	3day Max. Rainfall (mm/3day)	Successive No-rain Days (<0.1, days)	Successive No-rain Days (<5.0, days)
9637000	1/500	0.20	485.8	134.3	216.4	195	250
	1/200	0.50	515.1	124.8	195.8	165	223
	1/100	1.00	541.1	117.4	180.5	144	202
	1/50	2.00	571.4	109.8	165.5	124	182
	1/20	5.00	620.7	99.2	145.7	99	156
	1/10	10.00	668.8	90.5	130.6	82	136
	1/ 5	20.00	733.2	80.9	114.9	64	115
	1/ 2	50.00	877.4	64.9	91.6	41	83
9637020	1/500	0.20	1,041.2	314.0	542.5	133	137
	1/200	0.50	1,145.2	282.4	483.4	105	115
	1/100	1.00	1,239.0	258.5	439.4	87	100
	1/50	2.00	1,350.4	234.6	395.9	71	86
	1/20	5.00	1,536.2	202.5	338.6	52	69
	1/10	10.00	1,722.6	177.4	294.7	41	57
	1/ 5	20.00	1,979.1	150.8	249.1	31	45
	1/ 2	50.00	2,580.7	109.5	180.6	20	30
9637047	1/500	0.20	474.8	181.4	329.0	196	261
	1/200	0.50	519.2	159.6	288.1	173	234
	1/100	1.00	558.4	143.7	258.4	157	213
	1/50	2.00	604.0	128.1	229.6	141	192
	1/20	5.00	677.9	108.2	192.8	120	165
	1/10	10.00	749.8	93.2	165.4	104	143
	1/ 5	20.00	845.5	78.0	137.8	88	120
	1/ 2	50.00	1,058.4	56.1	98.4	64	84
9638005	1/500	0.20	466.3	191.3	250.8	130	146
	1/200	0.50	504.8	175.3	231.8	116	135
	1/100	1.00	539.0	162.9	217.0	106	126
	1/50	2.00	578.9	150.1	201.7	95	117
	1/20	5.00	644.0	132.5	180.2	82	105
	1/10	10.00	707.9	118.1	162.7	71	95
	1/ 5	20.00	793.5	102.2	143.1	60	83
	1/ 2	50.00	986.4	75.9	110.2	44	65
9638008	1/500	0.20	543.2	215.6	227.6	111	111
	1/200	0.50	564.3	187.3	206.1	104	104
	1/100	1.00	583.9	167.3	190.1	97	97
	1/50	2.00	607.8	148.2	174.2	91	91
	1/20	5.00	649.4	124.4	153.2	82	82
	1/10	10.00	692.9	107.3	137.1	74	74
	1/ 5	20.00	755.4	90.5	120.2	65	65
	1/ 2	50.00	913.5	67.7	94.8	50	50
9638020	1/500	0.20	302.6	205.8	561.5	102	135
	1/200	0.50	363.9	180.3	440.2	93	123
	1/100	1.00	415.6	162.0	362.4	86	113
	1/50	2.00	473.1	144.6	295.6	79	104
	1/20	5.00	561.3	122.9	222.3	69	91
	1/10	10.00	641.8	107.1	176.6	61	81
	1/ 5	20.00	742.1	91.7	138.4	53	71
	1/ 2	50.00	942.7	70.5	97.1	40	54
9638022	1/500	0.20	474.3	152.9	201.6	207	235
	1/200	0.50	511.9	138.6	188.0	178	206
	1/100	1.00	545.3	127.8	177.3	157	185
	1/50	2.00	584.2	117.0	166.1	137	164
	1/20	5.00	647.8	102.6	150.2	112	137
	1/10	10.00	710.1	91.4	137.0	94	117
	1/ 5	20.00	793.6	79.5	122.0	76	96
	1/ 2	50.00	981.7	61.1	96.3	50	65

Table C.13 RESULT OF PROBABILITY ANALYSIS ON THE RAINFALL DATA (2/3)

Station Code	Return Period	F[%]	Annual Rainfall (mm/year)	24hr Max. Rainfall (mm/day)	3day Max. Rainfall (mm/3day)	Successive No-rain Days (<0.1 days)	Successive No-rain Days (<5.0 days)
9638023	1/500	0.20	472.4	216.0	280.1	68	136
	1/200	0.50	521.7	193.8	251.0	64	125
	1/100	1.00	565.0	177.2	229.7	61	116
	1/50	2.00	615.1	160.7	208.8	58	108
	1/20	5.00	695.8	138.8	181.8	53	96
	1/10	10.00	773.8	121.8	161.4	49	86
	1/ 5	20.00	876.9	104.1	140.7	44	75
	1/ 2	50.00	1,103.7	77.1	110.4	34	57
9638033	1/500	0.20	419.8	170.9	319.9	166	144
	1/200	0.50	454.8	151.0	277.3	147	134
	1/100	1.00	485.9	136.7	246.7	133	127
	1/50	2.00	522.4	122.9	217.4	119	119
	1/20	5.00	582.2	105.4	180.5	101	107
	1/10	10.00	641.0	92.5	153.6	88	98
	1/ 5	20.00	720.4	79.7	127.0	74	87
	1/ 2	50.00	900.5	61.7	90.2	55	68
9638034	1/500	0.20	419.2	170.9	199.5	132	157
	1/200	0.50	447.1	151.0	181.5	114	148
	1/100	1.00	472.2	136.7	168.0	102	140
	1/50	2.00	502.1	122.9	154.5	90	133
	1/20	5.00	551.9	105.4	136.7	75	121
	1/10	10.00	602.0	92.5	122.8	65	111
	1/ 5	20.00	670.9	79.7	108.2	55	100
	1/ 2	50.00	832.7	61.7	85.9	42	79
9638038	1/500	0.20	541.8	241.5	597.2	180	188
	1/200	0.50	577.9	208.7	482.2	165	173
	1/100	1.00	609.5	185.5	405.8	154	161
	1/50	2.00	646.1	163.6	337.7	142	149
	1/20	5.00	705.0	136.4	259.5	125	133
	1/10	10.00	761.8	117.0	208.2	112	119
	1/ 5	20.00	836.8	98.2	162.9	97	105
	1/ 2	50.00	1,001.5	72.8	109.7	72	81
9737000	1/500	0.20	351.5	198.2	261.0	270	214
	1/200	0.50	424.8	182.0	243.4	229	196
	1/100	1.00	486.4	169.6	229.4	200	181
	1/50	2.00	554.9	157.0	214.7	172	167
	1/20	5.00	659.8	139.8	193.7	137	147
	1/10	10.00	755.2	126.0	176.1	113	130
	1/ 5	20.00	873.8	111.1	155.9	89	112
	1/ 2	50.00	1,110.1	87.1	120.9	56	82
9737008	1/500	0.20	832.8	952.9	1,663.0	219	168
	1/200	0.50	838.5	673.6	1,155.3	186	155
	1/100	1.00	844.4	510.8	860.8	163	152
	1/50	2.00	852.2	382.5	629.8	143	145
	1/20	5.00	867.4	256.7	404.6	118	134
	1/10	10.00	885.4	188.1	282.7	102	125
	1/ 5	20.00	915.0	137.8	193.8	86	115
	1/ 2	50.00	1,008.1	93.4	116.2	67	98
9737011	1/500	0.20	785.7	269.4	411.7	195	337
	1/200	0.50	816.7	236.9	359.7	178	299
	1/100	1.00	845.0	213.3	322.3	165	271
	1/50	2.00	879.0	190.4	286.3	151	243
	1/20	5.00	936.6	160.9	240.7	132	206
	1/10	10.00	995.5	139.0	207.3	116	178
	1/ 5	20.00	1,078.0	116.9	174.1	99	150
	1/ 2	50.00	1,277.4	85.1	127.6	71	107

Table C.13 RESULT OF PROBABILITY ANALYSIS ON THE RAINFALL DATA (3/3)

Station Code	Return Period	F[%]	Annual Rainfall (mm/year)	24hr Max. Rainfall (mm/day)	3day Max. Rainfall (mm/3day)	Successive No-rain Days (<0.1, days)	Successive No-rain Days (<5.0, days)
9737014	1/500	0.20	616.1	204.9	298.5	174	192
	1/200	0.50	650.4	187.8	277.5	153	169
	1/100	1.00	681.6	174.7	261.2	138	151
	1/50	2.00	718.7	161.5	244.2	122	134
	1/20	5.00	781.1	143.6	220.4	103	113
	1/10	10.00	844.1	129.4	200.8	87	97
	1/ 5	20.00	931.5	114.2	178.9	72	81
	1/ 2	50.00	1,139.0	90.0	142.0	49	58
9737026	1/500	0.20	483.9	379.9	529.4	59	82
	1/200	0.50	606.9	324.5	456.5	54	77
	1/100	1.00	709.9	285.3	404.6	50	73
	1/50	2.00	823.7	248.2	355.5	46	69
	1/20	5.00	996.8	202.4	294.3	41	63
	1/10	10.00	1,153.3	169.6	250.3	37	58
	1/ 5	20.00	1,346.3	137.8	207.5	32	52
	1/ 2	50.00	1,726.1	95.2	149.4	25	41
9738002	1/500	0.20	323.9	287.4	287.4	168	159
	1/200	0.50	365.4	257.8	257.8	148	149
	1/100	1.00	402.1	235.7	235.7	133	140
	1/50	2.00	445.0	213.7	213.7	118	131
	1/20	5.00	515.0	184.5	184.5	99	118
	1/10	10.00	583.6	161.9	161.9	85	107
	1/ 5	20.00	675.6	138.2	138.2	70	95
	1/ 2	50.00	882.6	102.1	102.1	48	73
9738008	1/500	0.20	484.4	146.8	217.8	213	267
	1/200	0.50	519.9	135.7	197.2	179	242
	1/100	1.00	551.3	127.2	181.8	155	222
	1/50	2.00	587.7	118.5	166.5	133	202
	1/20	5.00	646.8	106.7	146.3	105	175
	1/10	10.00	704.2	97.2	130.7	86	153
	1/ 5	20.00	780.8	87.0	114.5	67	128
	1/ 2	50.00	951.0	70.5	90.0	42	89
9738009	1/500	0.20	87.4	166.8	232.6	325	290
	1/200	0.50	143.6	152.8	214.4	269	257
	1/100	1.00	192.8	141.9	200.1	231	232
	1/50	2.00	249.4	130.6	185.0	195	207
	1/20	5.00	340.0	114.7	163.6	152	175
	1/10	10.00	427.0	101.7	145.7	122	151
	1/ 5	20.00	541.1	87.1	125.4	94	125
	1/ 2	50.00	789.3	62.6	90.2	59	87

Table C.14 SUMMARY OF RATING CURVE COEFFICIENTS

Q=A*H^B+C

STATION CODE	NAME OF STATION	ABAILABLE PERIOD	COEFFICIENT A	COEFFICIENT B	COEFFICIENT C	L.W.L (m)	R (%)
1H2	Ruvu S. Estate	52-59	11.0240	1.66429		2	95.4
			1.02973	3.54281	23	6	97.5
1H3	Kidunda	52-66	24.1237	1.03527		1.6	96.2
			6.14850	2.44617	20	6.00	91.6
1H5	Kibungo	59-70	19.1636	3.10753		1.10	98.7
			40.6208	1.25447	-20	4.50	98.5
		71-80	23.0633	3.49743		1.10	96.9
			33.8732	1.41340	-10	4.50	99.8
		81-87	20.5394	2.89784		1.10	92.6
			51.7881	1.10724	-30	4.50	98.6
1H8	Ruvu Bridge	58-70	8.22767	1.81509		6.11	99.1
			100.475	1.50195	-1300	8.00	95.2
		71-81	9.06448	1.76623		6.11	98.8
			0.00002	8.23453	160	8.00	86.4
		82	5.01726	1.71714		6.11	99.6
		83-85	9.18824	1.80456		6.11	99.2
			25.0344	1.95137	-600	8.00	99.9
		86-89	6.72828	1.79702		6.11	88.5
			0.00151	6.27380	50	8.00	96.4
1H10	Mikula	66-84	11.448	1.896		8.00	98.0
1HA1A	Utari Bridge	66-77	3.73814	3.35047		0.8	84.1
			3.62428	1.61445	-1	4.50	99.7
		80-85	7.77635	2.94829		0.8	97.7
			3.04418	1.67539	1.5	4.50	99.1
1HA5	Kiluwa	53-60	3.35462	2.24316		1.5	95.3
			3.00350	2.25029		3	93.7
		61	2.39806	2.66217		1.5	99.4
			3.00350	2.25029		3	93.7
		62	0.56487	6.81209		1.5	98.7
			3.00350	2.25029		3	93.7
		63-69	2.44482	2.8857		1.5	95.1
			3.00350	2.25029		3	93.7
1HA15	Mgera	68-73	4.16574	1.48870		1.5	98.5
			3.00561	2.47466		4	98.3
		74-77	2.46166	2.79574		1.5	96.9
			0.35630	4.42856	5	4	90.3
		78-79	1.63595	2.88427		1.5	95.1
			4.02192	2.41713	-5	4	97.5
		80-86	3.24384	2.77980		1.5	96.2
			0.23692	4.85933	8	4	89.4
		87-92	0.69703	2.40865		1.5	91.7
			2.87339	2.76867	-7	4.00	97.2
1HB1	Kisaki	50-60.4	9.57690	1.02742		0.8	94.1
			31.9738	0.63273	-20	3.00	99.2
		60.5-63	7.26274	1.45101		0.8	77.2
			18.6199	0.89488	-10	3.00	97.6
1HB2	Mgeta	58-80	8.88722	2.14663		0.75	97.2
			7.95385	3.68474	2	1.50	98.8
		80-90	13.9812	2.95973		0.75	98.9
			4.56838	5.55936	5		99.9
1HC2	Mvuha	54-56	6.81975	2.08840		2	93.8
			7.88480	1.88107		3.50	99.9
		58-80	2.25136	2.16116		2	75.5
			7.96119	1.86076	-20	3.50	75.8
		81-84	5.02611	2.82574		2	95.1
			59.5741	0.95754	-80	3.50	99.8

Note L.W.L : Limit Water Level (m)
R : Correlation Coefficient (%)

Table C.15 SUMMARY OF RIVER DISCHARGE (1/2)

unit : discharge-m3/s, runoff-mm

Item	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
1H2	Catchment Area12,488 km2				Data Period 1950 to 1959								
MEAN	49.1	79.8	58.8	194.5	239.4	96.0	38.3	22.4	18.2	17.2	36.6	46.6	74.7
MEAN MAX.	107.4	156.3	144.8	265.0	286.9	187.3	54.8	33.8	35.7	35.3	79.5	110.9	124.8
MEAN MIN.	23.0	24.6	25.1	86.1	158.0	48.0	27.5	16.1	12.9	10.6	14.4	20.3	38.9
AB. MAX.	282.8	293.0	222.2	307.1	365.7	290.0	107.9	55.6	86.5	73.6	232.1	232.1	365.7
AB. MIN.	7.0	6.1	5.7	47.2	42.3	20.3	19.3	12.3	8.0	6.1	7.5	4.8	4.8
Runoff	10.5	15.5	12.6	40.4	51.3	19.9	8.2	4.8	3.8	3.7	7.6	10.0	188.8
1H3	Catchment Area 6,697 km2				Data Period 1951 to 1969								
MEAN	52.6	40.7	63.2	176.1	131.2	43.6	27.5	20.2	17.0	18.1	49.8	54.1	57.8
MEAN MAX.	124.2	88.1	156.2	308.6	291.4	78.4	38.5	30.6	31.7	36.0	140.1	138.2	121.8
MEAN MIN.	24.5	22.1	26.7	71.1	49.9	29.9	21.9	16.3	12.8	12.6	19.0	23.8	27.5
AB. MAX.	563.7	259.0	428.0	624.0	544.4	193.8	69.6	76.3	93.4	81.8	699.0	627.4	699.0
AB. MIN.	0.4	3.4	2.0	18.3	22.6	13.2	9.8	7.1	6.3	5.6	5.6	2.4	0.4
Runoff	21.0	14.7	25.3	68.2	52.5	16.9	11.0	8.1	6.6	7.2	19.3	21.6	272.4
1H5	Catchment Area 420 km2				Data Period 1952 to 1992								
MEAN	17.76	13.95	19.18	40.68	34.55	17.71	11.74	8.74	8.40	10.27	18.83	20.11	18.49
MEAN MAX.	51.52	34.45	53.14	103.76	82.31	39.16	27.82	21.64	33.19	41.37	70.00	62.59	51.75
MEAN MIN.	8.97	7.56	8.26	17.48	19.00	10.45	7.23	5.61	4.70	4.62	6.37	8.42	9.06
AB. MAX.	207.70	91.25	136.64	257.03	170.77	126.82	82.19	72.95	127.15	247.88	291.86	205.43	291.86
AB. MIN.	2.09	1.83	1.83	4.67	6.72	4.38	3.83	3.44	2.76	2.09	0.67	1.39	0.67
Runoff	113.2	80.4	122.3	251.0	220.3	109.3	74.9	55.7	51.9	65.5	116.2	128.3	1,388.6
1H8	Catchment Area15,190 km2				Data Period 1958 to 1992								
MEAN	57.7	39.8	57.7	163.4	161.4	60.0	28.3	19.8	16.5	15.8	47.6	65.1	61.1
MEAN MAX.	106.7	66.2	118.0	287.6	283.0	112.9	39.4	27.3	25.9	29.9	101.6	124.9	110.3
MEAN MIN.	28.2	24.6	28.1	82.9	77.0	33.4	21.2	15.6	12.2	10.7	19.5	33.8	32.3
AB. MAX.	540.4	137.2	341.2	800.9	694.5	643.8	80.7	65.5	86.6	163.7	533.1	505.3	800.9
AB. MIN.	3.0	6.2	6.2	8.5	21.6	7.3	10.1	8.3	7.7	6.0	6.0	3.7	3.0
Runoff	10.2	6.3	10.2	27.9	28.5	10.2	5.0	3.5	2.8	2.8	8.1	11.5	126.8
1H8	with Culvert												
MEAN	59.5	39.8	58.4	183.0	179.1	61.6	28.3	19.8	16.5	15.8	51.3	68.6	65.1
MEAN MAX.	113.5	66.2	124.8	345.0	339.2	121.1	39.4	27.3	25.9	29.9	113.4	141.9	124.0
MEAN MIN.	28.2	24.6	28.1	86.6	77.0	33.4	21.3	15.6	12.2	10.7	19.6	33.8	32.6
AB. MAX.	675.9	137.2	398.1	1093.7	960.5	851.6	80.7	65.5	86.6	163.7	665.8	627.1	1093.7
AB. MIN.	3.0	6.3	6.3	8.5	21.6	7.3	10.1	8.3	7.7	6.0	6.0	3.7	3.0
Runoff	10.5	6.3	10.3	31.2	31.6	10.5	5.0	3.5	2.8	2.8	8.8	12.1	135.2
1H10	Catchment Area 5,870 km2				Data Period 1966 to 1991								
MEAN	41.6	39.5	61.4	131.4	118.5	42.6	24.0	17.7	17.8	16.1	32.7	58.5	50.2
MEAN MAX.	97.0	73.6	141.2	252.9	261.1	74.4	37.3	28.0	36.0	36.3	100.6	141.3	106.6
MEAN MIN.	21.3	22.9	22.8	48.6	53.5	27.8	18.5	13.8	12.2	10.2	13.3	24.2	24.1
AB. MAX.	280.1	326.4	486.7	877.2	708.6	190.9	89.9	86.6	119.1	72.8	422.8	592.0	877.2
AB. MIN.	2.1	2.0	5.2	6.8	29.9	17.7	12.2	9.1	6.6	5.1	5.8	5.5	2.0
Runoff	19.0	16.3	28.0	58.0	54.1	18.8	11.0	8.1	7.9	7.4	14.4	26.7	269.5

Table C.15 SUMMARY OF RIVER DISCHARGE (2/2)

unit : discharge-m3/s, runoff-mm

Item	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
1HA1A Catchment Area 2,840 km2 Data Period 1950 to 1992													
MEAN	3.89	2.99	3.22	12.24	13.36	3.89	1.85	1.02	0.78	0.83	3.59	4.31	4.33
MEAN MAX.	10.71	7.81	11.69	27.54	28.60	7.68	3.45	1.91	1.64	3.19	8.35	10.93	10.29
MEAN MIN.	1.22	0.90	0.88	3.30	5.35	1.99	1.01	0.54	0.38	0.30	1.14	1.83	1.57
AB. MAX.	55.29	39.07	62.55	62.02	61.43	28.57	14.44	9.93	15.98	36.94	51.34	62.29	62.55
AB. MIN.	0.00	0.00	0.00	0.13	0.69	0.39	0.07	0.03	0.00	0.00	0.00	0.00	0.00
Runoff	3.7	2.5	3.0	11.2	12.6	3.5	1.7	1.0	0.7	0.8	3.3	4.1	48.1
1HA5 Catchment Area 1,646 km2 Data Period 1953 to 1970													
MEAN	3.90	2.70	3.37	11.69	9.25	3.35	1.76	1.15	1.12	1.16	3.63	3.51	3.88
MEAN MAX.	11.93	8.75	11.12	26.87	21.55	7.12	4.05	2.62	2.34	5.98	8.56	8.06	9.91
MEAN MIN.	1.42	1.01	1.07	4.04	3.60	1.72	0.98	0.66	0.60	0.44	1.37	1.61	1.54
AB. MAX.	50.51	25.25	41.84	53.77	49.04	19.24	17.34	13.37	17.86	48.56	52.01	23.92	53.77
AB. MIN.	0.10	0.13	0.10	0.06	1.25	0.51	0.17	0.08	0.03	0.01	0.03	0.02	0.01
Runoff	6.3	4.0	5.5	18.4	15.1	5.3	2.9	1.9	1.8	1.9	5.7	5.7	74.4
1HA15 Catchment Area 2,370 km2 Data Period 1968 to 1992													
MEAN	4.33	3.14	5.61	13.90	13.66	3.56	1.34	0.90	0.74	1.96	3.82	3.74	4.73
MEAN MAX.	16.16	9.97	21.37	43.92	52.00	6.93	2.25	1.36	1.60	12.04	15.30	11.54	16.20
MEAN MIN.	1.21	1.18	1.98	3.87	3.76	1.85	0.93	0.63	0.38	0.29	1.13	1.35	1.54
AB. MAX.	57.26	34.49	86.35	108.62	155.79	17.28	5.06	3.50	4.58	124.44	67.46	70.82	155.79
AB. MIN.	0.01	0.07	0.00	0.00	1.29	0.68	0.36	0.40	0.15	0.01	0.00	0.00	0.00
Runoff	4.9	3.2	6.3	15.2	15.4	3.9	1.5	1.0	0.8	2.2	4.2	4.2	62.9
1HB1 Catchment Area 963 km2 Data Period 1953 to 1963													
MEAN	6.25	6.98	8.47	17.07	12.59	4.94	3.50	2.54	2.34	2.29	4.51	4.46	6.33
MEAN MAX.	20.86	17.77	21.68	37.74	29.82	8.39	5.46	3.65	5.68	4.07	9.44	11.58	14.68
MEAN MIN.	2.87	3.43	3.80	7.33	6.23	3.80	2.78	2.13	1.89	1.53	2.86	2.64	3.44
AB. MAX.	36.35	31.41	33.95	50.80	48.74	19.02	15.20	9.57	27.56	13.97	38.21	31.34	50.80
AB. MIN.	0.27	1.11	1.30	2.56	1.30	1.11	0.94	0.94	0.82	0.82	1.10	0.94	0.27
Runoff	17.4	17.5	23.6	46.0	35.0	13.3	9.7	7.1	6.3	6.4	12.1	12.4	207.2
1HB2 Catchment Area 101 km2 Data Period 1959 to 1992													
MEAN	2.47	2.29	2.76	5.02	3.82	2.04	1.51	1.24	1.20	1.55	2.75	2.88	2.46
MEAN MAX.	10.58	6.29	7.85	12.78	10.44	2.92	1.89	1.82	3.43	5.54	9.90	9.50	6.91
MEAN MIN.	1.63	1.44	1.65	2.54	2.28	1.63	1.33	1.06	0.88	0.93	1.16	1.59	1.51
AB. MAX.	71.37	22.25	27.30	35.58	45.41	8.58	3.95	5.73	15.31	41.05	37.43	37.43	71.37
AB. MIN.	0.20	0.20	0.23	0.93	0.93	0.40	0.26	0.12	0.10	0.06	0.06	0.29	0.06
Runoff	65.4	54.9	73.1	128.9	101.3	52.4	40.2	32.9	30.9	41.1	70.5	76.4	768.5
1HC2 Catchment Area 251 km2 Data Period 1954 to 1992													
MEAN	8.66	7.60	12.62	23.32	13.01	5.51	4.32	3.78	4.36	6.13	10.09	8.67	9.00
MEAN MAX.	52.50	32.33	62.79	102.66	50.03	15.23	13.87	14.57	19.01	33.46	55.91	50.17	41.88
MEAN MIN.	2.87	3.11	3.58	6.43	5.04	3.52	2.75	2.26	2.30	2.32	2.60	2.74	3.29
AB. MAX.	204.70	111.26	289.29	296.69	216.26	100.03	141.53	122.29	101.33	196.30	310.47	288.81	310.47
AB. MIN.	0.00	0.01	0.02	0.34	0.17	0.03	0.00	0.00	0.00	0.01	0.00	0.02	0.00
Runoff	92.4	73.2	134.7	240.8	138.8	56.9	46.1	40.3	45.0	65.4	104.2	92.5	1,131.4

