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SUPPORTING REPORT
(VOLUME 1)
PART ONE HYDROLOGY

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CHAPTER I INTRODUCTION

The major river system in the objective area mainly consists of the Walanae River, the Bila River, Lake Tempe and the Cenranae River, with a catchment area of about 7,300 sqkm in total. The Walanae River flows from the south to the north and the Bila River flows from the north to the south, and both of them drain into Lake Tempe with slightly different hydrological characteristics. The Cenranae River flows out of Lake Tempe and drains to Gulf of Bone in the east.

The Gilirang River is located to the north-east, outside of said major river basin, with a catchment area of about 520 sqkm.

The locations of principal rivers and their watersheds are shown in Fig. 1.1 and their catchment areas including sub-basins are summarized and presented in Table 1.1.

The catchment areas of the principal rivers in the objective area can be summarized as follows;

The Bila River	1,368 sqkm	22.3%	
Lake Tempe	1,580 sqkm	25.7%	/1
The Walanae River	3,190 sqkm	52.0%	/2
Sub-total	6,138 sqkm	100.0%	
The Cenranae River	1,155 sqkm	-	
Total catchment area	7,293 sqkm	-	

/1 Including Lake Sidenreng, Lake Buaya and other small rivers flowing into Lake Tempe directly.

/2 The catchment area at the confluence of R.Mario is 2,680 sqkm which corresponds to 43.7% of above Sub-total 6,138 sqkm.

CHAPTER II HYDROLOGICAL DATA

2.1 CURRENT NETWORK OF HYDROLOGICAL OBSERVATION STATIONS

The Team collected the hydrological data at 45 rainfall gauging stations consisting of 10 automatic-type stations and 35 standard-type stations, and at 29 water level gauging stations consisting of 14 automatic-type stations and 15 standard-type stations.

The locations of these stations are shown in Fig. 2.1. The summarized lists of stations are presented in Table 2.1 and Table 2.2 for the rainfall gauging stations, and in Table 2.3 and Table 2.4 for the water level gauging stations.

2.2 RAINFALL

2.2.1 Isohyetal Map

An isohyetal map of the region, drawn up according to the rainfall data from 1911 to 1940, is already published by Meteorological and Geophysical Institute, Department of Communication. Based upon this isohyetal map and taking the newly obtained rainfall data by the Team into consideration, an isohyetal map was prepared for the survey as shown in Fig. 2.2.

Along the mountain ranges, which form the western and southern borders of the main river basin in the objective area, the annual rainfall is around 2,500 mm. However, most of the area within the main river basin receives annual rainfall of around 1,800 mm - 2,000 mm and the area surrounding Lake Tempe has a slightly lower annual rainfall of around 1,500 mm - 1,600 mm.

2.2.2 Rainfall Data

The team collected the rainfall data at 45 rainfall gauging stations. Daily rainfalls are observed at 33 rainfall gauging stations, and 38 stations provide the monthly rainfall data. Collected data are compiled in DATA BOOK PART II.

2.3 WATER LEVEL AND DISCHARGE MEASUREMENT

2.3.1 Discharge Measurement

Most of the collected data on discharge measurement have been limited within the range of low water levels. The deficiency of measurement data on high or relatively high water levels made it unavoidable to depend upon the calculation for the estimation of the discharges at high water levels.

The calculation was made, based upon the results of river cross-sectional surveying at selected water level gauging stations, with the estimation of water-surface slope I and roughness coefficient n of Manning's formula at each site.

2.3.2 Discharge Rating Curves

A series of river cross-sectional surveying at 14 water level gauging stations was carried out already in November 1977 by P3SA. The discharge rating curves were prepared by the Team for 11 water level gauging stations, out of said 14 gauging stations, which are closely related to the envisaged irrigation projects or considered necessary for the studies of flood control and sedimendation.

Besides, a river cross-sectional surveying at Sanrego water level gauging station was carried out in October 1978 by the Team. Thus the total number of the water level gauging stations, of which the discharge rating curves were prepared, becomes 12 as follows;

Bulu Cenrana (2)	R.Boya
Bila	R.Bila
Tanru Tedong	R.Bila
Sengkang	R.Cenranae
Sanrego	R.Sanrego
Ujung Lamuru	R.Walanae
Langkemme	R.Langkemme
Lakibong	R.Walanae
Cabenge	R.Walanae
Lawo	R.Lawo
Batu-Batu	R.Batu-Batu
Tarumpakkae	R.Gilirang

Of said 12 water level gauging stations, those at Sengkang, Cabenge and Tanru Tedong are relatively well provided with measurement data on high discharges. Hence, the discharge rating curves at Sengkang, Cabenge and Tanru Tedong were drawn with their measurement data by the least square method.

As for the other 9 water level gauging stations, the lower part of the discharge rating curve was prepared with their measurement data by the least square method. While the higher portion of the curve was drawn by extrapolation with the estimated waterlevel-discharge relation at high water levels by use of Manning's formula.

For the estimation of waterlevel-discharge relation, the water surface slope was obtained from the topographic maps in 1/25,000 scale and by actual measurement during October 1978, though the water levels were relatively low at that time. The roughness coefficient for the high water stage was obtained through observation at the same time.

2.3.3 Discharge Rating Curves at Bila, Bulu Cenrana and Lakibong Stations

The staff gauge at Bila station was restored after a damage by the flood in August 1976, without checking the difference of elevation at O-point on the old and new staff gauges. After drawing up the discharge rating curves for before-and-after August 1976, the said difference was clearly estimated as 15 cm.

At Bulu Cenrana station, the automatic gauge took place of the standard gauge in February 1977, without checking the difference of elevation at O-point on the standard and the automatic gauges. After drawing up the discharge rating curves for before-and-after February 1977, the said difference was estimated as 70 cm.

At Lakibong station, the deficiency of discharge measurement at high water levels was supplemented with the available data at Cabenge station which is located 8.2 km downstream from Lakibong station.

The relation between the daily water levels at relatively high water stage at Lakibong station, those at Cabenge station, and the obtained discharges at Cabenge station in 1977 was compared as follows;

Data	Lakibong Water Lev.	Cabenge Water Lev.	Cabenge Discharge Q	$\sqrt{Q}$
11 Jan. 1977	6.00 m	6.51 m	1,003.8 cu m/s	31.683
24 Jan. 1977	6.00 m	7.31 m	1,268.4 cu m/s	35.614
23 Feb. 1977	5.00 m	5.15 m	625.0 cu m/s	25.000
7 Mar. 1977	4.67 m	5.85 m	808.8 cu m/s	28.440
12 Apr. 1977	3.67 m	4.80 m	542.0 cu m/s	23.280

The catchment areas of the stations are 2,758 sqkm for Lakibong and 2,846 sqkm for Cabenge, and the difference is quite small (about 3%) without any inflow of tributary. Hence, the discharges at Lakibong were assumed to be the same as discharges at Cabenge on each corresponding date.

Thus, the discharge rating curve at Lakibong station was obtained, applying the said waterlevel-discharge relation at the higher portion of the curve, as shown in Fig. 2.4.

2.3.4 Tide Level

The data of the tidal gauge station at T. Palette, Bay of Bone, are available to know the tide levels at the mouth of the Cenranae River. An automatic gauge station was established by P3SA in May, 1977 and the gauge is in motion since that date.

According to the report, O-point of the gauge is -1.25 m below the mean sea level. The tide levels are shown in Fig. 2.5 which were obtained by harmonic analysis based on the records from 29 May, 1977 through 25 February, 1978. /1

/1 The Analysis of Tidal Harmonic Constants by Electronic Computer. May 1978, JAPAN INTERNATIONAL COOPERATION AGENCY.

CHAPTER III WATER RESOURCES

3.1 RAINFALL CHARACTERISTICS OF THE BASIN

3.1.1 General Rainfall Characteristics

Most part of the project river basin is surrounded by mountain ranges which shield the basin from direct influences of the west and the east monsoons. Hence, the general rainfall characteristics of the project river basin are quite different from those in Java which are distinctively affected by both of those monsoons.

Along the mountain ranges, which form the western and southern borders of the main river basin in the objective area, the annual rainfall amounts to around 2,500 mm. However, most of the area within the main river basin receives annual rainfall of around 1,800 mm - 2,000 mm and the area surrounding Lake Tempe has a slightly lower annual rainfall of around 1,500 mm - 1,600 mm.

The amounts of monthly rainfalls at 38 rainfall gauging stations are compiled and presented in Table 3.1 in terms of average, maximum and minimum values during the observation periods. Fig. 3.1 shows the annual pattern at main gauging stations according to each river basin.

Amounts and annual pattern of the rainfall in the objective area vary widely according to the location and the year. However, from Table 3.1 and Fig. 3.1, the general tendencies can be described as follows;

1) The annual rainfall in most of the area, except in mountainous zones, averages 1,800 - 2,000 mm. A small portion in the upper Walanae basin near Camba receives around 2,400 mm annually, and the area around Lake Tempe has a slightly lower annual rainfall around 1,500 - 1,600 mm.

2) Almost whole basin experiences the dry season from August to October with average monthly rainfalls around 60 - 80 mm. The rainy season appears from April to June or July in most part of the area.

3) However, a small portion in the upper Walanae basin near Camba has the rainy season from December to March or April, and the dry season from July to October affected by the west and the east monsoon patterns. Also, some parts of the basin near the western mountain range have slightly rich rainfalls during December and January affected by the west monsoon. The upstream basin of the Bila seems to have a slightly different rainfall pattern affected by the northern mountain range.

3.1.2 Rainfall Characteristics of Each River Basin

Amounts and annual patterns of the rainfall according to the location of river basins are as follows:

(a) The Walanae River Basin

The central and lower basin of the Walanae receives average annual rainfall around 1,600 - 1,800 mm. The annual pattern of average monthly rainfalls shows the dry season from August to October with average monthly rainfalls around 60 - 100 mm, and the rainy season from April to June or July. The rainfall slightly increases in December and January in the area near the western mountain range.

In the upper basin of the Walanae, the annual rainfall averages around 1,800 mm. The pattern of average monthly rainfalls shows the dry season from August to November and from January to March with average monthly rainfalls around 60 - 90 mm, and the rainy season from April to July.

However, a small portion in the southwestern upstream basin of the Walanae has an annual pattern of average monthly rainfalls which is quite different from other major portion of the basin. The rainy season appears from December to March or April, and the dry season occurs from July to October with average monthly rainfalls around 30 - 90 mm. The annual rainfall averages around 2,400 mm.

(b) The area around Lake Tempe

The average annual rainfall in the area around Lake Tempe is slightly lower than other parts of the study area. The dry season occurs from August to October with average monthly rainfalls around 60 - 80 mm, and the rainy season appears from April to June. The area receives average annual rainfall of around 1,500 - 1,600 mm.

Besides, the area to the east of Lake Tempe has relatively small monthly rainfalls around 80 - 100 mm from December to February. While in the area to the west of Lake Tempe, the rainfall slightly increases from November to January.

(c) The Bila River basin

In the lower basin of the Bila, the annual rainfall averages around 1,500 - 1,900 mm with prolonged months of small rain. The rainy season occurs from April to July. The dry season appears from August to October followed by prolonged months of small rain until February with average monthly rainfalls around 80 - 100 mm.

As for the upstream basin of the Bila, a sufficient number of available data is still absent at present. Judging from the available data in limited number, the annual rainfall averages around 2,000 mm. The dry season occurs from January to March and from August to October, and the rainy season appears from April to June.

The reason that the upstream basin of the Bila has a complicated pattern of rainfalls seems to be attributable to the effect of northern mountain range.

(d) The Cenranae River basin

The upper part of the Cenranae basin has the average annual rainfall around 1,600 mm. The dry season appears from August to October with average monthly rainfalls around 60 - 80 mm and from December to February with average monthly rainfalls around 90 mm. The rainy season occurs from April to June.

The lower basin of the Cenranae has the average annual rainfall around 2,200 mm. The dry season appears from August to October with average monthly rainfalls around 80 - 100 mm. The rainy season occurs from April to June.

(e) The Gilirang River basin

In the lower basin of the Gilirang, the rainy season appears from April to June, and the dry season occurs from August to October followed by the months of small rainfall from December to March. The average monthly rainfalls during the dry season are around 70 - 110 mm.

In the upstream basin of the Gilirang, although a sufficient number of available data is still absent at present, the pattern of monthly rainfalls seems to be affected by the northern mountain range. Judging from the available data in limited numbers, the dry season appears in August and from November to March with average monthly rainfalls around 40 - 90 mm. The rainy season appears from April to July followed by relatively large rainfall in September. The annual rainfall averages around 1,840 mm.

3.2 RIVER DISCHARGE

3.2.1 General Discharge Characteristics

The total number of water level gauging stations in the objective area is 29 as mentioned in "2.1 Current Network of Hydrological Observation Stations." The discharge rating curves were prepared by the Team at 12 water level gauging stations out of said 29 gauging stations as mentioned in "2.3 Water Level and Discharge Measurement." The selected water level gauging stations are closely related to the envisaged irrigation projects or considered as important for the study of flood control and sedimentation.

The names of the water level gauging stations and the corresponding rivers are listed below;

Bulu Cenrana (2)	R.Boya
Bila	R.Bila
Tanru Tedong	R.Bila
Sengkang	R.Cenranae

Sanrego	R.Sanrego
Ujung Lamuru	R.Walanae
Langkemme	R.Langkemme
Lakibong	R.Walanae
Cabenge	R.Walanae
Batu-Batu	R.Batu-Batu
Tarumpakkae	R.Gilirang
Lawo	R.Lawo

The daily water levels were converted into daily discharges using the discharge rating curve at each gauging station. The results are compiled in DATA BOOK PART III by each gauging station.

However, for the convenience to know the general pattern of the river discharge in the objective area, the mean monthly discharges are presented in Table 3.2 and Fig. 3.2 in terms of average, maximum and minimum values during the observation period at each gauging station.

According to Fig. 3.2, the annual pattern of mean monthly discharges show the general tendency of the low-water flow from August or September to October or November and the wet season flow from April to June or July. Besides, in the northern part of the objective area, the river discharge slightly declines from January to February or March. While, in the southern and western portion of the objective area, the river discharge increases in January and February.

Generally, the annual pattern of the mean monthly discharges at each station varies widely according to the year. The minimum values of each mean monthly discharge during the observation period, presented in Table 3.2 and Fig. 3.2, show that there are considerable fluctuations in each monthly discharge. The deviation is large in the rivers within the northern and northwestern portion of the objective area, especially in the case of small rivers.

3.2.2 Discharge Characteristics of Each River Basin

The annual pattern of the mean monthly discharges according to the river basin can be shortly described as follows;

(a) The Bila River

The wet season flow appears from April to June or July, but occasionally July has a declined mean monthly discharge. The drought flow appears from September to November, and the minimum values of each mean monthly discharge during said months decline severely below the average values. Another low-water flow appears from January to March.

(b) The Walanae River

The Sanrego River in the upper basin of the Walanae River shows a relatively flat pattern of mean monthly discharge throughout the year, with some wet season flow from April to June. The low-water flow appears from September to November. The minimum values of each mean monthly discharge do not decline so much throughout the year. (Sanrego)

In the middle reaches of the Walanae River, the wet season flow appears in January, February and from May to July and the low-water flow appears from August to November. The minimum values of each mean monthly discharge during the low-water flow decline considerably. (Ujung Lamuru)

In the lower reaches of the Walanae River, the wet season flow appears in January, February and from April to July, but occasionally May and July have small monthly discharge. The minimum values of each mean monthly discharge during the low-water flow decline considerably. (Lakibong, Cabenge)

The tributary in the western portion of the central Walanae basin has the wet season flow from December to February. The low-water flow appears from August to November. The minimum values of each mean monthly discharge are small except in December and January. (Langkemme)

(c) The small rivers in the western portion of the area

The small rivers in the western portion of the objective area, which flow into Lake Tempe directly, have the wet season flow from April to June and from December to January or February, and the low-water flow from August to November. However, because of the small size of catchment areas and due to the topographic conditions, the minimum values of each mean monthly discharge decrease severely to zero in some months in a year. (Lawo, Batu-Batu)

(d) The Cenranae River

The discharge of the Cenranae River is largely related to the water level of Lake Tempe. The river has rich flow from May to July. The minimum values of mean monthly discharge during these months do not fall so much. The river discharge decreases from September to December. The minimum values of each mean monthly discharge decline considerably during these months especially in October and November. (Sengkang)

(e) The Gilirang River

In the Gilirang River, the wet season flow appears from May to July, but occasionally the mean monthly discharge decrease severely around June. The low-water flow appears from August to April with a remarkable drought flow in November and December. The minimum values of each mean monthly discharge become very small in most of the months during this period. (Tarumpakkae)

3.3 RAINFALL, RIVER RUNOFF AND IRRIGATION INTAKE DISCHARGE

3.3.1 Annual Rainfall in Upstream Basin of Sengkang

The average depth of annual rainfall on the upstream basin of Sengkang can be calculated with the observed rainfall data by Thiessen method or Isohyetal method as shown in Table 3.4 and Table 3.5.

The result of the calculation gives the average annual rainfall of 1,807 mm by Thiessen method (1975-1977) and the annual rainfall of 1,980 mm by Isohyetal method.

3.3.2 Annual Runoff of Upstream Basin of Sengkang

The total annual river runoff discharge of the upstream basin of Sengkang can be calculated with the observed discharge data of the Cenranae River at Sengkang gauging station as presented in Table 3.7, taking the storage or supplement effect of Lake Tempe into consideration as shown in Table 3.6.

The result of the calculation shows the annual runoff of 5,931 million cu m at Sengkang, which corresponds to the average depth of 966 mm over the upstream basin area of Sengkang (1976-1978). /1

3.3.3 Annual Runoff Coefficient at Sengkang

The annual runoff coefficient at Sengkang, or the ratio of the corresponding depth of total runoff to the average depth of annual rainfall over the upstream basin area of Sengkang can be calculated with preceding figures of the annual rainfall and the runoff as shown in Table 3.8.

The result of the calculation gives the average annual runoff coefficient of 53% (1975-1977). Table 3.8 shows that the annual runoff coefficient varies according to the year - relatively large in the wet year and relatively small in the dry year.

The difference between the rainfall and the runoff can be regarded as the evaporation, transpiration, percolation and other losses as follows (1975-1977);

Average annual rainfall	1,807 mm	(11,091 mil cu m)	100%
Average annual runoff	973 mm	(5,971 mil cu m)	53%
Evaporation, transpiration, percolation and other losses	834 mm	(5,120 mil cu m)	47%

/1: Figures are for average value, 1975-1978. (5,971 million cu m and 973 mm for 1975-1977)

3.3.4 Utilization Percentage of River Runoff for Irrigation

(1) Irrigation Area and Intake Discharge

The irrigation area and its intake discharge depending upon the river flow in the upstream basin of Sengkang, both in present and after-development conditions, are estimated as follows;

(a) Present condition

Irrigation area	21,337 ha	
Intake discharge	186.5 million cu m/yr	/1

(b) After-development condition

Irrigation area	75,150 ha	/2
Intake discharge	879 million cu m/yr	/3

(2) Estimation of Original River Flow

Taking account of no return flow from irrigation intake discharge, the original river flow before the irrigation intake will be estimated as follows;

Consumption for irrigation	= 186.5 million cu m/yr
Observed total runoff	= 5,931 million cu m/yr
Original river flow	= 6,117.5 million cu m/yr

(3) Utilization Percentage of River Runoff for Irrigation

According to the preceding figures, the utilization percentage of river runoff used for irrigation can be estimated as follows;

Present condition	186.5/6,117.5 = 3.0%
After-development condition	879 /6,117.5 = 14.5%

3.4 ESTIMATION OF MEAN MONTHLY DISCHARGE DURING DRY SEASON BY RAINFALL-DISCHARGE CORRELATION

3.4.1 Estimation of Mean Monthly Discharge by Rainfall-Discharge Correlation

To supplement the river discharge data of limited observation period, the mean monthly discharges during the dry season from October to next February were estimated from the rainfall data as follows;

/1: Refer to Table 3.9.
/2: Refer to Table 3.10 (Excluding R.Gilirang basin)
Planned irrigation area 71,000 ha Out-of-plan irrigation area 4,150 ha
/3: Refer to Table 3.10.

(1) The selected 6 gauging stations are closely related to the envisaged irrigation projects as follows;

Gauging station	River basin
Bila	R.Bila
Bulu Cenrana	R.Boya
Tarumpakkae	R.Gilirang
Lawo	R.Lawo
Langkemme	R.Langkemme
Sanrego	R.Sanrego

(2) The average depth of rainfall over each river basin will be estimated by Thiessen method, taking into account the recorded period of rainfall and the location of rainfall gauging station.

(3) The correlation between rainfall and discharge will be obtained for each gauging station, through plotting the average depth of rainfall in the river basin and the mean monthly discharge at corresponding gauge station for each month of dry season.

(4) Fig. 3.3 shows the results of said plotting at Bila (R.Bila) and Bulu Cenrana (R.Boya) gauging stations. Although plotted points are rather scattered, the minimum and maximum values of correlation will be obtained from the figures. For the sake of safety of water resources utilization planning, it will be desirable to use the minimum value of correlation in this case.

3.4.2 Estimated Mean Monthly Discharge

(1) The mean monthly discharges will be estimated from the average depth of rainfall over the river basin by use of the minimum value of correlation. The low-discharge of 1/5 in terms of probability will be estimated from these mean monthly discharges. Table 3.11 shows the results of calculation at Bila (R.Bila) and Bulu Cenrana (R.Boya) gauging stations.

(2) The estimated low-discharge of 1/5 probability at each gauging station during dry season, from October to next February, are summarized as follows;

Estimated Low-Discharge of 1/5 Probability

(Unit: cu m/s)

Name of Station	Oct.	Nov.	Dec.	Jan.	Feb.
Bila (R.Bila)	3.7	6.3	6.1	6.7	5.0
Bulu Cenrana (R.Boya)	4.0	8.6	8.1	8.6	6.9
Tarumpakkae (R.Gilirang)	1.2	1.0	1.0	1.0	1.0
Lawo (R.Lawo)	0.3	0.5	0.5	0.5	0.5
Langkemme (R.Langkemme)	1.7	2.1	2.3	2.5	2.2
Sanrego (R.Sanrego)	4.7	5.2	5.8	6.4	5.5

3.5 WATER QUALITY

To know the water quality of the rivers in the objective area, two series of water sampling were carried out at 11 locations shown below during October 1978 in their low-water flow conditions and during March 1979 in their high-water flow conditions.

Sample Number	Name of River	Name of Location	Month of Sampling
1	R.Boya	Bulu Cenrana	Oct. 1978, Mar. 1979
2	R.Gilirang	Gilirang	Oct. 1978, Mar. 1979
3	R.Walanae	Pacongkang	Oct. 1978, Mar. 1979
4	R.Sanrego	Sanrego	Oct. 1978, Mar. 1979
5	R.Cenranae	Solo	Oct. 1978, Mar. 1979
6	L.Sidenreng	in the Lake	Oct. 1978, Mar. 1979
7	R.Bila	Bila	Oct. 1978, Mar. 1979
8	R.Mario	Langkemme	Oct. 1978, Mar. 1979
9	L.Tempe	in the Lake	Oct. 1978, Mar. 1979
10	R.Lawo	Watansoppen	Oct. 1978, Mar. 1979
11	R.Cenranae	Sengkang	Oct. 1978, Mar. 1979

The samples were sent to the Hydrochemical Laboratory, Institute of Hydraulic Engineering, Bandung for analysis. The results of water quality analyses for each location are shown in Table 3.12 and Table 3.13 respectively according to the month of sampling.

Many of the samples collected during the low-water stage in October 1978 show relatively high values of organic solid and nitrogen total, except in the upstream reaches of small rivers.

3.6 ESTIMATION OF SALT WATER INTRUSION INTO THE CENRANAE RIVER

3.6.1 Premise Conditions

The result of a series of salinity measurement of the Cenranae River on 10-11 January, 1979 showed the salinity intrusion only up to 1-2 km upstream from the estuary. A very small figure of salinity-affected distance will be principally due to the rich flow of the river on these dates, which was estimated as 260 - 270 cu m/s at Sengkang.

Hence, an estimation of the possible uppermost distance of the salinity intrusion along the longitudinal profile of the Cenranae River will be prepared by calculation in the following.

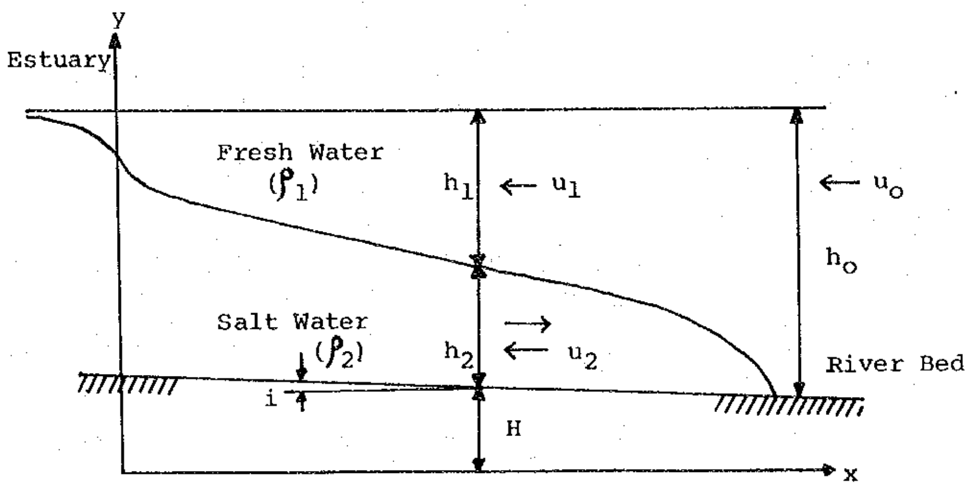
At first, some assumptions will be necessary to simplify the calculation. They are as follows;

(a) The tide level is assumed to be fixed as constant at the Mean High Water Springs, EL.0.67 m.

(b) The river discharge is assumed as 15.4 cu m/s, that is the lowest flow recorded at Sengkang in November 1977.

(c) The density current in the estuary will take a form of the steady stratified flow.

(d) The possible uppermost distance of the salinity intrusion will be obtained as the distance from the estuary to the point where the velocity of salt water comes to zero ($u_2 = 0$)



3.6.2 Basic Equation and its Solution

The basic equation of the stratified flow near the estuary will take a form as (1) shown below;

$$\frac{dh_1}{dx} = f_i' {}_2 \cdot \frac{q_1{}^2 h}{2(q_1{}^2 - \varepsilon g h_1{}^3)(h - h_1)} \qquad (1)$$

where,

$f_i' = A(Re\, F_{ri}^2)^{-n}$: coefficient of frictional resistance along the internal boundary between fresh water and salt water

$Re = q_1/\nu$: Reynolds number

$F_{ri}^2 = q_1{}^2/\varepsilon g h_1{}^3$: (Froude number)^2

$q_1 = u_1 \times h_1$: discharge per unit width

$h = h_1 + h_2$: total depth of water

$\varepsilon = (\rho_2 - \rho_1)/\rho_2$ (=0.023)

ρ_1 = density of fresh water (=1.0)

ρ_2 = density of salt water (=1.024)

$g = 9.8\ m/s^2$

ν : viscosity coefficient ($-1 \times 10^{-6}\ m^2/s$)

A : a constant value (=0.4)

n : a constant value (=2/3)

While, the critical depth h_c of the fresh water at the estuary will be obtained from the equation (2) as below:

$$h_c = (q_1^2/\varepsilon g)^{1/3} \qquad (2)$$

Applying the proper values of n, A, ν and ε as figures in parentheses above, the gradient of the internal boundary of stratified flow dh_1/dx will be re-written in a simple form of (3) as below;

$$dh_1/dx = h_1^2h/(135{,}000\ q_1^2 - 30{,}429\ h_1^3)(h - h_1) \qquad (3)$$

While, the value of h_1 at the estuary will be obtained approximately as 0.30 m from the equation (2).

Assuming the corresponding rectangular cross section at each cross-sectional measurement point of the river, the gradient of the internal boundary of stratified flow dh_1/dx is calculated from each fractional distance (km), q_1(cu m/s), total depth h(m), and fresh water depth h_1(m). The point where the calculated value of h_1 exceeds the actual total depth h will be the uppermost point of salinity intrusion.

Fig. 3.4 shows the result of the calculation, which indicate the salinity intrusion during a severe drought reaching to the point about 35 km upstream from the estuary at maximum.

3.7 HYDROLOGICAL CONSIDERATION ON STUDY PERIOD OF IRRIGATION PLANNING

3.7.1 Average Rainfall according to River Basin and Season

Some hydrological consideration, mainly from the viewpoint of rainfall, on the study period of irrigation planning (1974/75 - 1977/78) will be presented in the following.

At first, the average depth of rainfall over the basins of R.Bila, L.Tempe, R.Walanae and R.Gilirang are estimated, according to the rainfall data collected by the Team, as shown in Table 3.14 and Table 3.15.

Table 3.14 shows the average monthly rainfall in each river basin during the dry season, from October to March, for the observation period of 1927 - 1977. Table 3.15 shows the figures of wet season, from April to September, during the same observation period.

The figures of average monthly rainfall over each river basin in the preceding tables are rearranged in the order of magnitude as shown in Table 3.16 (dry season) and Table 3.17 (wet season). The results are shown graphically in Fig. 3.5 (1) - (5) according to the river basin.

3.7.2 Average Rainfall during Study Period of Irrigation Planning

The average depth of rainfall over each river basin during the study period of irrigation planning will be derived from Table 3.14 and Table 3.15 as shown in the following;

(Unit: mm/month)

	R.Bila	L.Tempe	R.Walanae	R.Gilirang	Sengkang
Dry season (Oct. - Mar.)					
1974/75	153	83	98	102	111
1975/76	119	110	109	109	123
1976/77	111	114	131	145	119
1977/78	99	79	111	120	112
Average	121	97	111	120	112
Wet season (Apr. - Sep.)					
1975	215	199	202	361	206
1976	118	124	157	253	133
1977	106	113	163	162	127
1978	183	213	187	257	194
Average	156	162	177	258	165

3.7.3 Hydrological Consideration on Study Period of Irrigation Planning

A hydrological consideration on the belonging period - whether the wet years, the average years or the dry years - of the study period of irrigation planning in Master Plan will be made clearly by plotting the preceding figures of average monthly rainfall of each season on the distribution curves of Fig. 3.5 according to the river basin.

The result of plotting reveals the following;

As for the dry season, from October to March, the study period of irrigation planning (1974/75 - 1977/78) belongs to the dry years in the upstream basin of Sengkang, and to the average years in the R. Gilirang basin.

As for the wet season, from April to September, the study period of irrigation planning (1975 - 1978) belongs to the average years in both of the upstream basin of Sengkang and the R.Gilirang basin.

CHAPTER IV WATER LEVEL OF LAKE TEMPE

4.1 WATER LEVEL RECORD

A staff gauge station was established at Lake Tempe by the Netherlands around the end of 1938. The station was called "Laringgi" and its location is shown in Fig. 4.1. Daily water level measurement was continued since 1939 up to August 1954 when the station was wrecked. The water level hydrographs are shown in Fig.4.2. At present, the station has no staff gauge but only the piles of station remain. The datum level of measured water level, therefore, cannot be confirmed.

In February 1968, measurement of daily water depth was begun at the same location by Fishery Service, Ministry of Agriculture /1 from the standpoint of fishery, and the measurement was continued up to May 1972. The bottom elevation at the measurement point is estimated at EL.3.30 m above the sea level based on the survey /2 conducted by the Team in November 1978 applying the datum level of SDS 49 at Sengkang. The water level hydrographs in terms of the /3 elevation are shown in Fig. 4.3.

In October 1975, the present staff-gauge station was established by P3SA on the shore of Lake Tempe and the daily water level has been measured since that time. The station is called "Staff Gauge Danau Tempe" and its location is shown in Fig. 4.1. The zero point of the gauge is EL.3.875 m which was surveyed by the Team in November 1978 applying above-mentioned datum level of SDS 49. The water level hydrographs at the staff gauge station are shown in Fig. 4.4.

Besides, a recording water level gauge station was established in December 1977 by P3SA near the site of Laringgi staff gauge. The station is called "AWLR Danau Tempe" and the gauge has been operated since March 1978 after some pre-operation. The zero point of the gauge is EL.3.285 m which was surveyed by the Team in November 1978 applying the datum level of SDS 49.

Based on the daily water level records, the monthly average water levels were calculated for each year during 1969 - 1971 and 1975 - 1978 as shown in Table 4.1. Furthermore, the average water levels for each month are plotted in Fig. 4.5 which indicates the seasonal tendency of water level fluctuation of Lake Tempe, that high-water levels occur from June to August and low-water levels occur from October to December.

Remarks: /1: Dinas Perikanan Darat Daerah Sulawesi Selatan.
/2: The datum level is based on the mean sea level at T. Pallete, Bay of Bone.
/3: Bench mark established by JICA Topographic Survey Team in 1977.

4.2 WATER LEVEL CORRELATION BETWEEN LAKE TEMPE AND SENGKANG

The water level of the Cenranae River at Sengkang is closely related to the water level of Lake Tempe as shown in Fig. 4.6, which is plotted after the daily water level records of Lake Tempe and Sengkang in 1977.

The lack of daily water level data at Lake Tempe and Sengkang during the period from 1975 to 1978 was supplemented using the above mentioned correlation for the purpose of further studies.

4.3 RETURN PERIOD OF PEAK WATER LEVEL

The available records in the past give the annual maximum water levels of Lake Tempe as shown in Table 4.2. Although the number of samples is rather limited to estimate the long-term return period of water level of Lake Tempe, the calculation was made by use of Thomas method as plotted in Fig. 4.7. The results of calculation are as follows;

Return period (yr)	2	5	10	20	50
Water level (EL. m)	8.0	8.9	9.4	9.9	11.0

or

Water level (EL. m)	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5
Return period (yr)	1.2	1.4	2.0	2.9	5.4	11.8	23.3	33.0

4.4 FREQUENCY OF LOW WATER LEVEL

Table 4.3 shows the annual minimum water level, average in 5 days, of Lake Tempe according to the available records in the past. The lowest annual minimum water level presented in Table 4.3 is EL. 3.2 m in November 1977. On the other hand, according to the information collected from local people in Sengkang, a drought occured in 1972 with a low water level of Lake Tempe lower than that of 1977.

Thus, interviews with local people and examination of records of water level mentioned above disclosed the following;

(a) The water level less than EL.3.0 m, El.3.5 m and EL.4.0 m occurred once, twice and three-times respectively during 9 years from 1968 to 1972 and from 1975 to 1978.

(b) The water level usually declines from October to November due to the decrease of inflow of rivers draining into Lake Tempe. The water surface areas of Lake Tempe during the low water level period are estimatdd as follows;

Water level (EL. m):	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4
Water surface area (sq km):	6.1	14.5	21.5	32.0	40.0	49.0	55.0	60.5

CHAPTER V FLOOD DISCHARGE

5.1 PROBABLE FLOOD DISCHARGE

The flood discharges of rivers in the objective area were estimated based on the correlation curves between specific discharge and catchment area.

At first, the discharges corresponding to selected return periods were estimated based on the observed discharges at Cabenge, Ujung Lamuru and Bila gauge stations, considering the accuacy of rating curve and the record period, for drawing said correlation curves. Furthermore, the calculated discharges by Rational Formula method at Batu-Batu and Langkemme gauge stations were adopted for extrapolation of the curves to the range of smaller catchment areas such as tributaries.