Table C.16 SUMMARY OF RUNOFF COEFFICIENT

unit : mm

Station	Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1H2	Rainfall	123.0	108.4	184.8	248.6	117.1	29.0	16.1	19.1	27.9	54.9	93.9	111.4	1,131.5
12,488	Runoff	10.5	15.5	12.6	40.4	51.3	19.9	8.2	4.8	3.8	3.7	7.6	10.0	188.8
(km2)	R.C.	8.6%	14.3%	6.8%	16.2%	43.8%	68.7%	51.0%	25.1%	13.5%	6.7%	8.1%	9.0%	16.7%
1H3	Rainfall	143.1	126.9	215.5	287.7	136.7	34.4	20.2	22.2	29.3	52.3	95.0	119.6	1,290.8
6,697	Runoff	21.0	14.7	25.3	68.2	52.5	16.9	11.0	8.1	6.6	7.2	19.3	21.6	272.4
(km2)	R.C.	14.7%	11.6%	11.7%	23.7%	38.4%	49.1%	54.5%	36.3%	22.4%	13.8%	20.3%	18.1%	21.1%
1H5	Rainfall	207.4	182.4	337.7	540.2	286.8	111.4	98.6	94.8	113.1	148.4	217.3	233.5	2,620.0
420	Runoff	113.2	80.4	122.3	251.0	220.3	109.3	74.9	55.7	51.9	65.5	116.2	128.3	1,388.6
(km2)	R.Ratio	54.6%	44.1%	36.2%	46.5%	76.8%	98.1%	76.0%	58.8%	45.8%	44.1%	53.5%	54.9%	53.0%
1H8	Rainfall	117.3	101.0	179.3	239.9	116.1	28.3	15.3	17.8	28.1	57.0	96.2	110.0	1,099.4
15,190	Runoff	10.2	6.3	10.2	27.9	28.1	10.2	5.0	3.5	2.8	2.8	8.1	11.5	126.5
(km2)	R.C.	8.7%	6.3%	5.7%	11.6%	24.2%	36.2%	32.5%	19.5%	10.1%	4.9%	8.4%	10.4%	11.5%
(1H8)	with Culvert													
	Runoff	10.5	6.3	10.3	31.2	31.6	10.5	5.0	3.5	2.8	2.8	8.8	12.1	135.2
	R.C.	9.0%	6.3%	5.7%	13.0%	27.2%	37.1%	32.6%	19.5%	10.1%	4.9%	9.1%	11.0%	12.3%
1H10	Rainfall	148.8	131.8	225.4	300.0	145.7	36.1	21.9	23.0	30.2	49.3	95.3	121.6	1,341.7
5,870	Runoff	19.0	16.3	28.0	58.0	54.1	18.8	11.0	8.1	7.9	7.4	14.4	26.7	269.5
(km2)	R.C.	12.8%	12.3%	12.4%	19.3%	37.1%	52.1%	50.1%	35.2%	26.0%	14.9%	15.1%	22.0%	20.1%
1HA1A	Rainfall	101.1	87.7	153.8	206.5	103.3	24.3	13.4	16.2	28.0	47.8	89.0	103.3	970.3
2,840	Runoff	3.7	2.5	3.0	11.2	12.6	3.5	1.7	1.0	0.7	0.8	3.3	4.1	48.1
(km2)	R.C.	3.6%	2.9%	2.0%	5.4%	12.2%	14.6%	13.0%	6.0%	2.5%	1.6%	3.7%	3.9%	5.0%
1HA5	Rainfall	103.0	91.2	158.5	214.6	106.8	25.9	14.6	15.9	25.2	41.4	86.1	107.7	985.6
1,646	Runoff	6.3	4.0	5.5	18.4	15.1	5.3	2.9	1.9	1.8	1.9	5.7	5.7	74.4
(km2)	R.C.	6.2%	4.4%	3.5%	8.6%	14.1%	20.3%	19.7%	11.9%	7.0%	4.6%	6.6%	5.3%	7.5%
1HA15	Rainfall	101.5	88.7	155.3	209.0	104.6	25.0	13.9	16.1	26.9	45.1	88.0	105.0	974.3
2,370	Runoff	4.9	3.2	6.3	15.2	15.4	3.9	1.5	1.0	0.8	2.2	4.2	4.2	62.9
(km2)	R.C.	4.8%	3.6%	4.1%	7.3%	14.8%	15.6%	11.0%	6.3%	3.0%	4.9%	4.8%	4.0%	6.5%
1HB1	Rainfall	120.8	95.6	196.7	269.1	168.4	30.5	11.9	17.7	15.7	27.4	64.5	67.8	1,080.0
963	Runoff	17.4	17.5	23.6	46.0	35.0	13.3	9.7	7.1	6.3	6.4	12.1	12.4	207.2
(km2)	R.C.	14.4%	18.3%	12.0%	17.1%	20.8%	43.6%	81.5%	40.0%	40.1%	23.3%	18.8%	18.3%	19.2%
1HB2	Rainfall	131.1	127.7	190.4	265.0	110.9	61.3	54.2	52.1	62.2	81.6	84.9	111.6	1,333.0
101	Runoff	65.4	54.9	73.1	128.9	101.3	52.4	40.2	32.9	30.9	41.1	70.5	76.4	768.5
(km2)	R.C.	49.9%	43.0%	38.4%	48.7%	91.3%	85.5%	74.1%	63.1%	49.6%	50.3%	83.0%	68.4%	57.6%
1HC2	Rainfall	165.9	145.9	270.1	432.2	229.4	89.1	78.8	75.8	90.5	118.7	173.8	186.8	2,057.2
251	Runoff	92.4	73.2	134.7	240.8	138.8	56.9	46.1	40.3	45.0	65.4	104.2	92.5	1,131.4
(km2)	R.C.	55.7%	50.2%	49.9%	55.7%	60.5%	63.8%	58.4%	53.2%	49.7%	55.1%	59.9%	49.5%	55.0%

Note R.C. : Runoff Coefficient

Table C.17 RESULT OF PROBABILITY ANALYSIS ON DISCHARGE DATA

(1) Annual Mean Discharge

unit : m/s

Return Period	Stream Gauging Station											
	1H2	1H3	1H5	1H8	1H8*	1H10	1HA1A	1HA5	1HA15**	1HB1	1HB2	1HC2
1/500	41.09	6.96	9.65	23.40	22.97	31.65	1.68	0.67	-	3.19	0.52	0.62
1/200	43.08	11.04	10.32	25.23	24.85	32.16	1.75	0.89	-	3.45	0.71	0.92
1/100	44.89	14.53	10.90	26.94	26.63	32.65	1.82	1.08	-	3.68	0.86	1.21
1/50	47.04	18.49	11.58	29.05	28.84	33.29	1.91	1.30	-	3.95	1.04	1.58
1/40	47.82	19.88	11.82	29.84	29.66	33.53	1.95	1.38	-	4.04	1.10	1.72
1/30	48.91	21.78	12.15	30.95	30.84	33.88	2.01	1.50	-	4.18	1.18	1.92
1/25	49.66	23.04	12.38	31.72	31.80	34.13	2.05	1.57	-	4.27	1.23	2.06
1/20	50.65	24.68	12.67	32.75	32.75	34.47	2.10	1.67	-	4.39	1.30	2.25
1/10	54.29	30.47	13.72	36.66	36.94	35.80	2.33	2.02	-	4.82	1.55	2.99
1/ 5	59.34	37.85	15.10	42.36	43.12	37.88	2.71	2.49	-	5.41	1.85	4.11
1/ 4	61.46	40.77	15.65	44.85	45.83	38.83	2.89	2.69	-	5.65	1.97	4.62
1/ 3	64.78	45.14	16.50	48.83	50.22	40.41	3.21	2.98	-	6.02	2.15	5.45
1/ 2	71.33	53.21	18.11	57.05	59.35	43.87	3.94	3.54	-	6.73	2.47	7.23

Note * : with culvert
**: Data not available

(2) Annual Minimum Discharge

unit : m/s

Return Period	Stream Gauging Station											
	1H2	1H3	1H5	1H8	1H8*	1H10	1HA1A	1HA5	1HA15	1HB1	1HB2	1HC2
1/500	3.86	0.00	0.452	2.079	2.079	0.568	0.00000	0.00015	0.00000	0.000	0.000	0.000
1/200	4.00	0.05	0.677	2.684	2.684	1.203	0.00000	0.00028	0.00001	0.018	0.000	0.000
1/100	4.15	0.37	0.870	3.189	3.189	1.748	0.00000	0.00046	0.00002	0.109	0.000	0.000
1/50	4.33	0.76	1.089	3.747	3.747	2.367	0.00000	0.00079	0.00005	0.212	0.035	0.000
1/40	4.40	0.91	1.165	3.939	3.939	2.584	0.00000	0.00095	0.00006	0.247	0.050	0.000
1/30	4.50	1.13	1.271	4.200	4.200	2.882	0.00001	0.00121	0.00009	0.297	0.071	0.020
1/25	4.57	1.28	1.341	4.372	4.372	3.080	0.00001	0.00143	0.00012	0.329	0.085	0.036
1/20	4.67	1.48	1.432	4.593	4.593	3.338	0.00001	0.00176	0.00016	0.371	0.105	0.058
1/10	5.06	2.27	1.754	5.356	5.356	4.248	0.00006	0.00361	0.00047	0.520	0.182	0.157
1/ 5	5.66	3.46	2.165	6.294	6.294	5.415	0.00030	0.00860	0.00167	0.707	0.298	0.341
1/ 4	5.93	3.99	2.328	6.655	6.655	5.877	0.00056	0.01195	0.00272	0.781	0.349	0.438
1/ 3	6.39	4.87	2.573	7.185	7.185	6.571	0.00139	0.01933	0.00551	0.891	0.433	0.613
1/ 2	7.38	6.73	3.026	8.133	8.133	7.855	0.00696	0.04519	0.01925	1.093	0.612	1.060

(3) Annual Maximum Discharge

unit : m/s

Return Period	Stream Gauging Station											
	1H2	1H3	1H5	1H8	1H8*	1H10	1HA1A	1HA5	1HA15	1HB1	1HB2	1HC2
1/500	499	1,524	406	1,218	1,958	1,519	90	75	297	73	95	649
1/200	463	1,329	366	1,071	1,667	1,275	83	70	256	69	83	544
1/100	437	1,187	335	962	1,457	1,105	78	67	225	66	74	471
1/50	411	1,048	305	854	1,257	946	72	63	196	62	66	402
1/40	402	1,005	295	820	1,194	898	70	62	186	61	63	380
1/30	391	949	282	775	1,114	836	68	60	174	59	59	354
1/25	385	914	274	747	1,059	799	66	59	167	58	57	337
1/20	376	871	264	712	1,004	753	64	58	158	57	54	317
1/10	350	739	232	604	819	618	57	53	130	53	46	257
1/ 5	322	605	197	492	637	490	49	48	101	49	37	199
1/ 4	313	561	186	454	577	450	46	46	92	47	34	181
1/ 3	300	502	170	403	500	399	42	43	80	45	30	157
1/ 2	280	413	144	323	383	324	35	38	61	41	24	123

Table C.18 COEFFICIENTS OF TANK MODELS

Gauging Statio 1H5
Catchment Area 420 km2
Coefficient of Tank Hole

	Cu	Cm	Cd	Cb
Tank 1	0.250	0.050	0.035	0.400
Tank 2	0.050	0.030	0.000	0.300
Tank 3	0.040	0.030	0.000	0.250
Tank 4	0.007	0.000	0.000	0.002

Hight of Tank Hole

	Hu	Hm	Hd
Tank 1	100	50	0
Tank 2	100	0	0
Tank 3	50	0	0
Tank 4	0	0	0

Period of Hydorological Data
from 1952 to 1989
Evaporation Coefficien 0.4
Correlation Coefficient between
Actual data and Simulated data
R= 90.2 %

Gauging Station 1H8
Catchment Area 15190 km2
Coefficient of Tank Hole

	Cu	Cm	Cd	Cb
Tank 1	0.270	0.030	0.070	0.450
Tank 2	0.050	0.015	0.000	0.200
Tank 3	0.030	0.010	0.000	0.100
Tank 4	0.00055	0.000	0.000	0.000

Hight of Tank Hole

	Hu	Hm	Hd
Tank 1	350	200	0
Tank 2	150	0	0
Tank 3	100	0	0
Tank 4	0	0	0

Period of Hydorological Data
from 1959 to 1989
Evaporation Coefficient 0.5
Correlation Coefficient between
Actual data and Simulated data
R= 91.4 %

Gauging Statio 1H10
Catchment Area 5870 km2
Coefficient of Tank Hole

	Cu	Cm	Cd	Cb
Tank 1	0.600	0.080	0.030	0.150
Tank 2	0.040	0.030	0.000	0.100
Tank 3	0.002	0.002	0.000	0.100
Tank 4	0.0002	0.000	0.000	0.002

Hight of Tank Hole

	Hu	Hm	Hd
Tank 1	700	250	50
Tank 2	200	0	0
Tank 3	50	0	0
Tank 4	0	0	0

Period of Hydorological Data
from 1966 to 1989
Evaporation Coefficien 0.5
Correlation Coefficient between
Actual data and Simulated data
R= 90.6 %

Gauging Station 1HA1A
Catchment Area 2840 km2
Coefficient of Tank Hole

	Cu	Cm	Cd	Cb
Tank 1	0.068	0.037	0.007	0.210
Tank 2	0.005	0.001	0.000	0.100
Tank 3	0.005	0.001	0.000	0.100
Tank 4	0.0001	0.000	0.000	0.020

Hight of Tank Hole

	Hu	Hm	Hd
Tank 1	250	150	50
Tank 2	150	0	0
Tank 3	100	0	0
Tank 4	0	0	0

Period of Hydorological Data
from 1951 to 1989
Evaporation Coefficient 0.5
Correlation Coefficient between
Actual data and Simulated data
R= 91.3 %

Table C.19 ESTIMATED DISCHARGE AT PROPOSED DAM SITE (1/5)

(1) Rudete Catchment Area 246.8 km2

Mean Monthly Discharge (m3/s)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1950	0.88	2.59	11.38	12.10	6.86	2.03	1.13	0.75	0.63	0.60	0.78	0.85	3.38
1951	3.19	4.98	4.62	7.63	6.66	1.87	1.06	0.63	0.65	0.64	1.90	4.27	3.18
1952	1.47	4.12	4.15	10.59	6.42	1.76	0.78	0.63	0.64	0.61	0.65	0.60	2.70
1953	0.96	0.74	1.87	9.72	7.05	1.62	1.20	0.77	0.62	0.60	0.61	1.00	2.23
1954	2.51	2.90	2.06	5.92	6.28	1.39	0.88	0.62	0.61	0.58	0.60	0.59	2.08
1955	0.61	5.52	6.05	12.27	13.54	6.49	2.11	1.11	0.65	0.62	0.67	0.98	4.22
1956	6.09	5.27	7.33	15.70	8.62	3.10	1.58	0.73	0.69	0.66	0.68	0.93	4.28
1957	3.58	1.07	1.43	9.73	9.32	1.54	0.98	0.65	0.98	0.88	0.86	1.26	2.69
1958	0.79	2.61	11.15	11.54	3.50	1.78	1.08	0.75	0.71	0.68	0.69	0.81	3.01
1959	1.08	3.39	4.56	6.13	2.40	1.52	0.95	0.98	0.71	0.67	0.68	0.66	1.98
1960	1.22	2.27	8.15	8.10	3.81	2.81	1.14	0.75	0.69	0.67	0.68	0.65	2.58
1961	0.71	3.43	4.05	11.08	4.83	2.21	1.38	0.93	0.95	2.61	6.11	7.29	3.80
1962	6.26	4.83	5.51	10.53	4.97	1.66	1.15	0.98	0.73	0.70	0.83	1.07	3.27
1963	4.49	3.41	11.33	17.53	5.92	4.16	1.75	0.83	0.76	0.73	7.05	4.51	5.21
1964	3.64	3.16	7.25	6.64	1.76	1.18	0.86	0.73	0.75	0.72	0.74	1.24	2.39
1965	1.27	2.25	4.84	9.77	5.01	1.17	0.76	0.73	0.75	0.72	1.07	3.10	2.62
1966	1.22	1.28	7.70	8.60	6.57	2.54	1.24	0.88	0.76	0.73	0.91	1.00	2.79
1967	0.98	1.27	1.98	10.44	10.48	3.78	2.76	1.68	1.42	0.96	0.95	3.08	3.32
1968	5.89	3.75	11.60	15.32	6.51	3.57	1.80	1.09	0.83	0.79	0.96	0.88	4.42
1969	0.92	1.66	8.90	18.93	8.26	2.88	1.26	0.93	0.84	0.81	0.87	0.80	3.92
1970	3.62	9.23	8.11	5.46	2.07	1.26	0.91	0.78	0.84	0.77	0.79	2.98	3.07
1971	2.65	2.57	5.59	11.30	4.57	2.44	1.25	0.76	0.78	0.75	0.76	1.03	2.87
1972	1.07	1.29	6.81	14.15	13.29	3.75	1.87	1.11	0.85	1.17	2.81	4.11	4.36
1973	5.77	6.96	5.35	14.77	7.35	2.37	1.43	0.83	0.85	0.82	0.88	1.04	4.04
1974	4.48	1.28	1.30	18.16	15.99	5.85	2.73	1.10	0.86	0.84	0.86	0.82	4.52
1975	1.20	1.19	2.45	5.72	7.32	3.17	1.26	0.81	0.83	0.80	0.83	0.91	2.21
1976	1.14	1.26	4.72	6.13	3.66	1.97	1.22	0.86	0.81	0.78	0.80	0.77	2.01
1977	4.27	4.81	6.25	7.04	4.95	1.59	1.12	0.86	0.96	1.23	5.58	5.67	3.69
1978	3.18	1.58	5.43	8.98	4.48	1.66	1.15	0.84	0.83	0.79	4.06	5.99	3.25
1979	3.97	4.36	6.91	11.63	7.81	3.63	1.72	1.11	0.84	0.80	0.86	1.34	3.75
1980	1.58	2.47	2.02	5.30	3.95	1.32	0.96	0.85	0.80	0.76	1.60	2.60	2.02
1981	2.10	1.48	4.53	7.47	6.68	1.93	1.39	0.97	0.78	0.76	0.76	1.05	2.49
1982	0.88	0.83	0.90	6.58	5.88	2.38	1.56	1.04	0.78	4.17	3.71	7.95	3.06
1983	2.79	1.36	4.21	5.82	3.51	2.43	1.17	0.86	0.76	0.73	1.10	1.66	2.20
1984	4.68	1.36	3.73	11.01	6.25	2.10	1.30	0.92	0.78	0.75	1.12	1.25	2.94
1985	1.56	5.24	3.93	7.64	5.98	1.69	1.32	0.91	0.78	0.78	0.79	0.77	2.62
1986	3.20	2.56	5.71	8.15	7.44	2.04	1.21	0.86	0.76	0.78	0.91	2.06	2.97
1987	2.38	3.73	3.06	5.88	7.32	2.12	1.25	0.95	0.76	0.82	0.77	0.74	2.48
1988	1.02	0.86	1.16	4.89	1.73	1.57	1.03	0.82	0.78	0.84	0.80	0.76	1.36
1989	1.11	0.90	1.01	2.77	3.02	1.66	1.25	0.95	0.86	0.92	0.92	1.33	1.39
Mean	2.51	5.23	9.68	6.30	2.40	1.32	0.88	0.79	0.90	1.48	2.01	3.03	3.04

Table C.19 ESTIMATED DISCHARGE AT PROPOSED DAM SITE (2/5)

(2) Ngerengere Catchment Area2809.3 km2

Mean Monthly Discharge (m3/s)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1950	0.06	0.36	6.34	29.32	20.96	8.09	3.27	0.99	0.39	0.14	0.02	0.13	5.84
1951	0.29	0.75	0.53	6.25	14.17	2.31	1.11	0.21	0.03	0.00	2.49	3.42	2.63
1952	4.57	0.93	0.42	7.23	11.31	1.67	0.38	0.15	0.05	0.16	0.51	0.16	2.30
1953	0.08	0.07	0.28	3.77	17.32	4.39	0.60	0.29	0.51	0.11	0.04	0.01	2.29
1954	1.27	0.65	1.14	3.88	16.56	4.93	1.82	0.64	0.10	2.91	0.68	0.05	2.89
1955	0.06	3.57	2.35	11.20	20.34	11.71	4.27	1.77	0.48	0.21	0.81	1.21	4.83
1956	5.34	5.29	5.19	17.76	17.41	6.45	2.24	0.78	0.25	0.10	0.22	0.06	5.09
1957	0.24	6.57	3.06	7.87	24.66	5.11	1.88	1.19	0.32	1.14	1.53	1.79	4.61
1958	0.59	1.24	3.58	7.84	14.74	5.01	1.51	0.57	0.27	0.05	0.06	0.16	2.97
1959	1.65	4.01	5.64	2.96	7.68	0.98	0.38	0.43	0.95	0.23	0.06	0.96	2.16
1960	2.97	0.89	1.71	26.34	11.99	4.00	1.51	0.43	0.12	0.10	0.11	0.05	4.19
1961	0.05	1.20	0.99	2.45	7.99	1.12	4.22	2.61	0.56	3.15	32.11	23.66	6.68
1962	32.12	5.04	9.15	6.65	8.60	1.84	1.20	1.15	0.97	0.23	0.15	0.22	5.61
1963	3.33	1.85	4.71	24.76	9.49	3.05	2.15	0.80	0.22	0.07	15.43	13.43	6.61
1964	6.29	1.14	5.20	35.21	9.14	3.49	1.23	0.42	0.11	0.28	0.13	0.07	5.23
1965	1.37	0.32	0.07	13.28	3.73	4.26	0.39	0.11	0.03	0.71	3.10	2.23	2.47
1966	1.49	5.61	5.33	18.30	10.37	5.07	2.77	1.40	0.83	0.61	0.92	1.16	4.49
1967	0.07	0.07	0.93	16.41	24.45	11.99	4.82	5.36	8.57	5.60	6.93	14.71	8.33
1968	6.32	2.41	16.16	47.69	16.87	13.00	5.03	2.27	1.23	0.57	0.50	6.07	9.84
1969	0.89	2.45	4.17	10.97	18.63	2.21	1.68	1.64	1.40	1.02	3.91	1.22	4.18
1970	2.91	6.27	6.08	12.37	5.89	2.13	0.84	0.35	0.95	0.60	0.89	0.24	3.29
1971	4.28	5.48	0.72	9.79	10.32	2.68	2.71	0.68	0.46	0.17	0.06	0.06	3.12
1972	0.22	0.26	1.89	11.86	32.54	8.15	2.01	0.96	1.16	1.99	4.09	2.93	5.67
1973	11.25	8.10	2.67	16.63	25.70	4.31	2.41	0.69	0.22	0.37	0.06	1.09	6.13
1974	0.38	0.06	0.35	19.07	17.37	3.49	1.69	0.77	0.36	0.23	0.06	0.06	3.66
1975	0.16	0.06	1.31	13.77	13.58	5.11	1.56	0.45	0.24	0.12	0.06	0.05	3.04
1976	1.19	0.28	0.38	2.44	5.91	2.32	0.82	0.15	0.50	0.05	0.05	0.05	1.18
1977	0.33	2.43	1.93	3.15	5.12	2.92	0.31	0.17	0.36	0.43	1.56	4.91	1.97
1978	7.36	1.87	5.55	14.56	10.78	2.03	0.63	0.22	0.08	0.05	0.71	14.02	4.82
1979	5.21	13.47	15.59	33.98	29.34	18.63	6.67	2.51	0.76	0.50	0.81	3.66	10.93
1980	1.95	1.84	1.09	3.02	8.74	1.13	0.62	0.36	0.23	0.05	0.48	4.54	2.00
1981	0.87	0.59	4.21	8.31	13.55	3.35	1.06	0.56	0.55	0.08	0.58	4.10	3.15
1982	1.12	0.07	0.64	3.24	6.97	1.99	3.06	2.14	0.51	3.68	4.01	12.46	3.32
1983	4.42	2.30	3.44	7.80	20.09	9.39	7.99	2.35	0.66	0.33	0.06	0.30	4.93
1984	3.53	2.67	2.01	21.52	18.38	4.95	2.94	1.40	0.54	0.12	7.43	3.87	5.78
1985	1.09	1.38	2.28	6.97	16.51	2.55	1.84	0.76	0.15	0.06	0.07	0.92	2.88
1986	0.42	1.21	1.12	18.83	18.57	6.29	1.86	0.67	0.19	0.06	0.64	5.33	4.60
1987	2.76	1.97	2.03	5.80	18.30	2.29	3.44	1.66	0.44	0.11	0.07	0.07	3.25
1988	0.09	0.21	2.19	5.09	2.82	0.87	0.91	0.41	0.27	0.07	0.45	1.48	1.24
1989	14.86	2.96	1.01	25.46	16.92	8.19	1.84	0.83	0.59	0.86	1.06	1.65	6.35
Mean	3.34	2.45	3.34	13.60	14.60	4.84	2.19	1.03	0.67	0.68	2.32	3.31	4.36

Table C.19 ESTIMATED DISCHARGE AT PROPOSED DAM SITE (3/5)

(3) Mkombezi Catchment Area 602.9 km2

Mean Monthly Discharge (m3/s)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1950	0.00	0.10	3.93	7.94	7.88	4.30	2.37	1.12	1.07	0.30	0.10	0.06	2.43
1951	0.35	0.56	0.58	2.87	5.03	2.40	0.85	0.21	0.09	0.08	3.21	4.05	1.69
1952	0.99	0.81	2.72	3.69	2.32	0.79	0.17	0.06	0.04	0.01	0.07	0.01	0.97
1953	0.15	0.03	0.08	1.85	8.00	4.18	1.80	0.67	0.18	0.45	0.88	1.88	1.68
1954	2.17	4.22	2.42	3.95	5.59	2.31	0.73	0.26	0.13	2.29	0.91	0.33	2.11
1955	0.13	1.16	1.02	2.74	7.40	4.46	1.86	0.58	0.16	0.07	0.16	0.41	1.68
1956	0.53	0.43	0.45	4.90	3.21	1.11	0.30	0.11	0.02	0.01	0.01	0.03	0.93
1957	0.72	0.53	0.73	8.56	9.33	4.91	1.94	0.55	0.15	0.20	2.59	1.03	2.60
1958	0.16	0.22	5.31	4.90	2.14	1.10	0.28	0.13	0.04	0.02	0.01	0.08	1.20
1959	0.15	1.18	0.66	3.17	4.28	1.32	0.40	0.15	0.04	0.01	0.01	0.01	0.95
1960	0.11	0.04	0.43	2.04	1.09	0.72	0.20	0.07	0.01	0.01	0.01	0.01	0.40
1961	0.01	0.24	0.09	0.34	0.60	0.16	0.24	0.09	0.14	4.06	6.99	6.06	1.59
1962	7.44	4.98	5.23	4.61	1.61	0.58	0.20	0.19	0.10	0.03	0.01	0.04	2.09
1963	0.12	0.10	0.41	3.67	1.83	0.73	0.19	0.07	0.02	0.01	0.76	1.01	0.74
1964	0.79	0.54	0.93	1.40	0.59	0.36	0.12	0.02	0.01	0.03	0.01	0.01	0.40
1965	0.11	0.12	0.06	1.20	1.08	0.34	0.12	0.09	0.07	0.13	0.17	0.89	0.37
1966	0.30	1.09	2.33	6.83	5.68	2.64	0.81	0.19	0.09	0.09	0.07	0.01	1.68
1967	0.01	0.02	0.01	1.33	2.39	1.43	0.82	0.20	1.12	1.07	1.38	0.77	0.88
1968	0.13	0.09	6.94	9.33	6.93	6.41	2.81	0.31	0.31	0.09	2.27	1.72	3.11
1969	0.73	2.17	2.33	3.22	1.70	0.70	0.18	0.11	0.03	0.01	0.01	0.01	0.93
1970	0.08	0.16	0.85	0.87	0.29	0.06	0.01	0.01	0.01	0.01	0.01	0.01	0.20
1971	0.09	0.07	0.10	0.80	0.63	0.17	0.09	0.01	0.01	0.01	0.01	0.01	0.17
1972	0.01	0.01	0.06	1.32	4.03	0.91	0.27	0.08	0.04	0.27	0.75	1.08	0.74
1973	0.77	0.18	0.15	1.76	1.15	0.67	0.17	0.10	0.01	0.01	0.01	0.06	0.42
1974	0.07	0.05	0.04	2.03	1.85	0.88	0.46	0.11	0.02	0.01	0.01	0.01	0.46
1975	0.06	0.01	0.09	2.48	2.59	1.03	0.29	0.01	0.02	0.01	0.01	0.01	0.55
1976	0.01	0.01	0.06	1.18	1.08	0.55	0.08	0.01	0.01	0.01	0.01	0.01	0.25
1977	0.07	0.45	1.06	1.18	1.13	0.36	0.12	0.05	0.13	0.13	0.39	1.17	0.52
1978	0.52	0.12	0.30	0.71	0.50	0.16	0.09	0.01	0.01	0.01	0.49	0.99	0.33
1979	1.60	2.34	2.83	4.62	5.80	3.12	0.92	0.20	0.08	0.05	0.12	0.35	1.84
1980	0.31	2.60	1.09	0.85	0.51	0.14	0.05	0.01	0.01	0.01	0.10	0.16	0.49
1981	0.14	0.04	0.52	2.17	0.92	0.20	0.11	0.04	0.02	0.06	0.02	1.77	0.50
1982	0.32	0.08	0.07	0.47	0.63	0.62	0.44	0.15	0.13	3.77	1.22	0.53	0.70
1983	0.09	0.05	0.17	0.47	15.34	9.76	14.43	7.92	3.48	2.75	0.58	0.23	4.61
1984	0.17	0.04	0.14	1.78	2.00	1.15	0.56	0.16	0.09	0.16	2.77	3.53	1.05
1985	2.28	1.74	1.94	2.44	2.18	0.82	0.45	0.14	0.06	0.01	0.09	0.10	1.02
1986	0.17	0.06	0.50	2.30	5.19	2.11	0.60	0.16	0.06	0.03	0.29	1.44	1.08
1987	0.74	0.27	0.29	0.65	2.30	0.43	0.15	0.13	0.03	0.02	0.02	0.01	0.42
1988	0.12	0.24	1.17	2.78	1.50	1.08	0.34	0.17	0.14	0.09	0.20	0.54	0.70
1989	1.02	0.07	0.15	2.13	2.33	0.99	0.24	0.11	0.10	0.11	0.06	0.37	0.64
Mean	0.59	0.68	1.21	2.79	3.27	1.65	0.91	0.37	0.21	0.41	0.67	0.77	1.13

Table C.19 ESTIMATED DISCHARGE AT PROPOSED DAM SITE (4/5)

(4) Mgeta Catchment Area 938.7 km2

Mean Monthly Discharge (m3/s)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1950	3.30	10.91	48.44	46.36	25.31	8.04	4.63	3.06	2.57	2.52	3.05	3.97	13.51
1951	16.75	22.16	17.16	26.93	24.12	7.21	4.30	2.87	2.66	2.62	9.40	18.59	12.90
1952	8.58	19.15	16.18	40.10	23.62	6.89	4.13	2.88	2.69	2.58	2.78	2.54	11.01
1953	3.55	3.10	10.67	41.62	28.79	7.18	5.52	3.63	2.64	2.60	2.59	3.35	9.60
1954	7.87	12.60	11.39	22.95	23.31	5.49	3.60	2.57	2.54	2.44	2.50	2.70	8.33
1955	2.69	29.36	26.62	42.99	46.53	22.97	7.72	4.15	2.63	2.52	2.78	4.14	16.26
1956	32.39	22.10	30.67	60.86	21.77	8.72	5.06	2.74	2.81	2.69	2.76	3.85	16.37
1957	14.31	4.59	7.36	38.52	35.85	6.18	3.88	2.80	4.76	3.59	3.55	7.67	11.09
1958	3.33	10.90	41.07	43.09	13.92	6.65	4.14	2.96	2.85	2.73	2.80	4.43	11.57
1959	5.40	17.80	19.11	21.69	6.69	4.69	3.28	4.22	2.89	2.68	2.75	2.63	7.82
1960	4.43	11.21	30.68	41.63	16.40	9.52	4.58	3.12	2.81	2.69	2.76	2.64	11.04
1961	2.93	16.10	18.35	56.68	23.88	9.55	6.88	3.97	2.93	7.90	27.24	34.87	17.61
1962	27.01	23.75	25.11	45.58	18.68	5.10	3.98	3.23	2.83	2.72	2.88	4.04	13.74
1963	18.08	17.82	39.40	69.41	24.42	17.63	7.13	3.31	2.96	2.84	32.60	17.93	21.13
1964	13.64	12.07	44.88	32.51	9.06	5.32	3.83	2.94	3.01	2.89	2.96	4.68	11.48
1965	4.98	12.82	21.03	39.56	17.91	4.63	3.07	2.94	3.01	2.88	4.60	11.58	10.75
1966	5.57	7.01	31.39	37.19	22.09	9.50	4.79	3.33	2.99	2.87	3.47	3.45	11.14
1967	3.91	5.51	10.13	36.60	36.82	11.48	9.75	6.11	5.43	3.73	4.30	15.83	12.47
1968	21.65	15.33	46.77	61.41	25.05	14.13	7.38	4.35	3.32	3.12	3.84	3.75	17.51
1969	4.36	9.66	39.29	76.35	30.97	11.24	5.04	3.73	3.32	3.18	3.68	3.52	16.20
1970	13.25	50.66	37.79	24.14	9.31	4.42	3.11	3.08	3.34	3.04	3.11	7.48	13.56
1971	9.95	12.55	18.31	39.08	16.96	9.81	4.87	3.06	3.13	3.00	3.08	4.34	10.68
1972	5.18	5.38	23.57	46.15	40.10	10.38	5.86	3.95	3.29	4.92	10.32	18.47	14.80
1973	22.45	34.17	23.72	57.97	23.89	8.95	5.50	3.33	3.41	3.27	3.58	5.14	16.28
1974	15.90	5.28	5.31	71.20	65.85	25.83	11.08	4.54	3.60	3.36	3.63	3.43	18.25
1975	7.03	6.11	20.10	32.33	36.92	17.08	6.04	3.39	3.34	3.20	3.54	3.76	11.90
1976	4.85	4.66	18.42	28.50	14.13	8.31	4.92	3.51	3.45	3.19	3.25	3.12	8.36
1977	18.19	23.50	22.29	26.50	24.17	7.25	4.88	3.69	3.92	8.08	18.09	23.46	15.34
1978	15.58	6.37	21.55	33.46	16.95	6.63	4.62	3.32	3.26	3.13	16.15	26.38	13.12
1979	15.86	19.72	31.90	48.62	32.02	16.85	7.47	4.65	3.49	3.24	3.51	5.94	16.11
1980	6.54	10.39	5.18	20.75	18.56	5.68	4.04	3.51	3.24	3.10	4.77	13.53	8.27
1981	7.25	6.37	22.30	36.49	30.37	10.80	6.73	4.51	3.32	3.19	3.16	6.63	11.76
1982	4.10	3.57	4.07	27.83	22.65	9.18	8.01	4.35	3.41	10.65	13.84	32.12	11.98
1983	11.89	4.75	14.82	19.89	12.53	10.27	4.56	3.45	3.15	3.02	4.65	7.44	8.37
1984	20.31	8.14	17.09	51.92	31.15	11.63	6.14	4.16	3.30	3.22	5.23	5.72	14.00
1985	5.12	20.96	16.23	38.80	28.14	8.26	5.77	4.27	3.44	3.43	3.78	4.11	11.86
1986	17.91	10.00	22.48	39.82	38.78	12.61	6.25	4.38	3.46	3.63	4.57	18.71	15.22
1987	17.46	18.84	14.08	18.03	22.21	6.59	4.77	3.96	3.44	3.94	3.76	3.37	10.04
1988	4.27	3.74	5.34	20.16	7.14	6.23	4.25	3.45	3.31	3.75	3.83	3.88	5.78
1989	13.48	4.30	6.90	21.08	15.27	8.42	5.26	3.93	3.44	3.63	3.75	5.11	7.88
Mean	11.03	13.59	22.18	39.62	24.56	9.68	5.42	3.64	3.23	3.54	6.07	8.96	12.63

Table C.19 ESTIMATED DISCHARGE AT PROPOSED DAM SITE (5/5)

(5) Kidunda Catchment Area5760.9 km2

Mean Monthly Discharge (m3/s)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1950	10.37	15.78	69.25	130.72	124.04	91.80	64.63	44.01	34.06	21.68	16.79	12.91	53.00
1951	16.60	48.21	56.36	116.33	119.02	94.21	62.75	34.59	22.24	16.93	25.33	34.46	53.92
1952	18.38	47.74	77.09	121.44	112.84	83.66	52.87	31.00	24.26	19.96	16.93	8.71	51.24
1953	9.81	6.37	14.99	60.76	94.61	65.60	41.53	25.97	19.88	14.95	8.66	13.66	31.40
1954	16.63	21.14	35.74	70.08	89.94	61.55	35.47	21.78	15.34	10.69	5.41	4.93	32.39
1955	5.57	21.69	36.24	106.22	152.00	117.00	81.24	48.82	28.63	20.06	15.88	15.47	54.07
1956	60.85	89.40	106.11	291.28	134.44	109.10	70.76	38.65	26.19	16.39	9.12	7.87	80.01
1957	19.53	18.05	28.41	114.86	123.40	87.71	58.87	31.71	27.57	23.62	20.71	17.47	47.66
1958	11.14	20.58	96.03	132.08	105.51	88.70	56.07	31.98	23.38	13.89	7.00	9.79	49.68
1959	16.15	29.72	54.74	83.42	71.03	53.81	31.61	33.34	21.31	14.84	8.06	5.54	35.30
1960	15.95	16.86	57.57	98.97	76.27	69.27	40.61	23.18	16.35	9.40	4.46	4.30	36.10
1961	4.29	15.87	21.20	70.34	62.99	55.95	46.15	25.62	27.68	50.98	81.78	106.96	47.48
1962	111.91	107.84	114.96	182.68	125.53	91.59	62.81	57.28	33.46	25.13	22.60	20.32	79.68
1963	51.40	57.22	117.25	231.57	106.92	90.47	60.85	33.00	24.65	16.77	59.89	61.55	75.96
1964	62.00	60.57	96.79	139.28	105.18	75.48	49.51	29.96	22.89	18.72	9.71	11.16	56.77
1965	16.09	20.87	41.17	104.17	98.05	65.72	38.84	24.09	19.45	15.37	21.19	53.36	43.20
1966	47.69	61.14	106.65	196.45	129.78	108.97	71.57	42.22	12.83	13.51	22.15	16.44	69.12
1967	8.55	30.02	23.86	79.26	135.78	74.45	38.87	31.88	49.89	29.79	95.40	242.01	69.98
1968	94.06	46.36	156.44	472.06	133.45	89.35	36.33	55.77	16.79	12.54	44.96	58.22	101.36
1969	19.92	23.87	60.89	74.84	176.23	38.50	22.14	20.18	16.46	16.37	26.68	23.51	43.30
1970	59.36	110.47	96.05	120.65	49.56	22.33	14.13	10.07	18.01	11.44	8.06	45.25	47.12
1971	15.87	2.96	48.60	140.38	69.07	30.55	25.54	15.22	11.56	12.03	10.04	15.68	33.13
1972	41.14	16.88	35.64	186.02	195.07	52.39	24.63	15.73	21.37	29.18	44.56	49.00	59.30
1973	86.63	71.88	58.84	182.31	231.31	42.02	24.81	39.81	12.30	10.32	20.44	25.07	67.15
1974	19.22	15.57	18.01	111.37	213.25	47.44	28.69	17.04	11.19	12.07	7.96	7.56	42.45
1975	19.98	7.33	35.14	91.80	115.79	43.88	26.38	14.53	16.58	17.05	11.83	26.53	35.57
1976	28.50	39.85	82.20	101.42	88.48	52.38	31.44	20.45	14.63	18.68	11.70	13.63	41.95
1977	32.40	28.44	36.26	79.06	58.62	29.70	16.75	12.96	26.42	15.98	38.75	84.26	38.30
1978	50.27	34.15	73.39	126.65	63.86	31.60	19.09	13.19	9.38	8.46	71.62	153.20	54.57
1979	78.13	161.89	220.19	551.81	154.25	123.73	89.02	22.36	20.80	18.11	24.28	30.10	124.56
1980	36.54	56.70	54.91	82.23	79.32	35.51	20.24	16.83	12.79	10.15	28.88	112.96	45.59
1981	49.74	41.36	34.74	106.01	67.51	40.62	22.65	17.33	16.84	15.62	13.66	41.48	38.96
1982	31.58	14.15	18.32	53.18	72.62	26.96	17.07	21.96	19.63	40.12	45.92	66.84	35.70
1983	108.09	31.58	23.37	67.04	112.01	48.64	67.30	40.52	19.97	22.32	17.35	19.53	48.14
1984	25.29	21.75	21.67	99.91	89.14	68.18	24.90	19.59	14.12	19.75	98.98	75.29	48.21
1985	19.74	50.36	50.54	82.57	87.78	63.34	26.45	16.87	9.81	9.13	18.03	12.00	37.22
1986	20.86	28.81	61.34	93.54	97.12	69.64	21.32	26.79	20.42	17.16	18.10	28.65	41.98
1987	41.50	25.37	42.68	27.84	91.08	27.21	44.51	18.01	15.89	19.22	13.40	10.49	31.43
1988	24.51	25.57	44.10	42.39	33.42	33.19	22.30	17.64	23.16	12.31	24.91	23.53	27.25
1989	24.26	22.62	18.92	73.11	74.55	63.59	43.47	29.72	23.21	20.17	29.64	18.37	36.80
Mean	35.76	39.17	61.17	132.40	108.02	64.14	40.85	27.29	20.53	18.02	27.02	39.70	51.17

Table C.20 COEFFICIENTS OF STORAGE FUNCTION MODEL

(1) Coefficients of Basin

No.	Name of Basin	K	P	TL (hr)	F	Rsa (mm)	Area (km2)	QB (m3/s)	Outflow River No.
1	Basin 1	282.74	0.46	116.17	0.28	2000	1342	6.86	1
2	Basin 2	341.05	0.53	62.87	0.28	2000	1437	7.34	1
3	Basin 3	290.46	0.47	69.17	0.26	2000	1124	5.74	1
4	Basin 4	215.13	0.37	39.56	0.28	2000	1023	5.23	2
5	Basin 5	231.32	0.39	54.60	0.26	2000	1316	6.73	2
6	Basin 6	581.35	0.80	89.00	0.21	2000	1858	0.33	3
7	Basin 7	71.86	0.42	94.15	0.11	2000	526	0.37	4
8	Basin 8	98.16	0.53	123.76	0.10	2000	1387	0.98	4
9	Basin 9	139.85	0.70	233.17	0.10	2000	943	0.66	5
10	Basin 10	409.12	0.61	51.69	0.21	2000	511	0.09	6
11	Basin 11	462.35	0.67	33.45	0.21	2000	672	0.12	7
12	Basin 12	447.51	0.65	73.78	0.21	2000	924	0.16	7
13	Basin 13	457.50	0.66	91.26	0.21	2000	899	0.16	8
14	Basin 14	409.04	0.61	27.90	0.21	2000	700	0.12	8
15	Basin 15	128.72	0.66	300.57	0.10	2000	885	0.17	9
16	Basin 16	449.82	0.66	23.67	0.21	2000	171	0.03	9
17	Basin 17	128.84	0.66	287.88	0.10	2000	885	0.17	10
18	Basin 18	122.07	0.63	115.86	0.10	2000	287	0.06	10
19	Basin 19	473.57	0.68	32.60	0.21	2000	497	0.10	10
20	Basin 20	113.28	0.59	79.20	0.10	2000	324	0.06	11
21	Basin 21	567.66	0.79	17.00	0.21	2000	263	0.05	11