As the result, the following formulae were obtained.

Return Period	Discharge Formula
2 - year	$q = 21.744\ A^{-0.451}$
5 - year	$q = 26.214\ A^{-0.444}$
10 - year	$q = 33.176\ A^{-0.462}$
20 - year	$q = 41.308\ A^{-0.474}$
50 - year	$q = 53.634\ A^{-0.495}$
100 - year	$q = 62.762\ A^{-0.506}$
Where: q:	Specific discharge in cu m/s/sq km
A:	Catchment area in sq km

The flood discharges of the Walanae, the Bila and other rivers were calculated by use of the above-mentioned formulae, as shown in Table 5.1 and Table 5.2.

In the case of the Cenranae River, the discharge depends largely on the water level of Lake Tempe. The discharges corresponding to the selected return period at Sengkang gauge station were estimated from the water level of Lake Tempe through a correlation curve between Lake Tempe and Sengkang. The estimated discharges of the Ceranae River at Sengkang are shown in Table 5.3.

5.2 RETURN PERIOD OF PEAK DISCHARGE

Generally, there are two approaches to estimate the return period of peak discharge; the estimation by discharge records in the past and the estimation by rainfall records through runoff analysis. In the case of rivers within the objective area, the latter approach is almost impossible at present by following reasons.

(a) Rainfall records of a period long enough for the analysis are not available in the upper regions of the basin.

(b) As most of the rainfall occurs in spot, the correlation of daily rainfall depths between the existing stations hardly exists especially for large basin.

(c) Most of the characteristics of rainfall and runoff mechanism necessary for the runoff analysis are not known yet.

Therefore, the estimation of return period by discharge records in the past was adopted in the present study.

5.2.1 Return Period of Peak Discharge of the Walanae River

Cabenge

Cabenge water level gauge station is located in the downstream reaches of the Walanae River. The catchment area is 2846 sq km that is 89% of the total catchment area of the Walanae River.

According to the records, available data for the analysis of return period are as follows;

(a) At Cabenge station (Automatic gauge): 1975, 1977 and 1978

(b) At Lakibong station (staff gauge): 1971, 1972, 1976 and 1977 /1

On the other hand, according to the hearing from local people, the following information was obtained:

(a) The biggest flood after the World War II occurred in 1972, and the second biggest was the 1977-flood.

(b) During the flood in June 1977, some over-topping between Lakibong and Cabenge occurred, but there was no over-topping around Lakibong station. The water level records around the peak of the said flood are not available because of the staff gauge damage, but it is estimated as 9.0 m based on the flood mark survey by the Team.

/1: The Lakibong station is located 8 km upstream from Cabenge station, and its catchment area is 2,759 sq km.

Considering above-mentioned facts, annual maximum water levels and discharges are listed in Table 5.4. Using the data of 6 samples in Table 5.4, the discharge of 2-year return period is interpolated by Thomas Method as plotted in Fig. 5.1. However, sample size n=6 is too small to extrapolate to the range of longer return period such as 10-year, 20-year, 50-year and 100-year.

The estimation of peak discharge for longer return periods, therefore, has to depend on the foregoing information that 1972-flood is of the first rank and 1977-flood is of the second rank during 33 years from 1945 to 1978. Applying Thomas Method, their return periods were obtained as below.

Flood	Peak Discharge (cu m/s)	Rank	Return Period (year)
1972-flood	3,068	1	34
1977-flood	2,461	2	17

Making use of the first and the second biggest discharges during 33 years and 2-year discharge obtained from annual maximum discharges since 1971, the return period of discharge at Cabenge (or Lakibong) was estimated as follows;

Return period (yr):	2	5	10	20	50	100
Discharge (cu m/s):	1,700	2,200	2,400	2,700	3,000	3,200
Specific discharge: (cu m/s/sq km)	0.60	0.77	0.84	0.95	1.05	1.12

Ujung Lamuru

Ujung Lamuru water level gauge station is located at the center of the Walanae River basin with a catchment area of 1625 sq km. According to the water level records, available data for the analysis of return period are only 5 samples from 1974 to 1978 as shown in Table 5.4. Using these samples, the discharge of 2-year return period was estimated by Thomas Method as plotted in Fig. 5.2. The result was as follows;

Return Period	Discharge	Specific Discharge
2-year	1,250 cu m/s	0.77 cu m/s/sq km

In drawing the correlation curve, a sample of 1977 was omitted because the discharge magnitude is too big. It was tried to collect information whether the flood of 1977 was the biggest after the World War II or not, but clear information could not be obtained.

5.2.2 Return Period of Peak Discharge of the Bila River

Tanru Tedong

Tanru Tedong water level gauge station is located downstream of the confluence of the Boya River with a catchment area of 1,123 sq km, that is 82% of the total catchment area of the Bila River. The annual maximum water levels and discharges are listed in Table 5.4.

Table 5.4 shows that the maximum discharges of every year have almost the same magnitude. Interviews with local people and further examination of recorded papers, which were made to clear this point, disclosed the following;

(a) According to the information from local people in the up-stream area of Tanru Tedong, the over-topping of flooded river water occurs once or twice every year or every two years during flood season.

(b) According to the recorded papers, the water level around the peak of big flood is almost flat, which indicates the fact of over-topping in the area upstream of Tanru Tedong.

Therefore, the observed data were concluded not to be used for the analysis of return period.

Bila

Bila water level gauge station is located 12 km upstream from Tanru Tedong station with a catchment area of 379 sq km. Available data for the analysis of return period are listed in Table 5.4. Using these samples, discharges corresponding to the return period of 2-year, 5-year and 10-year were estimated by Thomas Method as plotted in Fig. 5.3. As a result, the following discharges were obtained.

Return period	(year)	:	2	5	10
Discharge	(cu m/s)	:	580	700	790
Specific discharge	(cu m/s/sq km)	:	1.53	1.85	2.08

5.3 RELATION BETWEEN SPECIFIC DISCHARGE AND CATCHMENT AREA

Based on the observed discharges at Cabenge, Ujung Lamuru and Bila, and calculated discharges by Rational formula, the specific discharge-catchment area relation curves under present channel condition were drawn for each return period as shown in Fig. 5.4. These curves serve for the estimation of flood discharge in the area as mentioned in Section 5.1.

For the purpose of estimation of specific discharge in the small scale river, the probable discharges at Batu-Batu gauge station (113 sq km) on the Batu-Batu River and Langkemme gauge (104 sq km) on a tributary of the Walanae River were calculated by the Rational formula method, considering that the runoff calculation may be applied to such small scale rivers.

The above-mentioned two gauge stations were selected from the view-points of size of catchment area and conformity with the rainfall and water level records, and accuracy of discharge rating curves.

The Rational formula for peak discharge and Mononobe formula for rainfall intensity are shown below.

Rational formula : $Q = 0.2778 \, A \, r \, f$

Mononobe formula : $r = \frac{R24}{24} \left(\frac{24}{T}\right)^{2/3}$

Where,

Q	:	Peak discharge (cu m/s)
A	:	Catchment area (sq km)
f	:	Runoff coefficient
r	:	Rainfall intensity (mm/hr)
24	:	Daily rainfall (mm)
T	:	Duration of rainfall (hr)

In the calculation, the probable rainfall at Watansoppeng was used, and the runoff coefficient was estimated to be 0.45 based on the observed data from 1974 to 1977 presented in Table 5.5. The results of calculation are shown in Table 5.6.

5.4 HYDROGRAPHS FOR DAM PLANNING

A multipurpose dam is proposed in the middle reaches of the Walanae River. The probable discharge hydrographs for the study of flood control storage capacity of the reservoir were prepared on the basis of the flood hydrograph of June 1977 at Cabenge.

The reasons of selection of the June 1977-flood as the basic hydrograph are as follows;

(a) The flood was one of the remarkable floods in the past and the hourly water level records are available.

(b) THe flood has a double peak which means that the flood has a larger volume than the others of the same peak discharge.

(c) As the flood has a peak discharge of 10-year return period, the rate of proportional enlargement is not so large; e.g. the rate is only 1.3 even in the case of 100-year hydrograph. If the enlargement rate gets larger, those enlarged hydrographs may give some problems on the reliability of occurrence.

In the observed flood hydrograph of June 1977 at Cabenge, a part of the peak is flat due to the over-topping between Lakibong and Cabenge as mentioned in Section 5.2. Hence, in order to use the June 1977-flood as the basic flood hydrograph, the discharge hydrograph was restored to the condition before over-topping by use of the peak discharge at Lakibong as shown in Table 5.7 and Fig. 5.5.

Based on the above mentioned discharge hydrograph, 20-year, 50-year and 100-year discharge hydrograph at Cabenge were enlarged proportionally in the rate of peak discharge as shown in Table 5.8 and Fig. 5.6. The obtained flood discharge hydrograph can be applied Mong Dam site without modification as the increment of catchment area between Mong Dam site and Cabenge is very small.

As for the alternative dam site at Walimpong, located upstream from the confluence of the Mario River, the flood discharge hydrograph will be obtained by the ratio of catchment area at the dam site and Cabenge gauge station.

Table 5.8 and Fig. 5.6 show the flood discharge hydrograph of June 1977 flood at Mong Dam site. Table 5.10 and Fig. 5.8 show the flood discharge hydrograph by return periods at Walimpong Dam site.

CHAPTER VI RECOMMENDATION

The hydrological data play a basic role among the flood control and water resources development projects. Unless sufficient and exact data are available, the investigation may be hampered on its way or may be brought to the results losing some accuracy.

After collection and arrangement of the hydrological data in the objective area, the Team would like to present some recommendation as follows.

Basically the following two points would be necessary of further improvement:

(a) To decrease the period of data absence caused by accidents, by missing in storage or other reasons.

(b) To expand the coverage of discharge measurement into higher water levels so as to make it easier and more accurate to draw up the discharge rating curve.

Besides, following improvement would be useful, as they are practical and may not need much expenditure.

(1) To make sub-observation on the standard gauge at the automatic gauging station to ascertain the correct running of the automatic gauge. To make prompt adjustment, if some differences are found out between both readings.

(2) To reinforce the management of the storage of observation data to prevent from missing.

(3) To practice the re-education of observers on the method of observation.

Table 1.1.(1) Catchment Areas of Main Streams

Name of River	Distance from River Mouth (km)	Catchment Area (sqkm)	Remarks
R.Walanae	0.0	3,190	Confluence of Cenranae River
	43.2	3,076	Confluence of R.Belo (downstream)
	43.2	2,859	Confluence of R.Belo (upstream)
	74.5	2,684	Confluence of R.Mario (downstream)
	74.5	2,199	Confluence of R.Mario (upstream)
	118.5	1,625	Ujung Lamuru gauging station
	145.0	1,200	Confluence of R.Menraleng (downstream)
	145.0	686	Confluence of R.Menraleng (upstream)
	179.0	398	Confluence of R.Sanrego (downstream)
	179.0	168	Confluence of R.Sanrego (upstream)
R.Bila	0.0	1,368	Confluence of Lake Tempe
	6.8	1,188	Confluence of R.Lancireng (upstream)
	17.0	1,123	Confluence of R.Boya (downstream)
	17.0	420	Confluence of R.Boya (upstream)
R.Cenranae	0.0	7,293	River mouth
	7.1	7,138	Branch point
	27.0	6,836	Solo gauging station
	64.0	6,138	Sengkang gauging station
Around Lake Tempe		1,580	Including L.Sidenreng, L.Buaya and small rivers flowing into L.Tempe directly

Table 1.1.(2) Catchment Areas of Small Scale Rivers and Tributaries of R.Walanae and R.Bila

River System	Name or River	Catchment Area (sqkm)
R.Walanae	R.Belo	216
	R.Mario	485
	R.Langkemme	104
	R.Menraleng	515
	R.Sanrego	230
R.Bila	R.Lancireng	180
	R.Kalora	167
	R.Boya	536
Around L.Tempe	R.Lawo	168
	R.Batu-Batu	113
Gilirang	R.Gilirang	518

Table 2.1.(1) List of Rainfall Gauging Stations

No.	(1) Name of Station	(2) Belonging		Setting Year	River System	Name of River	Remarks
1	Enrekang	N	PMG		Sadang	Sadang	Out of basin
2	Baraka	N	PMG		Bila	Boya	
		A	P3SA	Dec. 1973			
		N	DIPERTA				
3	Rappang	N	PMG	1909	Rappang	Rappang	Out of basin
		N	PMA				
		N	DIPERTA				
4	Marcanging	N	PMG	1930	Bila	Boya	
		N	PMA	Nov. 1974			
5	Bulu Cenrana	A	P3SA	Dec. 1973	Bila	Boya	
		N	PMA				
6	Barukku	N	PMG		Bila	Bila	
		N	P3SA	Sep. 1975			
7	Bila	N	PMG		Bila	Bila	
		A	P3SA	1977			
		N	PMA	Nov. 1975			
8	Tanru Tedong	N	PMG	1930	Bila	Bila	
		N	DIPERTA				
		N	PMA	Nov. 1974			
9	Belawa/Menge	N	PMG		L.Tempe	L.Tempe	
		N	DIPERTA	1922			
		N	PMA				
10	Anabanua	N	PMG	1925	L.Tempe	L.Tempe	
		N	DIPERTA				
11	Bontouse	N	PMG	1930	L.Tempe	L.Tempe	
		N	DIPERTA				
12	Bulutimorang	N	PMA	Nov. 1974	Around L.Tempe	L.Sidenreng	
13	B.Alakuang	N	PMG	1909	Around L.Tempe	L.Sidenreng	
14	Amparita	N	PMG	1921	Around L.Tempe	L.Sidenreng	
		N	DIPERTA				
15	Bilokka	N	PMG	1929	Around L.Tempe	Bilokka	
16	Batu-Batu	N	PMG	1928	Around L.Tempe	Batu-Batu	
		A	P3SA	1978			
		N	DIPERTA				

Table 2.1.(2) List of Rainfall Gauging Stations

No.	(1) Name of Station	(2) Belonging		Setting Year		River System	Name of River	Remarks
17	Sengkang	N	PMG		1909	Cenranae	Cenranae	
		A	P3SA	May	1974			
		N	DIPERTA					
18	Palaguna	N	PMG			Cenranae	Cenranae	
		N	DIPERTA		1926			
19	Lerang	N	PMG		1937	Cenranae	Cenranae	
		N	PMA					
		N	DIPERTA					
20	Pampanua	N	PMG		1906	Cenranae	Cenranae	
21	Palima	N	PMG		1918	Cenranae	Cenranae	
22	Watampone	N	PMG		1906	Cenranae	Cenranae	
		N	DIPERTA					
23	Maccope	N	PMG		1937	Cenranae	Cenranae	
		N	PMA					
24	Biru	N	PMG			Cenranae	Cenranae	
		N	DIPERTA					
25	Cellu	N	PMG			Cenranae	Cenranae	
		N	PMA					
		N	DIPERTA					
26	Katumpi	N	PMG			Cenranae	Cenranae	
		N	PMA					
		N	DIPERTA					
27	Camba	N	PMG			Walanae	Menraleng	
		A	P3SA	May	1974			
		N	PMA					
28	Kappang	N	PMG		1917	Walanae	Menraleng	
29	Maradda	N	PMG		1971	Walanae	Sanrego	
		N	PMA					
30	Palattae	N	PMG			Walanae	Sanrego	
		A	P3SA		1978			
		N	PMA		1974			
31	Camming	N	PMG		1928	Walanae	Walanae (upper part)	
32	Parigi	N	P3SA	May	1975	Walanae	Batupute	
33	Matango	N	P3SA	May	1975	Walanae	Walanae (upper part)	
34	Ujung Lamuru	N	PMG		1914	Walanae	Walanae	
		A	P3SA	Mar.	1974			

Table 2.1.(3) List of Rainfall Gauging Stations

(1) No.	Name of Station	(2) Belonging		Setting Year		River System	Name of River	Remarks
35	Bengo	N	PMG			Walanae	Walanae	
		N	PMA					
		N	DIPERTA		1971			
36	Paciro	N	P3SA	May	1975	Walanae	Walanae	
37	Turucinae	N	P3SA	May	1975	Walanae	Walanae	
38	Takalala	N	PMG		1928	Walanae	Walanae (lower part)	
		N	DIPERTA					
39	Malanroe	N	DIPERTA	Sep.	1972	Walanae	Walanae (lower part)	
40	Watansoppeng	N	PMG		1906	Walanae	Walanae	
		N	DIPERTA					
41	Cabenge	N	PMG	Jun.	1971	Walanae	Walanae	
		A	P3SA		1974			
42	Canru	N	PMG		1953	Walanae	Walanae	
		N	PMA					
		N	DIPERTA					
43	Sakkoli	N	PMG		1969	Gilirang	Gilirang	
		N	DIPERTA					
44	Paria	N	PMG		1918	Gilirang	Gilirang	
		A	P3SA		1978			
		N	DIPERTA					
45	Paneki	N	PMG		1928	Gilirang	Gilirang	
		N	DIPERTA					

Note: (1) Rainfall station number in Fig. 2.1

(2) Classification of automatic or normal gauge

(3) P3SA ; Proyek Perancangan dan Pengembangan Sumber Sumber Air

PMA ; Penyelidikan Masalah Air

PMG ; Pusat Meteorologi dan Geofisika

DIPERTA; Dinas Pertanian

Table.2.2 Existing Condition of Rainfall Data

Remarks
* • Rainfall gauging station number in Fig 2.1
○ • Monthly Rainfall Data, available
◉ • Daily Rainfall Data, available

No.	Station / Year (19)	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	Remarks
1	Enrekang	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○																														○	○	○	○	○	◉	◉		
2	Baraka																																					○	○	○																				○	◉	◉	•	
3	Rappang	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○											○	○	○	○	○	○					○	○	○	○						○	○	○	○	◉	◉	◉	•	
4	Maroanging																																						○	○	○	○	○	○	○																			
5	Bulucenrana																																																										•	•	•	•	•	
6	Barukku					○	○	○	○	○	○	○																																															○	○	◉	○		
7	Bila															○	○	○	○	○	○	○	○	○	○																																						
8	Tanrutedong															○	○	○	○	○	○	○	○	○	○	○												○	○	○		○	○	○												○	○	○	◉	◉	◉	◉	•	
9	Bekwa <Menge>						•	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉												◉	◉	◉	•	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉			◉	•		•	•	◉	•	
10	Anabanua									○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○												○	○	○	○	○	○	◉	◉	◉	◉	◉	◉	◉	◉	◉										•		
11	Bontouse																																					○	○	○	○	○	○	○	○	○	○	○	○	○	○				○	○	○				◉	◉	•	
12	Bulutimorang																																																													•	•	
13	B. Alakuang	○	○	○	○	○	○																																																									
14	Amparita						○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○											○	○	○	○	○															○	○	○	○	○	◉	◉		
15	Biloka															○	○	○	○	○	○	○	○	○	○	○																																					
16	Batu - Batu															○	○	○	○	○	○	○	○	○	○	○										○	○	○	○	○		○	○	○	○	○	○	○	○	○	○	○						◉	◉	◉	◉	◉	•	
17	Sengkang	○	○	○	○	○	○	○	○	○	○	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉												◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	•		•	•	•			
18	Palaguna																																																							○	○	○	○	○	•	◉	•	
19	Lerang																					○	○	○	○	○																														◉	◉	◉	◉	◉	◉	◉	•	
20	Pampanua	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○																																					
21	Palima		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○																																					
22	Watampone	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○									•	◉	◉	◉	◉	◉	◉	•	◉	◉	•	•	•	•	◉	◉	◉	•	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	•	
23	Maccope																					○	○	○	○	○																		○	○	○	○	○	○	○		○	○	○	◉	◉	◉	◉	◉	◉	◉	◉	•	
24	Biru																																																								○	○	○	○	◉	◉	•	
25	Cellu																					○	○	○	○	○																		○	◉	◉	◉	◉	◉	◉	•	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	•	
26	Katumpi																																																						•	◉	◉	◉	◉	◉	◉	◉	•	
27	Camba	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○																																	•	•	•	•	•	
28	Kappang				○	○	○	○	○	○																																																					
29	Maradda																																																							◉	◉	◉	◉	◉	◉	◉	◉	
30	Palatae	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○																																	•	•	•	•	•	
31	Camming														○	○	○	○	○	○	○	○	○	○	○	○																																					
32	Parigi																																																											•	•	•	•	
33	Matango																																																											•	•	•	•	
34	Ujung Lamuru	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○																																	•	•	•			
35	Bengo									○	○	○	○																																											◉	◉	◉	◉	◉	◉	◉	•	
36	Paciro																																																											•	•	•	•	
37	Turucinnae																																																											•	•	•		
38	Takalala																																			○	○	○	○	○		○	○	○	○	○	○	○	○	○	○	○	○	○	○	◉	◉	◉	◉	◉	◉	•	•	
39	Maianroe																																																												•	•	•	
40	Watan soppeng	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○												○	○	○	○		○	○	○	○	○	○	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉		
41	Cabenge																																																								○	○	◉	◉	◉	◉		
42	Canru																																					○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◉	◉	◉	•	
43	Sakoli																																																					○	○	○	○	○	○	○	◉	◉	•	
44	Paria		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○												○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		○	○	○	○	○	◉	◉	•	
45	Peneki														○	○	○	○	○	○	○	○	○	○	○	○													○	○	○	○	○														○	○	○	○	○	◉	◉	•	

Table 2.3 List of Water Level Gauging Stations

No.	(1) Name of Station	(2) Belonging		Setting Year	River System	Name of River	Remarks
1	Bulu Cenrana(1)	N	P3SA	Oct. 1975	Bila	Boya	
2	Bulu Cenrana(2)	N.A	P3SA	Oct. 1975	Bila	Boya	(3)
3	Bila	A	PMA	Apr. 1973	Bila	Bila	
4	Tanru Tedong	A	P3SA	Mar. 1974	Bila	Bila	
5	Sengkang	A	DPMA	Oct. 1974	Cenranae	Cenranae	
6	Kampiri	N	P3SA	Jul. 1975	Cenranae	Cenranae	
7	Solo	A	P3SA	Feb. 1976	Cenranae	Cenranae	
8	Cenranae	N	P3SA	Jul. 1975	Cenranae	Cenranae	
9	Tg.Pallette	N.A	P3SA	Jul. 1975	Bay of Bone		(4)
10	Sanrego	A	PMA	Apr. 1973	Walanae	Sanrego	
11	Batupute	N	P3SA	Jul. 1975	Walanae	Batupute	
12	Ujung Lamuru	A	P3SA	Apr. 1974	Walanae	Walanae	
13	Langkemme	A	PMA	Jul. 1974	Walanae	Mario	
14	Sero	N	P3SA	Jul. 1975	Walanae	Mario	
15	Kalempang	A	P3SA	May 1977	Walanae	Walanae	
16	Pacongkang (Mong)	N.A	P3SA	Sep. 1975	Walanae	Walanae	(5)
17	Lakibong	N	P3SA	Aug. 1970	Walanae	Walanae	
18	Cabenge	A	DPMA	Oct. 1974	Walanae	Walanae	
19	Canru	N	P3SA	Jul. 1975	Walanae	Walanae	
20	Wage	N	P3SA	Jul. 1975	Walanae	Walanae	
21	Lawo	N	P3SA	Jul. 1975	L.Tempe	Lawo	
22	Pandangeng	N	P3SA	Jul. 1975	L.Tempe	Leworeng	
23	Batu Batu	N	P3SA	Jun. 1975	L.Tempe	Batu Batu	
24	L.Tempe	A	P3SA	Mar. 1978	L.Tempe	L.Tempe	
25	L.Tempe	N	P3SA	Oct. 1975	L.Tempe	L.Tempe	
26	Laringgi	N	DIPERTA	Feb. 1968	L.Tempe	L.Tempe	
27	L.Sidenreng	N	P3SA	Oct. 1975	L.Tempe	L.Sidenreng	
28	Gilirang	N.A	P3SA	Sep. 1975	Gilirang	Gilirang	
29	Tarumpakkae	N	P3SA	Sep. 1975	Gilirang	Gilirang	

Note: (1) ; Water level station number in Fig. 2.1
(2) ; Classification of automatic or normal gauge
(3) ; Bulu Cenrana(2) is automatic gauging station after Mar. 1977.
(4) ; Tg.Pallette is automatic gauging station after May 1977.
(5) ; Pacongkang is automatic gauging station after Mar. 1978, and the name of station was changed to Mong.
(6) ; Gilirang is automatic gauging station after Oct. 1978.
P3SA ; Projek Perancangan & Pengembangan Sumber Sumber Air
PMA ; Penyelidikan Masalah Air
DPMA ; Direktorat Penyelidikan Masalah Air
PMG ; Pusat Meteorologi & Geofisika
DIPERTA; Dinas Pertanian

Table 2.4 Existing Condition of water level data

☆	Year / Station Name	1968	1969	1970	1971	1972	1973
		1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
1	Bulu Cenrana(1)	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
2	Bulu Cenrana(2)	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
3	Bila	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / Δ O O O O O O O O
4	Tonru Tedong	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
5	Seng Kang	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
6	Kampiri	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
7	Solo	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
8	Cenranae	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
9	Tg. Pallete	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
10	Sanrego	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / Δ Δ / / / Δ O O O
11	Batupute	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
12	Ujung Lamuru	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
13	Lang Kemme	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
14	Sero	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
15	Kalempang	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
16	Pantjon Kang	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
17	Lakibong	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / O O O O O	O O O / O O O / O O O O	O O / O O O O O O O O O	/ / / / / / / / / / / /
18	Cabenge	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
19	Canru	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
20	Wage	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
21	Lawo	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
22	Padangeng	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
23	Batu - Batu	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
24	L. Tempe (Auto.)	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
25	-do- (Normal)	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
26	Laringgi	/ Δ Δ Δ Δ Δ O O Δ O O O	Δ O Δ O O O O O O O O /	O O O O O O O O O O O O	O O O O O O O O O O O O	O O O O O Δ / / / / / /	/ / / / / / / / / / / /
27	L. Sidenreng	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
28	Gilirang	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /
29	Tarumpakkae	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /

☆	Year / Station Name	1974	1975	1976	1977	1978	
		1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
1	Bulu Cenrana(1)	/ / / / / / / / / / / /	/ / / / / / / / / / / /	O Δ O O O O O Δ / O O O	O Δ Δ O O O Δ Δ / / / O	O O O O O / O O ✱ ✱ ✱ ✱	
2	Bulu Cenrana(2)	/ / / / / / / / / / / /	/ / / / / / / / / O O O	O Δ O O O O O Δ / Δ Δ Δ	O / Δ Δ Δ O Δ / Δ O Δ Δ	O O Δ Δ / Δ / Δ ✱ ✱ ✱ ✱	
3	Bila	O Δ Δ O O O O O O O Δ O	O Δ Δ O Δ Δ O O O O O O	O O O O O O O Δ Δ O O O	O / O O O O O O O O O O	O O O O O O O O O ✱ ✱ ✱	
4	Tonru Tedong	/ / Δ Δ O Δ O O Δ O Δ O	O Δ O O Δ Δ O O O O O O	O O O O Δ O O Δ Δ O Δ O	O / O O O O O O O O O O	O O O Δ O O O O O O Δ O	
5	Seng Kang	/ / / / / / / / / / Δ O	O O O O O O O O O O O O	O O O O O O O O O O O O	O O O O O O O O O Δ O O	O O O O O O O O O O O O	
6	Kampiri	/ / / / / / / / / / / /	/ / / / / / Δ O O O O O	O O O O O O O O O O O O	O O O O O O O O O O O O	O O O ✱ ✱ ✱ ✱ ✱ ✱ ✱ ✱ ✱	
7	Solo	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / Δ Δ Δ Δ O O	O O O Δ O O Δ O Δ Δ O O	O O O O O O O O O Δ ✱ ✱	
8	Cenranae	/ / / / / / / / / / / /	/ / / / / / Δ O O O O O	O O O O O O O O O O O O	O O O O O O O O O O O O	O O O O O O O O O ✱ ✱ ✱	
9	Tg. Pallete	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	O O O O Δ Δ ✱ ✱ ✱ ✱ ✱ ✱	
10	Sanrego	O O Δ Δ O Δ O O O O O O	O Δ O O O Δ O O Δ O O O	O / Δ O O O O O O O O O	O O O O O Δ Δ Δ O / Δ O	O O O O O O O O O ✱ Δ O	
11	Batupute	/ / / / / / / / / / / /	/ / / / / / Δ O O O O O	O O Δ O / O O O O O O O	O O O O O O O Δ O O O O	O O O O ✱ ✱ ✱ ✱ ✱ ✱ ✱ ✱	
12	Ujung Lamuru	/ / / Δ O O O O O O O O	Δ / Δ O O O O Δ O O O /	/ / O O Δ O O O O O O O	O O O O O Δ O O O O / O	O / O Δ ✱ ✱ ✱ ✱ ✱ ✱ ✱ ✱	
13	Lang Kemme	/ / / / Δ O O O O O Δ O	O O O Δ / Δ Δ O O O O O	O O O O O O O O O O O O	O O O O Δ O O O O O Δ O	O O O O Δ / / / ✱ ✱ ✱ ✱	
14	Sero	/ / / / / / / / / / / /	/ / / / / / Δ O O O O O	O O O O O O O O O O O O	O O O O O O O O O O O O	O O O O O O ✱ ✱ ✱ ✱ ✱ ✱	
15	Kalempang	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	Δ Δ Δ O Δ ✱ ✱ ✱ ✱ ✱ ✱ ✱	
16	Pantjon Kang	/ / / / / / / / / / / /	/ / / / / / / / Δ O O Δ	O O O O O O Δ O O O O O	O O O O O O O O Δ Δ O Δ	Δ O ✱ ✱ ✱ ✱ ✱ ✱ ✱ ✱ ✱ ✱	
17	Lakibong	/ / / / / / / / / / / /	/ / / / / / / / Δ Δ / /	/ Δ O O O O O O O O O Δ	O O O O Δ O O O O O O O	O O O O O O O ✱ ✱ ✱ ✱ ✱	
18	Cabenge	/ / / / / / / / / / Δ O	O O O O O O O O O O Δ /	/ / / / / / / / / / Δ O	O O O O O O O O O O Δ /	O O O O O O O O O O O O	
19	Canru	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	
20	Wage	/ / / / / / / / / / / /	/ / / / / / Δ O O O O O	O O O O O O O O O O O O	O O O O O O O O O O / O	O O O O ✱ ✱ ✱ ✱ ✱ ✱ ✱ ✱	
21	Lawo	/ / / / / / / / / / / /	/ / / / / / Δ O O O O O	O O O / O Δ O O O O O O	/ / / O O Δ Δ O O O O O	O O O / O O O ✱ ✱ ✱ ✱ ✱	
22	Padangeng	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / O O O O O / O O	Δ / / / / / / Δ O O Δ O	O O O O O O O ✱ ✱ ✱ ✱ ✱	
23	Batu - Batu	/ / / / / / / / / / / /	/ / / / / O O O O O O O	O Δ O O O O O O O O O O	O O O O O O O O O O O O	O O O O O O O O O O ✱ ✱	
24	L. Tempe (Auto)	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / Δ Δ Δ O Δ O O Δ ✱ ✱	
25	-do- (Normal)	/ / / / / / / / / / / /	/ / / / / / / / / Δ O O	O O O O O O O O O O O O	O O O O O O O O Δ / / /	O O O O O O O O O O ✱ ✱	
26	Laringgi	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	
27	L. Sidenreng	/ / / / / / / / / / / /	/ / / / / / / / / O O O	O O O O O O O / / O O O	Δ Δ O O O O Δ Δ / / O O	O O O O O / O O ✱ ✱ ✱ ✱	
28	Gilirang	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	/ / / / / / / / / / / /	
29	Tamumpakkae	/ / / / / / / / / / / /	/ / / / / / / / Δ O O O	O O O O O O O O O O O O	O O O O O O O O O O O O	O O O O O O O ✱ ✱ ✱ ✱ ✱	

Remarks

☆ : Water level gauging station number in Fig 2.1

/ : No data (no information or gauge trouble)

Δ : Data, partialy available

O : Data, available

✱ : Seems to be available but not formally arranged yet

Table 3.1.(1) Average Monthly Rainfall

(Unit: mm)

No. Station	Rivers		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Max. Min.	Ob-served Period	Avail-able Nos. of yrs
1 Enrekang	R.Sadang	Ave.	225	212	261	297	237	182	99	66	81	120	173	237	2190		
		Max.	573	429	485	535	385	403	417	199	420	326	312	409	573	32	29
		Min.	46	81	101	122	48	38	3	0	0	0	50	80	0		
2 Baraka	R.Boya	Ave.	131	172	121	212	213	335	203	179	148	158	201	210	2283		
		Max.	299	287	211	285	278	561	529	418	209	242	347	519	561	6	4
		Min.	50	40	47	136	72	122	27	22	9	0	52	67	0		
3 Rappang	R.Rappang	Ave.	139	141	169	225	283	192	140	115	92	131	139	153	1926		
		Max.	416	552	419	512	578	473	348	365	397	315	279	380	578	42	27
		Min.	24	36	21	35	60	0	0	0	0	0	32	42	0		
4 Maroanging	R.Boya	Ave.	104	102	155	200	340	498	279	240	138	154	132	200	2542		
		Max.	269	397	316	284	436	863	578	366	377	356	247	279	863	7	3
		Min.	61	62	75	92	259	137	35	50	31	68	94	116	31		
6 Baruku	R.Bila	Ave.	140	115	152	232	184	159	109	80	48	90	89	193	1591		
		Max.	264	216	386	438	438	320	199	232	182	261	216	319	438	13	8
		Min.	32	32	45	89	76	9	0	7	0	0	14	84	0		
7 Bila	R.Bila	Ave.	131	140	231	332	468	381	336	202	92	216	161	72	2762		
		Max.	268	302	568	430	700	597	630	423	177	384	374	120	700	10	8
		Min.	25	52	64	95	251	216	73	29	5	71	54	30	5		
8 Tanru Tedong	R.Bila	Ave.	76	61	120	235	364	281	199	154	162	130	141	98	2021		
		Max.	254	282	275	440	643	541	529	442	442	274	331	206	643	24	11
		Min.	5	35	17	77	0	47	5	0	0	0	36	18	0		

Table 3.1.(2) Average Monthly Rainfall

(Unit: mm)

No.	Station	Rivers		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Max. Min.	Ob-served Period	Avail-able Nos. of yrs
9	Belawa (Menge)	L.Tempe	Ave.	124	94	98	173	239	190	123	89	65	77	109	110	1491		
			Max.	500	396	273	451	561	473	526	292	213	250	237	390	561	37	24
			Min.	18	29	11	17	10	21	5	0	0	0	4	13	0		
10	Anabanua	L.Tempe	Ave.	73	104	141	256	342	295	213	118	80	96	110	82	1910		
			Max.	250	299	329	661	556	658	529	540	297	255	258	238	661	32	21
			Min.	0	3	34	25	150	31	18	5	0	0	0	7	0		
11	Bontouse	L.Tempe	Ave.	89	82	110	179	224	184	147	135	84	114	82	89	1519		
			Max.	418	206	302	402	322	431	576	620	221	310	298	203	620	19	13
			Min.	6	0	14	28	17	17	4	0	0	0	12	10	0		
13	B.Alakuang	L.Sidenreng	Ave.	90	219	248	215	199	175	65	18	28	101	148	119	1625		
			Max.	145	525	435	302	294	450	180	55	93	185	208	182	525	6	4
			Min.	13	41	67	53	2	54	0	0	0	3	42	69	0		
14	Amparita	L.Sidenreng	Ave.	155	120	145	174	215	164	110	67	66	75	113	145	1549		
			Max.	567	297	366	350	552	704	271	252	373	218	287	368	704	32	24
			Min.	17	21	26	21	62	0	0	0	0	0	25	46	0		
15	Biloka	R.Biloka	Ave.	192	139	141	154	272	227	97	45	25	52	121	128	1593		
			Max.	584	329	261	347	451	428	242	174	79	157	204	221	584	11	9
			Min.	71	56	43	107	115	93	0	5	0	2	23	61	0		
16	Batu Batu	R.Batu Batu	Ave.	149	131	150	198	287	206	112	75	64	73	117	108	1670		
			Max.	522	352	304	400	582	327	244	320	455	366	410	226	582	32	16
			Min.	0	22	40	15	60	55	0	0	0	0	10	31	0		