(2) Coefficients of River

No.	Name of River	K	P	TL (hr)	Outflow River No.
1	River 1	165.7	0.75	7.51	3
2	River 2	121.22	0.73	4.82	3
3	River 3	459.41	0.69	76.81	6
4	River 4	34.54	0.78	96.74	5
5	River 5	25.98	0.78	77.14	6
6	River 6	82.73	0.73	17.92	7
7	River 7	277.14	0.73	62.99	8
8	River 8	50.31	0.77	13.73	9
9	River 9	47.17	0.77	13.22	10
10	River 10	89.49	0.77	25.14	11
11	River 11	109.36	0.77	30.71	12

Table C.21 PEAK FLOOD DISCHARGE AT PROPOSED DAM SITE

unit : m3/s

Proposed Dam Site	Catchment Area(km2)	Return Period 1/5	1/10	1/20	1/50	1/100	1/200
Rudete	246.8	54.22	70.42	94.05	121.13	143.93	196.83
(Specific Q m3/s/km2)		(0.220)	(0.285)	(0.381)	(0.491)	(0.583)	(0.798)
Ngerengere	2809.3	48.47	56.24	63.06	71.21	76.95	82.42
(Specific Q m3/s/km2)		(0.017)	(0.020)	(0.022)	(0.025)	(0.027)	(0.029)
Mkombezi	602.9	13.39	17.9	22.65	29.29	34.59	40.25
(Specific Q m3/s/km2)		(0.022)	(0.030)	(0.038)	(0.049)	(0.057)	(0.067)
Mgeta	938.7	136.31	184.09	257.37	345.19	421.53	525.54
(Specific Q m3/s/km2)		(0.145)	(0.196)	(0.274)	(0.368)	(0.449)	(0.560)
Kidunda	5760.9	481.28	606.65	739.1	928.33	1084.0	1251.3
(Specific Q m3/s/km2)		(0.084)	(0.105)	(0.128)	(0.161)	(0.188)	(0.217)

Table C.22 SUMMARY OF SEDIMENT YIELD

Item	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
1H8	Catchment Area		15,190 km2		Data Period 1958 to 1992							unit : t/d	
MEAN	14,135	7,017	13,016	54,643	51,719	13,854	4,016	2,409	1,976	1,887	13,313	17,543	16,294
MEAN MAX.	32,114	13,880	33,571	114,899	108,316	34,691	6,456	3,870	3,869	5,000	34,334	42,328	36,111
MEAN MIN.	4,738	3,535	4,383	21,576	17,391	5,081	2,629	1,702	1,202	1,008	3,703	6,825	6,148
												unit : m3/km2	
MEAN	16.03	7.19	14.76	59.95	58.64	15.2	4.55	2.73	2.17	2.14	14.61	19.89	217.85
MEAN MAX.	36.41	14.21	38.06	126.07	122.81	38.06	7.32	4.39	4.25	5.67	37.67	47.99	
MEAN MIN.	5.37	3.62	4.97	23.67	19.72	5.58	2.98	1.93	1.32	1.14	4.06	7.74	
1H10	Catchment Area		5,870 km2		Data Period 1966 to 1991							unit : t/d	
MEAN	8,137	7,818	14,155	36,532	30,826	7,854	3,672	2,485	2,607	2,266	6,452	13,502	11,359
MEAN MAX.	23,516	17,359	38,739	79,855	83,247	16,216	6,516	4,603	6,600	6,306	26,376	40,242	29,131
MEAN MIN.	3,332	3,723	3,597	9,917	10,302	4,394	2,599	1,777	1,552	1,235	1,781	4,084	4,024
												unit : m3/km2	
MEAN	23.87	20.72	41.53	103.73	90.44	22.3	10.77	7.29	7.4	6.65	18.32	39.61	392.64
MEAN MAX.	68.99	46	113.66	226.73	244.24	46.04	19.12	13.51	18.74	18.5	74.89	118.07	
MEAN MIN.	9.78	9.87	10.55	28.16	30.22	12.48	7.62	5.21	4.41	3.62	5.06	11.98	

APPENDIX-C

FIGURES

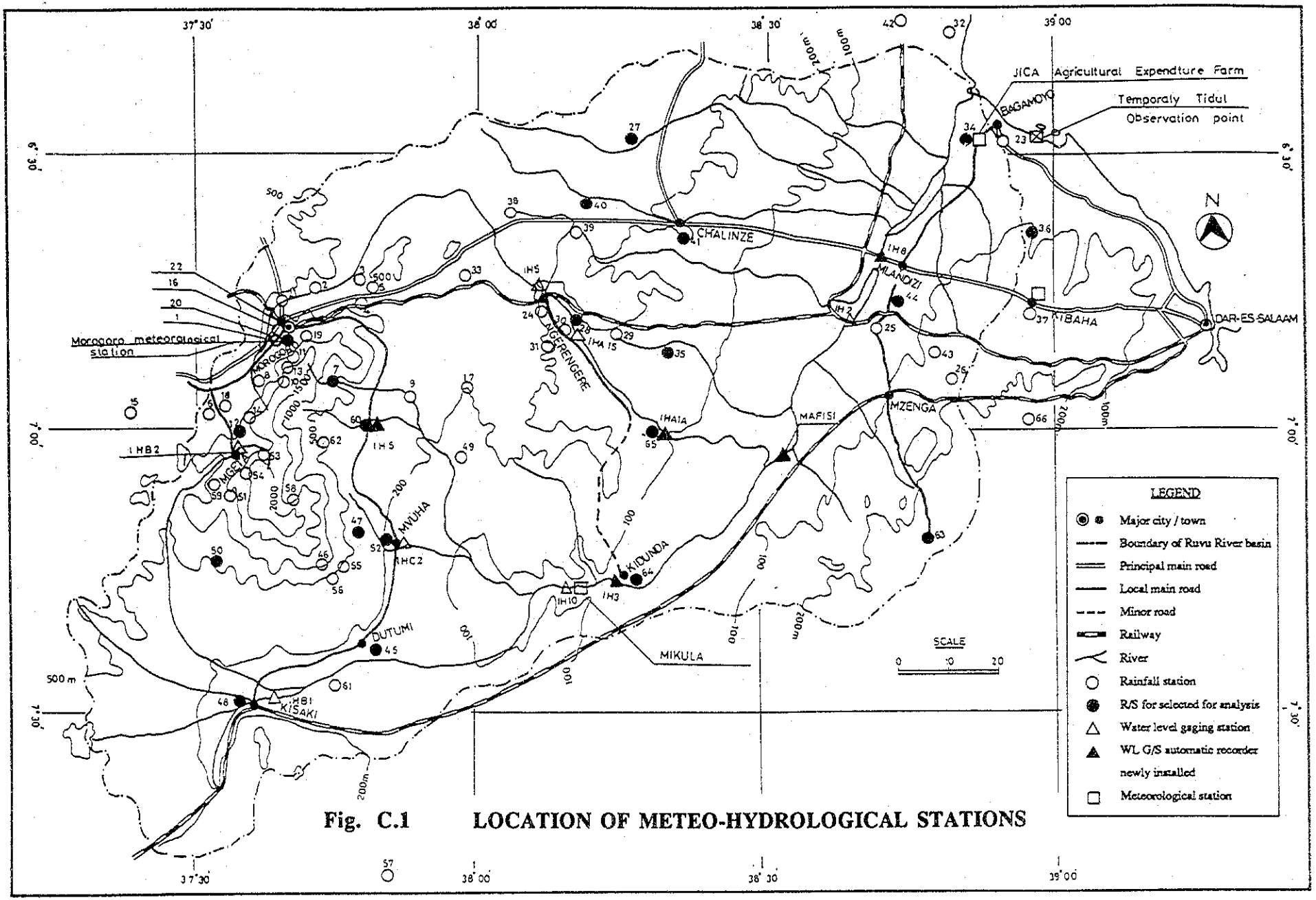
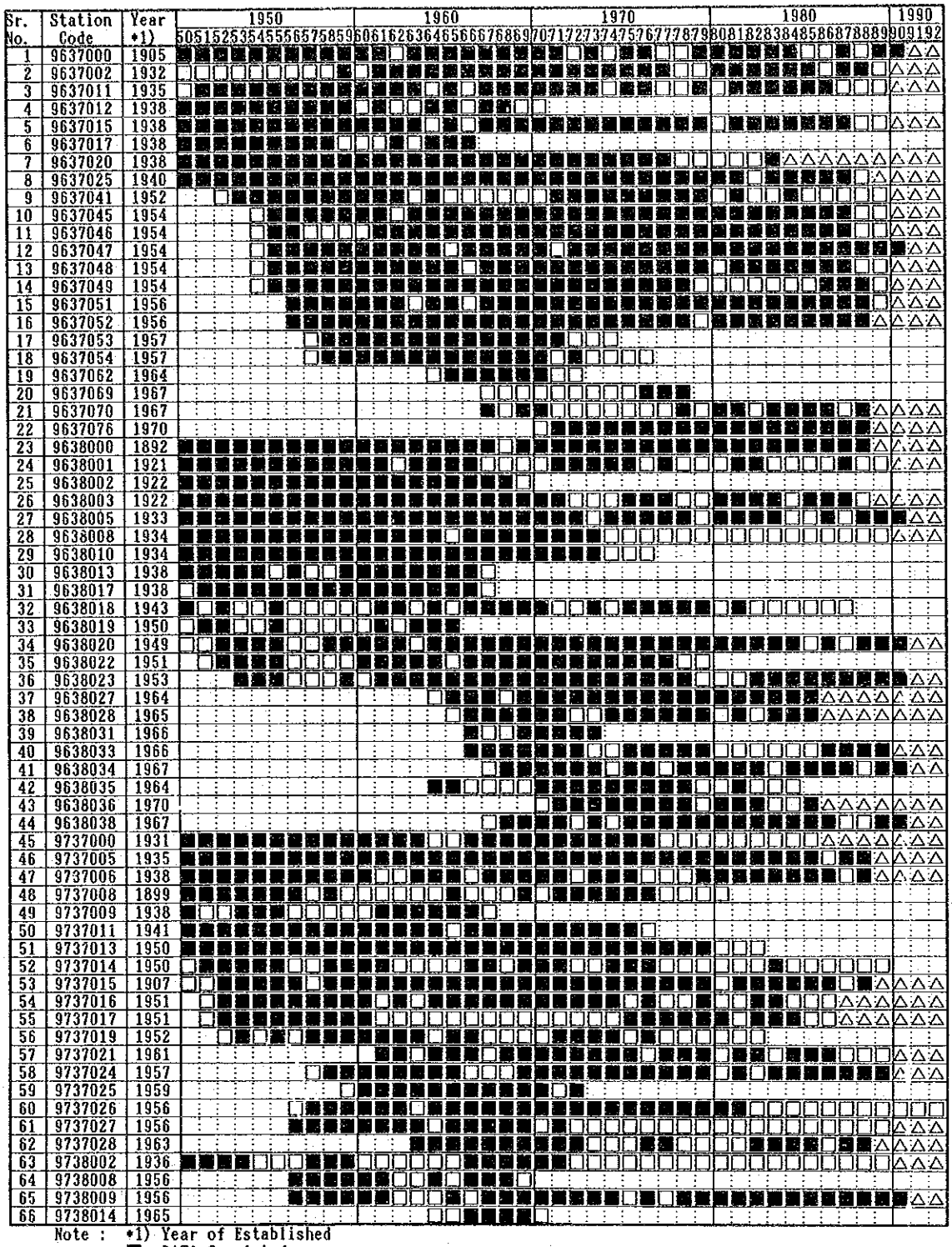


Fig. C.1 LOCATION OF METEO-HYDROLOGICAL STATIONS

(1) Rainfall Data



Note : *1) Year of Established
■ DATA Completed
□ DATA not Completed
△ Processing

Fig. C.2 BAR CHART OF DATA CONTINUITY (1/2)

(2) Meteorological Data

Sr. No.	CODE	NAME OF STATION	1970	1980	1990
			707172737475767778798081828384858687888990919 2		
1	9637076	Morogoro Meteorological Station	□□□■■□■■□■■■■■■■■□□△△△		
2	9638027	Kibaha Farmers	□□□□■■□■□□□□□□□□□■■■		
3	9000064	Mikura	■■■□		
4	-	Experimental Farm (JICA)			□■■

Note : ■ DATA Completed
□ DATA not Completed
△ Processing

(3) Hydrological Data

Sr. No.	Station Code	River	1950	1960	1970	1980	1990
			505152535455565758596061626364656667686970717273747576777879808182838485868788899091 92				
1	1H2*	Ruvu	□■■■■■□■■□				
2	1H3*	Ruvu	□■■■■■■■■■■■■■■□□				
3	1H5*	Ruvu	□■■□■□■■■□■■■■■■□□■■■■■■■■□□□□□□□□□□□□□				
4	1H8*	Ruvu	□■■■■■■■■■■■■■■■■■■■■■■□□□■□□■□□□□□□□□□				
5	1H10*	Ruvu	□■■■■■■■■■■■■■■■■■■■■■■□□□□□□□□□□□□□□□□□				
6	1HA1A*	Ngerengere	□■■□■□□□□□□■□■■□□■■■■□□□□□□□□□□□□□□□□□				
7	1HA3	Ngerengere	□■■■□■■□□□■■■□				
8	1HA4	Ngerengere	□□□□□□□				
9	1HA5*	Ngerengere	□□□□□■□■□□□□■■■■■□				
10	1HA6	Ngerengere	□■□■■□□□□■■□				
11	1HA7	Mlali	□□■□■□□□■■□				
12	1HA8	Morogoro	□□■□■□□□□□■□□■■■□■■□□□□■□■■□□□□□□□□□□□□				
13	1HA9	Ngerengere	□□■■■□□□				
14	1HA9A	Ngerengere	□□□□□□□■■□■■□□□■■□■■□□□□□□□□□□□□□□□□□				
15	1HA10	Ngerengere	□□■■□□■■□□				
16	1HA15*	Ngerengere	□□□□□□□□□□■■□■□□□□□□□□□□□□□□□□□□□□□□□				
17	1HB1*	Msoro	□□■■■■■■□				
18	1HB2*	Mgeta	□□□□□□□■■■■■■■□□□□□□■■□□■■■□□□□□□□□□□				
19	1HB3	Mgeta	□□□□■■■□				
20	1HB4	Mgeta	□□■■■□□■□□				
21	1HC2*	Mvuha	□■□■■■■□□□□□□□□□□□□□■■□□□□□□□□□□□□□□□□□				

Note * : Stations selected for the Study
■ DATA Completed
□ DATA not Completed

Fig. C.2 BAR CHART OF DATA CONTINUITY (2/2)

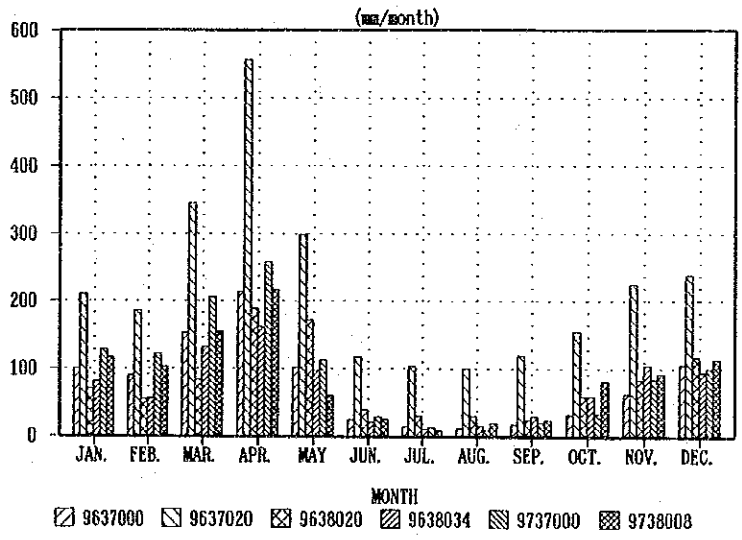


Fig. C.3 SEASONAL RAINFALL PATTERN AT 6 STATIONS

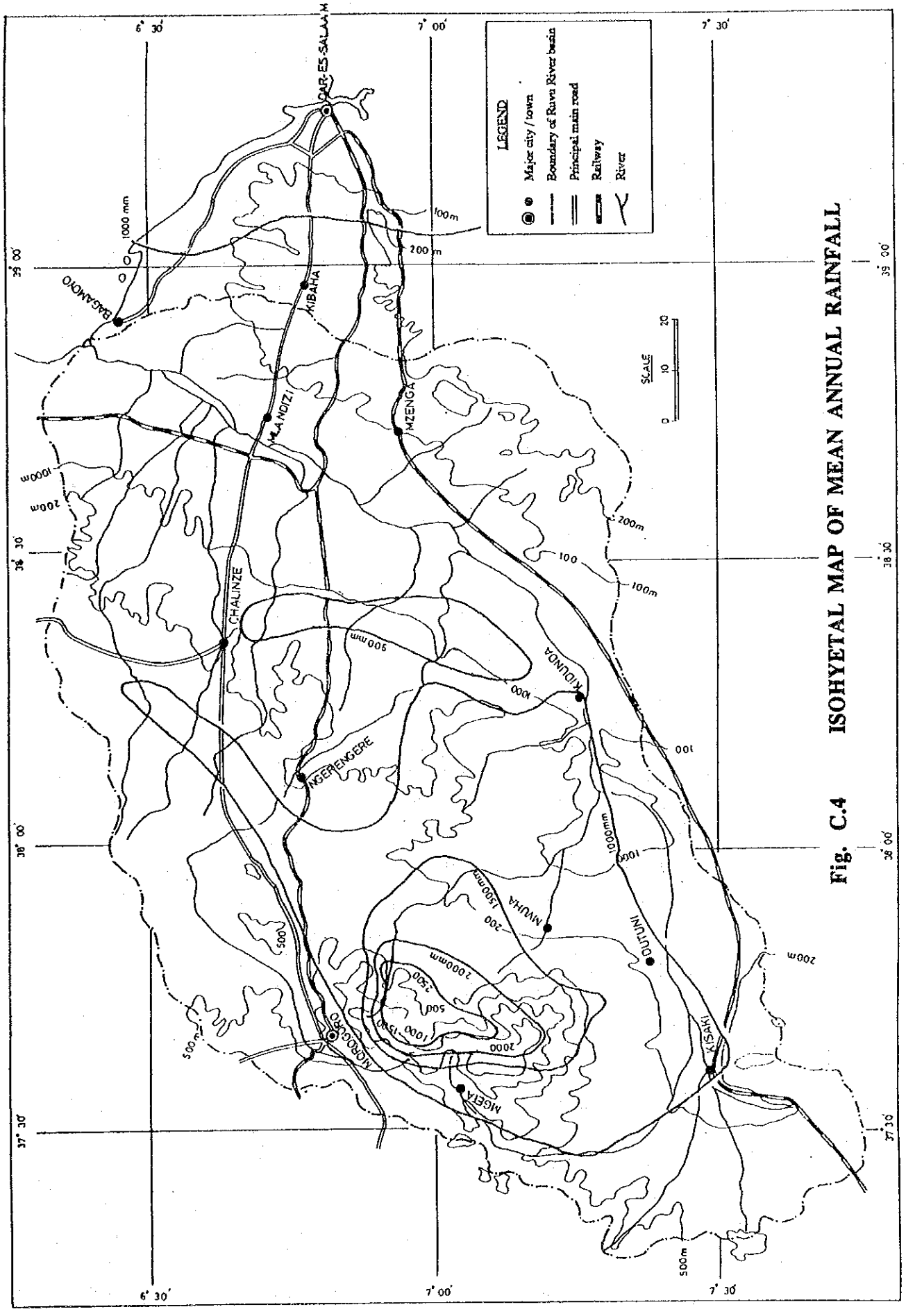


Fig. C.4 ISOHYETAL MAP OF MEAN ANNUAL RAINFALL

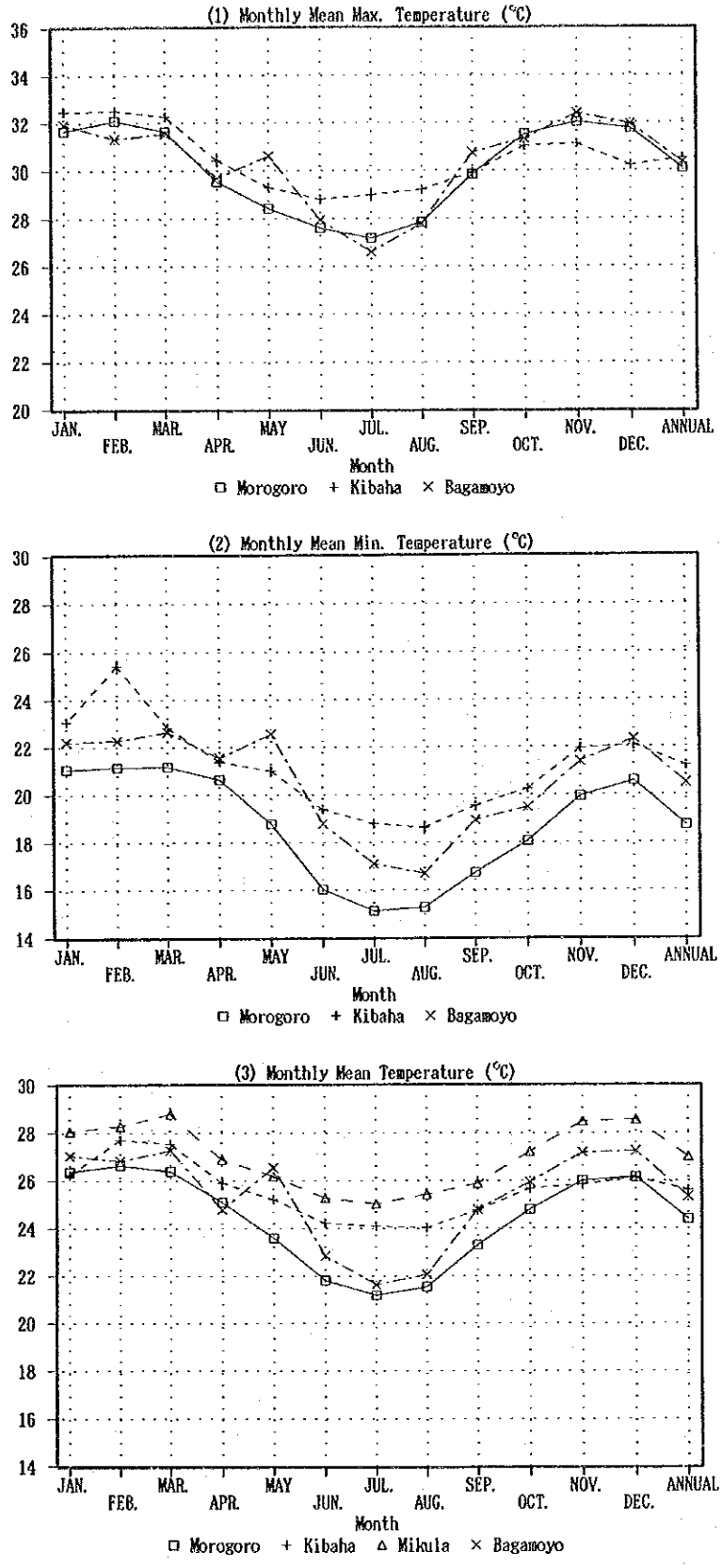
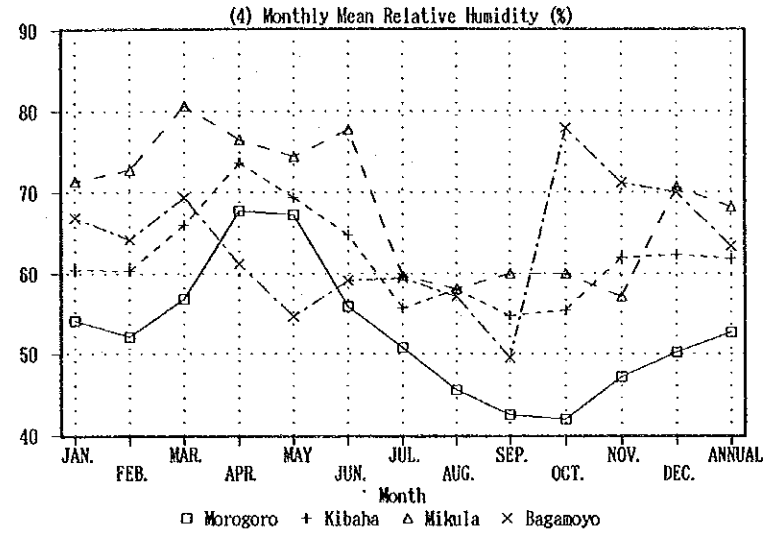
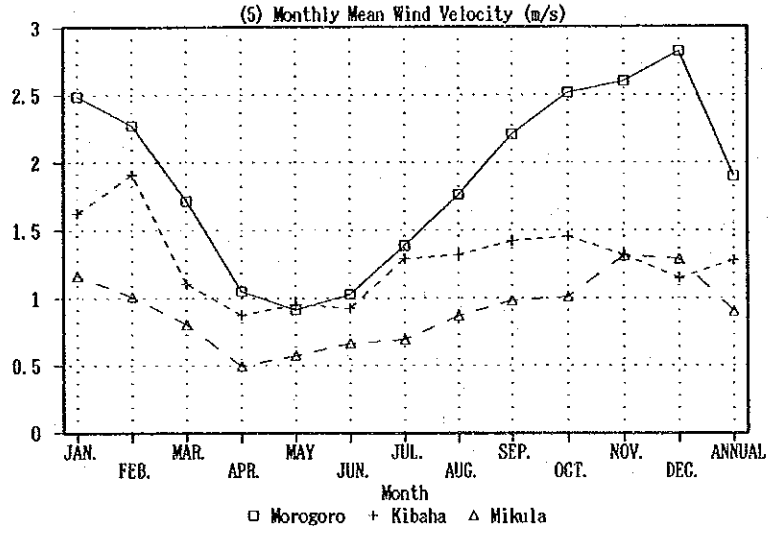


Fig. C.5 SUMMARY OF METEOROLOGICAL DATA (1/2)





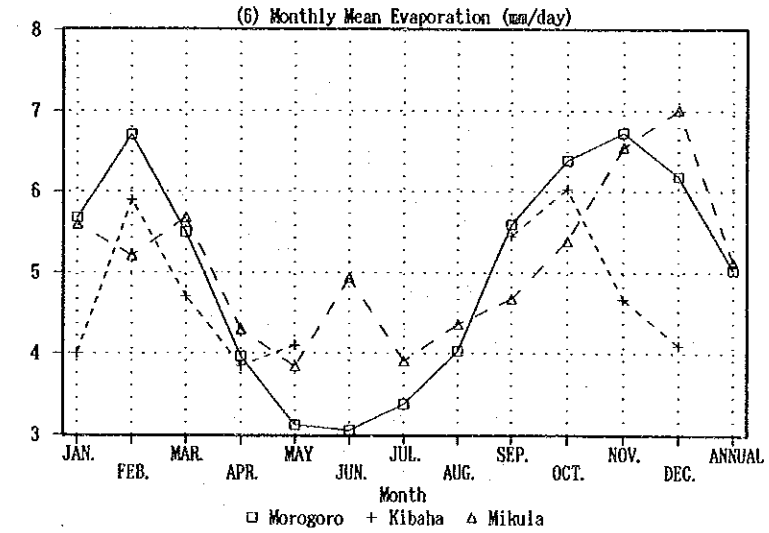


Fig. C.5 SUMMARY OF METEOROLOGICAL DATA (2/2)

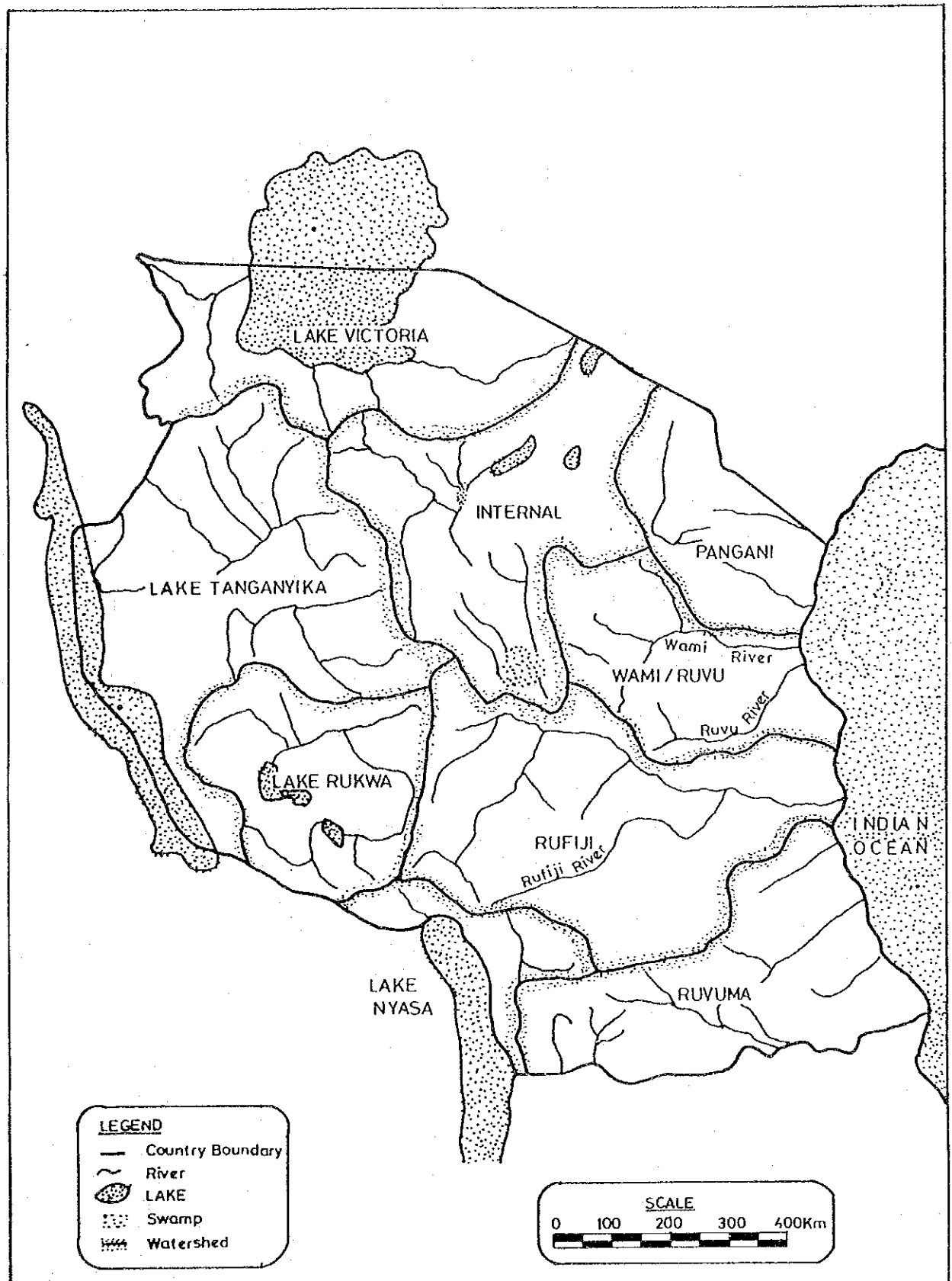


Fig. C.6 RIVER SYSTEM IN TANZANIA

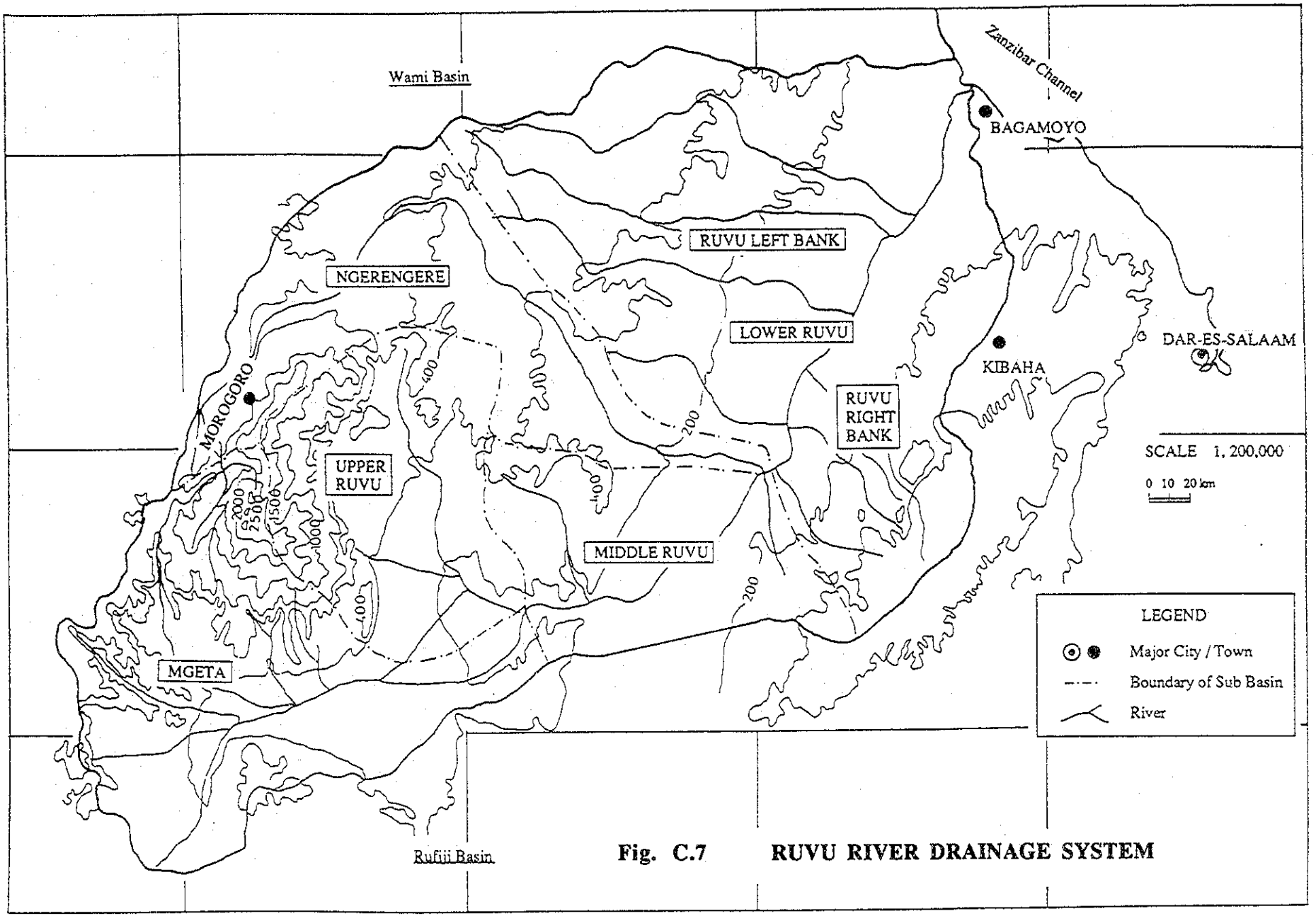


Fig. C.7 RUVU RIVER DRAINAGE SYSTEM

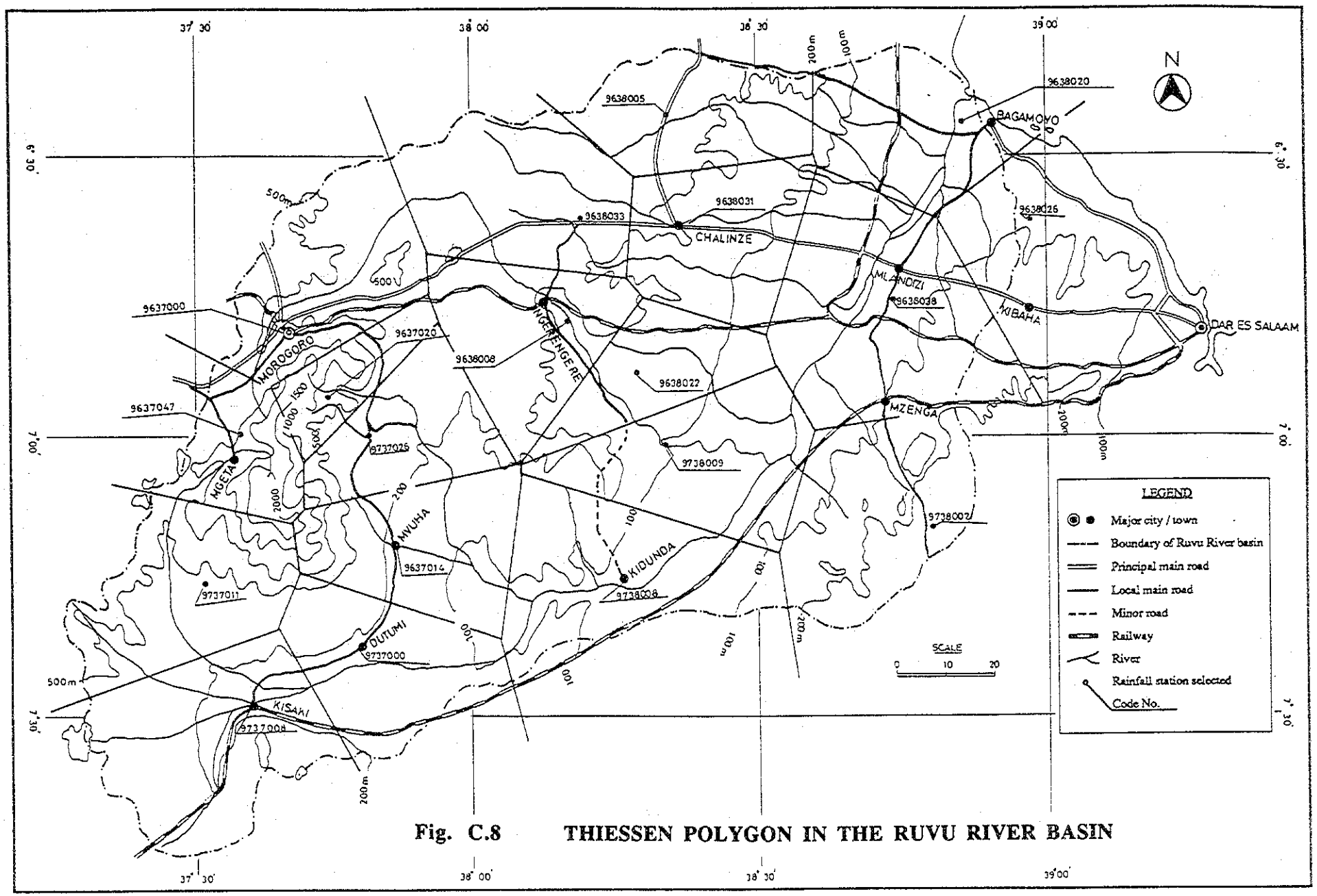


Fig. C.8 THIESSEN POLYGON IN THE RUVU RIVER BASIN

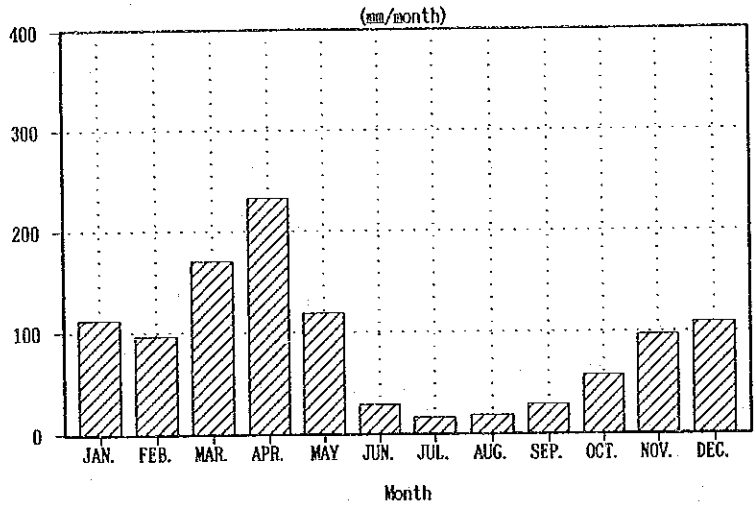


Fig. C.9 RAINFALL PATTERN IN THE RUVU RIVER BASIN

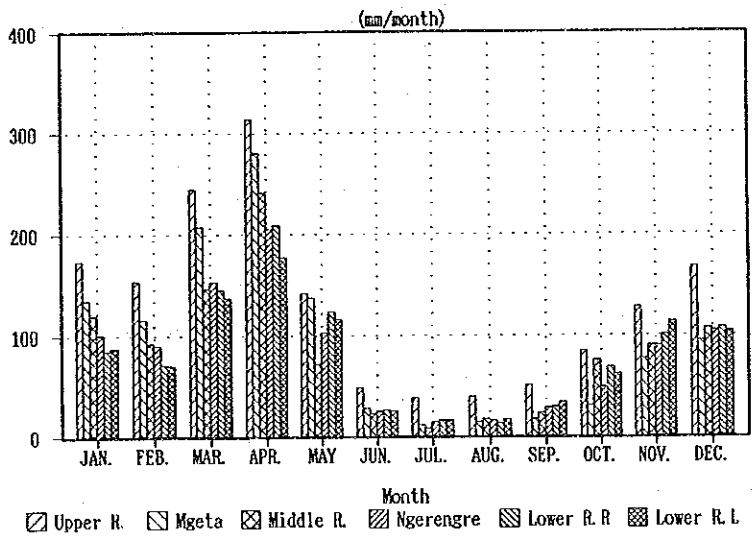


Fig. C.10 RAINFALL PATTERN IN THE SUB-BASIN

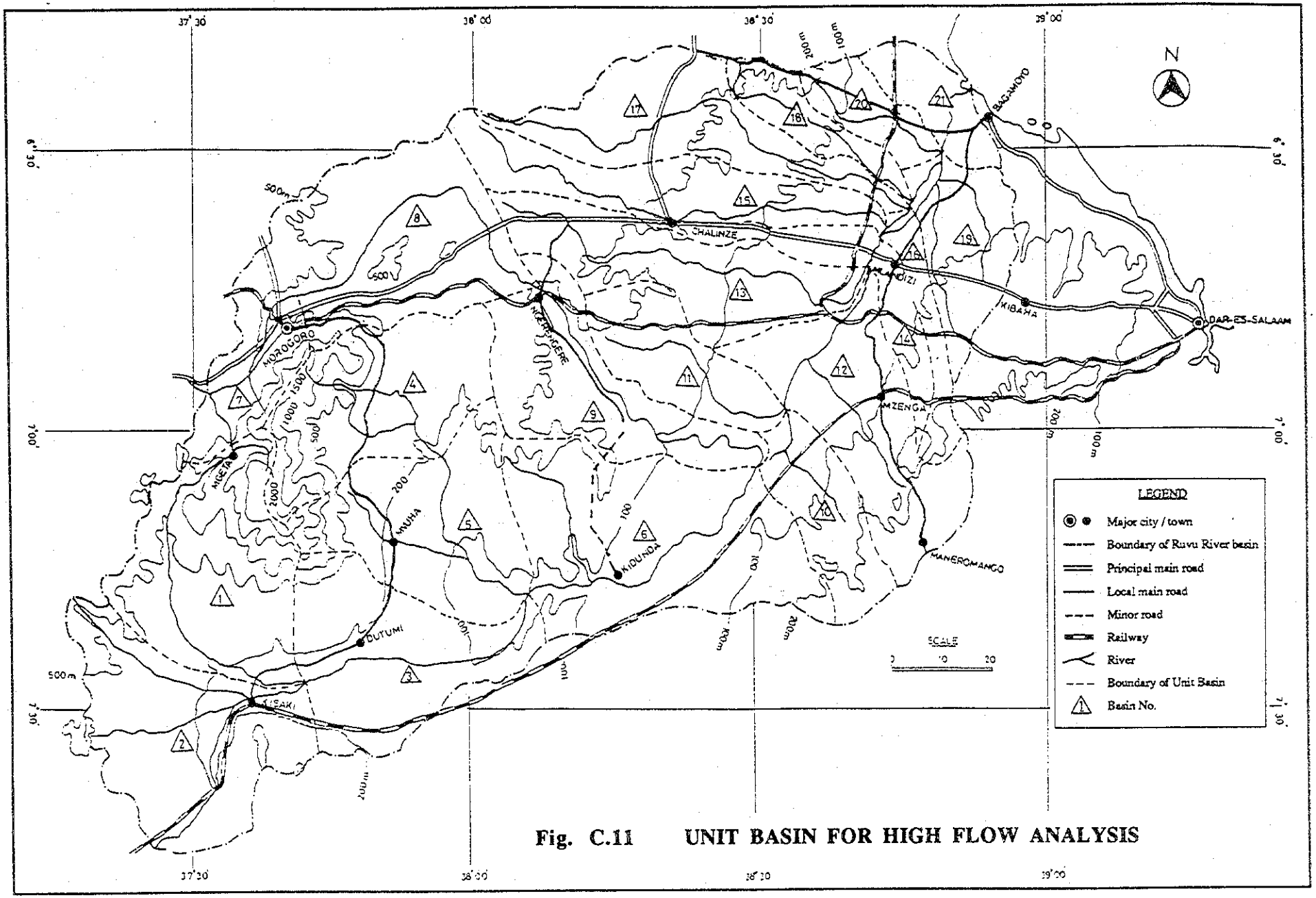
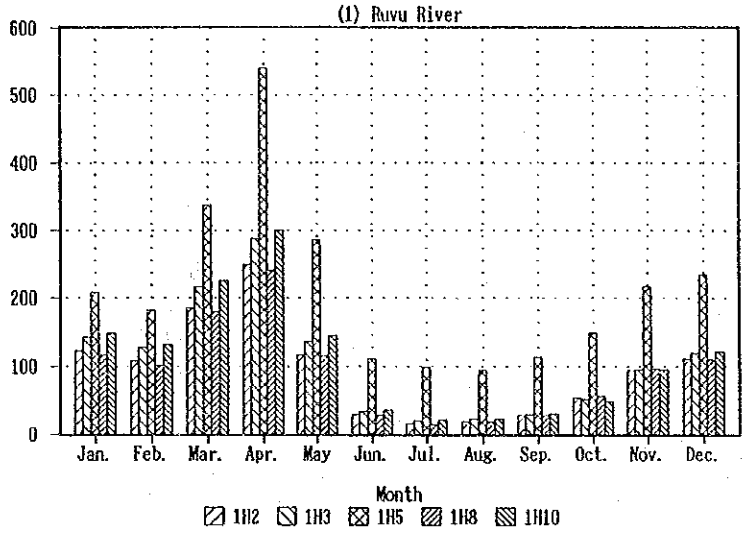