Table 3.1.(3) Average Monthly Rainfall

(Unit: mm)

No.	Station	Rivers		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Max. Min.	Ob-served Period	Avail-able Nos. of yrs
17	Sengkang	R.Cenranae	Ave.	86	95	121	188	267	210	142	87	57	80	122	97	1552		
			Max.	388	280	300	367	526	395	397	280	306	222	291	232	526	44	40
			Mix.	8	3	31	43	64	0	0	0	0	0	0	2	0		
18	Palaguna	R.Cenranae	Ave.	65	52	51	127	153	167	148	126	134	102	74	58	1257		
			Max.	239	103	64	225	211	194	199	213	241	241	120	178	241	6	5
			Min.	5	28	3	42	54	105	2	43	0	0	11	5	0		
19	Lerang	R.Cenranae	Ave.	140	136	257	316	528	390	237	153	66	70	112	195	2600		
			Max.	234	237	386	538	923	756	633	287	309	315	251	347	923	12	9
			Min.	64	15	120	194	74	70	9	31	0	0	16	56	0		
20	Pampanua	R.Cenranae	Ave.	93	147	157	256	305	227	136	86	44	84	124	118	1777		
			Max.	215	498	509	502	550	370	308	202	155	333	301	304	550	25	23
			Min.	16	19	34	92	120	54	10	0	0	0	48	27	0		
21	Palima	R.Cenranae	Ave.	107	119	170	281	380	292	207	88	62	114	119	99	2038		
			Max.	245	323	377	563	662	537	453	217	233	269	311	246	662	24	22
			Min.	15	32	87	104	187	105	0	0	0	0	0	0	0		
22	Watampone	R.Cenranae	Ave.	144	146	205	302	373	315	215	116	81	93	141	144	2269		
			Max.	449	410	475	514	727	717	493	344	281	284	336	282	727	46	35
			Min.	0	17	51	83	109	11	12	0	0	0	11	6	0		
23	Maccope	R.Cenranae	Ave.	101	102	177	254	331	322	221	128	85	100	135	142	2098		
			Max.	431	453	327	513	798	697	710	511	382	534	408	287	798	23	14
			Min.	39	7	44	101	74	16	8	7	0	0	25	57	0		

Table 3.1.(4) Average Monthly Rainfall

(Unit: mm)

No. Station	Rivers		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Max. Min.	Observed Period	Available Nos. of yrs
24 Biru	R.Cenranae	Ave.	128	123	150	285	366	248	287	156	218	166	133	217	2449		
		Max.	1110	156	288	319	524	534	349	289	434	250	162	352	1110	6	4
		Min.	45	49	80	164	146	51	19	25	0	0	27	97	0		
25 Cellu	R.Cenranae	Ave.	115	119	157	326	394	315	216	113	75	59	126	278	2293		
		Max.	632	875	347	910	806	539	530	416	231	411	512	624	910	23	12
		Min.	47	14	5	71	71	117	93	0	0	0	14	27	0		
26 Katumpi	R.Cenranae	Ave.	82	114	213	284	409	389	379	159	82	165	178	194	2646		
		Max.	184	289	289	449	764	483	955	299	314	275	378	300	955	7	4
		Min.	22	29	71	139	105	130	34	77	1	0	2	52	0		
27 Camba	R.Menraleng	Ave.	445	355	282	229	195	141	90	50	30	63	175	296	2351		
		Max.	977	994	608	542	345	256	285	173	105	165	389	794	994	25	20
		Min.	154	67	104	41	78	40	2	0	0	0	15	73	0		
28 Kappang	R.Menraleng	Ave.	867	613	726	283	145	123	50	50	24	142	348	726	4097		
		Max.	1160	815	885	508	288	183	180	235	100	271	618	1179	1179	6	5
		Min.	62	403	621	22	23	36	0	0	0	8	157	178	0		
29 Maradda	R.Sanrego	Ave.	115	77	97	245	239	297	204	82	101	126	55	135	1773		
		Max.	243	325	137	400	480	640	480	268	217	253	193	272	640	8	6
		Min.	22	30	48	61	0	135	21	0	0	0	0	29	0		
30 Palatae	R.Sanrego	Ave.	147	148	148	220	393	313	209	95	54	69	96	187	2079		
		Max.	333	356	324	498	815	692	434	306	296	413	250	373	815	25	24
		Min.	49	34	50	59	120	25	28	0	0	0	10	14	0		

Table 3.1.(5) Average Monthly Rainfall

(Unit: mm)

No.	Station	Rivers		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Max. Min.	Ob-served Period	Avail-able Nos. of yrs
31	Camming	R.Walanae	Ave.	153	154	172	238	399	332	167	91	39	66	95	150	2056		
			Max.	307	314	265	377	658	555	351	282	79	173	248	272	658	12	9
			Min.	22	33	19	78	240	137	40	0	0	0	15	40	0		
34	U.Lamuru	R.Walanae	Ave.	156	145	173	222	276	242	159	71	43	62	122	149	1820		
			Max.	327	448	286	397	533	400	298	320	120	205	274	339	533	25	23
			Min.	33	40	34	99	110	114	14	0	0	0	30	29	0		
35	Bengo	R.Walanae	Ave.	430	192	221	150	222	195	131	154	41	102	157	271	2266		
			Max.	1332	972	424	307	435	513	343	850	185	309	323	716	1332	11	7
			Min.	51	47	59	73	57	0	0	0	0	0	34	24	0		
38	Takalala	R.Walanae	Ave.	174	122	136	152	198	144	166	50	63	100	131	162	1598		
			Max.	789	231	337	281	321	299	603	212	344	342	421	345	789	25	16
			Min.	44	19	34	34	89	14	0	0	0	0	0	51	0		
40	Watan-soppeng	R.Walanae	Ave.	186	157	175	223	249	207	127	62	56	97	138	147	1824		
			Max.	495	601	697	429	670	433	305	229	236	356	352	305	697	50	42
			Min.	13	8	18	20	54	61	0	0	0	0	20	20	0		
41	Cabenge	R.Walanae	Ave.	143	78	100	167	181	124	108	77	74	121	48	108	1329		
			Max.	328	187	150	300	312	282	201	123	174	193	216	181	328	6	3
			Min.	36	16	50	66	109	7	9	8	0	0	10	20	0		
42	Canru	R.Walanae	Ave.	153	122	144	193	272	225	186	136	118	113	127	128	1917		
			Max.	431	319	480	505	536	457	468	350	506	370	310	310	536	25	17
			Min.	43	0	36	72	128	83	17	6	0	0	25	21	0		

Table 3.1.(6) Average Monthly Rainfall

(Unit: mm)

No. Station	Rivers		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Max. Min.	Ob-served Period	Avail-able Nos of Yrs
43 Sakoli	R.Gilirang	Ave.	72	42	104	163	197	278	295	110	241	130	112	93	1837		
		Max.	179	99	213	396	452	584	486	361	670	334	215	311	670	9	7
		Min.	0	0	0	0	0	0	0	0	27	0	0	0	0		
44 Paria	R.Gilirang	Ave.	74	109	132	282	419	332	191	160	114	134	164	133	2244		
		Max.	452	623	446	828	862	790	593	643	623	393	434	682	862	48	31
		Min.	0	1	5	23	135	14	0	0	0	0	7	11	0		
45 Peneki	R.Gilirang	Ave.	112	131	127	301	430	316	230	157	93	123	156	133	2369		
		Max.	359	257	311	709	779	551	536	428	449	332	473	527	779	24	16
		Min.	18	6	17	96	31	0	29	10	0	0	10	0	0		

Table 3.2.(1) <u>Average Mean Monthly Discharge</u>

(Unit: cu m/s)

Station	River & Catchment Area		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Max. Min.	Observation Period (Yr)
Bila	R.Bila	Ave.	10.1	13.2	14.4	21.3	30.5	23.6	28.9	20.1	27.0	15.8	12.3	19.6	19.7	
	CA=379 sqkm	Max.	18.3	28.7	23.3	34.0	45.2	26.6	50.7	33.3	54.2	28.9	18.3	28.1	54.2	6
		Min.	5.6	3.5	3.7	7.8	17.2	14.5	10.6	11.8	2.5	2.4	2.5	9.5	2.4	
Bulu Cenrana	R.Boya	Ave.	16.4	12.2	28.3	33.2	22.6	24.6	17.2	16.9	2.5	7.6	10.2	18.2	17.5	
	CA=514 sqkm	Max.	25.2	12.6	31.7	39.1	30.9	27.8	30.3	24.8	3.9	17.8	11.5	19.4	39.1	4
		Min.	10.7	11.8	24.8	27.3	14.3	21.4	4.0	9.0	1.1	0.5	6.2	10.5	0.5	
Tanru Tedong	R.Bila	Ave.	31.6	22.3	30.6	49.5	54.5	63.0	61.9	44.8	74.3	39.7	29.7	41.0	45.2	
	CA=1123sqkm	Max.	50.8	30.7	41.2	81.8	103.8	73.3	97.5	61.9	181.6	96.9	50.8	53.1	181.6	5
		Min.	22.0	14.4	10.9	34.2	25.6	43.2	17.2	31.0	8.0	4.0	4.3	31.7	4.0	
Sengkang	R.Cenranae	Ave.	163.0	169.1	174.7	166.2	235.5	328.3	300.6	202.5	139.1	124.4	87.0	115.2	183.8	
	CA=6138sqkm	Max.	201.8	274.6	301.5	267.0	327.5	450.9	342.7	299.2	307.1	206.4	148.2	177.7	450.9	5
		Min.	131.5	106.0	112.6	107.8	121.9	182.0	238.4	119.9	51.1	26.9	19.3	68.7	19.3	
Cabenge	R.Walanae	Ave.	184.5	198.9	106.9	111.6	168.1	238.9	125.4	84.3	43.2	46.6	49.0	76.9	119.5	
	CA=2846sqkm	Max.	307.1	383.7	161.1	153.3	336.4	388.6	210.9	130.4	84.3	94.9	118.1	137.0	388.6	5
		Min.	121.1	73.3	76.2	66.0	36.4	110.5	51.2	34.1	19.5	15.1	19.3	39.0	15.1	
Lakibong	R.Walanae	Ave.	360.2	228.1	167.3	116.6	158.8	209.7	160.1	117.1	117.8	114.2	145.8	274.4	180.8	
	CA=2759sqkm	Max.	913.0	361.4	465.0	279.3	287.8	539.9	334.4	313.6	302.4	277.2	339.9	503.4	539.9	7
		Min.	37.1	41.0	47.5	38.6	48.3	66.4	74.4	25.9	12.7	13.6	18.1	39.0	12.7	

Table 3.2.(2) Average Mean Monthly Discharge

(Unit: cu m/s)

Station	River & Catchment Area		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Max. Min.	Observation Period (Yr)
Ujung Lamuru	R.Walanae	Ave.	89.6	177.1	58.6	45.7	69.7	130.9	69.9	37.7	31.2	24.2	29.4	39.2	66.9	
	CA=1625sqkm	Max.	119.6	177.1	92.0	60.3	142.7	282.4	122.3	90.3	57.2	46.1	55.8	56.8	282.4	5
		Min.	43.7	177.1	23.5	23.2	27.5	55.0	31.0	14.0	6.2	7.5	14.3	22.8	14.0	
Sanrego	R.Sanrego	Ave.	9.4	8.8	8.8	9.1	9.3	11.9	8.4	9.1	8.8	7.4	8.0	8.9	9.0	
	CA=176 sqkm	Max.	11.4	10.3	10.4	11.3	14.6	20.8	10.7	14.6	15.5	9.2	10.5	10.7	20.8	6
		Min.	7.9	7.1	8.0	7.1	7.0	8.8	6.3	5.9	5.4	5.6	5.4	6.8	5.4	
Langkemme	R.Langkemme	Ave.	6.9	6.4	4.8	5.1	4.1	4.2	3.9	2.7	2.4	3.2	2.8	5.4	4.3	
	CA=104 sqkm	Max.	12.7	14.6	7.5	7.9	5.9	7.1	4.5	3.0	4.1	4.1	4.4	6.0	14.6	5
		Min.	4.8	1.9	2.1	2.9	2.3	1.5	2.4	2.4	1.4	1.5	1.8	5.0	1.4	
Lawo	R.Lawo	Ave.	4.8	3.2	3.7	5.4	3.0	5.0	2.3	0.8	1.6	1.2	1.6	5.5	3.2	
	CA= 63 sqkm	Max.	6.0	3.8	5.4	5.4	3.7	10.3	3.7	1.3	2.2	2.6	3.8	10.2	10.3	4
		Min.	3.5	2.5	2.0	5.4	1.7	2.2	1.1	0.2	0.6	0.3	0.5	3.2	0.2	
Batu Batu	R.Batu Batu	Ave.	6.5	5.3	3.0	3.2	2.9	4.9	2.9	1.7	1.5	1.9	1.3	3.7	3.2	
	CA=113 sqkm	Max.	12.4	11.9	3.9	7.1	5.5	9.3	6.5	2.7	4.6	4.6	2.8	8.0	12.4	5
		Min.	1.9	1.1	2.1	0.3	1.3	0.4	0.9	0.2	0.0	0.0	0.3	0.8	0.0	
Tarumpakkae	R. Gilirang	Ave.	13.5	11.9	16.1	19.4	41.9	34.1	48.5	17.1	22.7	15.0	2.6	6.9	20.8	
	CA=300 sqkm	Max.	24.5	33.0	37.7	35.2	68.3	56.1	62.3	23.1	59.7	22.2	3.8	20.9	68.3	4
		Min.	1.1	0.4	1.5	3.3	27.0	7.5	23.3	11.1	0.8	9.7	2.0	1.0	0.4	

Table 3.3.(1) Mean Monthly Discharge

(Unit: cu m/s)

Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
Bila	1973	-	-	-	34.0	45.2	26.6	50.7	28.2	36.1	19.5	14.6	28.1	-
	1974	7.7	8.8	3.7	15.1	18.5	16.8	31.9	12.2	54.2	28.2	18.3	13.1	19.6
	1975	9.8	28.7	23.3	10.1	33.7	25.4	36.1	33.3	47.2	28.9	14.8	11.0	24.5
	1976	5.6	3.5	10.0	7.8	21.6	14.5	10.9	11.8	2.9	4.9	11.5	9.5	9.6
	1977	9.2	-	7.7	29.5	17.2	25.8	10.6	17.2	2.5	2.4	2.5	31.0	14.1
	1978	18.3	11.7	27.2	31.5	46.7	32.3	33.3	17.8	19.2	10.9	-	24.7	24.9
	Average	10.1	13.2	14.4	21.3	30.5	23.6	28.9	20.1	27.0	15.8	12.3	19.6	19.7
Bulu Cenrana	1975	-	-	-	-	-	-	-	-	-	17.8	9.4	16.8	-
	1976	13.3	12.6	31.7	27.3	30.9	27.8	30.3	9.0	3.9	4.6	11.5	10.5	19.2
	1977	10.7	-	24.8	39.1	14.3	21.4	4.0	-	1.1	0.5	6.2	19.4	-
	1978	25.2	11.8	28.5	-	-	-	-	24.8	-	-	13.7	26.2	-
	Average	16.4	12.2	28.3	33.2	22.6	24.6	17.2	16.9	2.5	7.6	10.2	18.2	17.5
Tanru Tedong	1974	-	-	10.9	38.0	50.0	43.2	57.9	31.0	181.6	96.9	50.8	40.3	-
	1975	22.0	30.7	26.4	34.2	61.6	64.5	97.5	50.9	104.4	65.3	36.1	31.7	51.8
	1976	23.1	14.4	37.1	41.2	25.6	63.4	54.2	48.2	8.0	10.7	39.0	40.0	33.0
	1977	30.4	-	41.2	81.8	31.5	70.5	17.2	31.8	8.0	4.0	4.3	53.1	33.8
	1978	50.8	21.7	37.6	52.3	103.8	73.3	82.9	61.9	69.3	21.5	18.5	39.7	55.3
	Average	31.6	22.3	30.6	49.5	54.5	63.0	61.9	44.8	74.3	39.7	29.7	41.0	45.2
Sengkang	1974	-	-	-	-	-	-	-	-	-	-	148.2	118.3	-
	1975	131.5	171.3	147.7	150.0	327.5	450.9	342.7	399.2	307.1	306.4	238.7	177.7	263.0
	1976	175.5	124.5	112.6	107.8	121.9	182.0	238.4	121.8	54.7	56.8	53.1	85.4	119.7
	1977	201.8	274.6	301.5	267.0	185.7	380.5	332.4	119.9	51.1	26.9	19.3	68.7	185.6
	1978	143.2	106.0	137.0	139.9	307.0	299.7	289.0	269.0	143.5	107.3	75.7	125.9	179.4
	Average	163.0	169.1	174.7	166.2	235.5	328.3	300.6	227.5	139.1	124.4	107.0	115.2	187.6

Table 3.3.(2) Mean Monthly Discharge

(Unit: cu m/s)

Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
Cabenge	1974	-	-	-	-	-	-	-	-	-	-	-	67.8	-
	1975	121.1	139.0	83.5	153.3	336.4	217.5	210.9	130.4	84.3	94.9	118.1	-	-
	1976	-	-	-	-	-	-	-	-	-	-	21.4	63.8	-
	1977	307.1	383.7	161.1	114.7	36.4	388.6	51.2	34.1	19.5	15.1	19.3	39.0	130.8
	1978	125.4	73.3	76.2	66.8	131.6	110.5	114.2	88.5	25.7	29.7	37.3	137.0	85.0
	Average	184.5	198.9	106.9	111.6	168.1	238.9	125.4	84.3	43.2	46.6	49.0	76.9	119.5
Ujung Lamuru	1974	-	-	-	23.2	52.3	55.0	62.0	28.7	57.2	35.3	18.1	22.8	-
	1975	43.7	-	23.5	52.9	142.7	122.0	122.3	90.3	50.8	46.1	55.8	-	-
	1976	-	-	58.9	41.7	56.1	64.3	64.3	14.0	6.2	7.8	14.3	37.9	-
	1977	119.6	177.1	92.0	60.3	27.5	282.4	31.0	17.8	10.4	7.5	-	56.8	73.4
	1978	105.5	-	60.0	50.5	-	-	-	-	-	-	-	-	-
	Average	89.6	177.1	58.6	45.7	69.7	130.9	69.9	37.7	31.2	24.2	29.4	39.2	66.9
Lakibong	1970	-	-	-	-	-	-	-	313.6	224.7	262.4	339.9	503.4	-
	1971	290.0	317.1	465.0	-	287.8	539.9	334.4	-	302.4	277.2	282.1	328.7	-
	1972	913.0	361.4	-	279.3	274.8	238.3	153.8	101.4	82.5	69.4	68.6	461.1	273.2
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-
	1975	-	-	-	-	-	-	-	-	65.6	45.1	-	-	-
	1976	-	88.2	84.8	59.4	118.1	116.6	74.4	25.9	12.7	13.6	18.1	39.6	58.8
	1977	200.7	333.0	71.7	89.1	48.3	87.2	77.9	27.5	18.7	17.3	20.3	39.0	84.9
	1978	37.1	41.0	47.5	38.6	65.2	66.4	-	-	-	-	-	-	-
	Average	360.2	228.1	167.3	116.6	158.8	209.7	160.1	117.1	117.8	114.2	145.8	274.4	180.8

Table 3.3.(3) Mean Monthly Discharge

(Unit: cu m/s)

Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
Sanrego	1973	-	-	-	9.9	8.9	-	-	-	8.8	7.2	10.2	10.7	-
	1974	11.4	10.3	-	11.3	7.9	8.8	10.7	8.3	9.1	7.4	7.1	6.8	8.9
	1975	7.9	-	8.0	9.2	14.6	12.4	9.5	14.6	15.5	9.2	10.5	10.7	11.0
	1976	8.7	-	-	8.5	9.1	9.3	7.6	5.9	5.4	5.6	5.4	7.2	-
	1977	10.3	8.9	10.4	8.7	7.0	20.8	6.3	-	7.8	-	-	8.9	-
	1978	8.7	7.1	8.1	7.1	8.4	8.2	7.8	7.6	6.3	-	6.6	9.1	7.7
	Average	9.4	8.8	8.8	9.1	9.3	11.9	8.4	9.1	8.8	7.4	8.0	8.9	9.0
Langkemme	1974	-	-	-	-	3.0	4.3	4.0	2.6	2.3	4.4	2.8	5.1	-
	1975	4.8	4.9	4.6	5.5	-	1.5	2.4	2.5	2.3	1.5	1.8	5.6	3.4
	1976	4.9	1.9	2.1	2.9	2.3	3.4	3.9	2.4	1.4	3.1	2.7	5.0	3.0
	1977	12.7	14.6	7.5	7.9	5.9	7.1	4.5	3.0	2.1	2.7	2.3	6.0	6.3
	1978	5.1	4.1	5.1	4.1	5.1	4.6	4.8	3.0	4.1	4.1	4.4	-	4.4
	Average	6.9	6.4	4.8	5.1	4.1	4.2	3.9	2.7	2.4	3.2	2.8	5.4	4.3
Lawo	1975	-	-	-	-	-	-	2.2	1.3	2.0	1.2	0.9	4.5	-
	1976	3.5	2.5	2.0	-	1.7	2.2	1.1	0.2	2.2	0.7	1.3	4.0	2.1
	1977	-	-	-	5.4	3.6	10.3	2.3	1.1	0.6	0.3	0.5	3.2	-
	1978	6.0	3.8	5.4	-	3.7	2.5	3.7	0.7	1.5	2.6	3.8	10.2	4.0
	Average	4.8	3.2	3.7	5.4	3.0	5.0	2.3	0.8	1.6	1.2	1.6	5.5	3.2
Batu Batu	1975	-	-	-	-	-	7.4	6.5	2.3	4.6	4.6	2.8	8.0	-
	1976	5.1	1.1	2.9	0.3	1.3	0.4	2.6	0.2	0.0	0.1	0.7	0.8	1.3
	1977	12.4	11.9	3.9	7.1	1.8	9.3	0.9	1.6	0.1	0.0	0.3	2.4	4.2
	1978	1.9	2.8	2.1	2.1	5.5	2.5	1.6	2.7	1.2	2.9	-	-	-
	Average	6.5	5.3	3.0	3.2	2.9	4.9	2.9	1.7	1.5	1.9	1.3	3.7	3.2

Table 3.3.(4) Mean Monthly Discharge

(Unit: cu m/s)

Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
Tarumpakkae	1975	-	-	-	-	-	-	-	-	59.7	22.2	3.8	2.0	-
	1976	1.1	0.4	1.5	3.3	27.0	38.8	62.3	11.1	0.8	16.1	2.3	1.0	13.9
	1977	24.5	33.0	37.5	35.2	30.3	56.1	60.0	23.1	15.0	11.9	2.0	3.8	27.6
	1978	14.9	2.3	9.4	19.6	68.3	7.5	23.3	-	15.2	9.7	2.3	20.9	17.6
	Average	13.5	11.9	16.1	19.4	41.9	34.1	48.5	17.1	22.7	15.0	2.6	6.9	20.8

Table 3.4.(1) Calculation of Average Depth of Annual Rainfall over the Upstream Basin of Sengkang, Thiessen Method, (1975)

No.	Gauge Station	(1) Area (sq km)	(2) Percent Total area (%)	(3) Annual Rainfall (mm)	(4) = (2)x(3) Weighted Rainfall (mm)
1	Enrekang	64	1.0	2,334	24
2	Baraka	524	8.5	1,699	145
3	Rappang	211	3.4	2,055	71
6	Barukku	465	7.6	2,453	186
8	Tanru Tedong	416	6.8	2,064	140
14	Amparita	537	8.7	1,665	146
18	Palaguna	122	2.0	1,553	31
19	Lerang	9	0.1	3,068	4
29	Marada	1,189	19.5	2,471	479
30	Palatae	157	2.6	2,585	66
32	Parigi	-	-	-	-
33	Matango	-	-	-	-
35	Bengo	823	13.4	2,607	350
36	Paciro	-	-	-	-
37	Turucinnae	-	-	-	-
38	Takalala	572	9.3	1,674	156
39	Malanroe	-	-	-	-
40	Watansoppeng	509	8.3	1,751	145
41	Cabenge	196	3.2	1,852	59
42	Canru	277	4.5	2,378	107
43	Sakoli	-	-	-	-
44	Paria	67	1.1	3,366	37
	Total	6,138	100.0		2,146

Table 3.4.(2) Calculation of Average Depth of Annual Rainfall over the Upstream Basin of Sengkang, Thiessen Method, (1976)

No.	Gauge Station	(1) Area (sq km)	(2) Percent Total Area (%)	(3) Annual Rainfall (mm)	(4) = (2)x(3) Weighted Rainfall (mm)
1	Enrekang	53	0.9	1,466	13
2	Baraka	736	12.0	1,084	130
3	Rappang	888	14.5	1,597	231
6	Barukku	-	-	-	-
8	Tanru Tedong	-	-	-	-
14	Amparita	-	-	-	-
18	Palaguna	-	-	-	-
19	Lerang	-	-	-	-
29	Maradda	842	13.7	1,844	253
30	Paratae	149	2.4	1,676	41
32	Parigi	681	11.0	1,161	129
33	Matango	149	2.4	1,731	42
35	Bengo	178	2.9	1,471	43
36	Paciro	236	3.8	1,688	65
37	Turucinnae	221	3.6	1,309	47
38	Takalala	355	5.8	1,491	86
39	Malanroe	-	-	-	-
40	Watansoppeng	612	10.0	1,396	139
41	Cabenge	-	-	-	-
42	Canru	703	11.5	1,559	179
43	Sakoli	335	5.5	2,269	124
44	Paria	-	-	-	-
	Total	6,138	100.0		1,522

Table 3.4.(3) Calculation of Average Depth of Annual Rainfall over the Upstream Basin of Sengkang, Thiessen Method, (1977)

No.	Gauge Station	(1) Area (sq km)	(2) Percent Total area (%)	(3) Annual Rainfall (mm)	(4) = (2)x(3) Weighted Rainfall (mm)
1	Enrekang	-	-	-	-
2	Baraka	-	-	-	-
3	Rappang	-	-	-	-
6	Barukku	1,605	26.1	1,364	357
8	Tanru Tedong	-	-	-	-
14	Amparita	-	-	-	-
18	Palaguna	185	3.0	958	29
19	Lerang	-	-	-	-
29	Maradda	832	13.5	2,760	374
30	Paratae	140	2.3	1,941	44
32	Parigi	766	12.5	1,581	197
33	Matango	-	-	-	-
35	Bengo	244	4.0	2,458	98
36	Paciro	400	6.5	2,958	193
37	Turucinnae	-	-	-	-
38	Takalala	374	6.1	1,619	99
39	Malanroe	195	3.2	1,178	37
40	Watansoppeng	525	8.6	1,423	122
41	Cabenge	-	-	-	-
42	Canru	657	10.7	1,366	146
43	Sakoli	-	-	-	-
44	Paria	215	3.5	1,656	58
	Total	6,138	100.0		1,754

Table 3.5 Average Depth of Annual Rainfall over the Upstream Basin of Sengkang, Isohyetal Method

(1) Isohyet (mm)	(2) Area (sq km)	(3) Percent Total Area (%)	(4) = (1) x (3) Weighted Rainfall (mm)
1,500	368.3	6	90
1,500 - 2,000	3,191.7	52	910
2,000 - 2,500	2,271.1	37	832.5
2,500 - 3,000	184.1	3	82.5
3,000 - 3,500	122.8	2	65
Total	6,138.0	100	1,980

Table 3.6 Water Level and Storage of Lake Tempe at the Beginning of Each Year (1975 - 1979)

Year	Water Level El (m)	Storage Capacity (million cu m)	Increment or Decrement(-) (million cu m)
1975	5.255	113.04	-
1976	5.455	130.39	+ 17.35
1977	4.675	68.14	- 62.25
1978	5.025	93.09	+ 24.95
1979	6.175	247.28	+154.19

Table 3.7 Total Annual Run-off of the Upstream Basin of Sengkang (1975 - 1978)

Year	Annual Mean Discharge (cu m/s)	Annual River Runoff (mil cu m)	Storage Increment L.Tempe (mil cu m)	Total Runoff (mil cu m)	Equivalent Depth of Runoff (mm)
1975	263.0	8,294	17	8,311	1,354
1976	119.7	3,785	- 62	3,723	607
1977	185.6	5,853	25	5,878	958
1978	179.4	5,658	154	5,812	947
Average	-	-	-	5,931	966

Table 3.8 Annual Run-off Coefficient at Sengkang, Thiessen Method

Year	Average Annual Rainfall, Upstream Sengkang (mm)	Total Annual Runoff, Upstream Sengkang (mil cu m)	Equivalent Depth, Annual Runoff (mm)	Annual Runoff Coefficient (%)
1975	2,146	8,311	1,354	63
1976	1,522	3,723	607	40
1977	1,754	5,878	958	55
Average	1,807	5,971	973	53

Table 3.9 Annual Irrigation Intake Discharge from River

(Present Condition)

(Unit: million cu m)

River Basin		1974/75	1975/76	1976/77	1977/78	Average
R.Bila						
Sidrap	Wet s.	23.5	31.5	58.1	59.1	43.1
	Dry s.	35.0	44.4	42.4	42.4	40.6
	Total	58.5	75.9	100.5	101.5	83.7
Wajo	Wet s.	3.1	5.1	8.8	12.2	7.3
	Dry s.	6.2	13.3	1.0	1.0	6.8
	Total	9.3	18.4	9.8	13.2	14.1
Total	Wet s.	26.6	36.6	66.9	71.3	50.4
	Dry s.	41.2	57.7	43.3	43.4	47.4
	Total	67.8	94.3	110.3	114.7	97.8
L.Tempe						
Soppen	Wet s.	30.1	29.5	45.0	43.3	37.0
	Dry s.	35.3	45.5	42.2	42.2	41.0
	Total	65.4	75.0	87.2	85.5	78.0
R.Walanae						
Bone	Wet s.	1.9	0.5	2.9	5.2	2.6
	Dry s.	3.0	2.0	1.2	1.2	2.1
	Total	4.9	2.5	4.1	6.4	4.7
R.Cenranae						
Bone	Wet s.	1.7	1.4	4.7	5.1	3.2
	Dry s.	3.0	3.2	2.2	2.2	2.8
	Total	4.7	4.6	6.9	7.3	6.0
Total						
	Wet s.	60.3	68.0	119.5	124.9	93.2
	Dry s.	82.5	108.4	89.0	89.0	93.3
	Total	142.8	176.4	208.5	213.9	186.5

Note: Excluding Gilirange River Basin.

Table 3.10 Annual Irrigation Intake Discharge from River

(After-development Condition)

River Basin	Irrigation area (ha)	Irrigation Wet s. (mil cu m)	Intake Dry s. (mil cu m)	Discharge Annual (mil cu m)
R.Bila				
Bila and Boya	20,500	89	146	235
R.Walanae				
Existing (Batu2)	4,150	25	22	47
Pandageng	4,200	16	34	50
Lawo	3,000	11	15	26
Sanrego	10,000	18	65	83
Langkemme	5,000	20	28	48
Walanae	26,000	121	234	355
Cenranae	2,300	12	23	35
Sub-total	54,650	223	421	644
Total (Cenranae B.)	75,150	312	567	879
R.Gilirang	10,000	34	85	119
Total (Objective Area)	85,150	346	652	998

Table 3.11 Estimated Mean Monthly Discharge during Dry Season

(by Rainfall-Discharge Correlation)

(Unit: cu m/s)

Station	No.	Year	Oct	Nov	Dec	Jan	Feb
Bila	1	1931/32	(5.1)	(10.3)	(9.3)	(8.8)	(4.4)
	2	1932/33	(6.7)	(10.2)	(7.7)	(7.0)	(9.4)
	3	1933/34	(14.0)	(22.0)	(3.5)	(9.1)	(5.5)
	4	1934/35	(8.7)	(14.4)	(6.4)	(5.9)	(19.5)
	5	1935/36	(11.4)	(31.0)	(11.4)	(9.4)	(9.9)
	6	1936/37	(2.6)	(7.4)	(6.0)	(7.7)	(18.2)
	7	1937/38	(4.5)	(3.9)	(7.7)	(36.0)	(5.5)
	8	1938/39	(4.5)	-	-	-	-
	9	1939/40	(5.4)	(6.7)	-	(6.6)	(4.8)
	10	1940/41	(3.0)	(5.9)	(19.0)	(11.0)	(15.2)
	11	1971/72	(18.8)	(10.4)	(5.3)	(47.0)	(5.0)
	12	1972/73	(2.5)	(6.9)	(13.8)	(17.6)	(22.0)
	13	1973/74	19.5	14.6	28.1	7.7	8.8
	14	1974/75	28.2	18.3	13.1	9.8	28.7
	15	1975/76	28.9	14.8	11.0	5.6	3.5
	16	1976/77	4.9	11.5	9.5	9.5	(5.6)
	17	1977/78	2.4	2.5	31.0	18.3	11.7
	18	1978/79					
	Sample number		18	17	16	16	16
	Low-discharge of 1/5 probability		3.7	6.3	6.1	6.7	5.0
Bulu Cenrana	1	1931/32	(6.8)	(11.2)	(7.5)	(11.5)	(6.6)
	2	1932/33	(6.8)	(10.0)	(12.3)	(8.0)	(12.0)
	3	1933/34	(9.9)	(20.0)	(5.3)	(10.1)	(8.1)
	4	1934/35	(7.0)	(16.0)	(9.3)	(8.2)	(29.0)
	5	1935/36	(6.6)	(15.0)	(24.0)	(18.6)	(15.0)
	6	1936/37	(3.8)	(10.7)	(7.8)	(14.6)	(12.5)
	7	1937/38	(5.6)	(5.0)	(13.4)	(29.0)	(8.8)
	8	1938/39	(4.2)	-	-	-	-
	9	1939/40	(7.4)	(11.2)	-	(11.8)	(6.2)
	10	1940/41	(4.8)	(8.4)	(18.2)	(12.0)	(14.6)
	11	1971/72	(15.0)	(13.0)	(9.7)	(80.0)	(5.7)
	12	1972/73	(3.4)	(11.0)	(16.4)	(33.0)	(12.5)
	13	1973/74	(7.7)	(9.0)	(30.0)	(7.3)	(13.1)
	14	1974/75	(20.0)	(12.2)	(13.1)	(12.7)	(9.4)
	15	1975/76	19.3	12.6	20.5	16.5	13.4
	16	1976/77	6.3	15.3	15.2	13.2	(9.5)
	17	1977/78	3.4	7.0	23.8	27.1	12.9
	18	1978/79				-	-
	Sample number		18	17	16	16	16
	Low-discharge of 1/5 probability		4.0	8.6	8.1	8.6	6.9

( ) shows the estimated discharge from rainfall by use of correlation curve.