Fig. C.11 UNIT BASIN FOR HIGH FLOW ANALYSIS



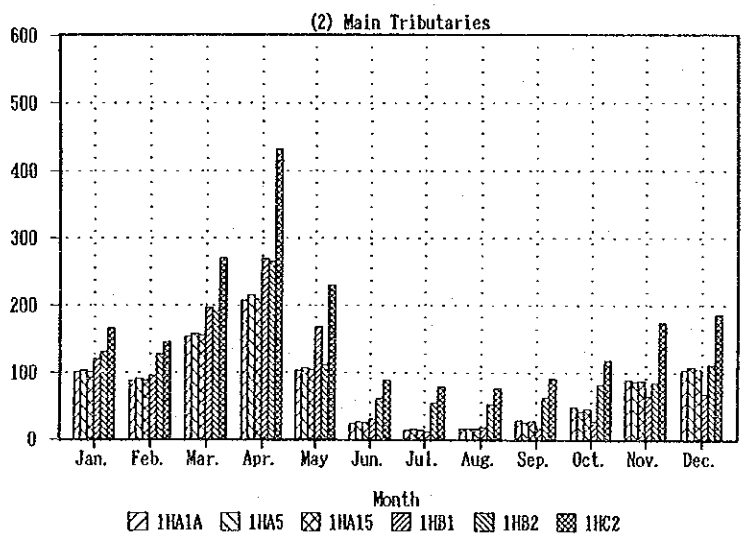


Fig. C.12 RAINFALL PATTERN IN THE HYDROLOGICAL STATIONS

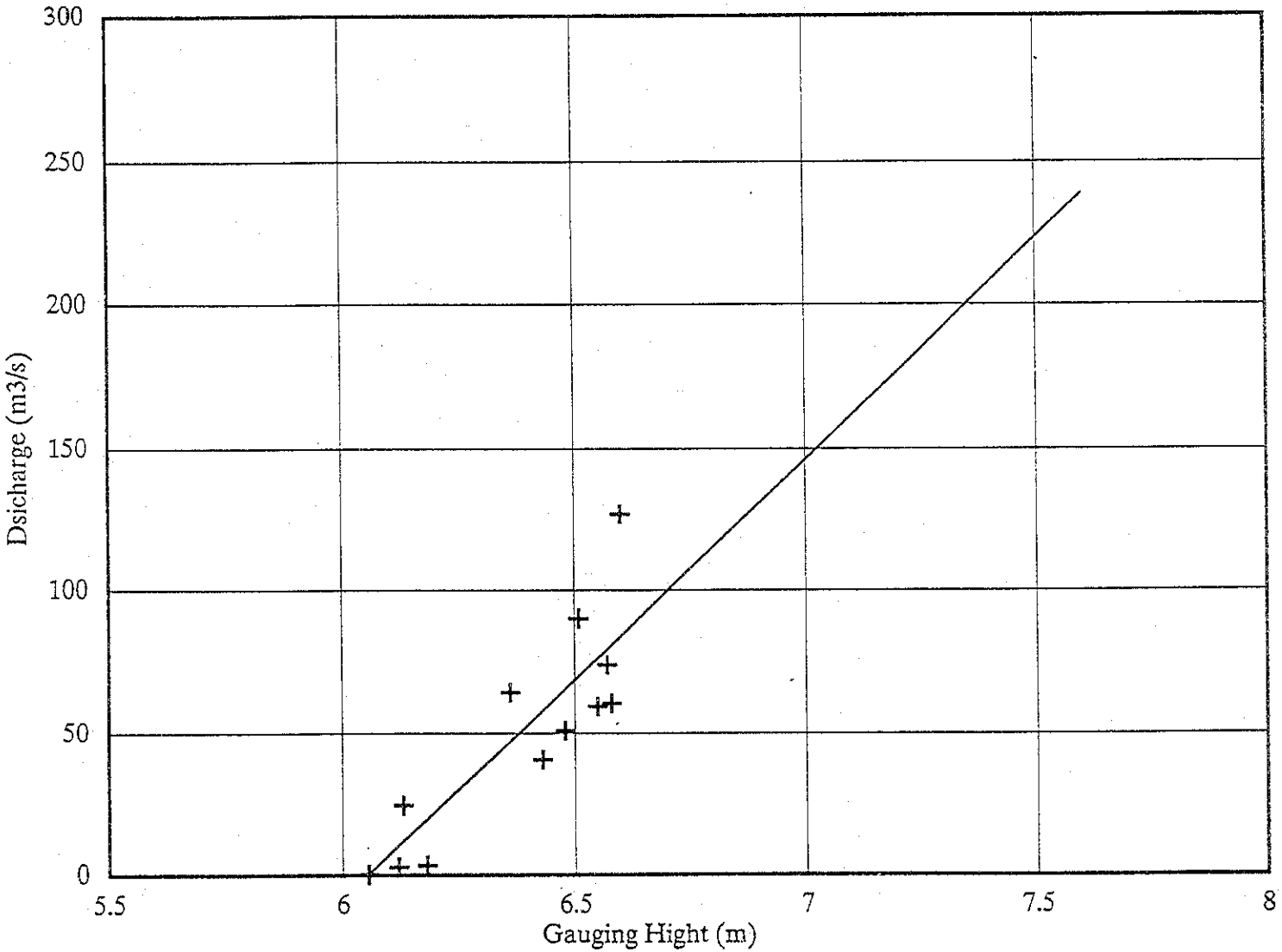
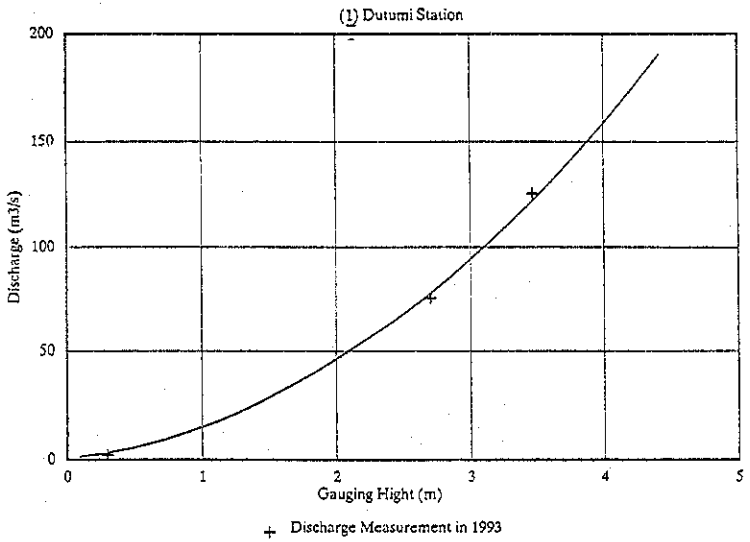
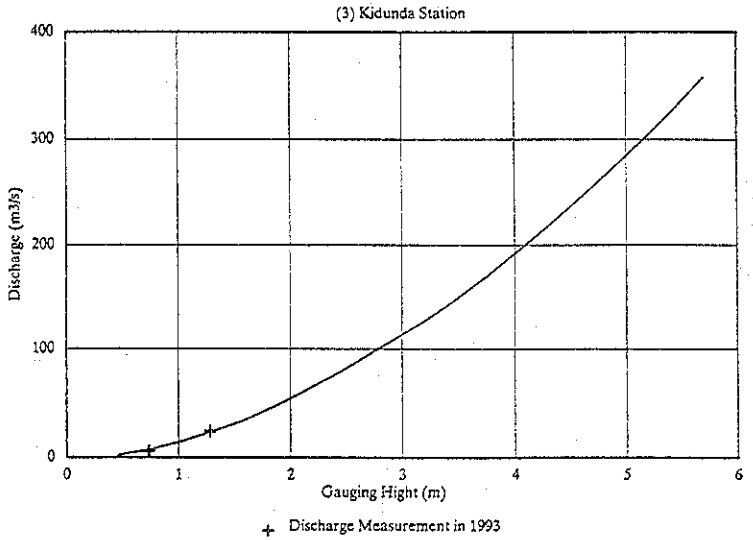
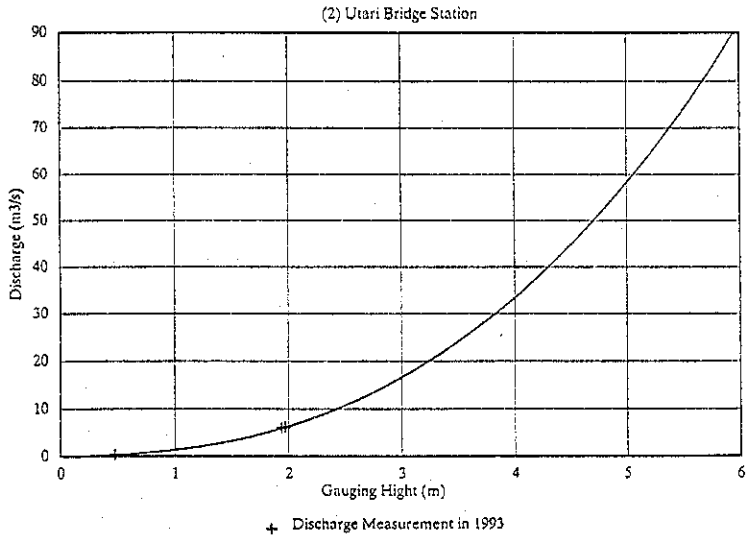


Fig. C.13 RELATION BETWEEN GAUGING HEIGHT AND CULVERT DISCHARGE AT 1H8







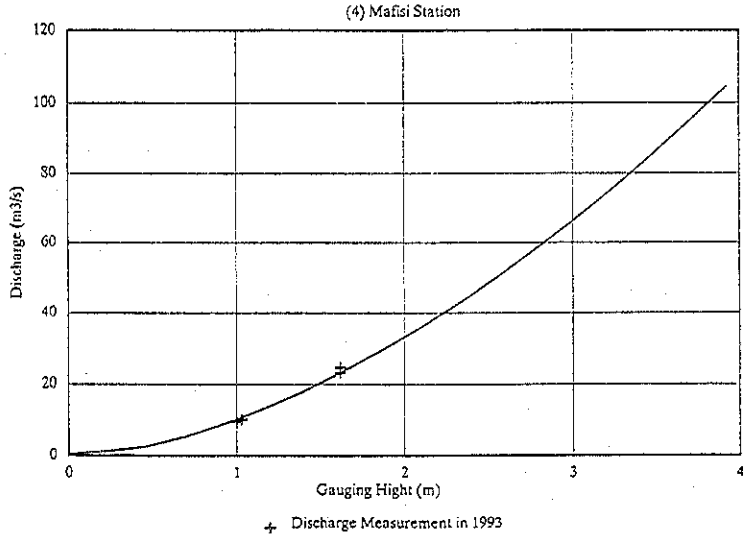
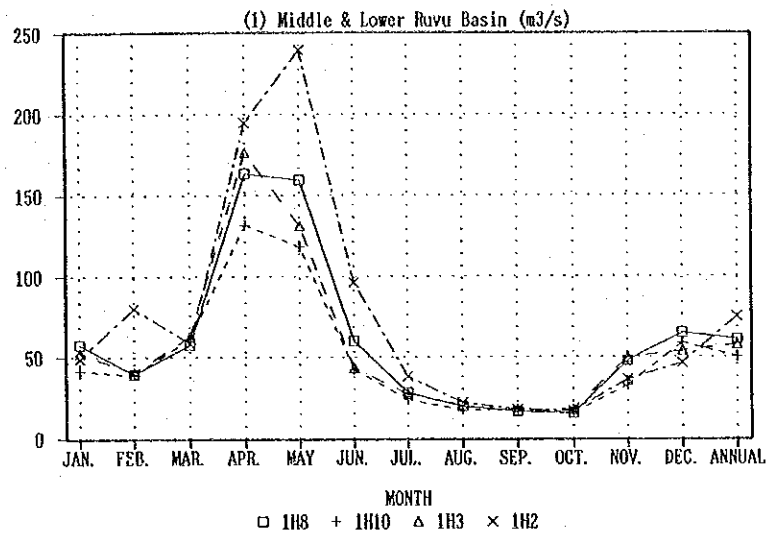
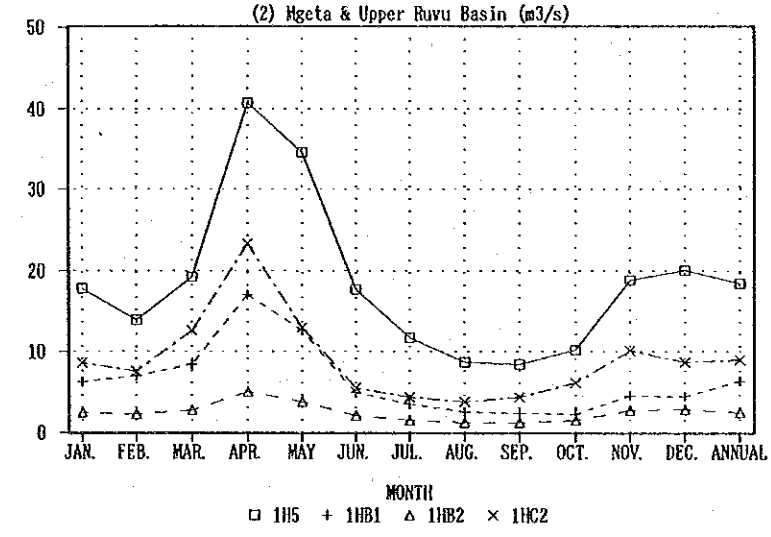


Fig. C.14 ESTIMATED RATING CURVE AT NEWLY STATIONS





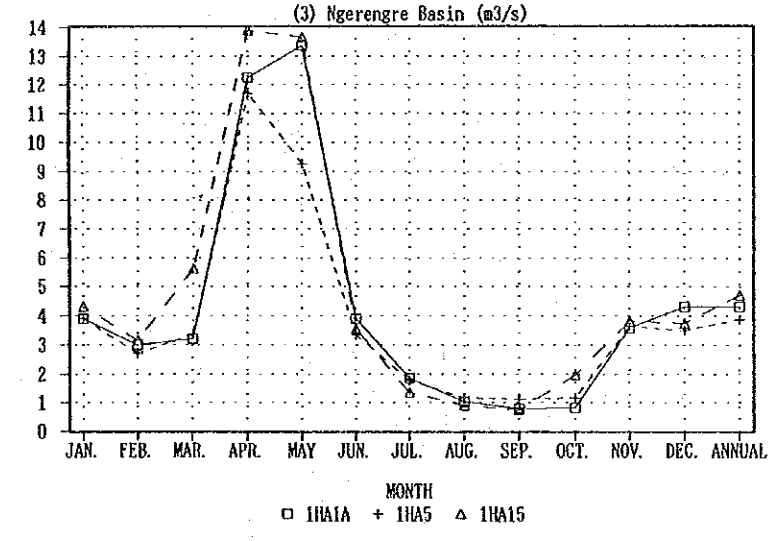
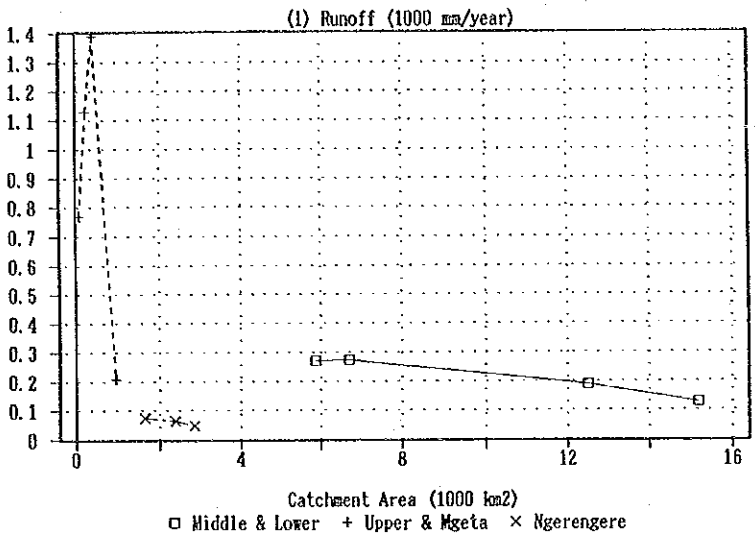


Fig. C.15 SUMMARY OF RIVER DISCHARGE



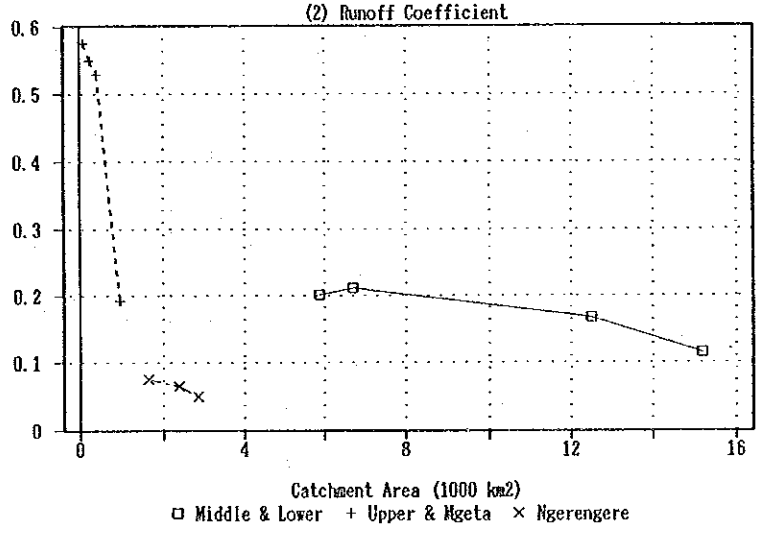


Fig. C.16 RELATION BETWEEN RUNOFF COEFFICIENT AND CATCHMENT AREA

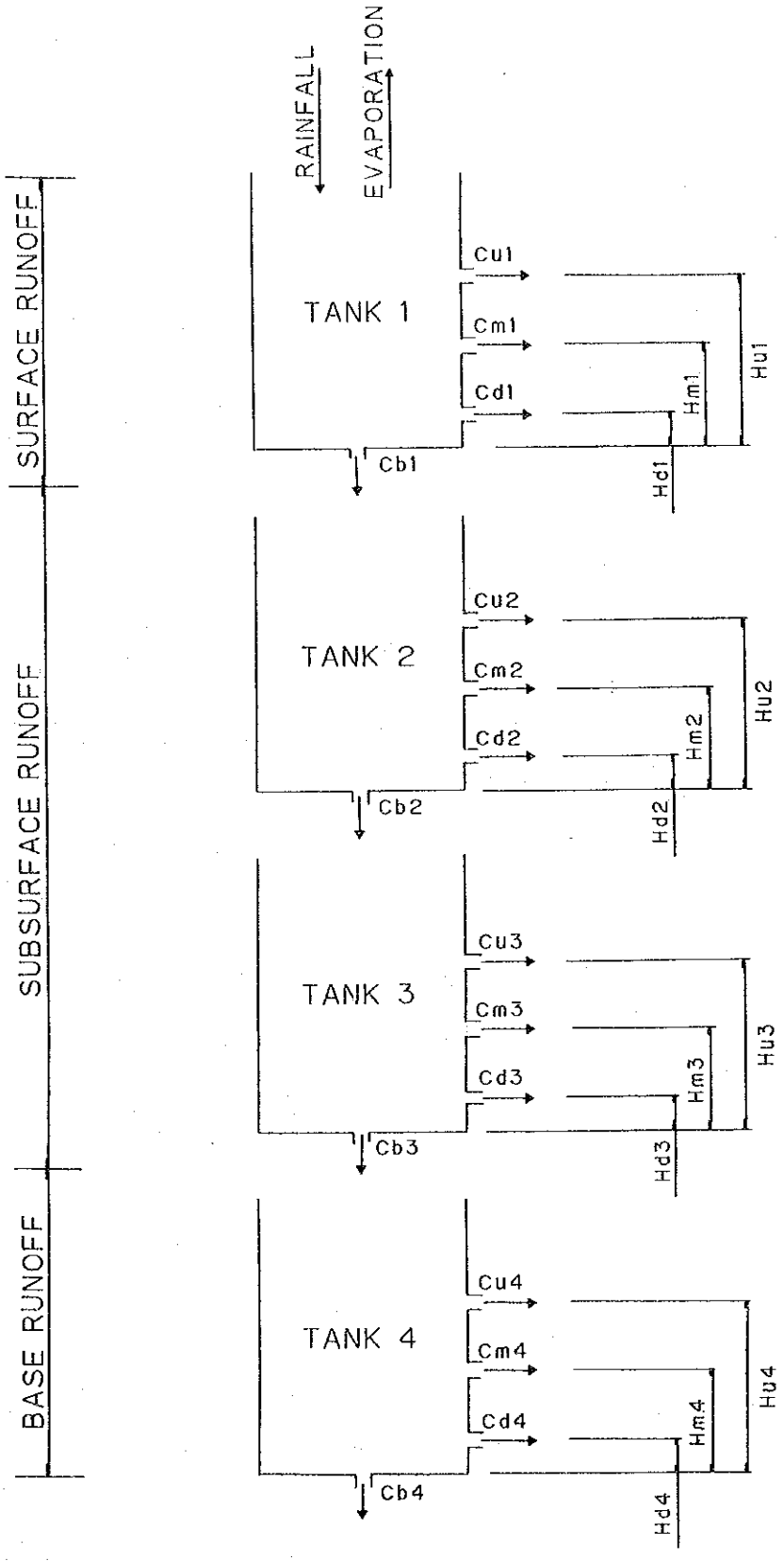


Fig. C.17 THE LOW FLOW ANALYSIS MODEL

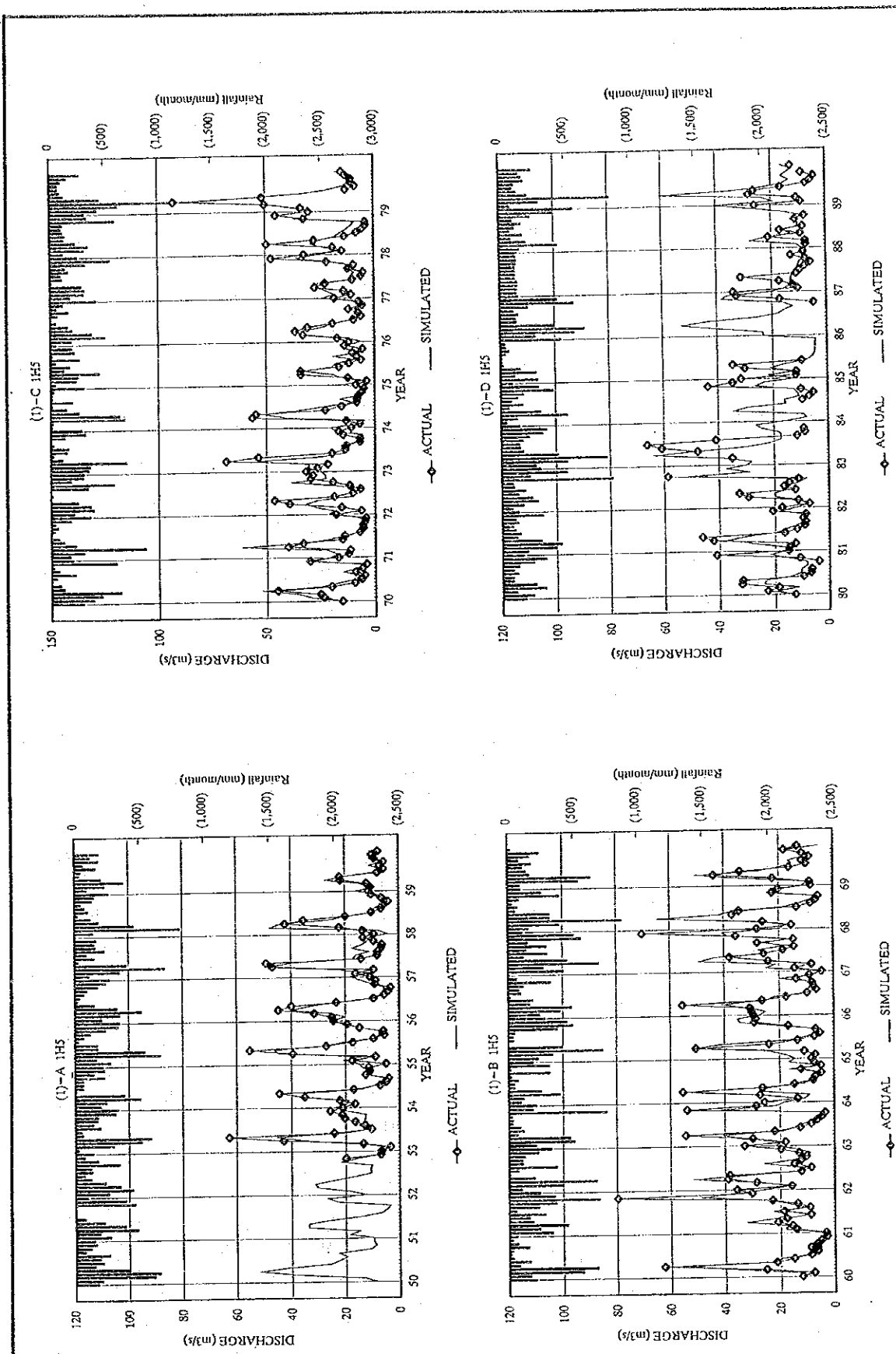
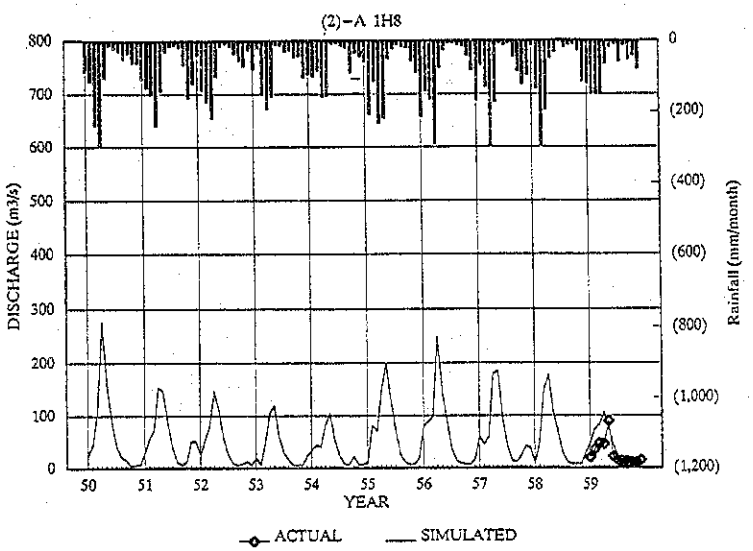
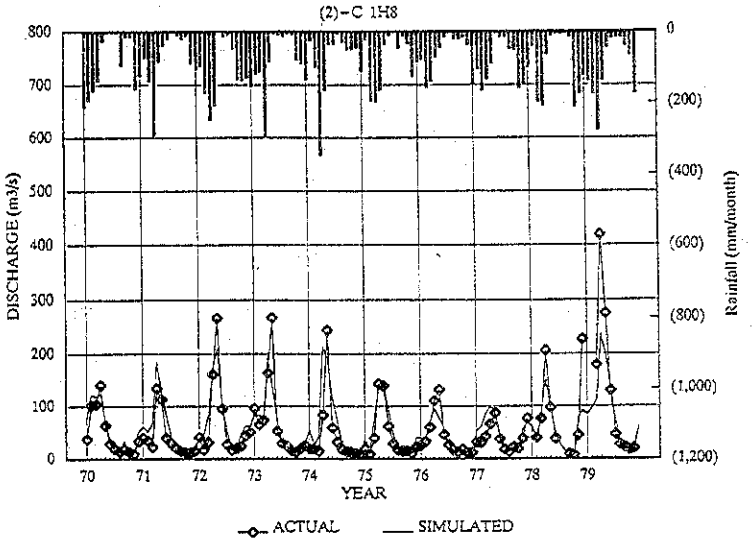
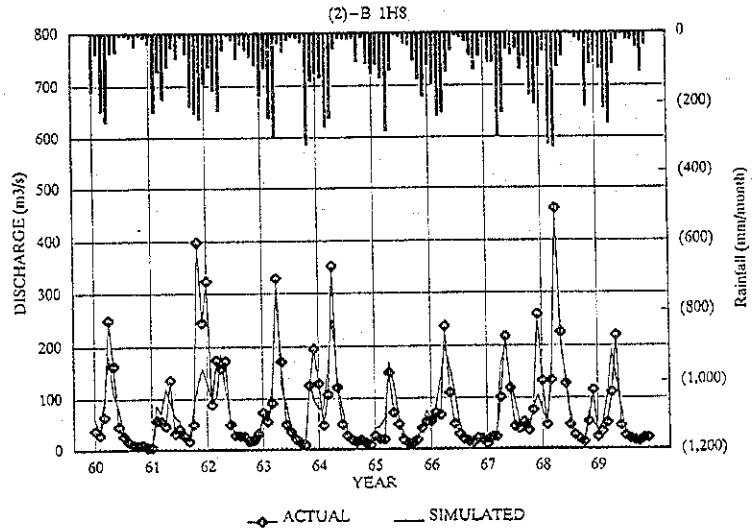


Fig. C.18 RESULT OF LOW FLOW ANALYSIS (1/4)







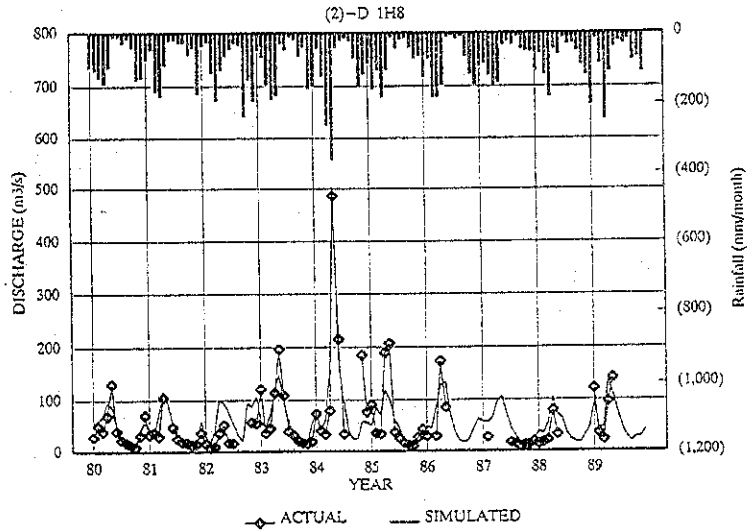


Fig. C.18 RESULT OF LOW FLOW ANALYSIS (2/4)

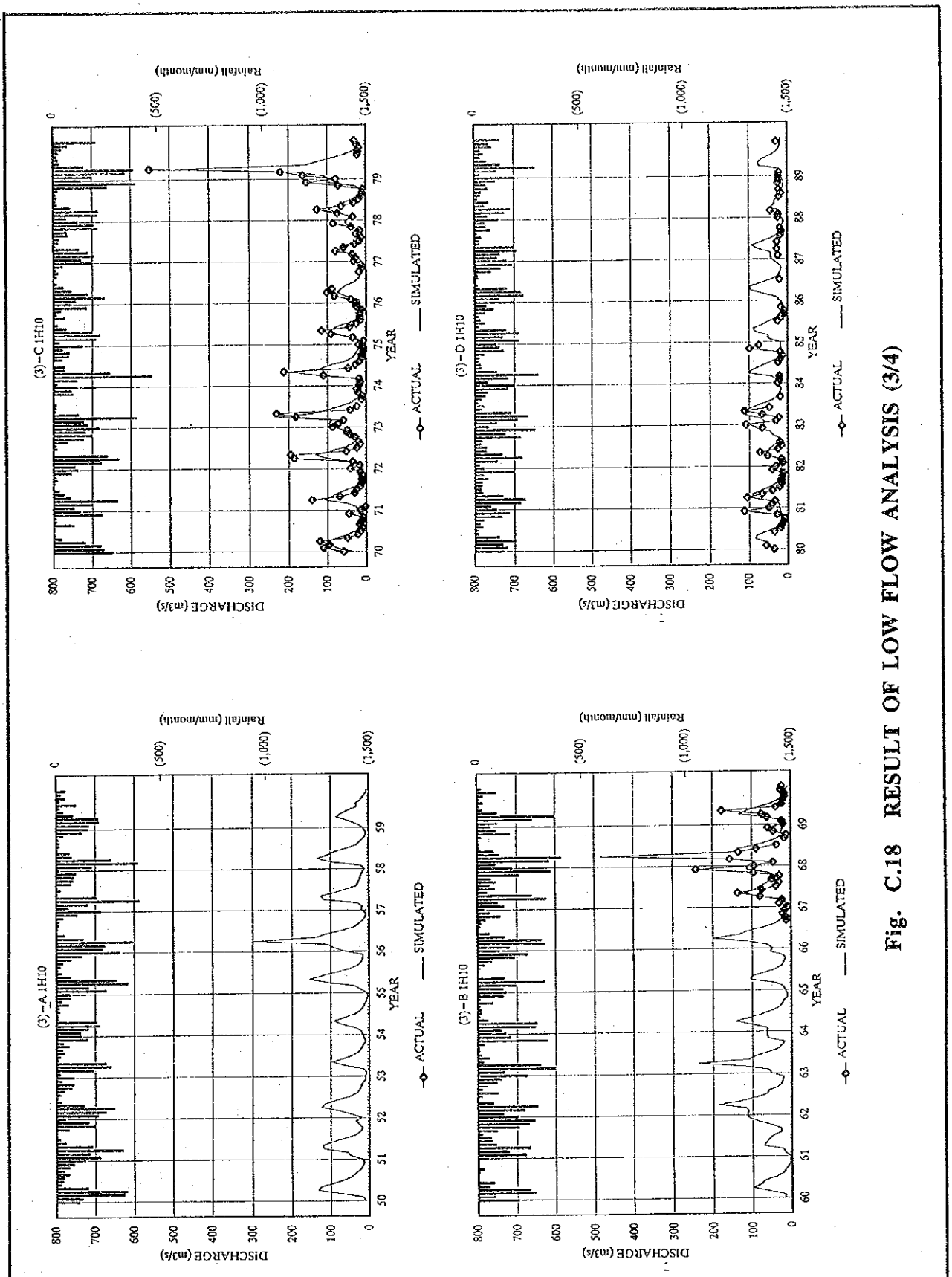


Fig. C.18 RESULT OF LOW FLOW ANALYSIS (3/4)

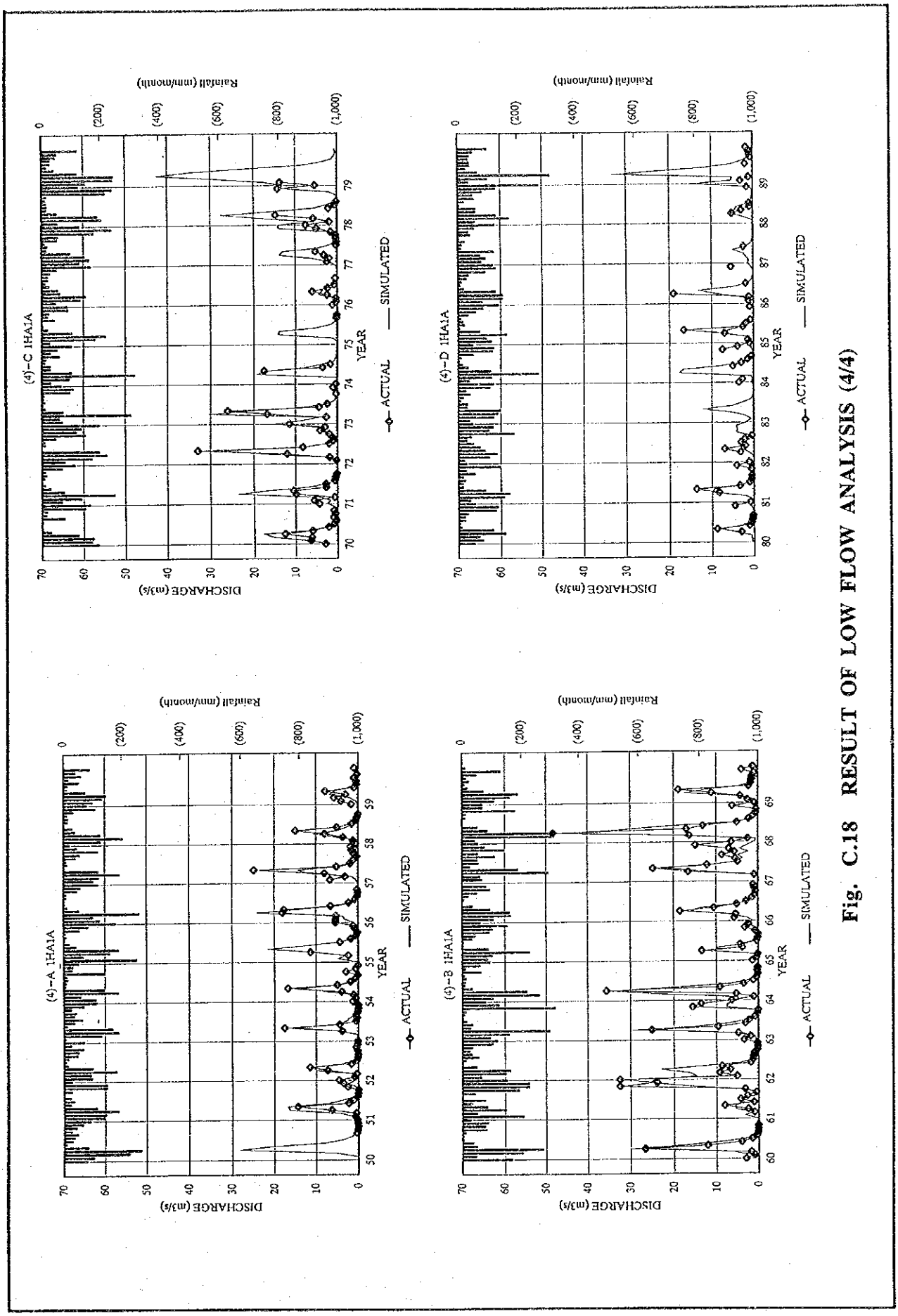


Fig. C.18 RESULT OF LOW FLOW ANALYSIS (4/4)

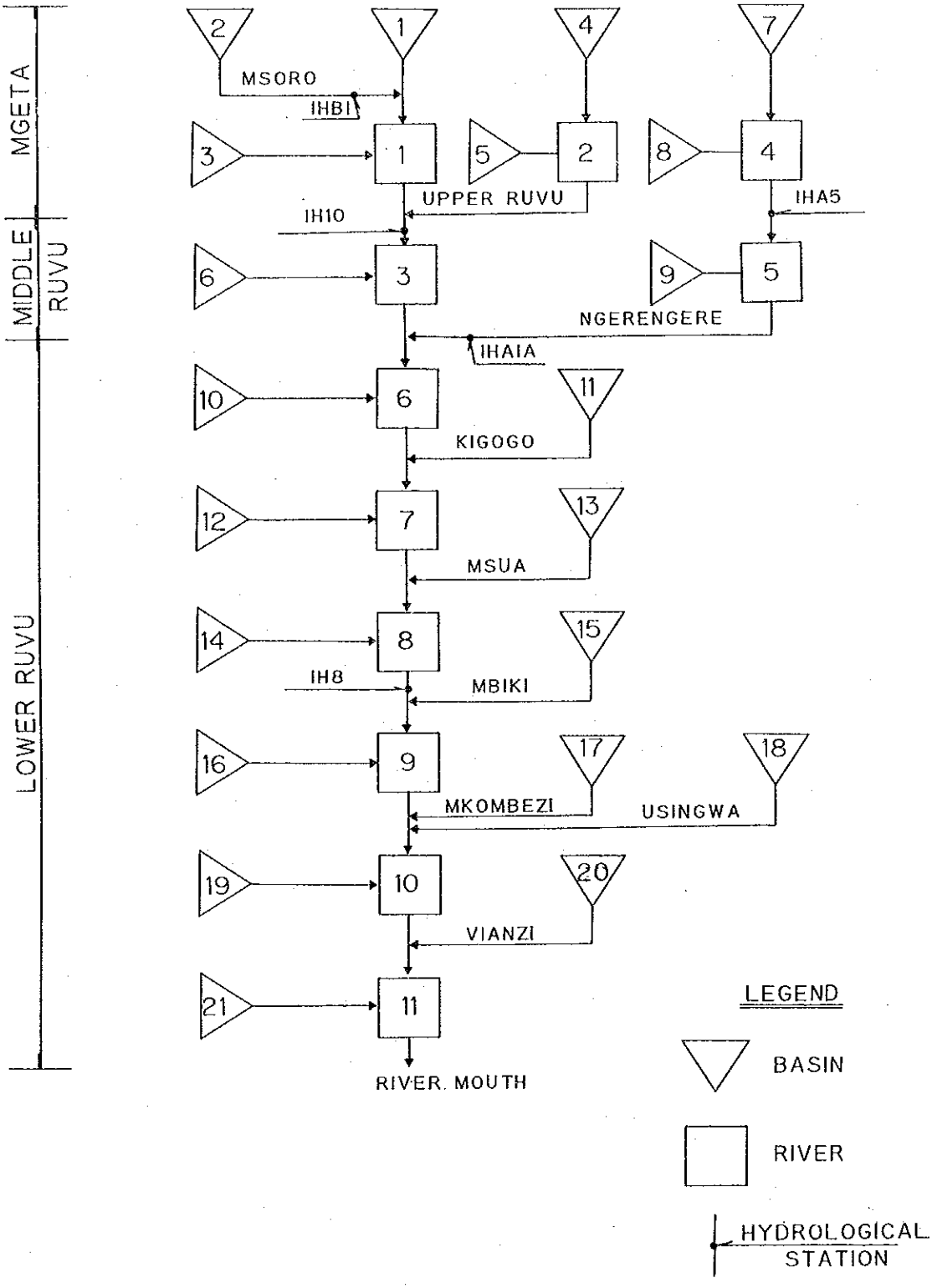


Fig. C.19 HIGH FLOW ANALYSIS MODEL

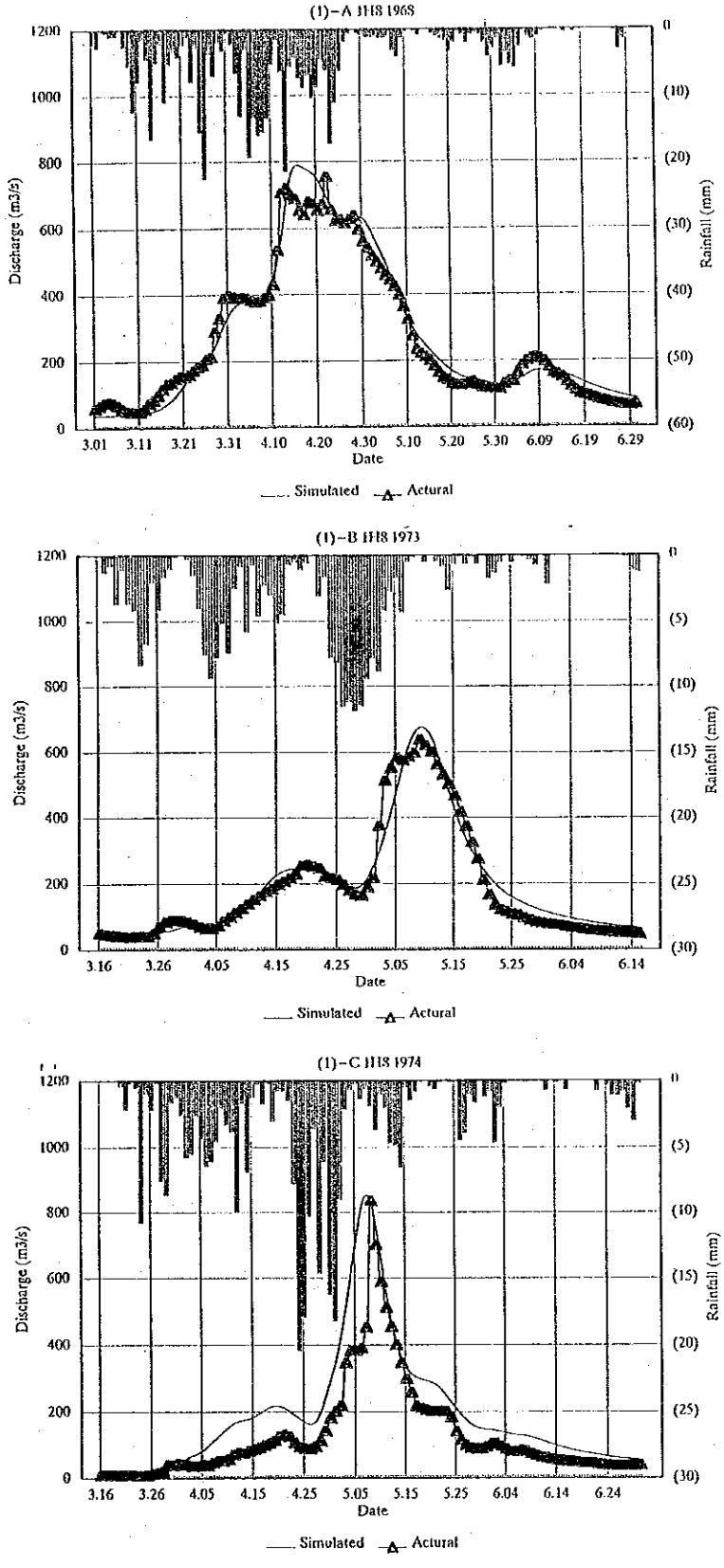


Fig. C.20 RESULT OF HIGH FLOW ANALYSIS (1/3)