Table 3.12.(1) Result of Water Quality Analysis

(Low-Water Flow, October 1978)

Parameter	Unit	Sample Number 1	2	3	4	5	6
Chemical & Physical Properties							
Colour	Unit PtCo	2.5	5	2.5	2.5	10 K	12.5 K
Dissolved Solid	mg/l	932	212	156	264	122	100
Suspended Solid	"	88	208	12	412	154	1020
Total Solid	"	1020	420	168	676	276	1120
Conductivity	"	1210	360	304	363	223	185
P.H.	-	8.5	7.9	8.0	8.2	7.6	7.2
Organic Solid	mg/l KMn04	8.2	10	5.5	6.4	10	16
CO_2	mg/l	-	4.9	1.8	3.9	11	7.8
Hardness	d	18.5	8.1	7.6	8.5	5.7	3.9
K^+							
Potassium (K)	mg/l	20	3.5	4.1	2.3	3.1	3.9
Sodium (Na)	"	230	14	6.1	4.2	6.1	9.3
Calcium (Ca)	"	50	32	30	48	24	13
Magnesium (Mg)	"	50	16	14	78	10	9.0
Iron (Fe)	"	* /1	*	*	*	*	1.5
Manganese (Mn)	"	*	*	*	*	*	*
Ammonium (NH4)	"	0.24	0.25	0.27	*	0.07	0.25
Nitrogen Total	"	0.63	0.16	0.74	1.3	1.1	1.8
A^-							
Fluorine (F)	mg/l	0.24	*	0.36	*	0.25	*
Chloride (Cl)	"	23	8.0	8.4	7.1	17	7.4
Sulphate (SO4)	"	449	24	8.8	6.8	4.7	6.2
Nitrate (NO3)	"	2.9	3.7	6.5	4.4	2.7	6.4
Nitrite (NO2)	"	0.02	0.01	0.09	0.02	0.02	0.02
Phosphate (PO4)	"	0.08	*	*	0.16	*	0.16
Silicate (SiO2)	"	51	37	41	39	32	34
Bicarbonate (HCO3)	"	346	171	157	177	107	88
Carbonate (CO3)	"	32	- /2	-	-	-	-
Phosphor (P)	"	0.03	-	-	0.05	-	0.05
Silicon (Si)	"	24	17	19	18	15	16
Copper (Cu)	"	*	*	*	*	*	*
Cadmium (Cd)	"	*	*	*	*	*	*
Chromium (Cr)	"	*	*	*	*	*	*
Lead (Pb)	"	*	*	*	*	*	*
Zinc (Zn)	"	0.87	0.15	0.31	0.11	0.12	0.31

/1: negligibly small
/2: no analysis

Table 3.12.(2) Result of Water Quality Analysis

(Low-Water Flow, October 1978)

Parameter	Unit	Sample Number				
		7	8	9	10	11
Chemical & Physical Properties						
Colour	Unit PtCo	13 K	5	15 K	13 K	2.5 K
Dissolved Solid	mg/l	100	96	138	130	140
Suspended Solid	"	332	104	- /2	-	-
Total Solid	"	432	200	384	392	812
Conductivity	"	174	165	217	202	220
P.H.	-	8.4	7.7	8.4	8.4	7.6
Organic Solid	mg/l $KMnO_4$	12	6.6	30	6.4	12
CO_2	mg/l	-	5.4	-	-	-
Hardness	d	4.4	3.1	5.0	4.3	9.0
K^+						
Potassium (K)	mg/l	1.1	6.1	2.2	8.0	3.2
Sodium (Na)	"	4.2	3.3	5.1	5.1	6.1
Calcium (Ca)	"	18	11	20	16	48
Magnesium (Mg)	"	8.0	6.7	9.7	9.0	10
Iron (Fe)	"	0.42	* /1	0.15	*	0.04
Manganese (Mn)	"	*	*	*	*	*
Ammonium (NH_4)	"	0.04	0.29	0.12	0.23	0.27
Nitrogen Total	"	-	1.1	-	1.3	1.4
A^-						
Fluorine (F)	mg/l	1.2	*	0.21	0.99	*
Chloride (Cl)	"	4.2	6.0	4.2	5.1	5.6
Sulphate (SO_4)	"	5.1	6.4	5.4	4.9	7.7
Nitrate (NO_3)	"	7.7	2.3	12	4.8	4.5
Nitrite (NO_2)	"	0.03	0.01	0.05	0.01	0.03
Phosphate (PO_4)	"	*	0.06	0.05	0.39	0.41
Silicate (SiO_2)	"	42	45	35	44	32
Bicarbonate (KCO_3)	"	87	65	101	100	194
Carbonate (KCO_3)	"	10	-	10	10	-
Phosphor (P)	"	-	0.02	0.02	0.13	0.13
Silicon (Sl)	"	20	21	16	21	15
Copper (Cu)	"	*	*	*	*	*
Cadmium (Sd)	"	*	*	*	*	*
Chromium (Cr)	"	*	*	*	*	*
Lead (Pb)	"	*	*	*	*	*
Zinc (Zn)	"	0.12	0.07	0.12	0.12	0.02

/1: negligibly small
/2: no analysis

Table 3.13.(1) Water Quality Analysis Result

(High-Water Flow, March 1979)

Parameter	Unit	Sample Number					
		1	2	3	4	5	6
Chemist & Physics							
Colour	Unit Pt.CO	7.5	5.0	13	5.0	7.5	5.0
Conductivity	mg/l	185.0	160.0	220	130	138	220
P.H.	-	7.6	7.5	8.0	7.8	8.1	7.6
S.A.R.		0.20	0.25	0.76	0.20	0.23	1.3
% Natrium		10	13	30.0	13.0	14	45
R.S.C.	meg/l	- /2	-	0.01	-	-	0.02
CO_2	mg/l	8.8	11	4.4	4.9	2.7	3.5
K^+							
Potassium (K)	mg/l	1.4	2.2	2.4	* /1	*	4.4
Sodium (Na)	"	3.9	4.7	15.0	3.1	3.6	20.0
Calcium (Ca)	"	21	17	15	14	16	4.8
Magnesium (Mg)	"	4.4	4.7	8.8	2.0	2.0	8.8
Iron (Fe)	"	*	*	*	*	*	*
Manganese (Mn)	"	*	*	*	*	*	*
Ammonium (NH4)	"	0.10	0.12	0.09	0.21	0.07	0.16
Nitrogen Total	"	0.59	0.73	0.76	0.59	0.61	0.52
A^-							
Fluorine (F)	mg/l	0.10	*	*	*	*	0.01
Chloride (Cl)	"	6.0	7.1	19.0	4.6	5.7	27.0
Sulphate (SO4)	"	4.6	5.8	6.0	3.1	3.4	5.9
Nitrate (NO3)	"	0.28	0.16	0.13	0.26	0.30	0.26
Nitrite (NO2)	"	*	*	*	*	*	0.01
Phosphate (PO4)	"	0.24	0.38	0.11	0.10	0.10	0.30
Silicate (SiO2)	"	32	23	26	18	9.7	27
Bicarbonate (HCO3)	"	78	65	90	48	54	60
Carbonate (CO3)	"	-	-	-	-	-	-
Boron (B)	"	0.10	0.02	0.05	0.05	0.04	0.02
Copper (Cu)	"	*	*	*	*	*	*
Cadmium (Cd)	"	*	*	*	*	*	*
Chromium (Cr)	"	*	*	*	*	*	*
Lead (Pb)	"	*	*	*	*	*	*
Zinc (Zn)	"	*	*	*	*	*	*

/1: negligibly small
/2: no analysis

Table 3.13.(2) Water Quality Analysis Result

(High-Water Flow, March 1979)

Parameter	Unit	Sample Number 7	8	9	10	11	12
Chemist & Physics							
Colour	Unit Pt.CO	2.5	2.5	2.5	2.5	2.5	
Conductivity	mg/l	34	69	200	74	64	
P.H.		7.6	7.7	7.3	7.4	7.7	
S.A.R.		0.29	0.18	0.78	0.20	0.26	
% Natrium		26	12	34	15	21	
R.S.C.	meg/l	- /2	0.10	0.04	-	-	
CO2	mg/l	16	5.7	3.1	11	5.7	
K^+							
Potassium (K)	mg/l	2.4	4.9	2.9	1.5	1.5	
Sodium (Na)	"	2.1	2.1	13	2.6	2.6	
Calcium (Ca)	"	1.5	1.5	11	8.6	4.2	
Magnesium (Mg)	"	1.5	5.4	6.2	2.0	2.0	
Iron (Fe)	"	* /1	*	*	*	*	
Manganese (Mn)	"	*	*	*	*	*	
Ammonium (NH4)	"	0.13	0.11	0.08	0.06	0.14	
Nitrogen Total	"	0.45	0.69	0.92	0.81	0.89	
A^-							
Fluorine (F)	mg/l	*	*	0.03	0.24	*	
Chloride (Cl)	"	3.3	2.6	18.0	3.5	5.7	
Sulphate (SO4)	"	6.3	2.6	1.9	2.4	1.0	
Nitrate (NO3)	"	0.21	0.30	0.58	0.28	0.70	
Nitrite (NO2)	"	*	*	*	*	*	
Phosphate (PO4)	"	0.26	0.26	0.31	0.32	0.31	
Silicate (SiO2)	"	24	16	13	14	45	
Bicarbonate (HCO3)	"	10	37	67	36	18	
Carbonate (CO3)	"	-	-	-	-	-	
Boron (B)	"	0.02	0.06	0.07	0.03	0.05	
Copper (Cu)	"	*	*	*	*	*	
Cadmium	"	*	*	*	*	*	
Chromium (Cr)	"	*	*	*	*	*	
Lead (Pb)	"	*	*	*	*	*	
Zinc (Zn)	"	*	*	*	*	*	

/1: negligibly small
/2: no analysis

Table 3.14 Average Monthly Rainfall in Each River Basin

(Dry Season, October - March)

(Unit: mm)

Year	R.Bila	L.Tempe	R.Walanae	Sengkang	R.Gilirang
1917/18	284	203	181	223	***
1918/19	195	141	159	165	118
1919/20	174	99	198	157	76
1920/21	200	137	260	199	100
1921/22	129	96	218	148	66
1922/23	134	118	248	167	133
1923/24	175	120	201	165	167
1924/25	153	124	193	157	121
1925/26	131	111	183	142	106
1926/27	144	125	205	158	91
1927/28	172	102	185	153	94
1928/29	151	98	147	132	94
1929/30	129	115	147	130	104
1930/31	126	114	130	123	133
1931/32	111	99	139	116	106
1932/33	143	125	150	139	122
1933/34	139	132	133	135	131
1934/35	153	135	190	156	121
1935/36	199	158	143	167	165
1936/37	135	108	135	126	95
1937/38	172	174	173	173	159
1938/39	162	169	205	179	107
1939/40	101	87	115	101	67
1940/41	139	95	101	112	94
1941/42	***	***	***	***	***
1951/52	***	***	***	***	***
1952/53	129	107	135	124	***
1953/54	154	110	110	125	120
1954/55	164	144	164	157	136
1955/56	106	99	90	98	107
1956/57	156	125	123	135	106
1957/58	160	106	115	127	215
1958/59	125	104	109	113	86
1959/60	124	91	105	107	68
1960/61	126	108	116	117	145
1961/62	148	149	157	151	157
1962/63	134	124	136	131	103
1963/64	91	87	99	92	98
1964/65	94	110	127	110	99
1965/66	141	104	100	115	200
1966/67	78	117	130	108	126
1967/68	105	161	168	145	101
1968/69	***	115	147	***	142
1969/70	***	90	104	***	145
1970/71	***	95	120	***	56
1971/72	174	122	132	143	91

(Unit: mm)

Years	R.Bila	L.Tempe	R.Walanae	Sengkang	R.Gilirang
1972/73	168	116	129	138	165
1973/74	144	114	132	130	67
1974/75	153	83	98	111	102
1975/76	119	110	109	113	109
1976/77	111	114	131	119	145
1977/78	99	79	106	95	122

Table 3.15 Average Monthly Rainfall in Each River Basin

(Wet Season, April - September)

(Unit: mm)

Years	R.Bila	L.Tempe	R.Walanae	Sengkang	R.Gilirang
1917	232	223	226	227	***
1918	83	79	83	82	***
1919	137	97	136	123	195
1920	191	155	190	179	157
1921	129	161	167	152	200
1922	130	144	136	137	167
1923	127	117	110	118	173
1924	205	206	202	204	262
1925	136	146	143	142	145
1926	159	142	90	130	187
1927	159	153	151	154	205
1928	130	109	132	124	152
1929	143	154	165	154	165
1930	151	142	147	147	210
1931	318	249	236	268	291
1932	231	171	177	193	268
1933	221	186	195	201	278
1934	223	194	196	204	259
1935	245	207	190	214	251
1936	211	181	195	196	222
1937	221	185	204	203	208
1938	210	205	192	202	280
1939	182	150	177	170	234
1940	172	156	166	165	206
1941	137	114	147	133	173
1942	***	***	***	***	***
1951	***	***	***	***	***
1952	***	119	143	***	***
1953	136	108	115	120	180
1954	240	167	163	190	238
1955	278	230	217	242	337
1956	220	187	222	210	256

(Unit: mm)

Years	R.Bila	L.Tempe	R.Walanae	Sengkang	R.Gilirang
1957	146	119	103	123	198
1958	191	151	130	157	264
1959	222	182	164	189	306
1960	303	193	164	220	290
1961	263	143	124	177	296
1962	211	158	129	166	243
1963	128	92	75	98	155
1964	258	223	195	225	383
1965	100	103	99	101	223
1966	162	126	113	134	275
1967	224	144	138	169	268
1968	***	154	155	***	451
1969	***	155	129	***	244
1970	***	235	210	***	215
1971	205	153	156	171	193
1972	98	63	60	74	97
1973	280	285	280	282	297
1974	224	149	139	171	199
1975	216	199	202	206	361
1976	118	124	157	133	253
1977	106	113	163	127	162
1978	183	213	187	194	257

Table 3.16 Average Monthly Rainfall in Magnitude Order

(Dry Season, October - March)

(Unit: mm)

i	R.Bila		L.Tempe		R.Walanae		Sengkang		R.Gilirang	
	Years	Rain	Years	Rain	Years	Rain	Years	Rain	Years	Rain
1	1917/18	284	1917/18	203	1920/21	260	1917/18	223	1957/58	215
2	1920/21	200	1937/38	174	1922/23	248	1920/21	199	1965/66	200
3	1935/36	199	1938/39	169	1921/22	218	1938/39	179	1923/24	167
4	1918/19	195	1967/68	161	1926/27	205	1937/38	173	1935/36	165
5	1923/24	175	1935/36	158	1938/39	205	1922/23	167	1972/73	165
6	1919/20	174	1961/62	149	1923/24	201	1935/36	167	1937/38	159
7	1971/72	174	1954/55	144	1919/20	193	1923/24	165	1961/62	157
8	1927/28	172	1918/19	141	1924/25	193	1918/19	165	1960/61	145
9	1937/38	172	1920/21	137	1934/35	190	1926/27	158	1969/70	145
10	1972/73	168	1934/35	135	1927/28	185	1924/25	157	1976/77	145
11	1954/55	164	1933/34	132	1925/26	183	1919/20	157	1968/69	142
12	1938/39	162	1932/33	125	1917/18	181	1954/55	157	1954/55	136
13	1957/58	160	1926/27	125	1937/38	173	1934/35	156	1930/31	133
14	1956/57	156	1956/57	125	1967/68	168	1927/28	153	1922/23	133
15	1953/54	154	1924/25	124	1954/55	164	1961/62	151	1933/34	131
16	1934/35	153	1962/63	124	1918/19	159	1921/22	148	1966/67	126

(Unit: mm)

i	R.Bila		L.Tempe		R.Walanae		Sengkang		R.Gilirang	
	Years	Rain	Years	Rain	Years	Rain	Years	Rain	Years	Rain
17	1924/25	153	1971/72	122	1961/62	157	1967/68	145	1932/33	122
18	1974/75	153	1923/24	120	1932/33	150	1971/72	143	1977/78	122
19	1928/29	151	1922/23	118	1929/30	147	1925/26	142	1924/25	121
20	1961/62	148	1966/67	117	1928/29	147	1932/33	139	1934/35	121
21	1926/27	144	1972/73	116	1968/69	147	1972/73	138	1953/54	120
22	1973/74	144	1929/30	115	1935/36	143	1956/57	135	1918/19	118
23	1932/33	143	1968/69	115	1931/32	139	1933/34	135	1975/76	109
24	1965/66	141	1930/31	114	1962/63	136	1928/29	132	1955/56	107
25	1933/34	139	1973/74	114	1952/53	135	1962/63	131	1938/39	107
26	1940/41	139	1976/77	114	1936/37	135	1929/30	130	1956/57	106
27	1936/37	135	1925/26	111	1933/34	133	1973/74	130	1931/32	106
28	1962/63	134	1953/54	110	1971/72	132	1957/58	127	1925/26	106
29	1922/23	134	1964/65	110	1973/74	132	1936/37	126	1929/30	104
30	1925/26	131	1975/76	110	1976/77	131	1953/54	125	1962/63	103
31	1952/53	129	1960/61	108	1966/67	130	1952/53	124	1974/75	102
32	1929/30	129	1936/37	108	1930/31	130	1930/31	123	1967/68	101
33	1921/22	129	1952/53	107	1972/73	129	1976/77	119	1920/21	100
34	1930/31	126	1957/58	106	1964/65	127	1960/61	117	1964/65	99
35	1960/61	126	1958/59	104	1956/57	123	1931/32	116	1963/64	98
36	1958/59	125	1965/66	104	1970/71	120	1965/66	115	1936/37	95
37	1959/60	124	1927/28	102	1960/61	116	1975/76	113	1928/29	94
38	1975/76	119	1919/20	99	1939/40	115	1958/59	113	1940/41	94
39	1931/32	111	1955/56	99	1957/58	115	1940/41	112	1927/28	94
40	1976/77	111	1931/32	99	1953/54	110	1974/75	111	1971/72	91
41	1955/56	106	1928/29	98	1958/59	109	1964/65	110	1926/27	91
42	1939/40	101	1921/22	96	1975/76	109	1966/67	108	1958/59	86
43	1977/78	99	1970/71	95	1977/78	106	1959/60	107	1919/20	76
44	1964/65	94	1940/41	95	1959/60	105	1939/40	101	1959/60	68
45	1963/64	91	1959/60	91	1969/70	104	1955/56	98	1973/74	67
46	1966/67	78	1969/70	90	1940/41	101	1977/78	95	1939/40	67
47			1963/64	87	1965/66	100	1963/64	92	1921/22	66
48			1939/40	87	1963/64	99			1970/71	56
49			1974/75	83	1974/75	98				
50			1977/78	79	1955/56	90				

Table 3.17 Average Monthly Rainfall in Magnitude Order

(Wet Season, April - September)

(Unit: mm)

i	R.Bila		L.Tempe		R.Walanae		Sengkang		R.Gilirang	
	Years	Rain	Years	Rain	Years	Rain	Years	Rain	Years	Rain
1	1931	318	1973	285	1973	280	1973	282	1968	451
2	1960	303	1931	249	1931	236	1931	268	1964	383
3	1973	280	1970	235	1917	226	1955	242	1975	361

(Unit: mm)

i	R.Bila		L.Tempe		R.Walanae		Sengkang		R.Gilirang	
	Years	Rain	Years	Rain	Years	Rain	Years	Rain	Years	Rain
4	1955	278	1955	230	1956	222	1917	227	1955	337
5	1961	263	1964	223	1955	217	1964	225	1959	306
6	1964	258	1917	223	1970	210	1960	220	1973	297
7	1935	245	1978	213	1937	204	1935	214	1961	296
8	1954	240	1935	207	1924	202	1956	210	1931	291
9	1917	232	1924	206	1975	202	1975	206	1960	290
10	1932	231	1938	205	1934	196	1934	204	1938	280
11	1967	224	1975	199	1933	195	1924	204	1933	278
12	1974	224	1934	194	1936	195	1937	203	1966	275
13	1934	223	1960	193	1964	195	1938	202	1932	268
14	1959	222	1956	187	1938	192	1933	201	1967	268
15	1933	221	1933	186	1935	190	1936	196	1958	264
16	1937	221	1937	185	1920	190	1978	194	1924	262
17	1956	220	1959	182	1978	187	1932	193	1934	259
18	1975	216	1936	181	1939	177	1954	190	1978	257
19	1936	211	1932	171	1932	177	1959	189	1956	256
20	1962	211	1954	167	1921	167	1920	179	1976	253
21	1938	210	1921	161	1940	166	1961	177	1935	251
22	1924	205	1962	158	1929	165	1971	171	1969	244
23	1971	205	1940	156	1959	164	1974	171	1962	243
24	1920	191	1920	155	1960	164	1939	170	1954	238
25	1958	191	1969	155	1954	163	1957	169	1939	234
26	1978	183	1929	154	1977	163	1962	166	1965	223
27	1939	182	1968	154	1976	157	1940	165	1936	222
28	1940	172	1971	153	1971	156	1958	157	1970	215
29	1966	162	1927	153	1968	155	1927	154	1930	210
30	1926	159	1958	151	1927	151	1929	154	1937	208
31	1927	159	1939	150	1941	147	1921	152	1940	206
32	1930	151	1974	149	1930	147	1930	147	1927	205
33	1957	146	1925	146	1952	143	1925	142	1921	200
34	1929	143	1967	144	1925	143	1922	137	1974	199
35	1941	137	1922	144	1974	139	1966	134	1957	198
36	1919	137	1961	143	1967	138	1941	133	1919	195
37	1953	136	1930	142	1922	136	1976	133	1971	193
38	1925	136	1926	142	1919	136	1926	130	1926	187
39	1922	130	1966	126	1928	132	1977	127	1953	180
40	1928	130	1976	124	1958	130	1928	124	1923	173
41	1921	129	1957	119	1962	129	1957	123	1941	173
42	1963	128	1952	119	1969	129	1919	123	1922	167
43	1923	127	1923	117	1961	124	1953	120	1929	165
44	1976	118	1941	114	1953	115	1923	118	1977	162
45	1977	106	1977	113	1966	113	1965	101	1920	157
46	1965	100	1928	109	1923	110	1963	98	1963	155
47	1972	98	1953	108	1957	103	1918	82	1928	152
48	1918	83	1965	103	1965	99	1972	74	1925	145
49			1919	97	1926	90			1972	97
50			1963	92	1918	83				
51			1918	79	1963	75				
52			1972	63	1972	60				

Table 4.1 Monthly and Yearly Average Water Level of Lake Tempe

(Unit: EL. m)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Av-erage
1968	-	6.215	5.865	6.795	5.815	6.445	7.115	7.855	6.595	4.715	4.775	5.155	6.105
1969	5.975	5.945	5.805	6.485	7.145	8.025	6.975	6.095	5.525	4.615	4.465	-	6.095
1970	5.539	5.485	6.515	5.715	6.635	8.675	7.785	7.305	6.165	5.605	5.055	5.445	6.325
1971	5.725	5.595	5.995	5.115	4.285	5.545	6.135	6.275	6.675	6.725	6.365	6.355	5.895
1972	8.035	7.985	6.975	5.615	4.615	-	-	-	-	-	-	-	-
1975	(5.156)	(5.579)	(5.336)	(5.341)	(6.918)	(7.775)	(7.027)	(7.318)	(6.775)	(6.710)	(6.100)	5.651	6.307
1976	5.624	5.071	4.922	4.862	5.014	5.688	6.207	5.002	4.057	4.100	4.035	4.482	4.922
1977	5.953	6.473	6.713	6.473	5.827	7.111	6.785	5.008	3.938	3.462	(3.256)	(4.199)	5.441
1978	5.310	4.843	5.246	5.244	6.767	6.710	6.582	6.412	5.301	4.909			
Average	5.611	5.651	5.800	5.754	5.891	6.997	6.826	6.409	5.629	5.105	4.864	5.215	5.870

( ) shows estimated values from the water level at Sengkang (Cenranae River), using the correlation between the water levels at Sengkang and Lake Tempe.

Table 4.2 Annual Maximum Water Levels of Lake Tempe

Month	Year	W.L (m)	Zero Point of Gauge (EL. m)	W.L (EL. m)	Measured by	
Feb.	1939	9.49	0.0	9.49	DPU Sul. Sel	/1
Jun.	1940	9.33	0.0	9.33	DPU Sul. Sel	/1
Jun.	1941	8.00	0.0	8.00	DPU Sul. Sel	/1
Jun.	1948	8.33	0.0	8.33	DPU Sul. Sel	/1
Jun.	1952	6.93	0.0	6.93	DPU Sul. Sel	/1
Feb.	1953	7.86	0.0	7.86	DPU Sul. Sel	/1
Jun.	1954	9.38	0.0	9.38	DPU Sul. Sel	/1
Aug.	1968	3.95	3.3	7.34	Dinas Perikanan	/2
Jun.	1969	4.32	3.3	7.62	Dinas Perikanan	/2
Jun.	1970	6.28	3.3	9.58	Dinas Perikanan	/2
Oct.	1971	3.90	3.3	7.20	Dinas Perikanan	/2
Jun.	1975	-	-	8.10	Estimated W.L.	/3
Jul.	1976	2.91	3.875	6.785	P3SA	
Jun.	1977	5.05	3.875	8.925	P3SA	
May	1978	3.63	3.875	7.505	P3SA	

/1: Dinas Pekerjaan Umum Propinsi Sulawesi Selatan.
/2: Dinas Perikanan Darat Daerah Sulawesi Selatan.
/3: Water level estimated from W.L. of Sengkang by use of correlation between water levels of Lake Tempe and Sengkang

Table 4.3 Annual Minimum Water Level of Lake Tempe

(Average in 5 days)

Month	Year	L.W.L. (EL. m)	Remarks
Oct.	1968	3.9	
Nov.	1969	4.3	
Nov.	1970	4.3	
May	1971	4.2	
Apr.	1975	4.9	Estimated value by use of correlation
Nov.	1976	3.9	
Nov.	1977	3.2	Estimated value by use of correlation
Nov.	1978	4.5	

Table 5.1 Probable Flood Discharge of Main Stream of the Walanae and Bila Rivers

River Name	Distance from River Mouth (km)	Catchment Area (sq km)	Discharge (cu m/s)						Remarks
			1/2	1/5	1/10	1/20	1/50	1/100	
R.Walanae	0	3190	1824	2326	2546	2878	3154	3377	Confluence of Cenranae River
	43.2	3076	1787	2280	2497	2823	3097	3317	Downstream of confluence of Belo River
	43.2	2859	1717	2189	2400	2716	2984	3199	Upstream of confluence of Belo River
	74.5	2684	1659	2113	2320	2628	2891	3101	Downstream of confluence of Mario River
	118.5	1625	1259	1599	1771	2018	2243	2420	Ujung Lamuru gauge sta.
	145.0	1200	1066	1351	1505	1721	1925	2084	Downstream of confluence of Menraleng River
	145.0	686	784	990	1114	1282	1451	1581	Upstream of confluence of Menralang River
	179.0	398	582	731	831	963	1103	1208	Downstream of confluence of Sanrego River
	179.0	168	362	453	522	612	713	789	Upstream of confluence of Sanrego River
R.Bila	0	1368	1146	1453	1615	1843	2057	2223	Confluence of L.Tempe
	6.8	1188	1060	1343	1496	1712	1915	2073	Upstream of confluence of Lancireng River
	17.0	1123	1028	1302	1452	1662	1862	2073	Downstream of confluence of Boya River
	17.0	420	599	753	855	991	1133	1240	Upstream of confluence of Boya River

Table 5.2 Probable Flood Discharges at River Mouths of Small Scale Rivers and Tributaries of the Walanae and the Bila River

River System	River Name	Catchment Area (sq km)	1/2	1/5	1/10	1/20	1/50	1/100
Lawo	Lawo	168	362	453	522	612	713	789
Batu Batu	Batu Batu	113	291	363	422	497	584	649
Gilirang	Gilirang	518	672	847	957	1106	1259	1376
Walanae	Belo	216	416	521	598	698	810	893
	Mario	485	648	816	924	1068	1218	1332
	Langkemme	104	278	347	404	475	560	622
	Menraleng	515	670	844	955	1103	1256	1372
	Sanrego	230	430	539	619	722	836	921
Bila	Lancirang	180	376	470	542	634	739	816
	Kalora	167	361	451	521	610	711	787
	Boya	536	685	863	975	1126	1281	1399

Table 5.3 Estimated Flood Discharge of the Cenranae River at Sengkang

(Catchment area: 6138 sq km)

Return period (year)	:	2	5	10	20	50	100
Water level of L.Tempe (El.m)	:	8.0	8.9	9.4	9.9	11.0	12.0
Discharge at Sengkang (cu m/s)	:	487	646	744	849	1105	1367
Specific discharge (cu m/s/sqkm)	:	0.079	0.105	0.121	0.138	0.180	0.223

Table 5.4 Annual Maximum Water Levels at Water Level Gauge Station

River	Gauge Station	Occurrence Date	Water Level (m)	Peak Discharge (cu m/s)	Data Source
R.Walanae	Cabenge	18 Jun. 1971	8.34	2,132	-Lakibong
		13 Jan. 1972	10.11	3,068	-Lakibong
		12 Aug. 1975	7.93	1,461	-Cabenge
		21 Mar. 1976	3.41	421	-Lakibong
		Jun. 1977	9.00	2,461	-flood mark at Lakibong
		4 May 1978	7.47	1,325	-Cabenge
R.Walanae	Ujung Lamuru	29 Sep. 1974	5.00	1,030	
		11 Aug. 1975	6.54	1,560	
		4 Jul. 1976	4.10	730	
		16 Jun. 1977	11.50	3,560	
		3 May 1978	5.17	1,090	
R. Bila	Tanru Tedong	13 Sep. 1974	7.06	924	
		28 Jul. 1975	6.69	831	
		4 May 1976	6.88	878	
		18 Jun. 1977	6.00	672	
		20 Apr. 1978	6.82	863	
R.Bila	Bila	12 Sep. 1974	3.98	680	
		28 Jul. 1975	4.07	705	
		13 Mar. 1976	2.95	430	
		18 Jun. 1977	3.14	505	
		14 May 1978	4.10	750	

Table 5.5 Estimated Runoff Coefficient from the Observed Data

Name of River	Gauge Station	Observed Discharge			Rainfall at W.Soppeng		Runoff Coeffi-cient
		Date	W.L	Discharge	Daily	Intensity	
			(m)	(cu m/s)	(mm)	(mm/hr)	
Batu-Batu (Catchment Area; 113 sq km)	Batu-Batu	23 Dec. 1975		77	43	9.4	0.26
		18 Jun. 1975		56	20	4.4	0.41
		23 Jan. 1977		33	20	4.4	0.25
		18 Jun. 1977		149	75	16.4	0.29
Langkemme (Catchment Area; 104 sq km)	Langkemme	15 Dec. 1974	1.40	45	9	2.0	0.77
		16 Dec. 1974	1.28	34	17	3.7	0.32
		13 Jan. 1975	1.72	79	22	4.8	0.57
		24 Jan. 1977	1.78	87	34	7.4	0.46
		15 Feb. 1977	1.87	99	20	4.4	0.78
						Average	0.45

Remarks: Above discharges were converted from observed water level by use of the rating curve.

Table 5.6 Calculated Discharges

		Catch-ment Area (sqkm)	Return Period (yr)	Daily Rain-fall (mm)	Runoff Coeff.	Specific Discharge (cu m/s/sqkm)	Discharge (cu m/s)
Batu-Batu	Batu-Batu	113	2	89	0.45	2.42	273
			5	117	0.45	3.19	360
			10	138	0.45	3.76	425
			20	160	0.45	4.37	494
			50	186	0.45	5.08	574
			100	205	0.45	5.60	633
Langkemme	Langkemme	104	2	89	0.45	2.42	252
			5	120	0.45	3.28	341
			10	145	0.45	3.96	412
			20	170	0.45	4.64	483
			50	204	0.45	5.57	579
			100	225	0.45	6.14	639

Table 5.7 Flood Discharge Hydrograph at Cabenge

(June 1977 Flood)

Date/Time		Discharge Observed (cu m/s)	Restored (cu m/s)	Date/Time		Discharge Observed (cu m/s)	Restored (cu m/s)
13	0	87		18	0	245	
	3	110			3	542	
	6	171			6	1491	
	9	269			9	1740	1900
	12	446			12	1818	2085
	15	857			15	1877	2170
	18	1544			18	1907	2190
	21	1727	1840		21	1886	2150
14	0	1777	2035	19	0	1860	2070
	3	1818	2195		3	1835	1970
	6	1869	2325		6	1810	1850
	9	1899	2400		9	1772	1660
	12	1933	2445		12	1671	1480
	15	1968	2460		15	1427	1295
	18	1958	2440		18	1206	1145
	21	1985	2395		21	1045	
15	0	1968	2340	20	0	898	
	3	1951	2255		3	790	
	6	1929	2155		6	698	
	9	1899	2020		9	618	
	12	1856	1855		12	544	
	15	1793	1660		15	497	
	18	1731	1460		18	459	
	21	1394	1255		21	491	
16	0	1142	1100	21	0	499	
	3	955			3	478	
	6	792			6	436	
	9	662			9	390	
	12	560			12	350	
	15	493			15	318	
	18	444			18	294	
	21	401			21	272	
17	0	365		22	0	253	
	3	337			3	238	
	6	313			6	224	
	9	289			9	214	
	12	269			12	203	
	15	255			15	194	
	18	244			18	186	
	21	235			21	181	

Table 5.8.(1) Flood Discharge Hydrograph at Mong Dam Site
(10-year, 20-year, 50-year, 100-year flood)

Time	Flood Discharge (cu m/s)				
	1977 Flood	10-year Flood	20-year Flood	50-year Flood	100-year Flood
0	87	85	95	106	113
3	110	107	121	134	143
6	171	167	188	209	222
9	269	262	295	328	350
12	446	435	490	544	580
15	857	836	941	1045	1115
18	1544	1506	1695	1883	2008
21	1840	1795	2020	2244	2393
24	2035	1985	2234	2482	2647
27	2195	2141	2409	2677	2855
30	2325	2262	2552	2835	3024
33	2400	2341	2634	2927	3122
36	2445	2385	2684	2982	3180
39	2460	2400	2700	3000	3200
42	2440	2380	2678	2976	3174
45	2395	2337	2629	2921	3115
48	2340	2283	2568	2854	3044
51	2255	2200	2475	2750	2933
54	2155	2102	2365	2628	2803
57	2020	1971	2217	2463	2628
60	1855	1810	2040	2262	2413
63	1660	1620	1822	2024	2159
66	1460	1424	1602	1780	1899
69	1255	1224	1377	1530	1633
72	1100	1073	1207	1341	1431
75	955	932	1048	1165	1242
78	792	773	869	966	1030
81	662	646	727	807	861
84	560	546	615	683	728
87	493	481	541	601	641
90	444	433	487	541	576
93	401	391	440	489	522
96	365	356	401	445	475
99	337	329	370	411	438
102	313	305	344	382	407
105	289	282	317	352	376
108	269	262	295	328	350
111	255	249	280	311	332
114	244	238	268	296	317
117	235	229	258	287	306
120	245	239	269	299	319
123	542	529	595	661	705
126	1491	1455	1636	1818	1940
129	1900	1854	2085	2317	2472

Table 5.8.(2) Flood Discharge Hydrograph at Mong Dam Site
(10-year, 20-year, 50-year, 100-year flood)

Time	Flood Discharge (cu m/s)				
	1977 Flood	10-year Flood	20-year Flood	50-year Flood	100-year Flood
132	2085	2034	2288	2543	2712
135	2170	2117	2382	2646	2823
138	2190	2137	2404	2670	2849
141	2150	2098	2360	2622	2797
144	2070	2020	2272	2524	2693
147	1970	1922	2162	2402	2563
150	1250	1805	2030	2256	2407
153	1660	1620	1822	2024	2159
156	1480	1444	1624	1805	1925
159	1295	1263	1421	1579	1685
162	1145	1117	1257	1396	1489
165	1045	1020	1147	1274	1359
168	898	876	986	1095	1168
171	790	771	867	963	1028
174	698	681	766	851	908
177	618	603	678	754	803
180	544	531	597	663	708
183	497	485	545	606	647
186	459	448	504	560	597
189	491	479	539	599	639
192	499	487	548	609	649
195	478	466	525	583	622
198	436	425	479	532	567
201	390	380	428	476	507
204	350	341	384	427	455
207	318	310	349	388	414
210	294	287	323	359	382
213	272	265	299	332	354
216	253	247	278	309	329
219	238	232	261	290	310
222	224	219	246	273	291
225	214	209	235	261	278
228	203	198	223	248	264
231	194	189	213	237	252
234	186	181	204	227	242
237	181	177	199	221	235

Table 5.9 Flood Discharge Hydrograph at Walimpong Dam Site

(June 1977 - Flood)

(Unit: cu m/s)

Date	Time	Q_C	Q_W	Date	Time	Q_C	Q_W
13	0	87	67	18	0	245	189
	3	110	85		3	542	419
	6	171	132		6	1491	1152
	9	269	208		9	1900	1468
	12	446	345		12	2085	1611
	15	857	662		15	2170	1677
	18	1544	1193		18	2190	1692
	21	1840	1422		21	2150	1661
14	0	2035	1572	19	0	2070	1599
	3	2195	1696		3	1970	1522
	6	2325	1796		6	1850	1429
	9	2400	1854		9	1660	1283
	12	2445	1889		12	1480	1144
	15	2460	1901		15	1295	1001
	18	2440	1885		18	1145	885
	21	2395	1851		21	1045	807
15	0	2340	1808	20	0	898	694
	3	2255	1742		3	790	610
	6	2155	1665		6	698	539
	9	2020	1561		9	618	478
	12	1855	1433		12	544	420
	15	1660	1283		15	497	384
	18	1460	1128		18	459	355
	21	1255	970		21	491	379
16	0	1100	850	21	0	499	386
	3	955	738		3	478	369
	6	792	612		6	436	337
	9	662	512		9	390	301
	12	560	433		12	350	270
	15	493	381		15	318	246
	18	444	343		18	294	227
	21	401	310		21	272	210
17	0	365	282	22	0	253	195
	3	337	260		3	238	184
	6	313	242		6	224	173
	9	289	223		9	214	165
	12	269	208		12	203	157
	15	255	197		15	194	150
	18	244	189		18	186	144
	21	235	182		21	181	140

Remarks: Q_C: Observed discharge at Cabenge
Q_W: Estimated discharge at Walimpong dam site
($Q_W = Q_C$ 2199/2846)

Table 5.10.(1) Flood Discharge Hydrograph at Walimpong Dam Site

(2-year, 5-year, 10-year, 50-year, 100-year flood)

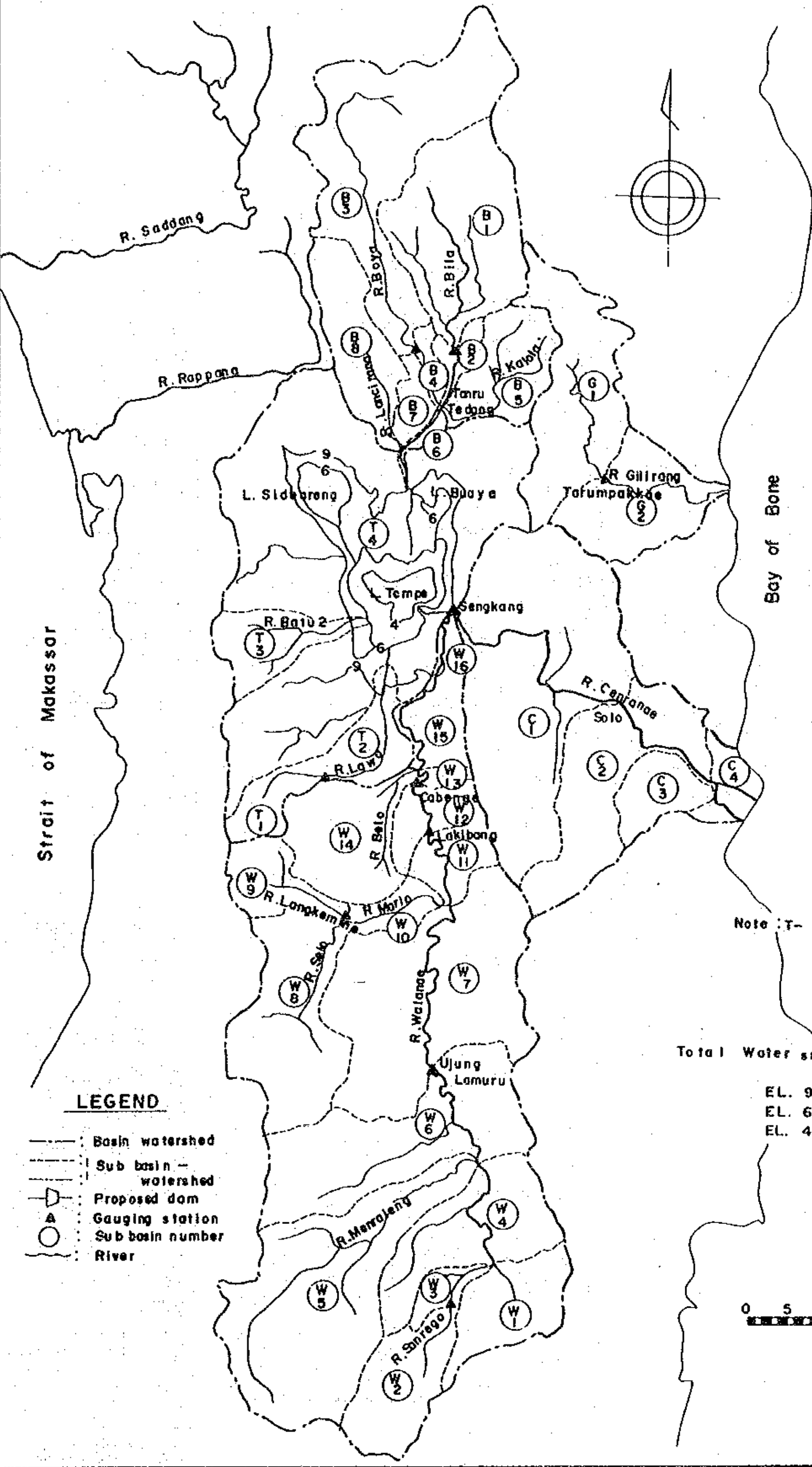
Time	Flood Discharge (Unit: cu m/s)						
	1977 Flood	2-Yr Flood	5-Yr Flood	10-Yr Flood	20-Yr Flood	50-Yr Flood	100-Yr Flood
0	67	46	60	66	74	82	87
3	85	59	76	83	93	104	111
6	132	91	118	129	145	161	172
9	208	144	186	203	228	253	270
12	345	238	308	336	378	420	448
15	662	458	592	646	727	808	861
18	1193	824	1067	1164	1309	1455	1552
21	1422	982	1271	1387	1560	1734	1849
24	1572	1087	1406	1534	1726	1918	2045
27	1696	1172	1517	1655	1861	2068	2206
30	1796	1241	1607	1753	1972	2191	2337
33	1854	1281	1658	1809	2035	2261	2412
36	1889	1306	1689	1843	2073	2304	2457
39	1901	1314	1700	1854	2086	2318	2473
42	1885	1303	1686	1839	2069	2299	2452
45	1851	1279	1655	1805	2031	2257	2407
48	1808	1249	1617	1764	1984	2205	2352
51	1742	1204	1558	1700	1912	2125	2266
54	1665	1151	1489	1624	1828	2031	2166
57	1561	1079	1396	1523	1713	1903	2030
60	1433	990	1282	1398	1573	1748	1864
63	1283	886	1147	1251	1408	1564	1668
66	1128	780	1009	1101	1238	1376	1467
69	970	670	867	946	1064	1183	1261
72	850	587	760	829	933	1036	1106
75	738	510	660	720	810	900	960
78	612	423	547	597	672	746	796
81	512	353	457	499	561	624	665
84	433	299	387	422	475	528	563
87	381	263	341	372	418	465	496
90	343	237	307	335	377	418	446
93	310	214	277	302	340	378	403
96	282	195	252	275	310	344	367
99	260	180	233	254	286	318	339
102	242	167	216	236	265	295	315
105	223	154	200	218	245	272	290
108	208	144	186	203	228	253	270
111	197	136	176	192	216	240	256
114	189	130	169	184	207	230	245
117	182	123	162	177	199	221	236
120	189	131	169	185	208	231	246
123	419	289	375	409	460	511	545
126	1152	796	1030	1124	1264	1405	1499
129	1468	1015	1313	1432	1611	1790	1910

Table 5.10.(2) Flood Discharge Hydrograph at Walimpong Dam Site

(2-year, 5-year, 10-year, 50-year, 100-year flood)

Time	Flood Discharge (Unit: cu m/s)						
	1977 Flood	2-Yr Flood	5-Yr Flood	10-Yr Flood	20-Yr Flood	50-Yr Flood	100-Yr Flood
132	1611	1113	1441	1572	1768	1965	2096
135	1677	1159	1499	1636	1840	2045	2181
138	1692	1169	1513	1651	1857	2064	2201
141	1661	1148	1486	1621	1823	2026	2161
144	1599	1105	1430	1560	1755	1950	2081
147	1522	1052	1361	1485	1671	1856	1980
150	1429	988	1278	1395	1569	1743	1859
153	1283	886	1147	1251	1408	1564	1668
156	1144	790	1023	1116	1255	1395	1488
159	1001	691	895	976	1098	1220	1302
162	885	611	791	863	971	1079	1151
165	807	558	722	788	886	985	1050
168	694	479	621	677	762	846	903
171	610	422	546	596	670	744	794
174	539	373	482	526	592	658	702
177	478	330	427	466	524	582	621
180	420	290	376	410	461	513	547
183	384	265	343	375	421	468	500
186	355	245	317	346	389	433	461
189	379	262	339	370	416	463	493
192	386	266	345	376	423	470	502
195	369	255	330	360	405	450	480
198	337	233	301	329	370	411	438
201	301	208	269	294	331	367	392
204	270	187	242	264	297	330	352
207	246	170	220	240	270	300	320
210	227	157	203	222	249	277	295
213	210	145	188	205	231	256	273
216	195	135	175	191	215	238	254
219	184	127	164	179	202	224	239
222	173	120	155	169	190	211	225
225	165	114	148	161	181	202	215
228	157	108	140	153	172	191	204
231	150	104	134	146	165	183	195
234	144	99	129	140	158	175	187
237	140	97	125	136	153	171	182

Fig. I. I Sub-basins in Master Plan Basin.



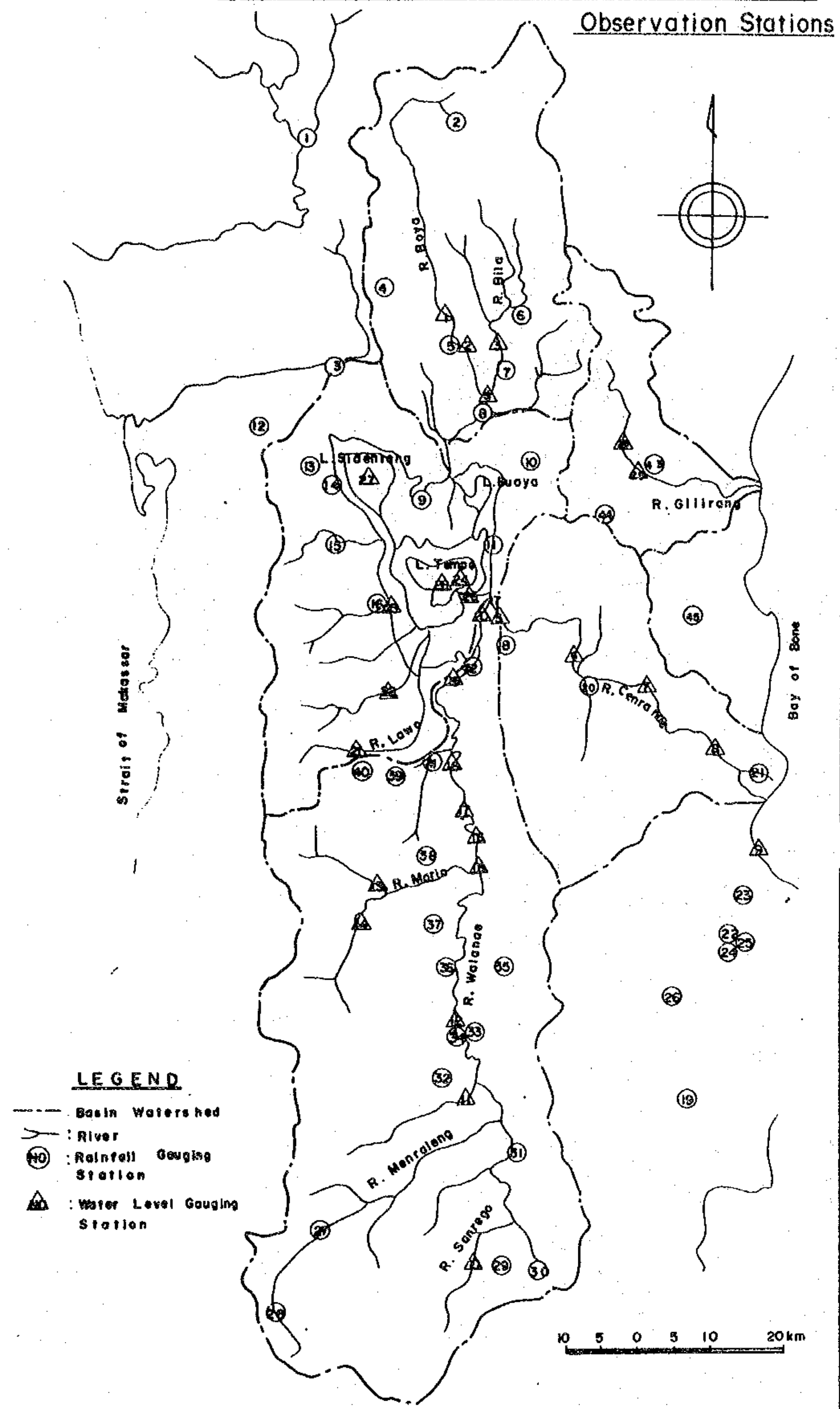
Subbasin number	A (km²)	Σ (km²)	
B - 1	379	379	BOYA
B - 2	41	420	
B - 3	514	514	
B - 4	22	536	
—	(Σ2+Σ4)	956	
B - 5	167	1123	
B - 6	13	1136	
B - 7	52	1188	
B - 8	180	1368	
T - 1	63	63	
T - 2	105	168	
T - 3	113	281	
T - 4	1299	1580	
W - 1	168	168	
W - 2	176	176	[illegible]
W - 3	55	230	
—	(Σ1+Σ3)	398	
W - 4	287	686	
W - 5	515	1200	
W - 6	425	1625	
W - 7	574	2199	
W - 8	325	325	MARIO
W - 9	104	430	
W - 10	56	485	
—	(Σ7+Σ10)	2684	
W - 11	75	2759	
W - 12	87	2846	
W - 13	13	2859	
W - 14	216	3076	
W - 15	92	3167	
W - 16	23	3190	
C - 1	698	698	
C - 2	302	1000	
C - 3	95	1095	
C - 4	60	1155	
TOTAL		7293	
G - 1	300	300	
G - 2	218	518	

Note : T- 4 include L. Tempe, L. Sidenreng and L. Buaya

Total Water surface area of lakes

EL. 9m : 430.6 km^2
EL. 6m : 172.6 km^2
EL. 4m : 49.2 km^2

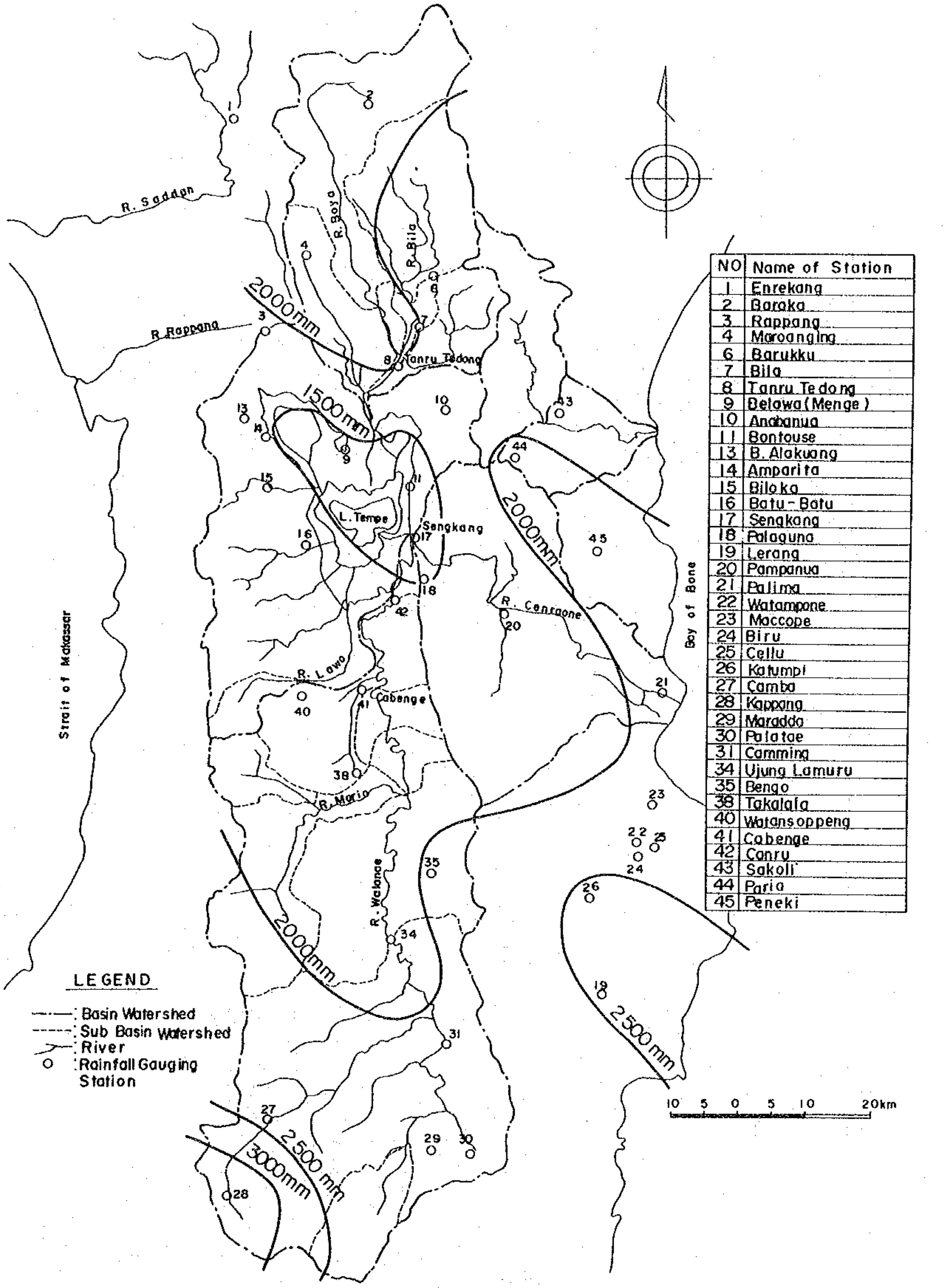
Fig 2.1 Location of Current Network of Hydrological Observation Stations



NO	Rainfall Gauging Station
1	Enrekang
2	Baraka
3	Rappang
4	Maroanging
5	Bulu Cenrana
6	Barukku
7	Bila
8	Tanru Tedong
9	Belawa (Menge)
10	Anabanua
11	Bontouse
12	Bulutimorang
13	B. Alakuang
14	Amparita
15	Biloka
16	Batu - Batu
17	Sengkang
18	Pala guna
19	Lerang
20	Pampanua
21	Palima
22	Watampone
23	Maccope
24	Biru
25	Cellu
26	Katumpi
27	Camba
28	Kappang
29	Maradda
30	Palatae
31	Camming
32	Parigi
33	Matango
34	Ujung Lamuru
35	Bengo
36	Paciro
37	Turucinnae
38	Takalala
39	B.B. Malanroe
40	Watansoppeng
41	Cabenge
42	Canru
43	Sakoli
44	Paria
45	Peneki

NO	Water Level Gauging Station
1	Bulu Cenrana (1)
2	Bulu Cenrana (2)
3	Bila
4	Tanru Tedong
5	Seng Kang
6	Kampiri
7	Solo
8	Cenranae
9	Tg. Pallete
10	Sanrego
11	Batupute
12	Ujung Lamuru
13	Lang kemme
14	Sero
15	Kalempang
16	Pantjon Kang
17	Lakibong
18	Cabenge
19	Canru
20	Wage
21	Lawo
22	Padangeng
23	Batu - Batu
24	L. Tempe (Auto)
25	- do - (Nomal)
26	Laringgi
27	L. Sidenreng
28	Gilirang
29	Tarumpakkae

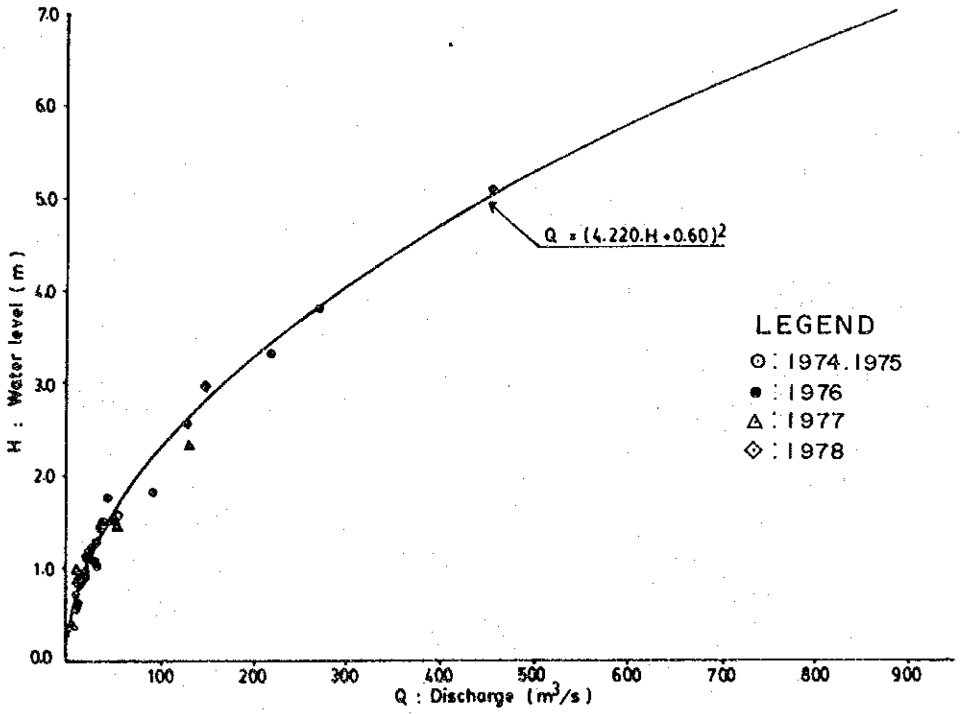
Fig 2.2 Annual Rainfall Isohyetal Map of Master Plan Basin.



NO	Name of Station
1	Enrekang
2	Baraka
3	Rappang
4	Maroanging
6	Barukku
7	Bila
8	Tanru Tedong
9	Belawa (Menge)
10	Anabanua
11	Bontouse
13	B. Alakuang
14	Amparita
15	Biloka
16	Batu - Batu
17	Sengkang
18	Palaguna
19	Lerang
20	Pampanua
21	Palima
22	Watampone
23	Maccope
24	Biru
25	Cellu
26	Katumpi
27	Camba
28	Kappang
29	Maradda
30	Palatae
31	Camming
34	Ujung Lamuru
35	Bengo
38	Takalala
40	Watansoppeng
41	Cabenge
42	Canru
43	Sakoli
44	Paria
45	Peneki

Fig 2.3 (1) Discharge Rating Curves.

Tanru Tedong



Sengkang

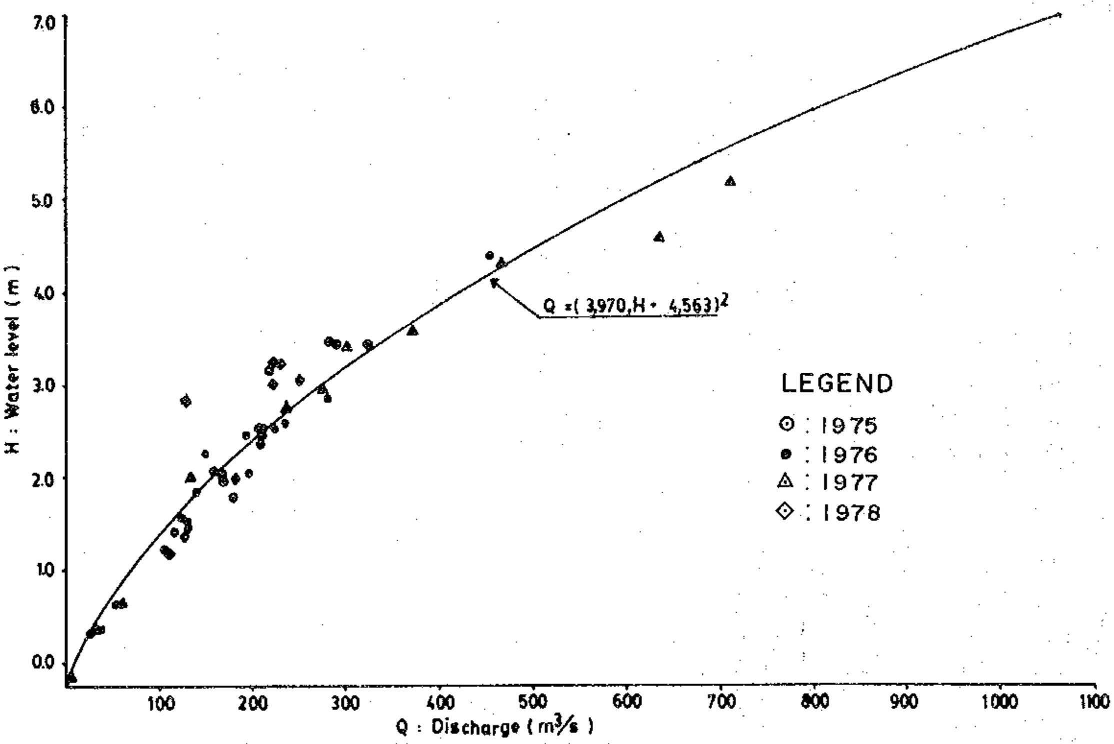


Fig. 2.3(2) Discharge Rating Curves

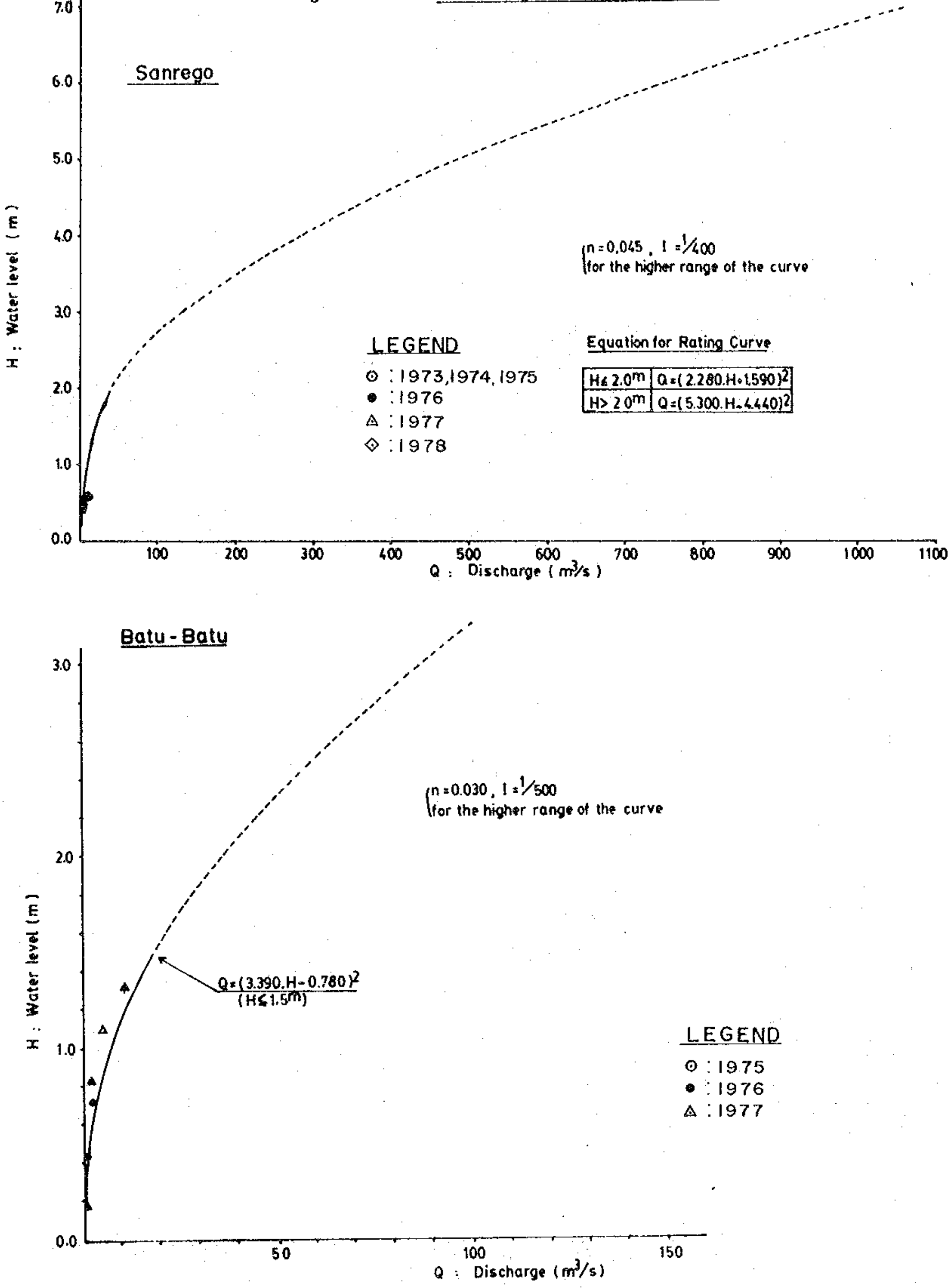
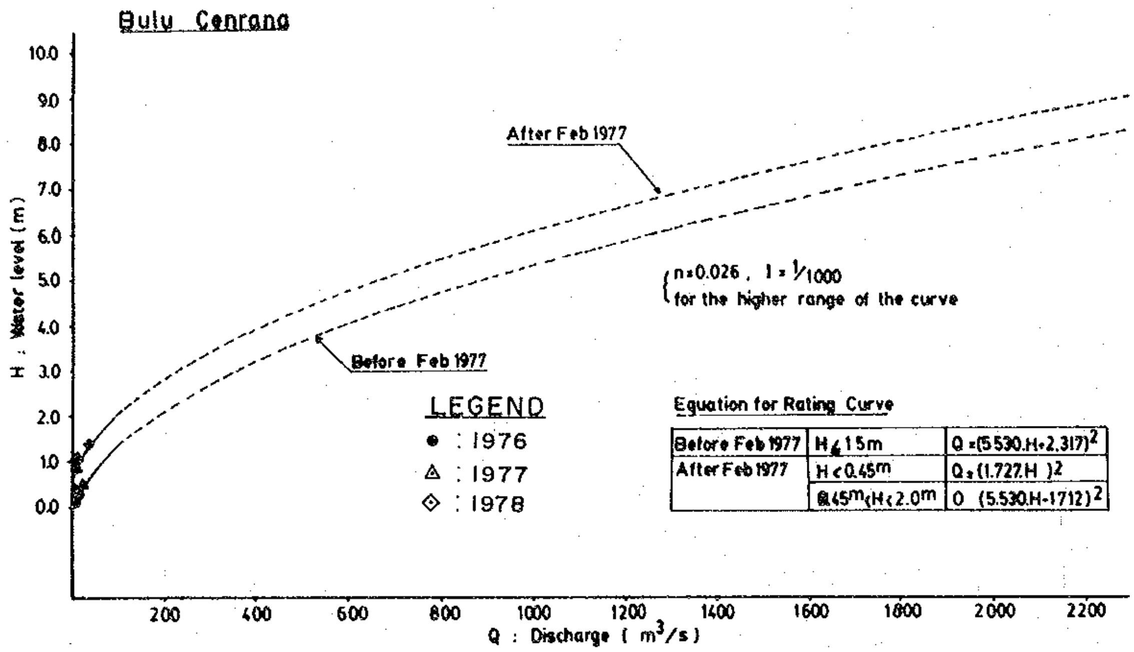


Fig. 2.3 (3) Discharge Rating Curves



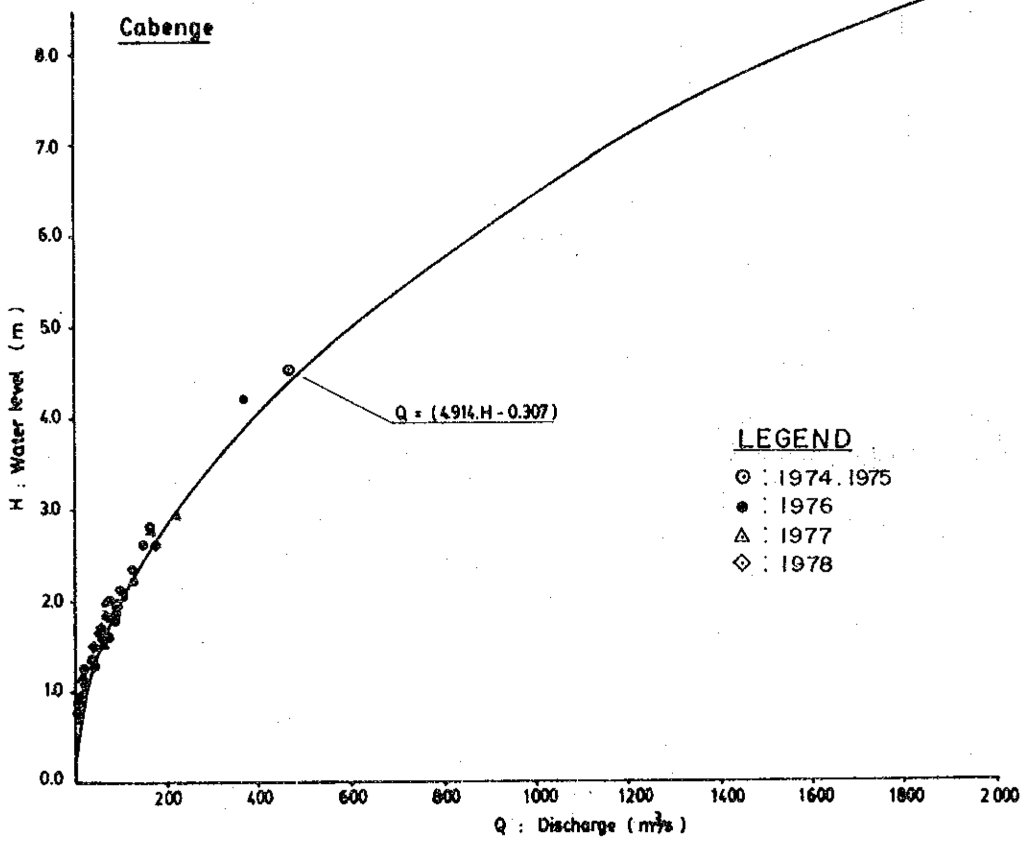
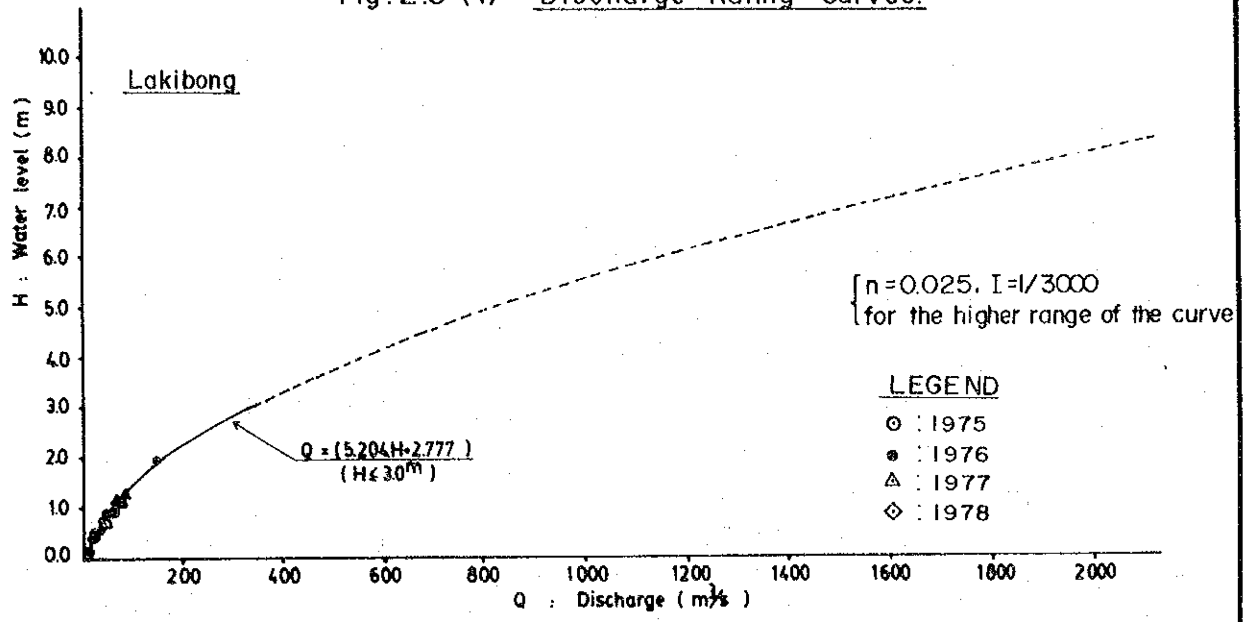


Fig. 2.3 (4) Discharge Rating Curves.