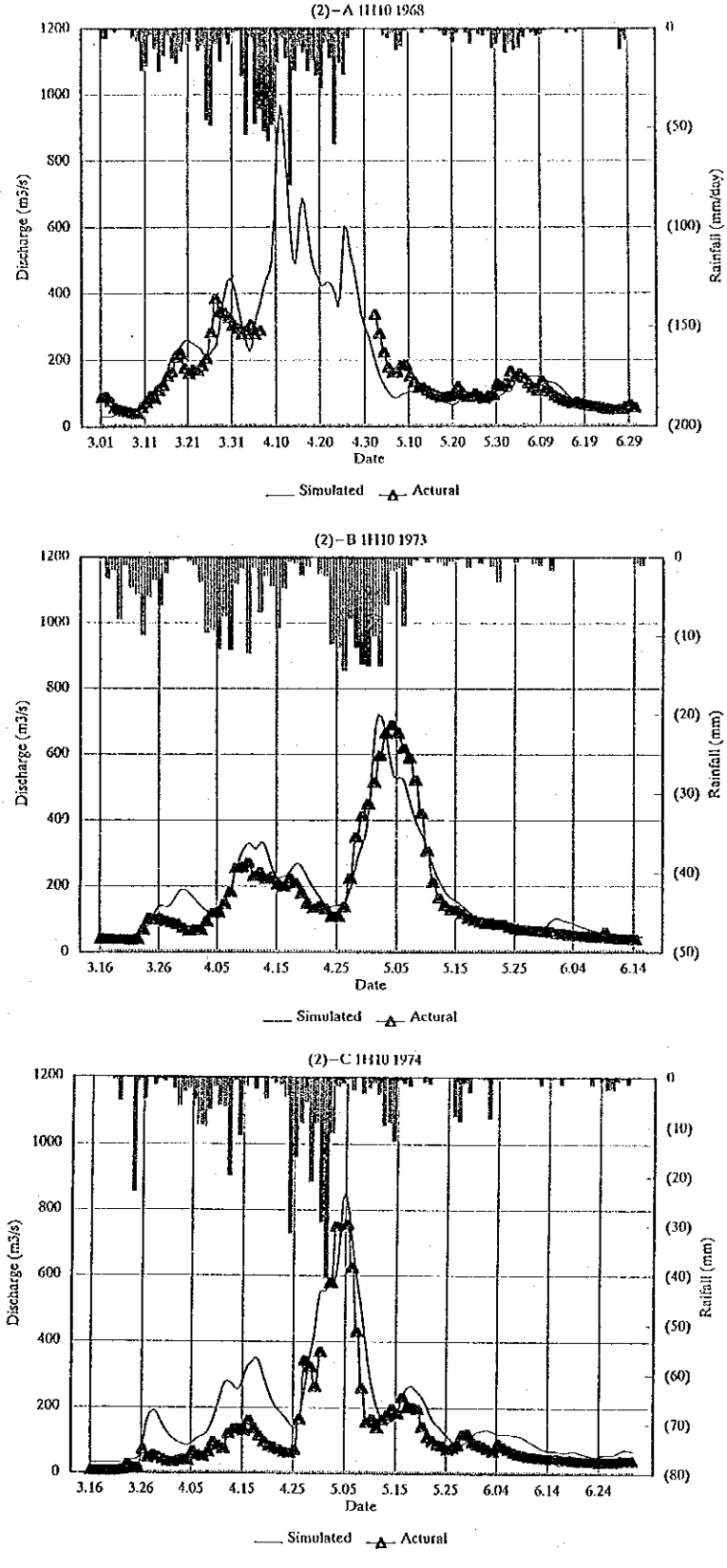


Fig. C.20 RESULT OF HIGH FLOW ANALYSIS (2/3)

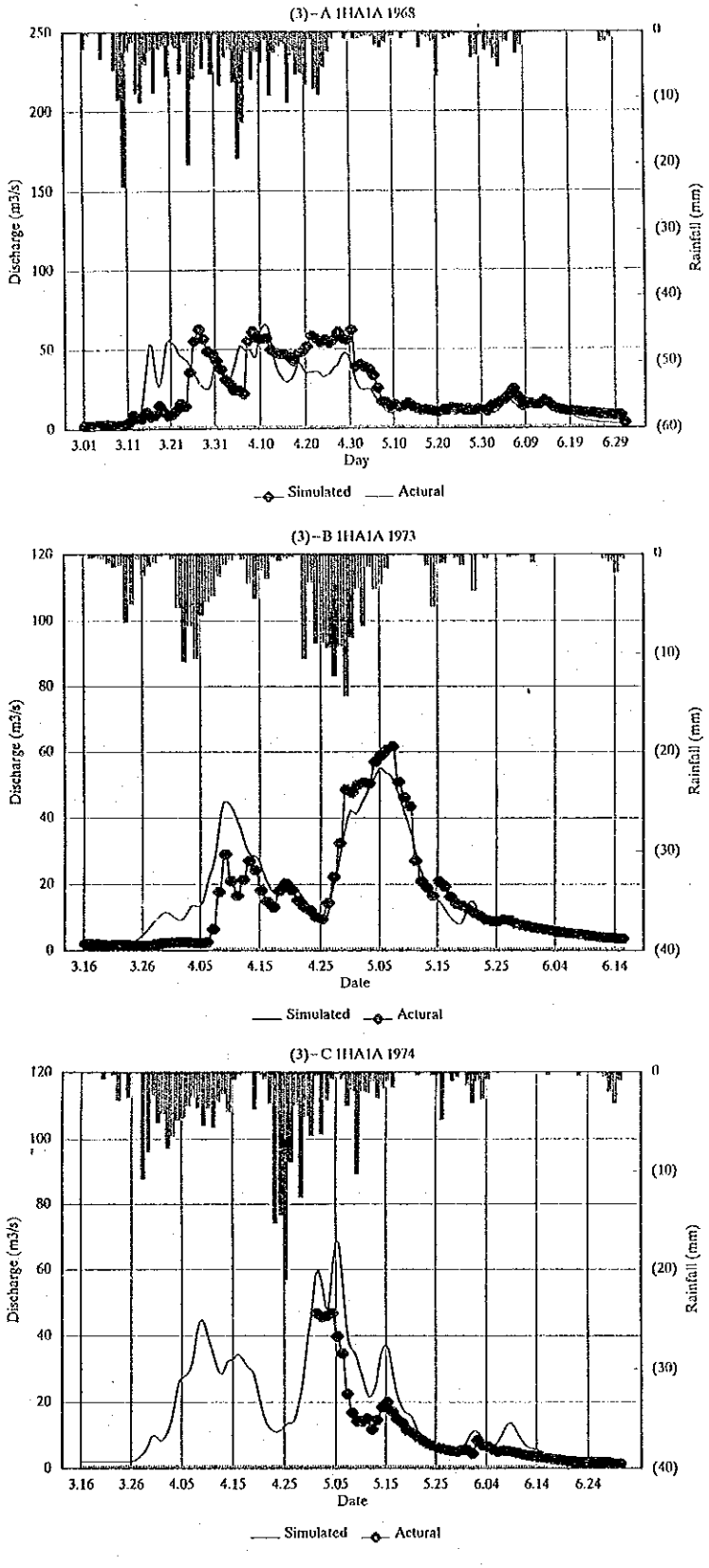
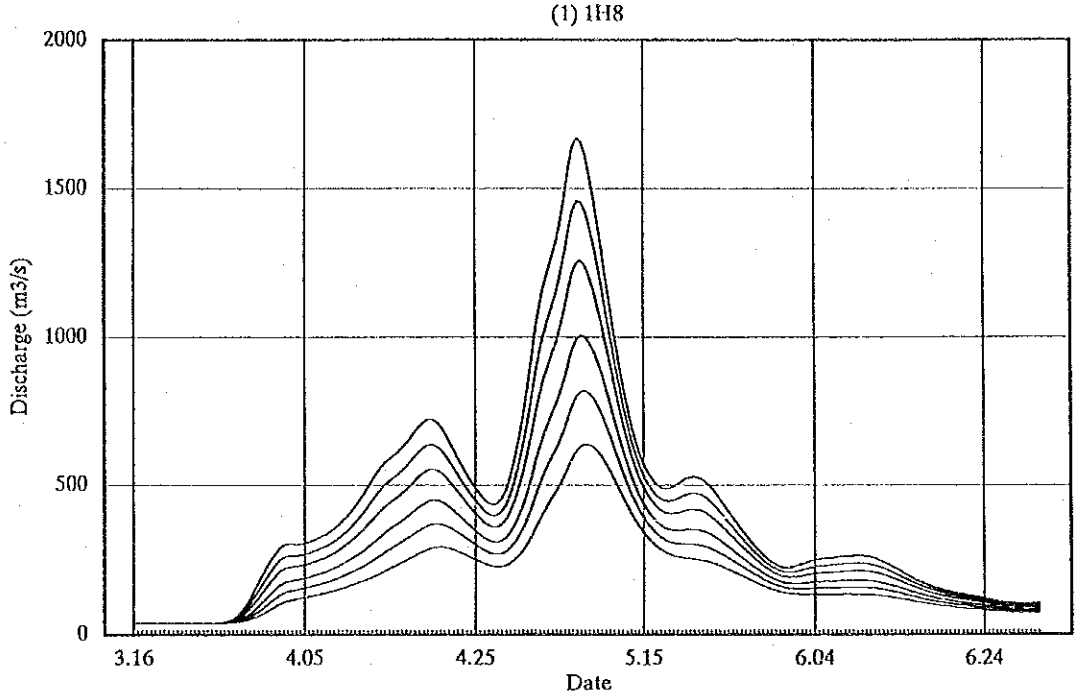


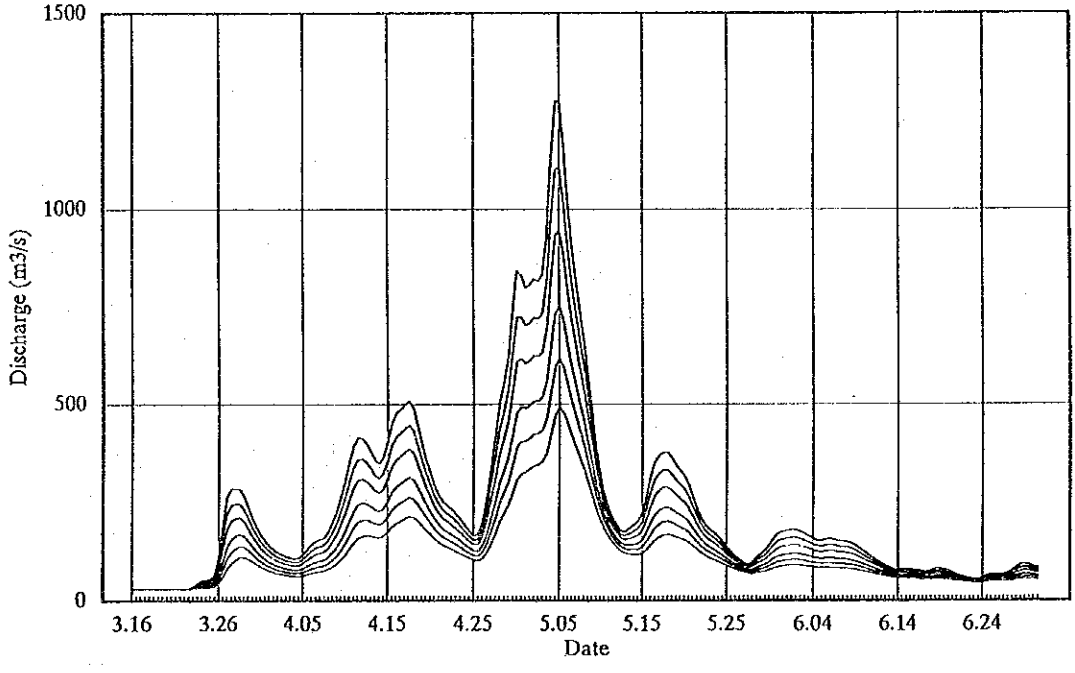
Fig. C.20 RESULT OF HIGH FLOW ANALYSIS (3/3)

(1) 1H8



____ Return Period 1/5,1/10,1/20,1/50,1/100 and 1/200

(2) 1H10



____ Return Period 1/5,1/10,1/20,1/50,1/100 and 1/200

Fig. C.21 PROPOSED FLOOD PATTERN

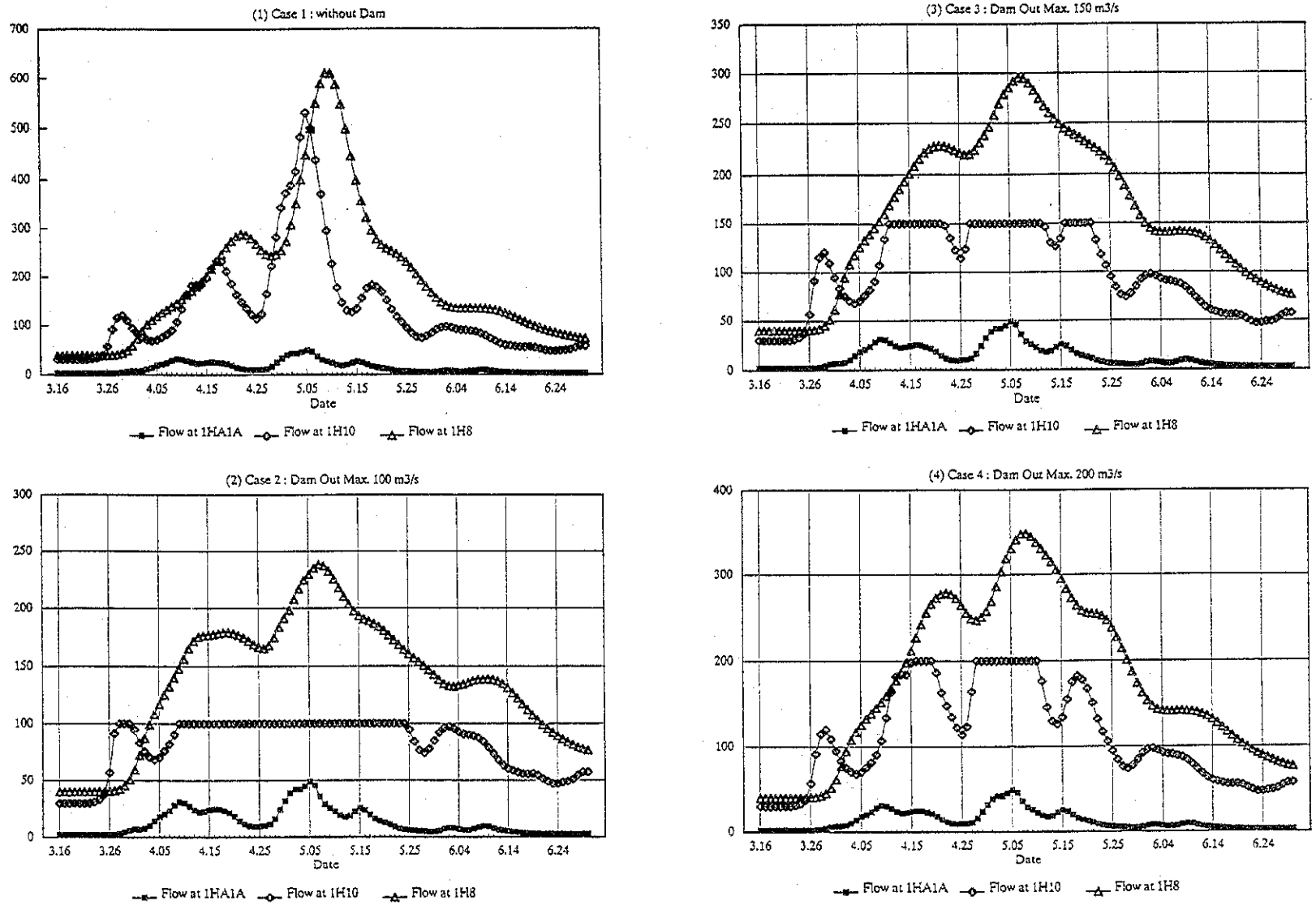


Fig. C.22 ESTIMATED FLOOD IN CASE OF 5-YEAR PROBABLE FLOOD

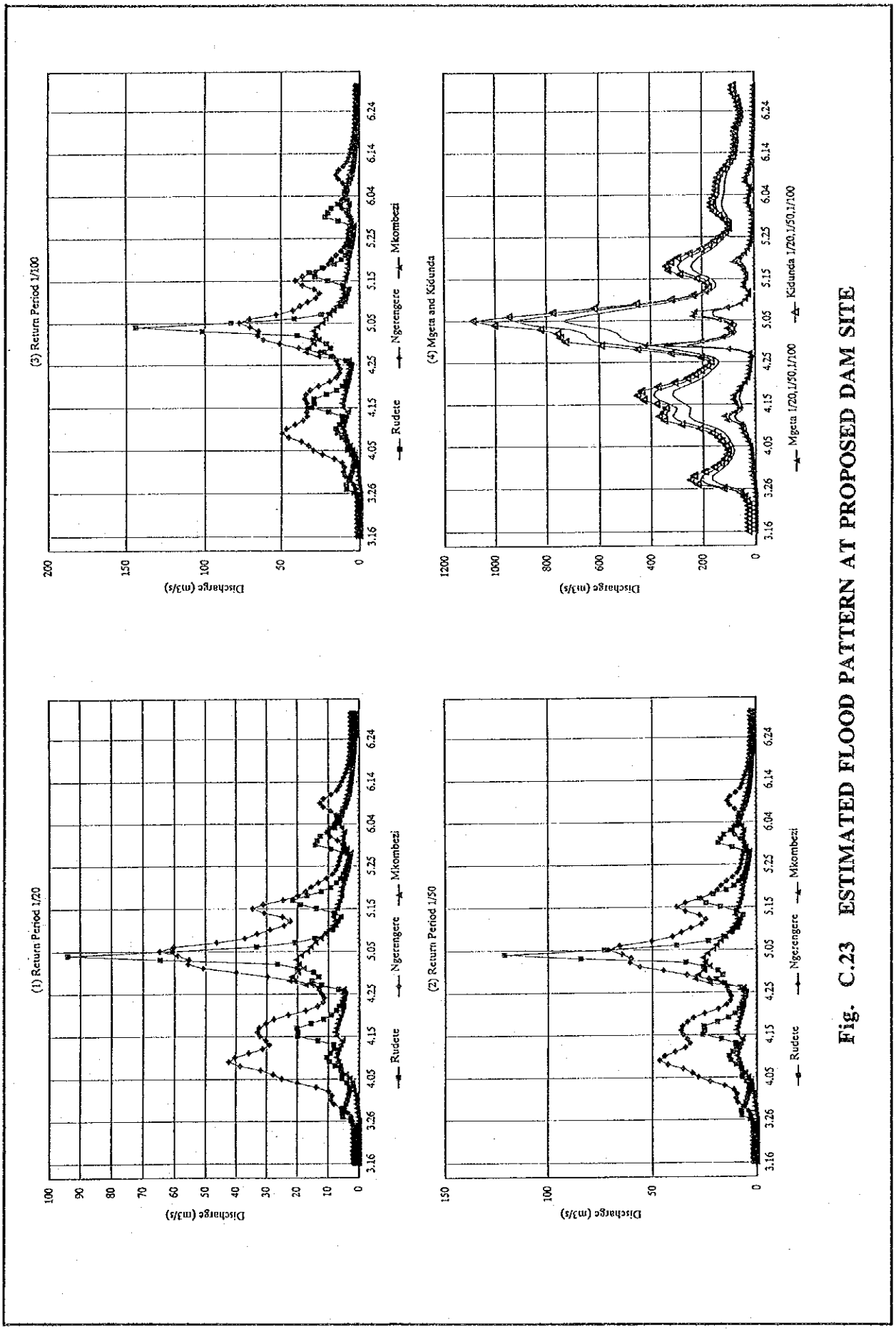


Fig. C.23 ESTIMATED FLOOD PATTERN AT PROPOSED DAM SITE

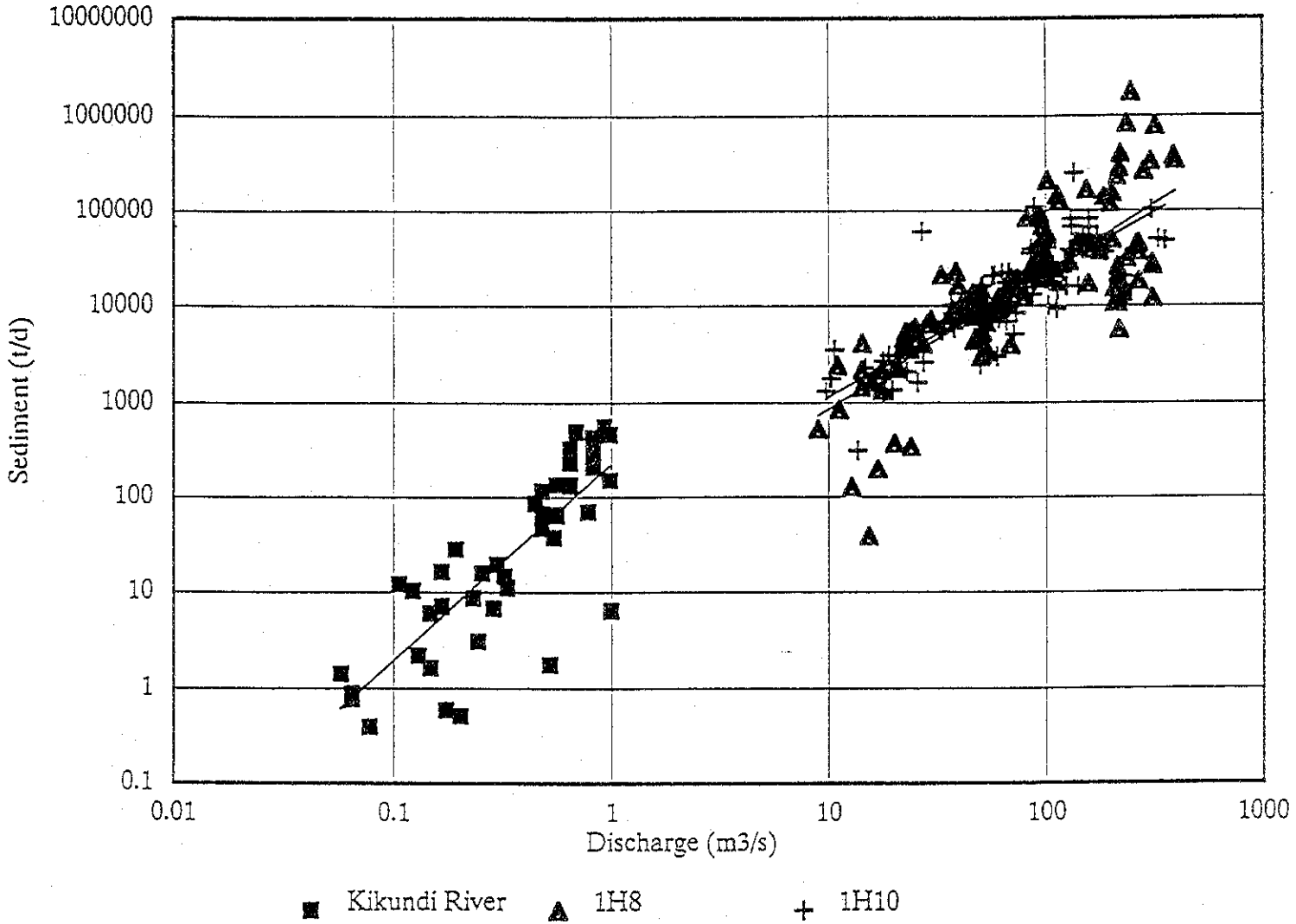


Fig. C.24 RESULT OF SEDIMENT ANALYSIS

APPENDIX-D

SOCIO-ECONOMIC SITUATION

APPENDIX-D

SOCIO-ECONOMIC SITUATION

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