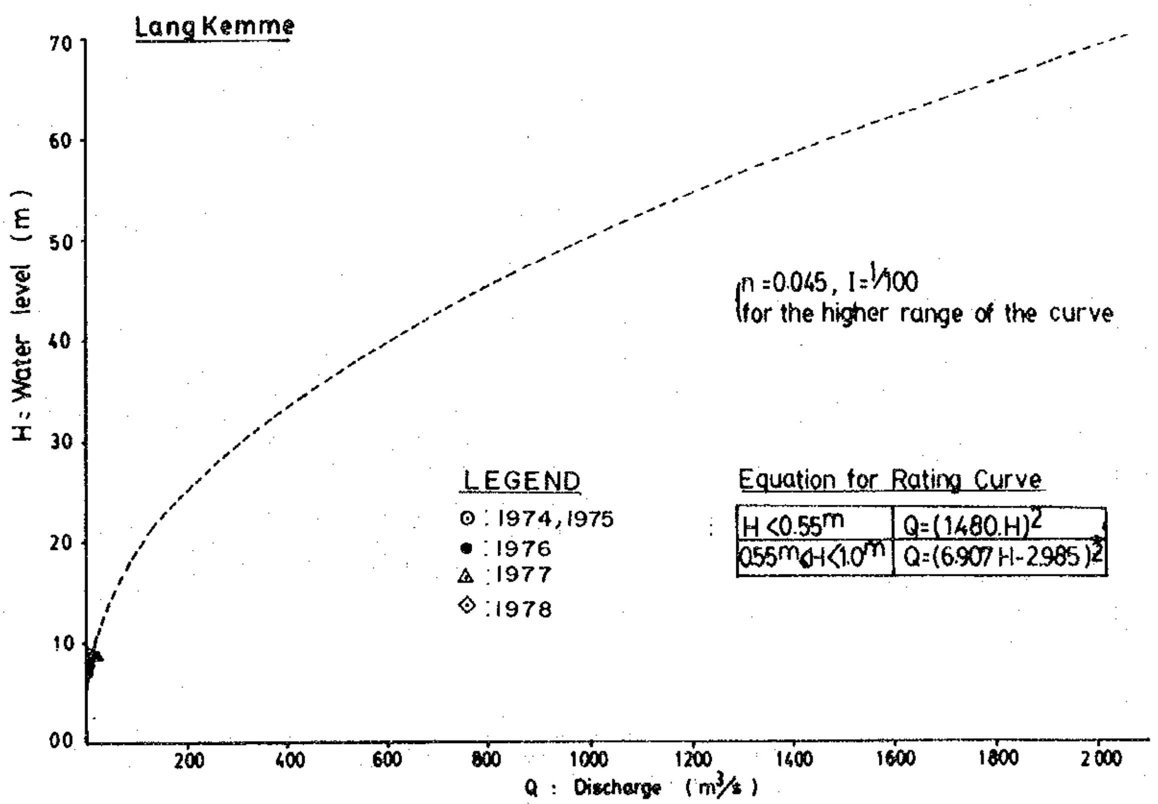
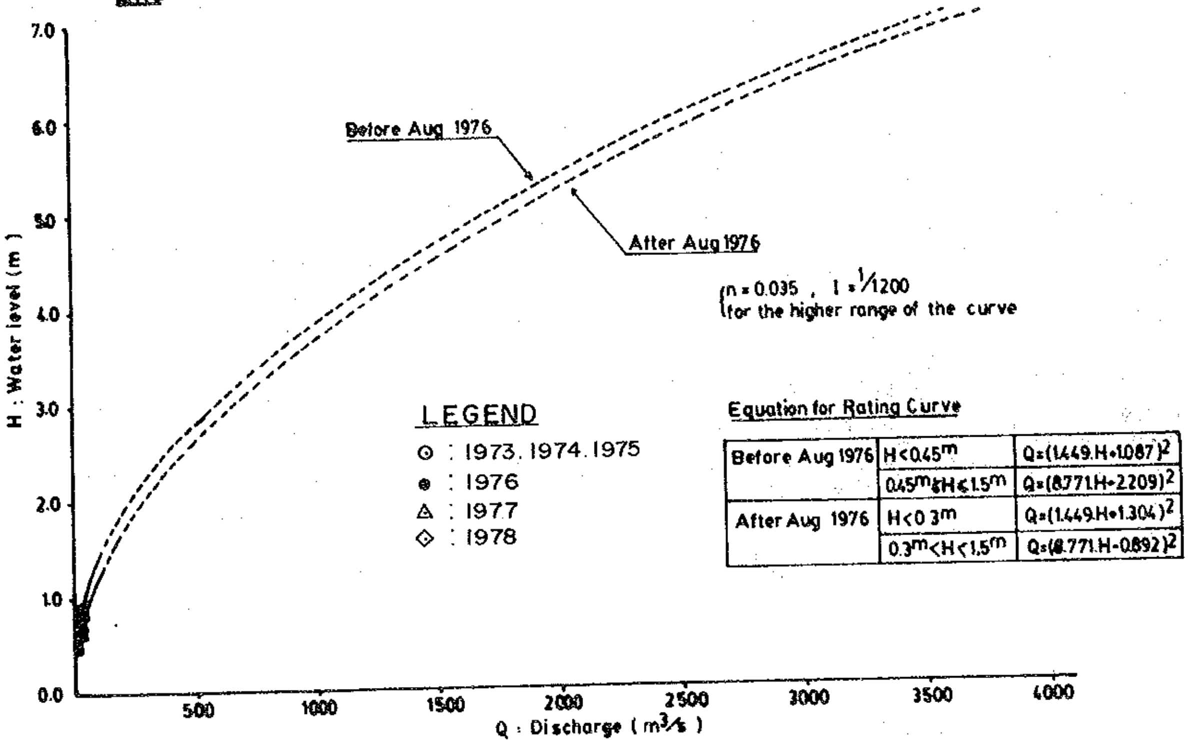


Fig. 2. 3 (5) Discharge Rating Curves

Bila



Ujung Lamuru

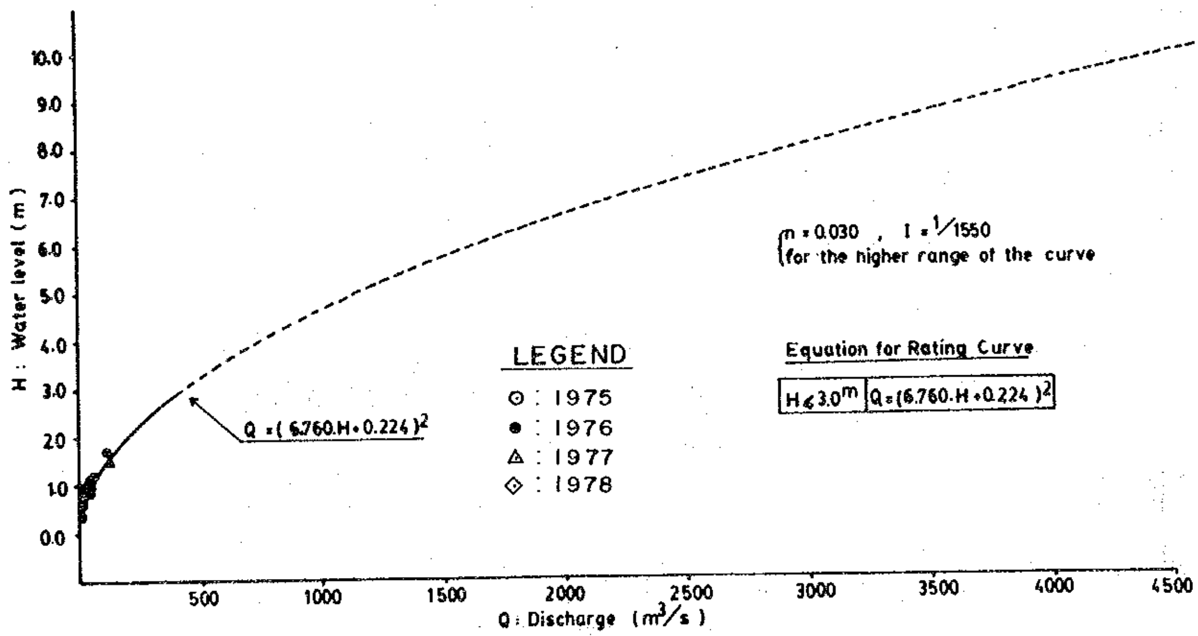


Fig .2.3.(6) Discharge Rating Curves

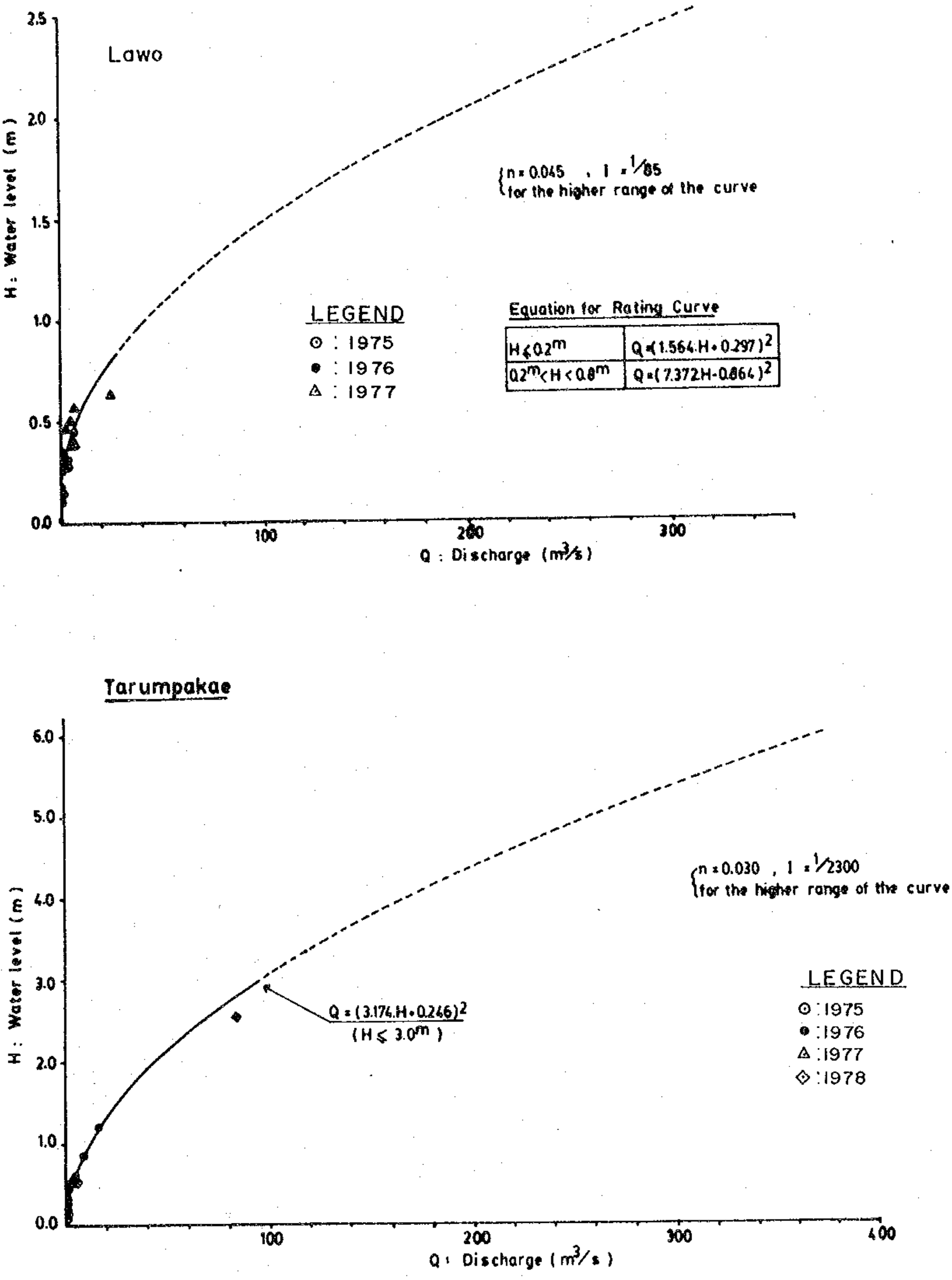


Fig. 2.4 H - √Q Rating Curve at Lakibong.

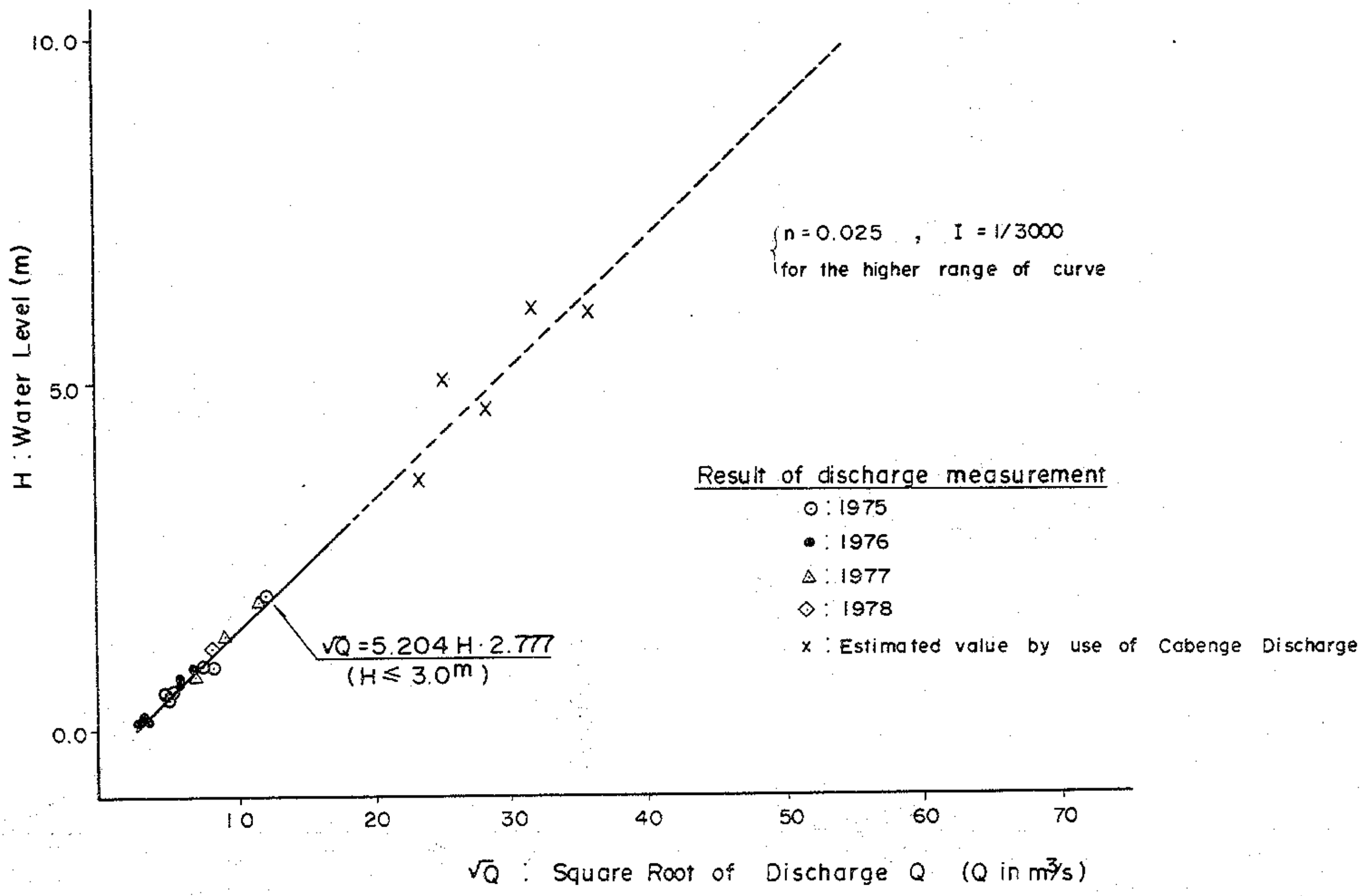
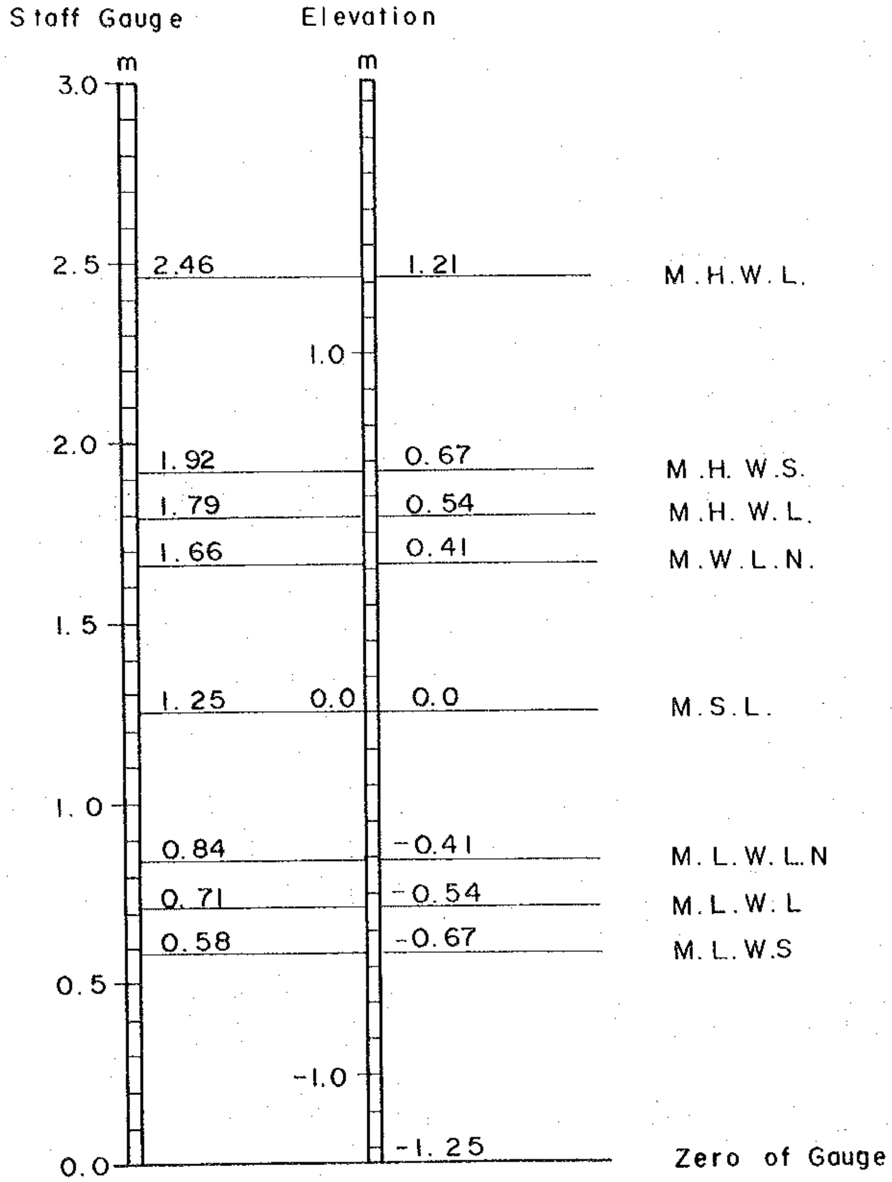


Fig. 2.5 Tide Levels at T. Palette, Bay of Bone



Remarks,

M.H.W.L.	Maximum High Water Level
M.H.W.S.	Mean High Water Springs
M.H.W.L.	Mean High Water Level
M.W.L.N.	Mean Water Level of Neap
M.S.L.	Mean Sea Level
M.L.W.L.N.	Mean Low Water Level of Neap
M.L.W.L.	Mean Low Water Level
M.L.W.S.	Mean Low Water Springs

Fig. 3.1 (I) Annual Pattern of Monthly Rainfall.

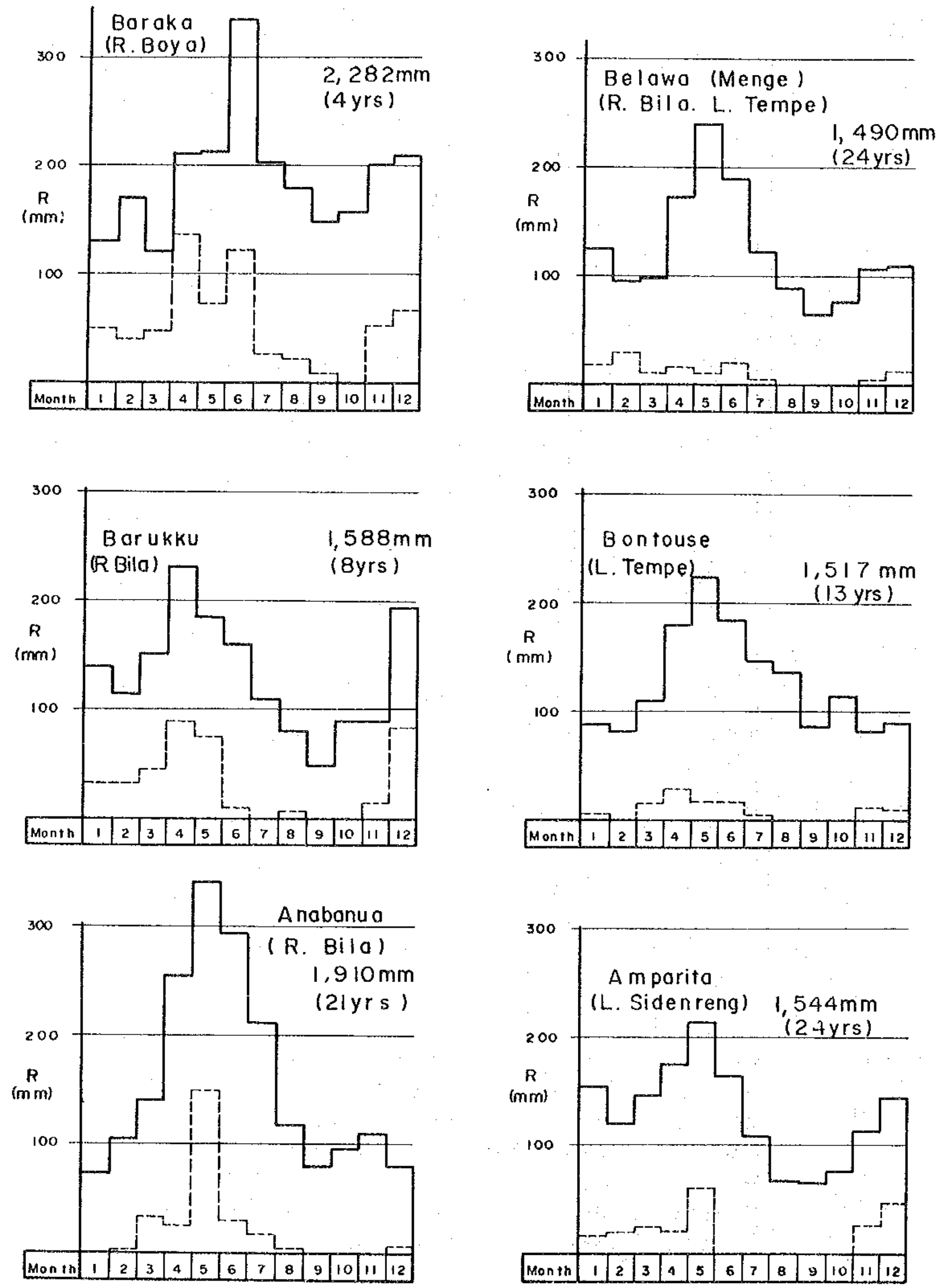


Fig. 3. 1 (2) Annual Pattern of Monthly Rainfall

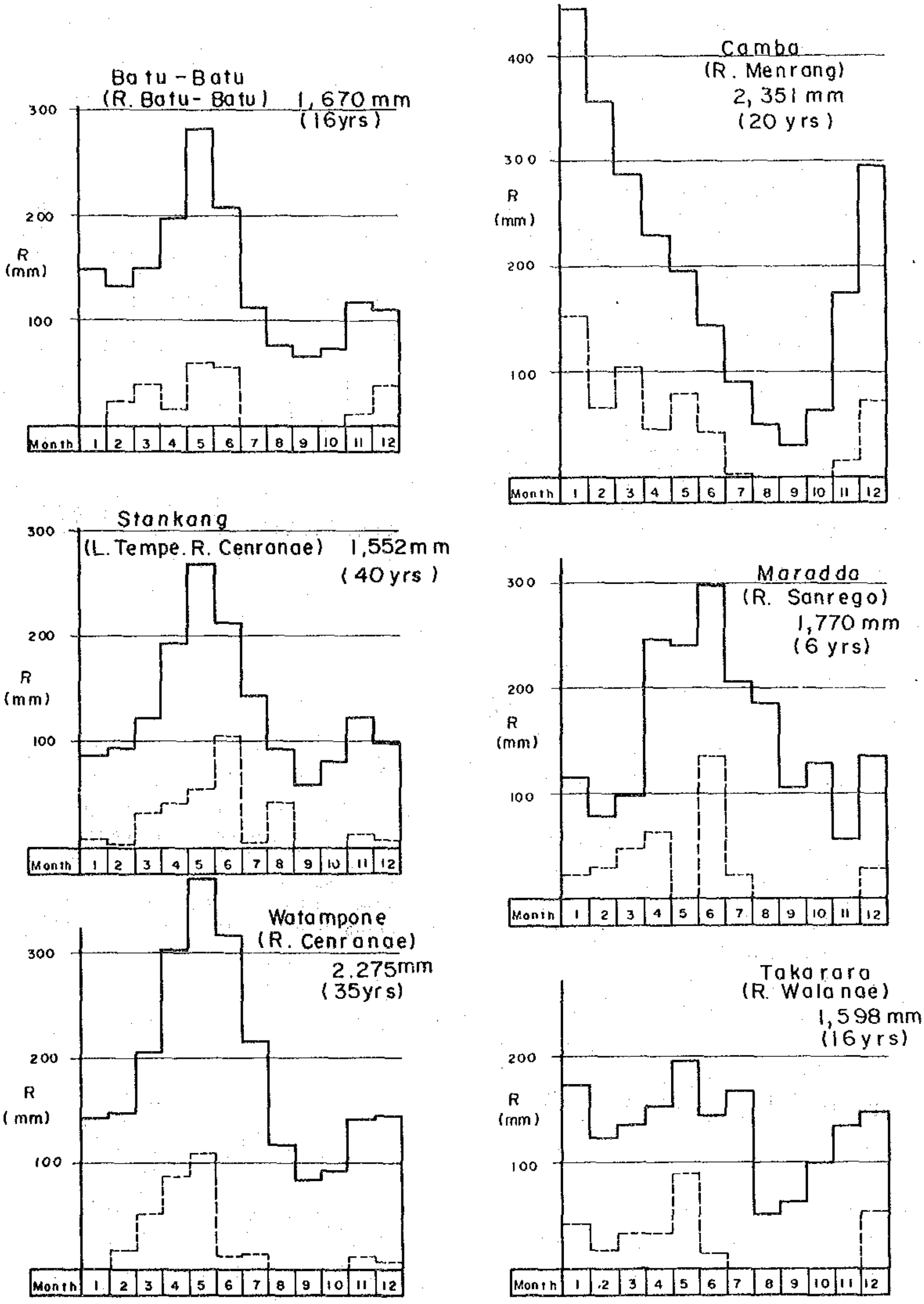


Fig. 3.1(3) Annual Pattern of Monthly Rainfall.

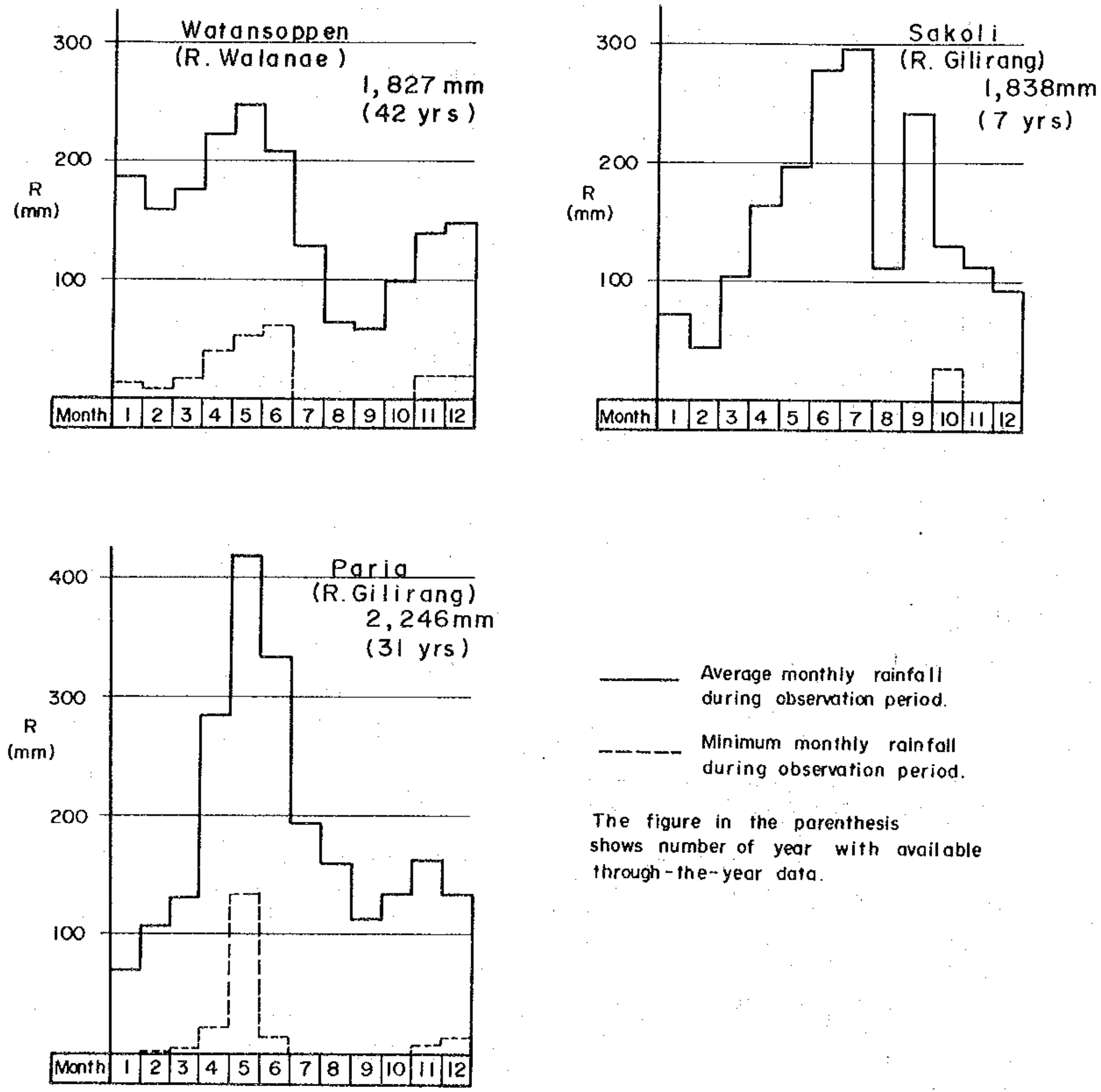


Fig 3.2 (1) Annual Pattern of Mean Monthly Discharge.

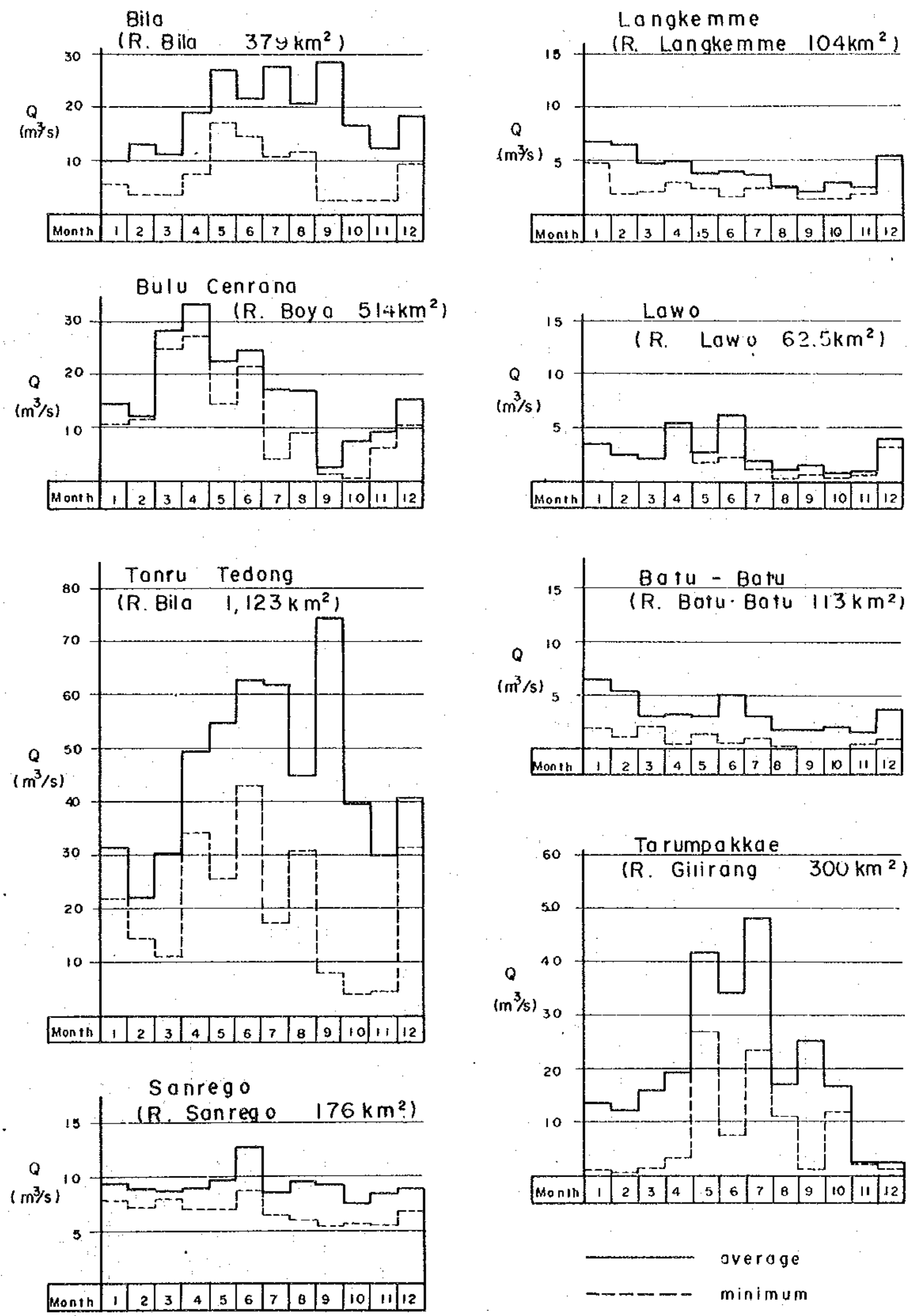


Fig 3.2 (2) Annual Pattern of Mean Monthly Discharge.

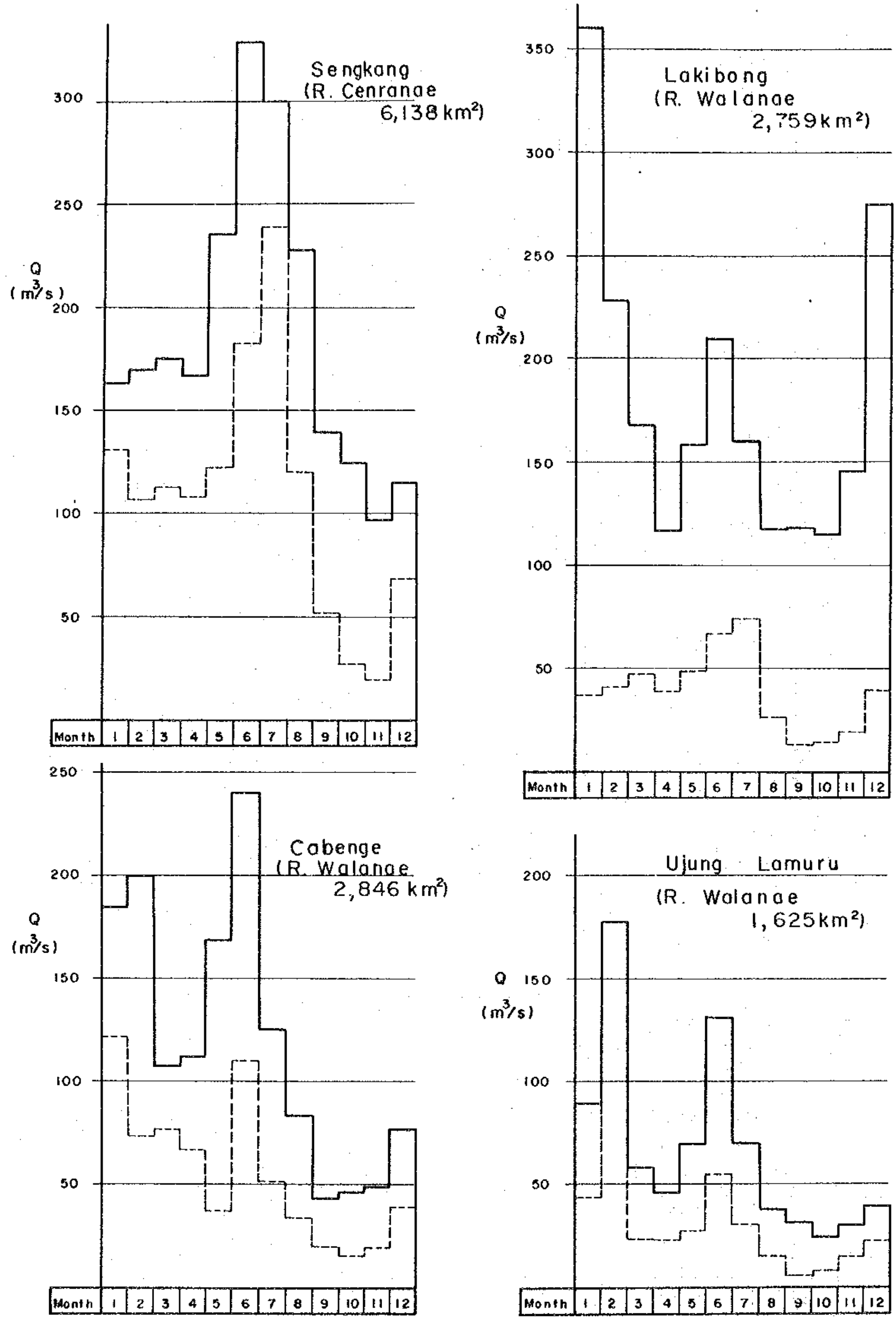
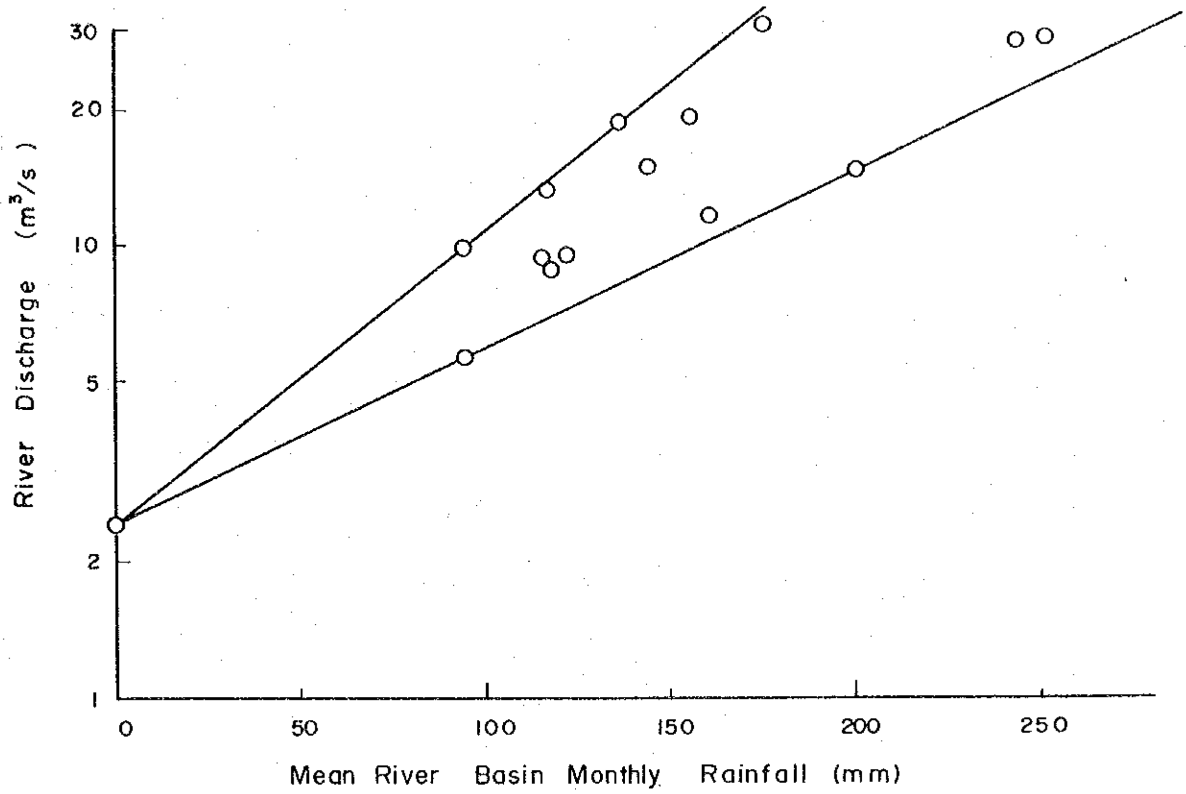


Fig. 3.3 Correlation between River Discharge and Monthly Rainfall during Dry Season (October-February)

Bila (Bila River)



Bulu Cenrana (Boya River)

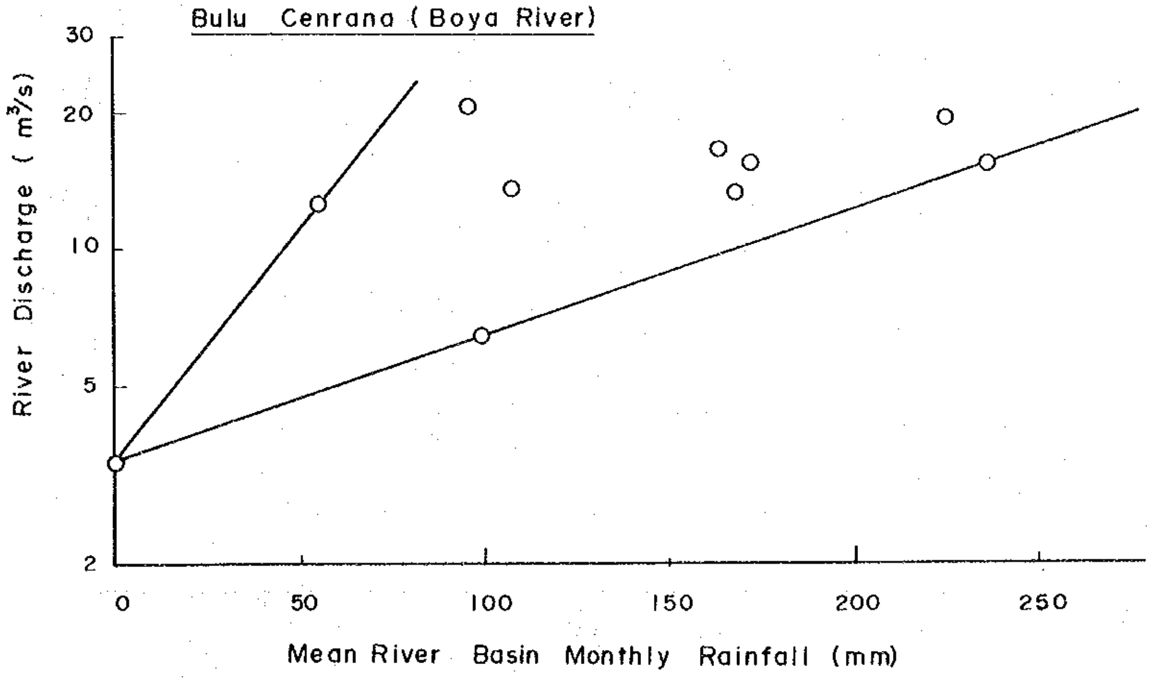


Fig. 3. 4 Longitudinal Profile of Salt Water Wedge in Cenranae River

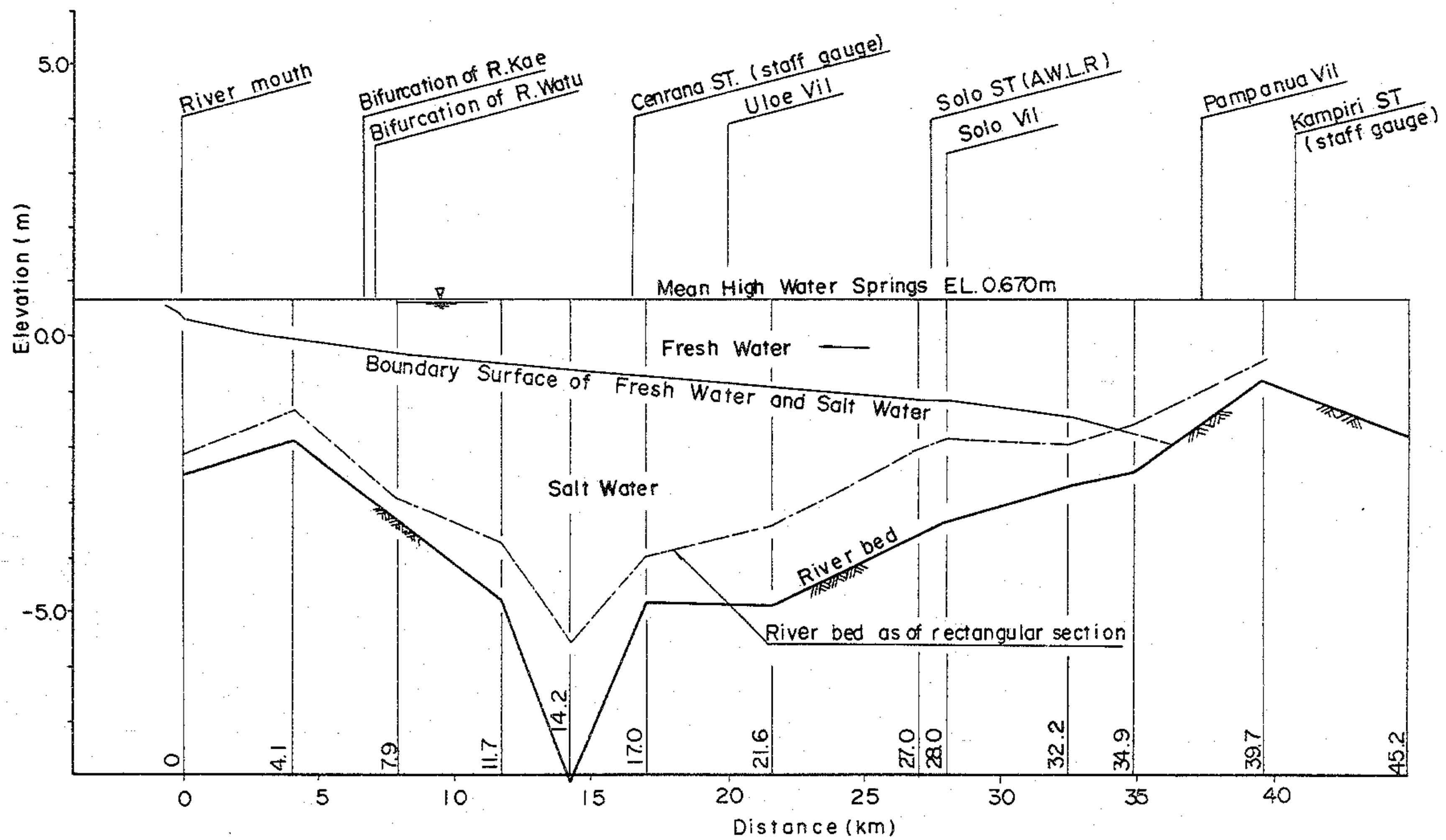


Fig 3.5 (I) Average Monthly Rainfallin River Basin Arranged in Magnitude Order

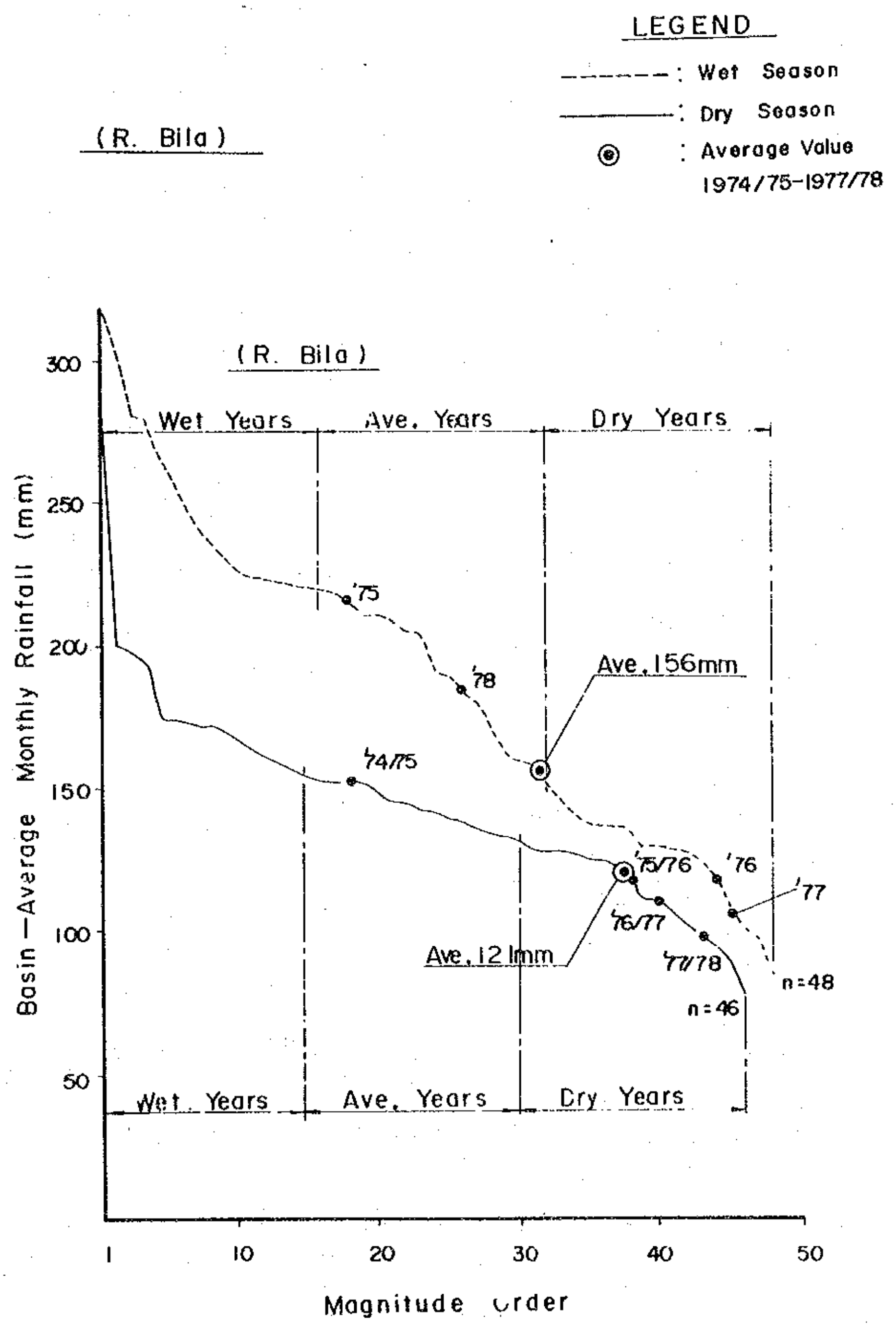


Fig 3.5 (2) Average Monthly Rainfallin River Basin Arranged in Magnitude Order

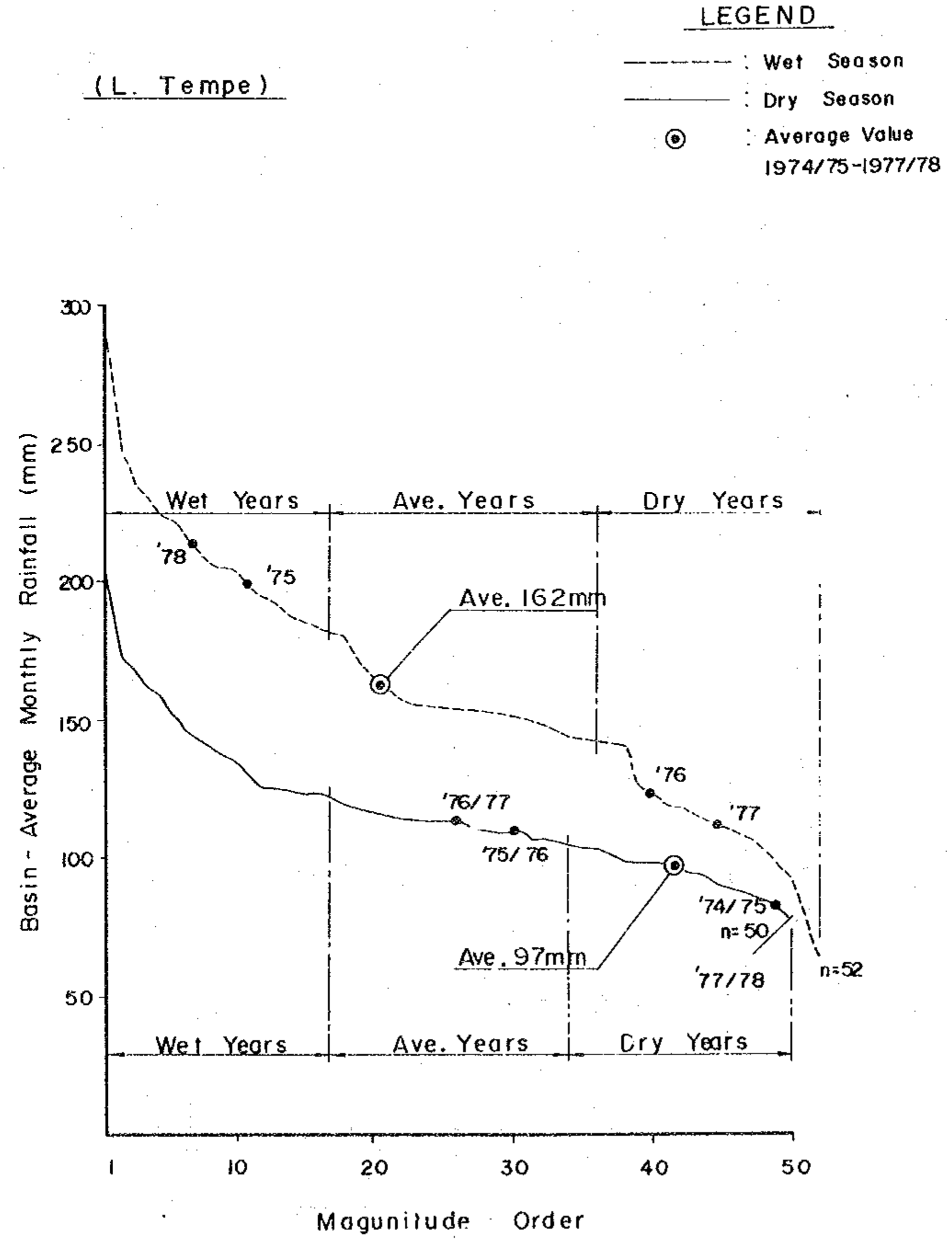


Fig 3.5 (3) Average Monthly Rainfall in River Basin Arranged in Magunitude Order

LEGEND

- - - - - : Wet Season
———— : Dry Season
⊙ : Average Value. 1974/75 - 1977/78

(R. Walanae)

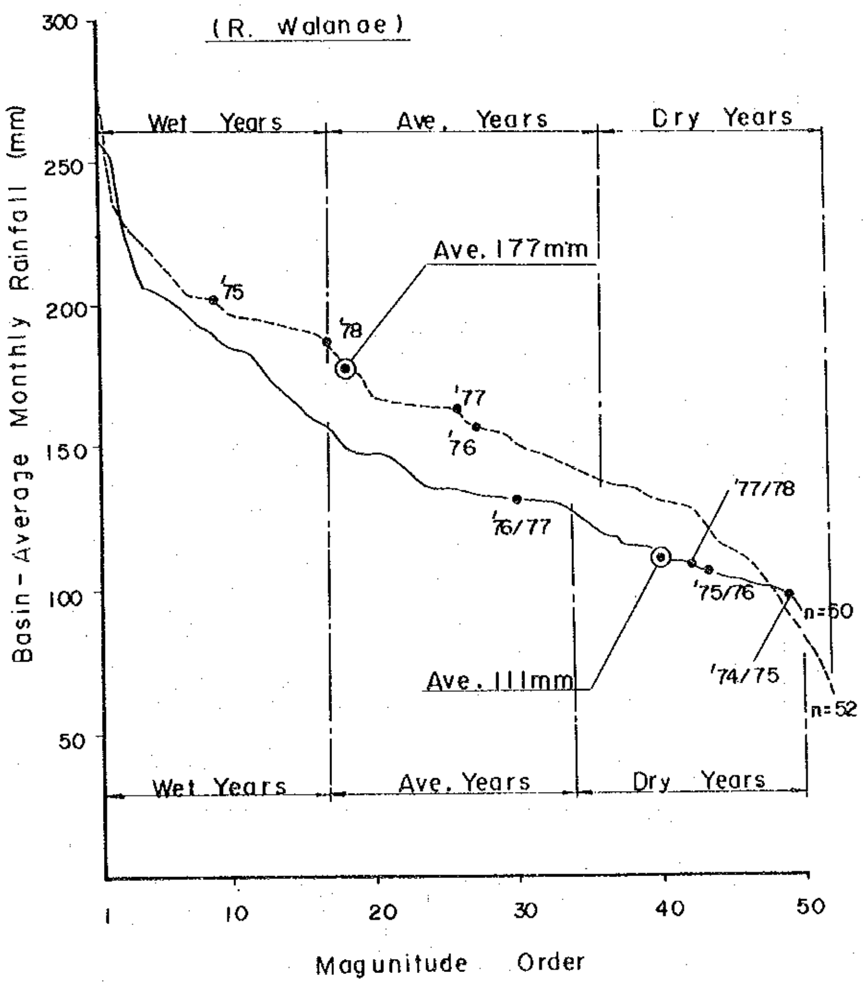


Fig 3.5 (4) Average Monthly Rainfall in River Basin Arranged in Magunitude Order

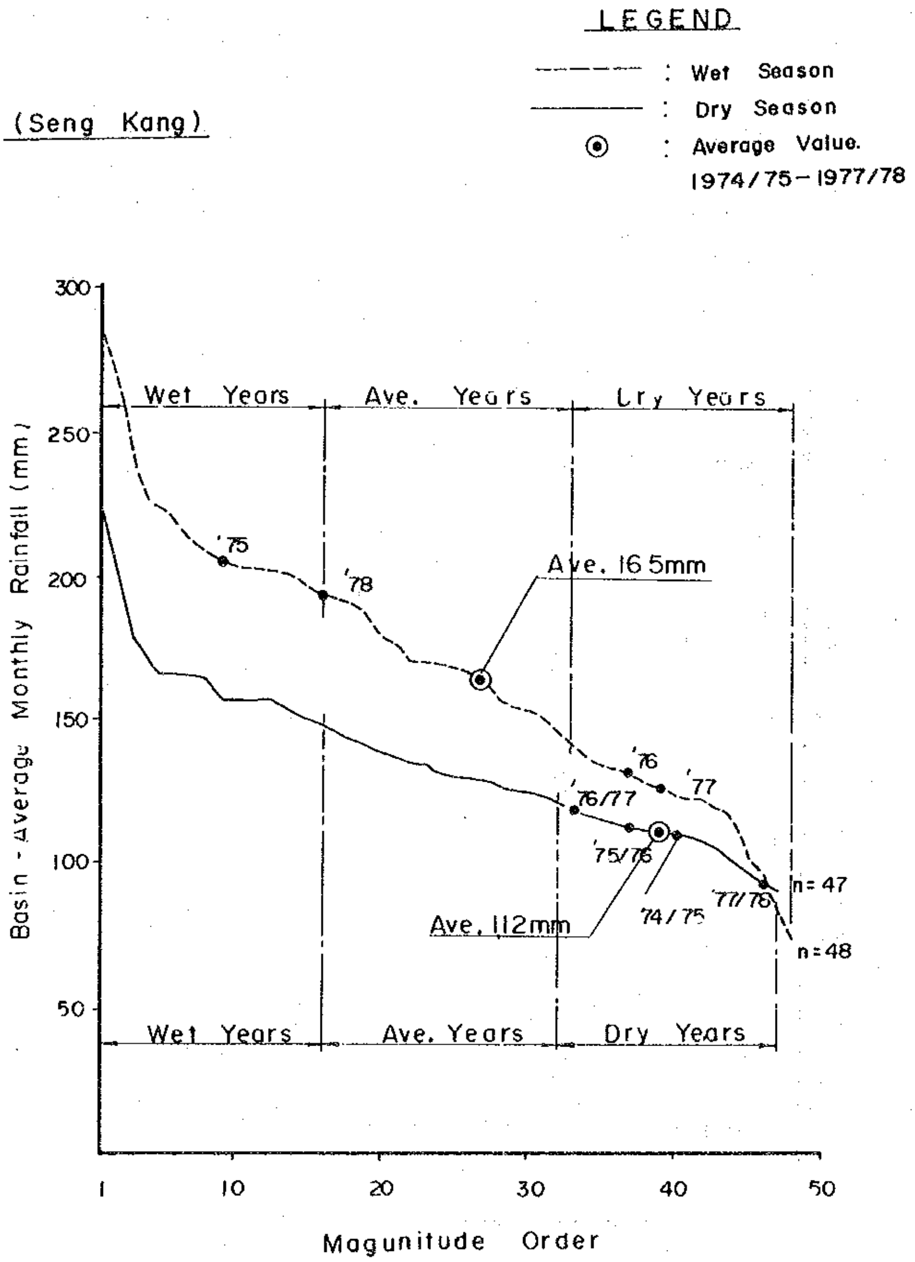
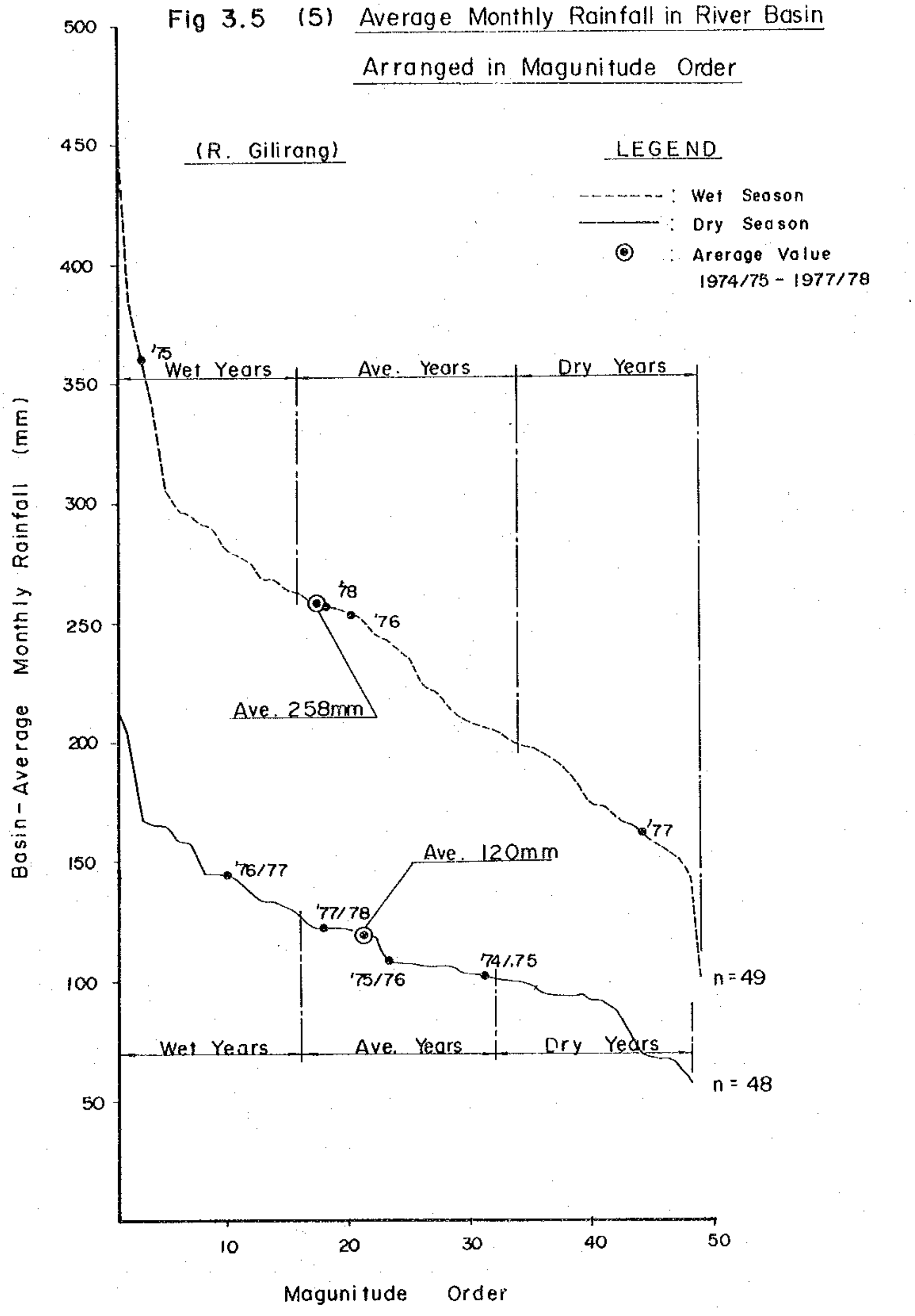


Fig 3.5 (5) Average Monthly Rainfall in River Basin Arranged in Magunitude Order



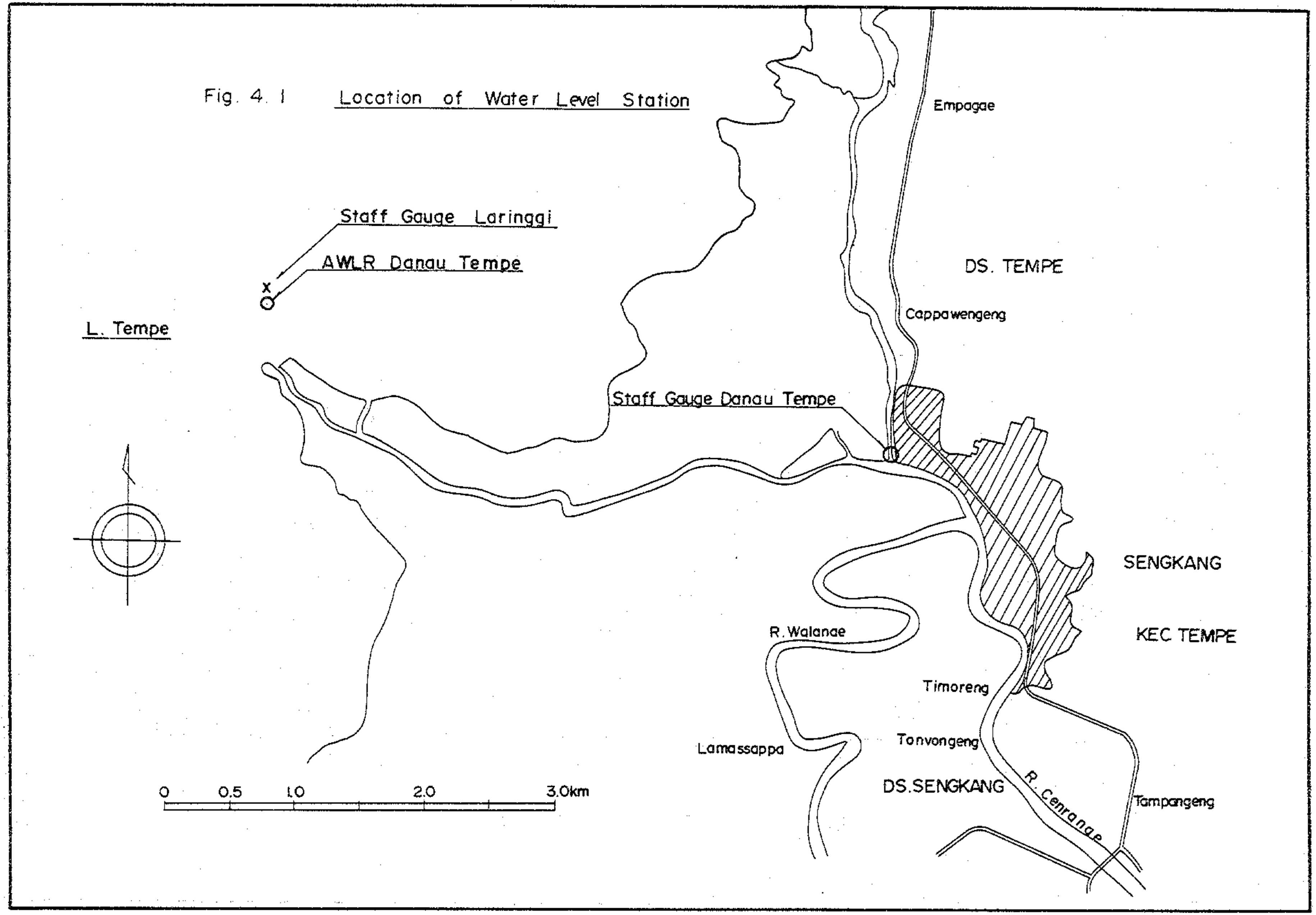


Fig. 4.1 Location of Water Level Station

Fig 4.2 Water Level Hydrograph of the Lake Tempe (Laringgi)

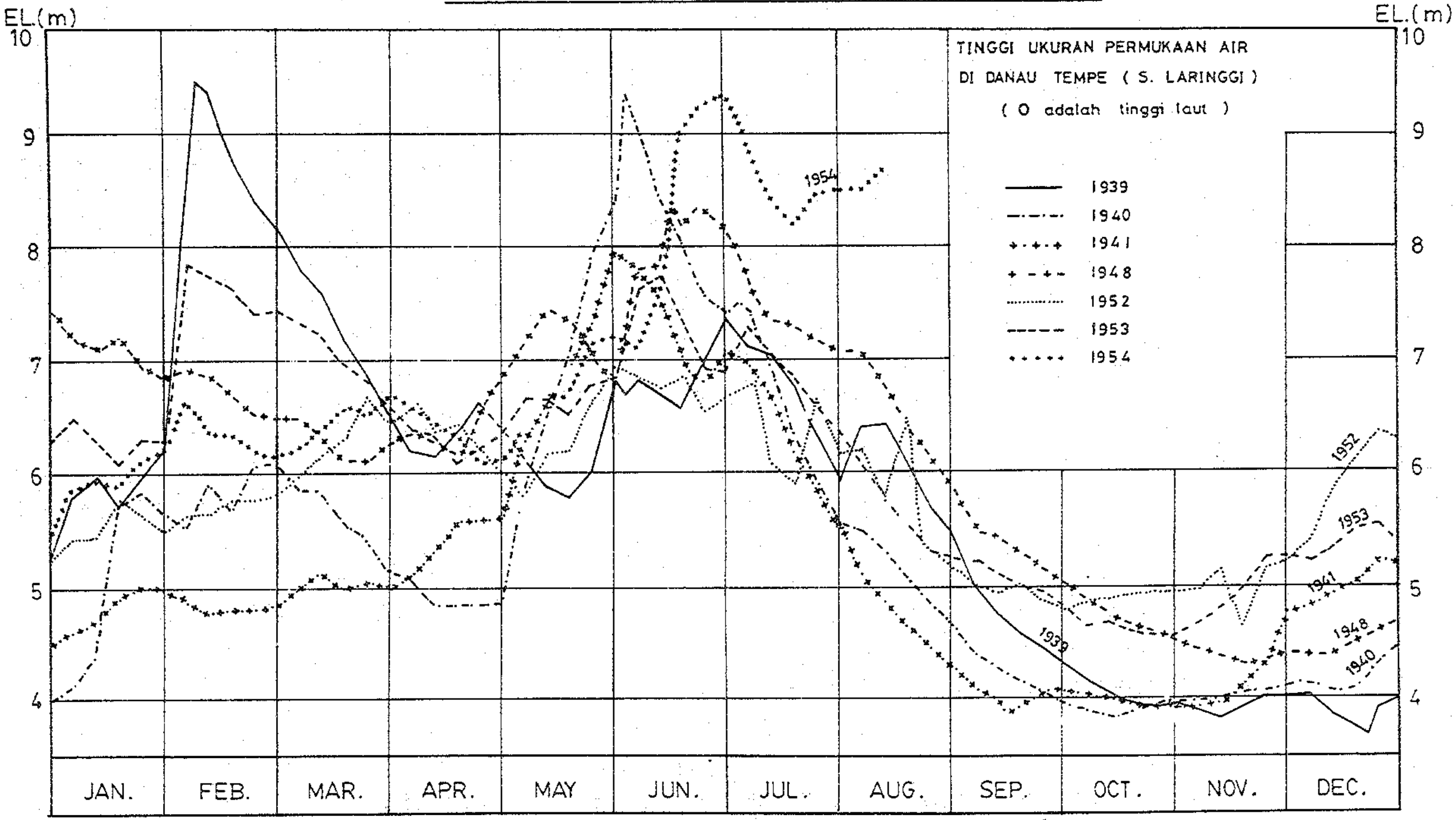


Fig 4.3 Water Level Hydrograph of Lake Tempe, observed by Dinas Perikanan (1968 - 1971)

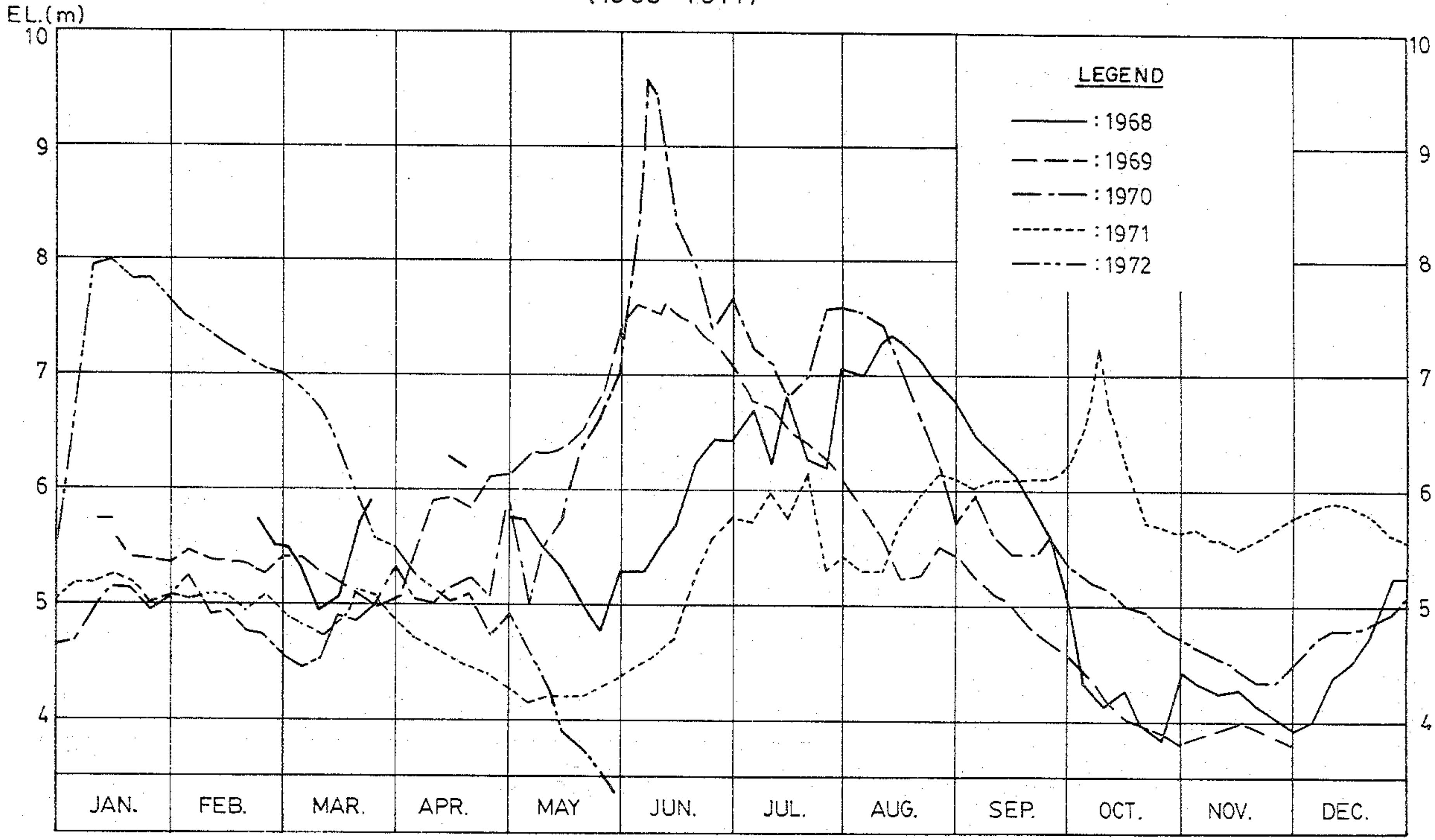


Fig. 4.4 Water Level Hydrograph of Lake Tempe, observed by P3SA
(1975 - 1978)

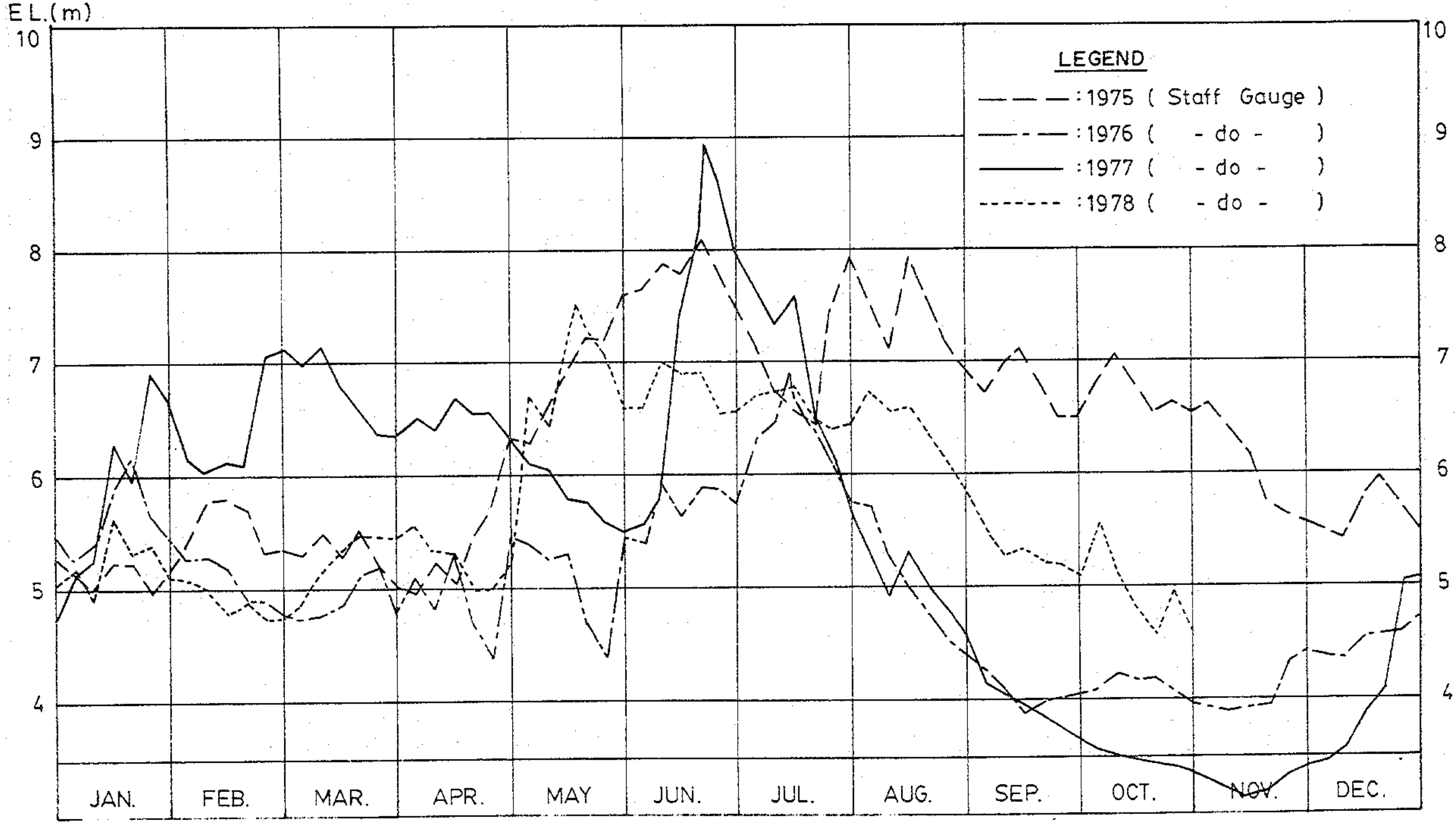


Fig. 4.5 Average Monthly Water Level Hydrograph of Lake Tempe.

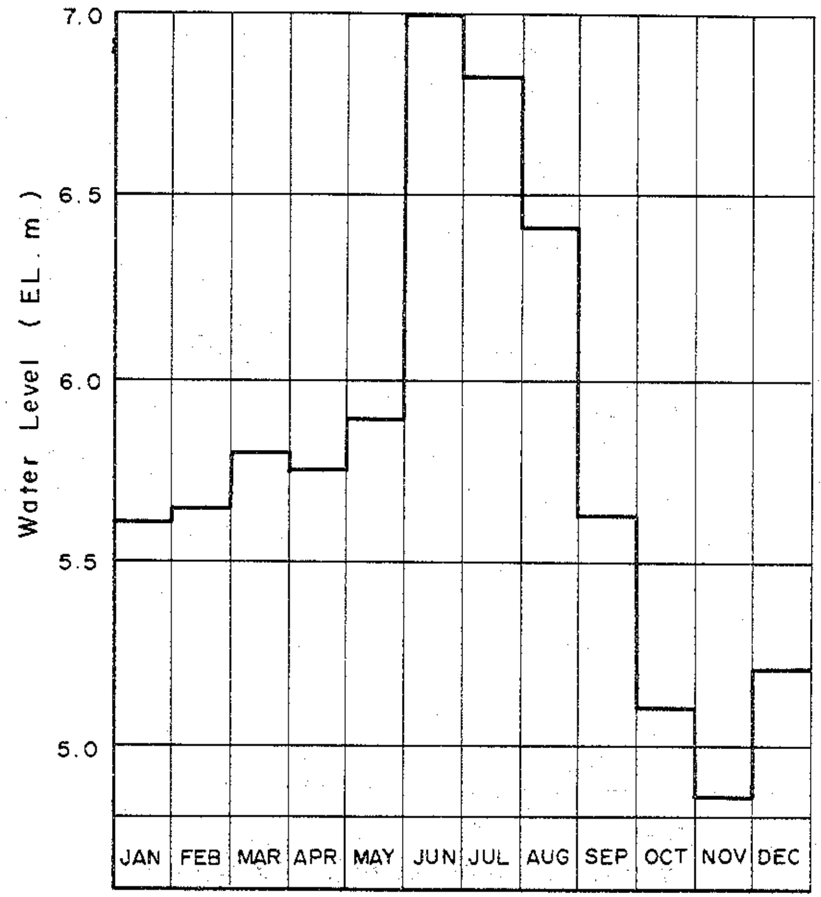


Fig. 4.7 Return Period of Water Level of Lake Tempe.

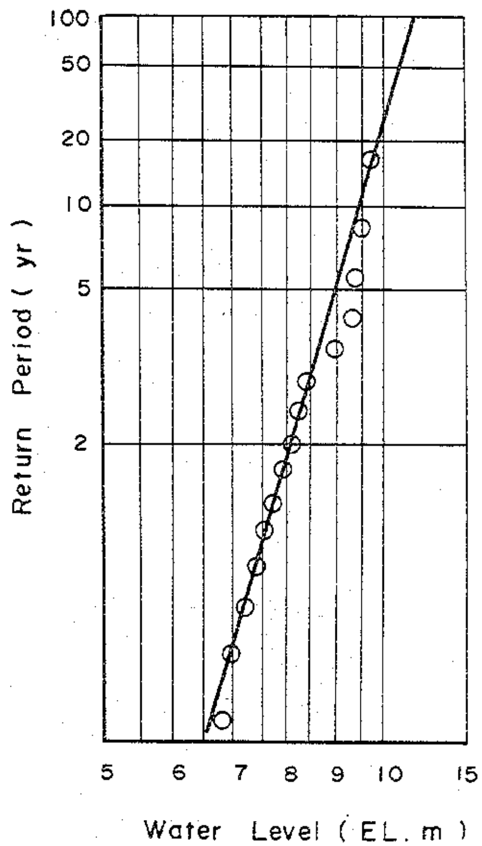


Fig 4.6 Relation of Water Level between Sengkang and Lake Tempe

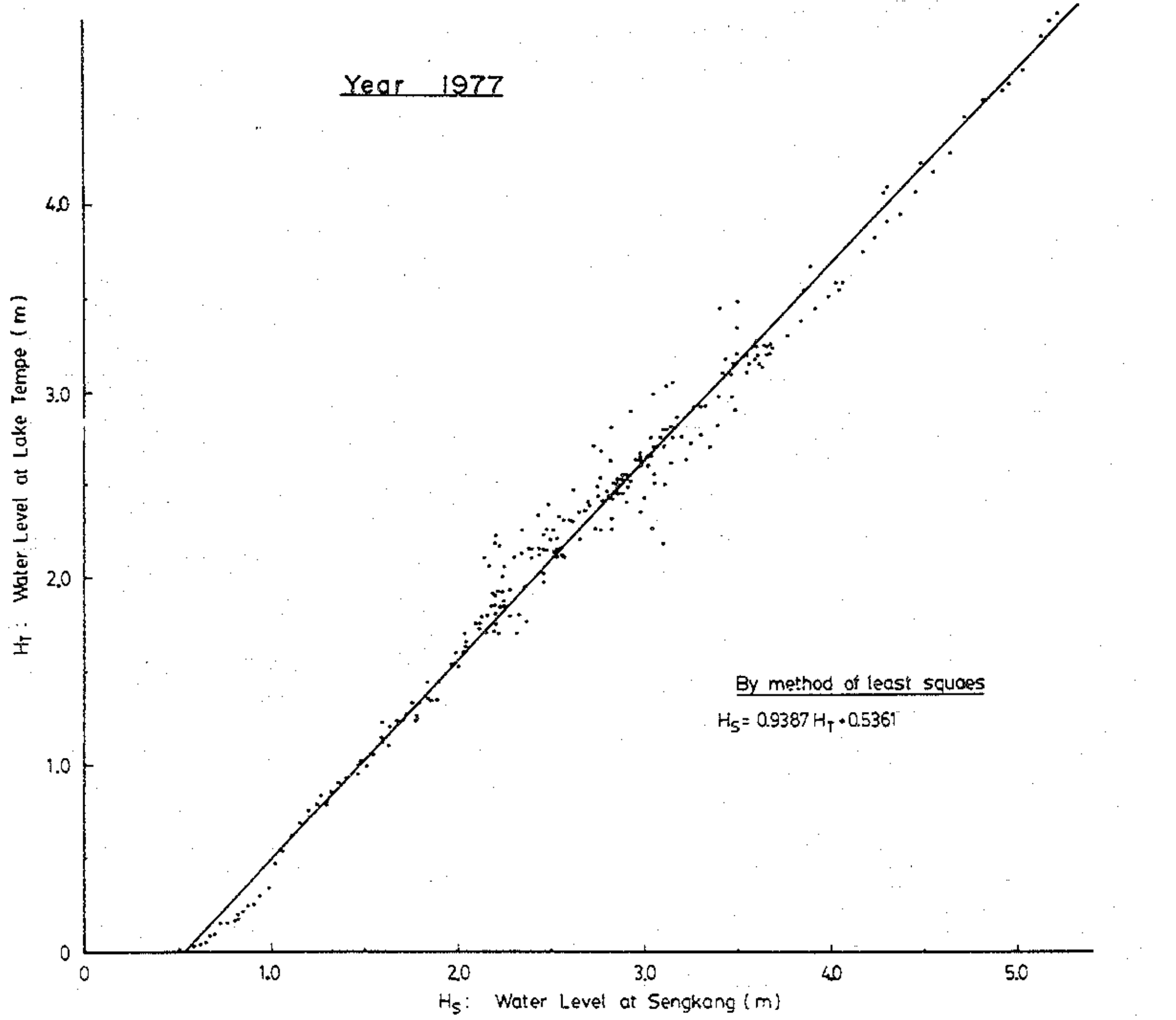


Fig. 5.1 Return Period
Cabenge

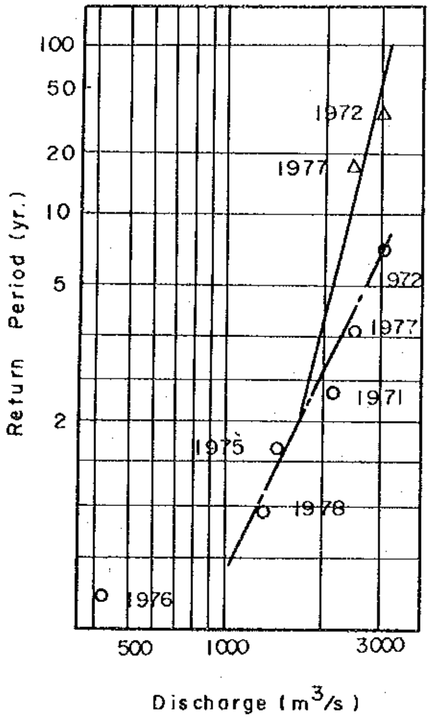


Fig. 5.2 Return Period
Ujung Lamuru

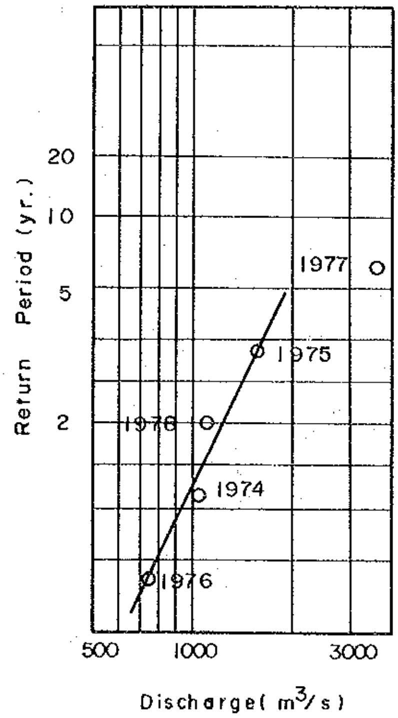


Fig. 5.3 Return Period
Bila

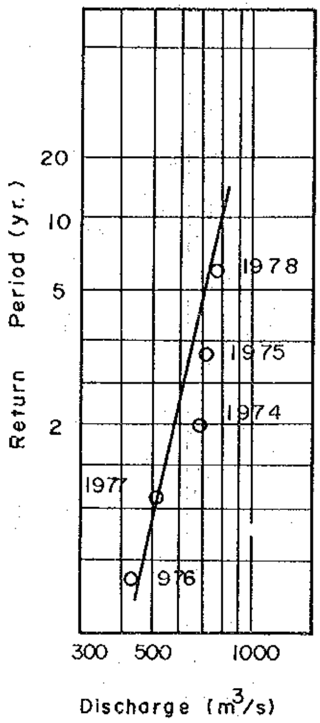


Fig. 5.4 Relation Between Specific Discharge and Catchment Area for Rivers in Objective Area

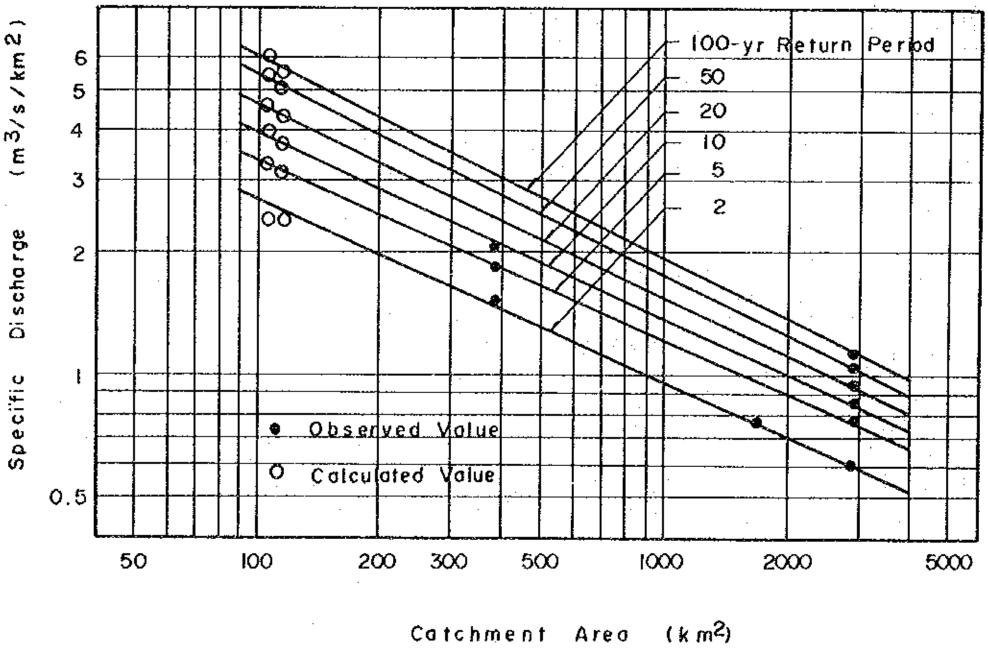


Fig. 5. 5 Flood Discharge Hydrograph at Cabenge

(June 1977- Flood)

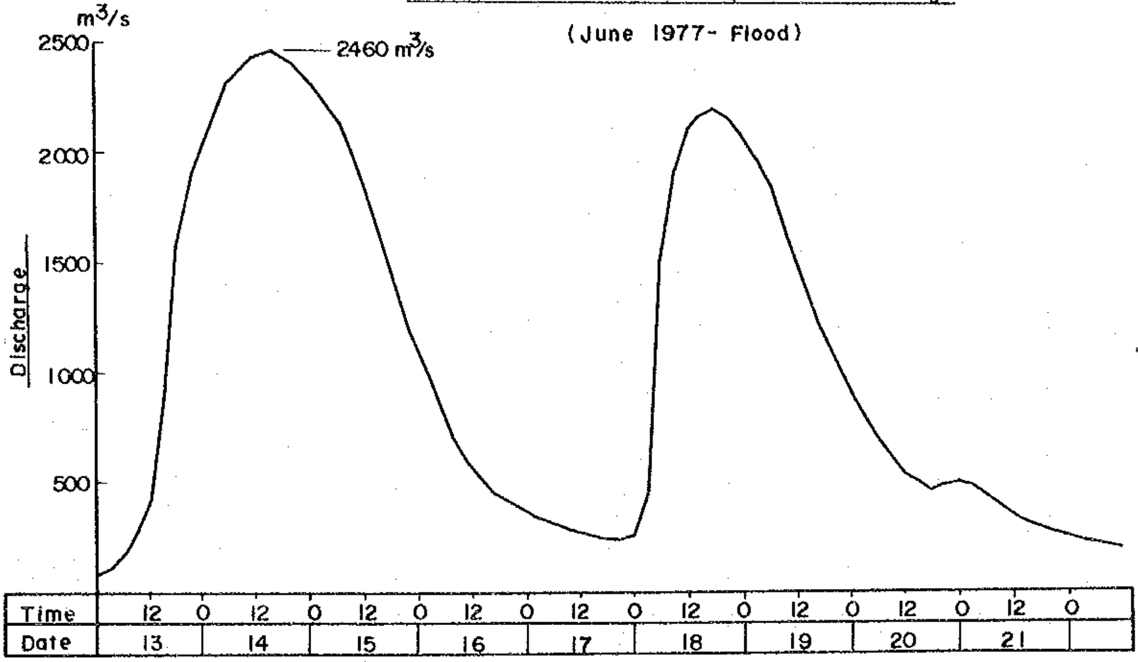


Fig. 5. 6 Flood Discharge Hydrograph by Return Periods at Mong Dam Site

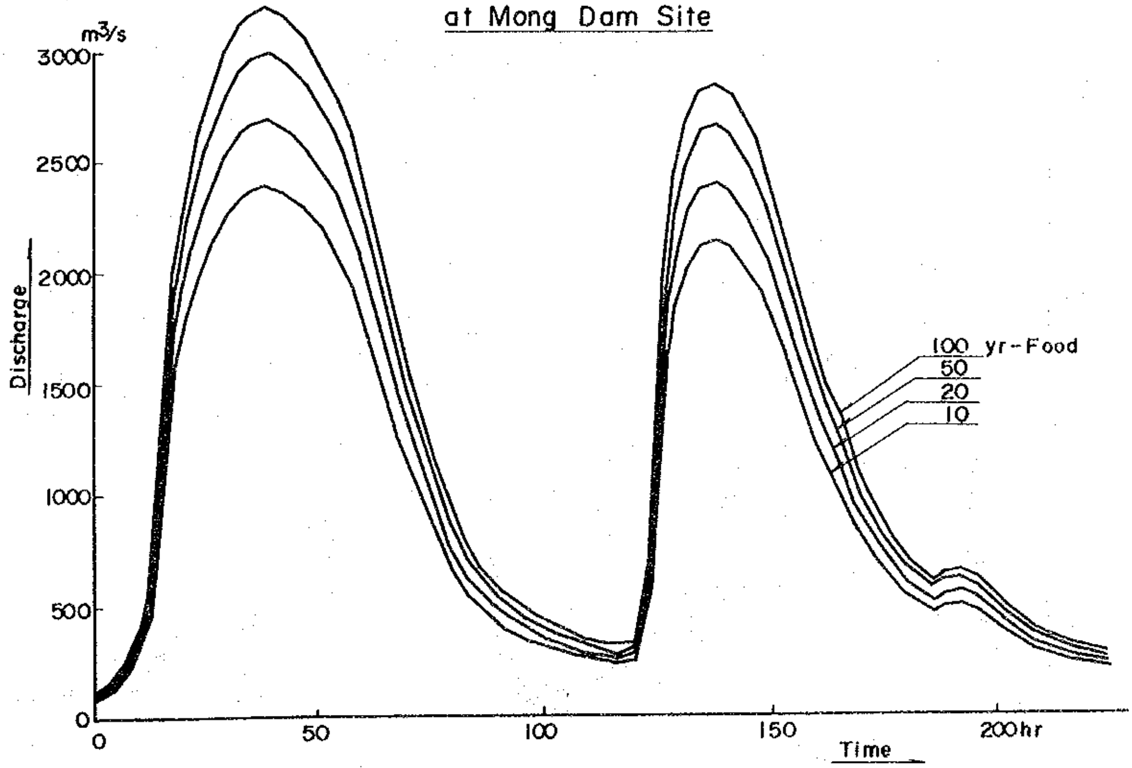


Fig. 5.7 Flood Discharge Hydrograph at Walimpong Dam Site
(June 1977 - Flood)

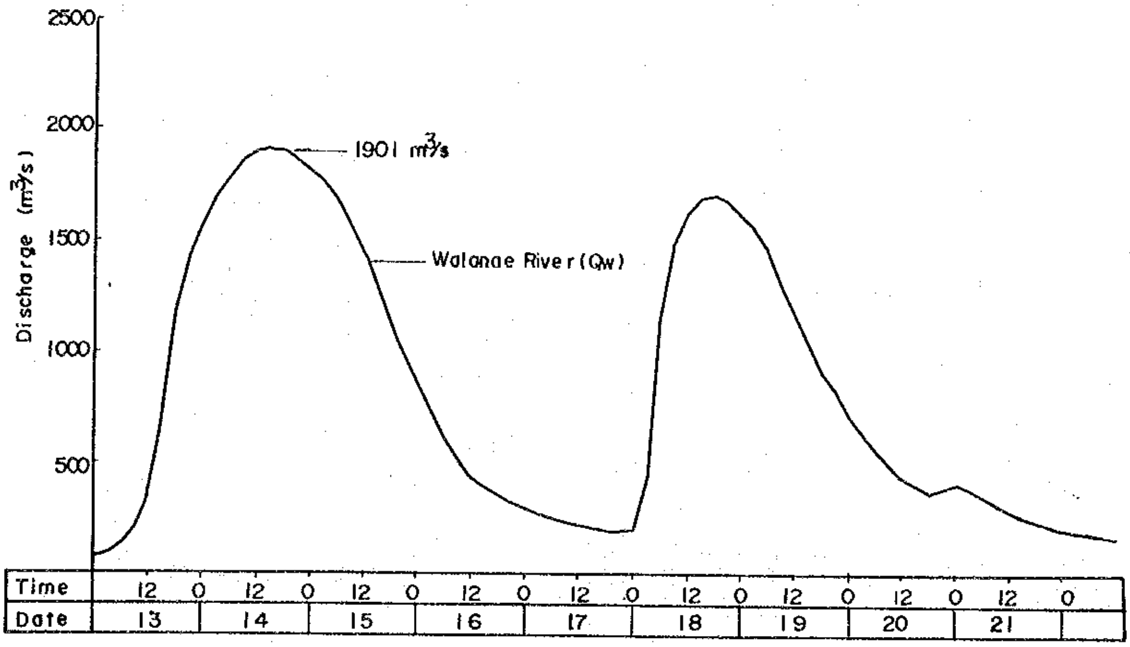


Fig. 5.8 Flood Discharge Hydrograph by Return Periods at Walimpong Dam Site