社会開発協力部報告書

GOVERNMENT OF MALAYSIA

NATIONAL WATER RESOURCES STUDY, MALAYSIA
PERLIS-KEDAH-PULAU PINANG
REGIONAL WATER RESOURCES STUDY
PART 2
BERIS DAM FEASIBILITY STUDY

VOL. 4
ANNEX

E. METEOROLOGY AND HYDROLOGY
F. STUDY ON OPERATION OF WATER RESOURCES SYSTEM

MARCH 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

NATIONAL WATER RESOURCES STUDY, MALAYSIA

PERLIS - KEDAH - PULAU PINANG

REGIONAL WATER RESOURCES STUDY

PART 2

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ABBREVIATIONS

(1) Organization/Plan

4MP (5MP)	:	Fourth (Fifth) Malaysia Plan
DID (JPT)	:	Drainage and Irrigation Department
EPU	:	Economic Planning Unit
FELCRA	:	Federal Land Consolidation and Rehabilitation Authority
FELDA	:	Federal Land Development Authority
IBRD	:	The World Bank
JICA	:	Japan International Cooperation Agency
MADA	:	Muda Agricultural Development Authority
MOH	:	Ministry of Health
MTR	:	Mid-Term Review of 4MP
NEB (LLN)	:	National Electricity Board
NWRS	:	National Water Resources Study
PWA	:	Pulau Pinang Water Authority
PWD (JKR)	:	Public Works Department
RESP	:	Rural Environmental Sanitation Program
RISDA	:	Rubber Industry Smallholders Development Authority
WHO	:	World Health Organization

(2) Others

B	:	Benefit
BOD	:	Biochemical Oxygen Demand
C	:	Cost
COD	:	Chemical Oxygen Demand
D & I	:	Domestic and Industrial
dia.	:	Diameter
EIRR	:	Economic Internal Rate of Return
El.	:	Elevation Above Mean Sea Level
Eq.	:	Equation
Fig.	:	Figure
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
H	:	Height, or Water Head
HWL	:	Normal High Water Level
O & M	:	Operation and Maintenance
Q	:	Discharge
Ref.	:	Reference
SS	:	Suspended Solid
VA	:	Value Added

ABBREVIATIONS OF MEASUREMENT

Length

mm = millimeter
cm = centimeter
m = meter
km = kilometer
ft = foot
yd = yard

Area

cm^2 = square centimeter
m^2 = square meter
ha = hectare
km^2 = square kilometer

Volume

cm^3 = cubic centimeter
l = lit = liter
kl = kiloliter
m^3 = cubic meter
gal.= gallon

Weight

mg = milligram
g = gram
kg = kilogram
ton = metric ton
lb = pound

Time

s = second
min = minute
h = hour
d = day
y = year

Electrical Measures

V = Volt
A = Ampere
Hz = Hertz (cycle)
W = Watt
kW = Kilowatt
MW = Megawatt
GW = Gigawatt

Other Measures

% = percent
HP = horsepower
° = degree
' = minute
" = second
°C = degree in centigrade
10^3 = thousand
10^6 = million
10^9 = billion (milliard)

Derived Measures

m^3/s = cubic meter per second
cusec= cubic feet per second
mgd = million gallon per day
kWh = kilowatt hour
MWh = Megawatt hour
GWh = Gigawatt hour
kWh/y= kilowatt hour per year
kVA = kilovolt ampere
BTU = British thermal unit
psi = pound per square inch

Money

M$ = Malaysian ringgit
US$ = US dollar
¥ = Japanese Yen

CONVERSION FACTORS

	From Metric System	To Metric System
Length	1 cm = 0.394 inch 1 m = 3.28 ft = 1.094 yd 1 km = 0.621 mile	1 inch = 2.54 cm 1 ft = 30.48 cm 1 yd = 91.44 cm 1 mile = 1.609 km
Area	1 cm^2 = 0.155 sq.in 1 m^2 = 10.76 sq.ft 1 ha = 2.471 acres 1 km^2 = 0.386 sq.mile	1 sq.ft = 0.0929 m^2 1 sq.yd = 0.835 m^2 1 acre = 0.4047 ha 1 sq.mile = 2.59 km^2
Volume	1 cm^3 = 0.0610 cu.in 1 lit = 0.220 gal.(imp.) 1 kl = 6.29 barrels 1 m^3 = 35.3 cu.ft 10^6 m^3 = 811 acre-ft	1 cu.ft = 28.32 lit 1 cu.yd = 0.765 m^3 1 gal.(imp.) = 4.55 lit 1 gal.(US) = 3.79 lit 1 acre-ft = 1,233.5 m^3
Weight	1 g = 0.0353 ounce 1 kg = 2.20 lb 1 ton = 0.984 long ton = 1.102 short ton	1 ounce = 28.35 g 1 lb = 0.4536 kg 1 long ton = 1.016 ton 1 short ton = 0.907 ton
Energy	1 kWh = 3,413 BTU	1 BTU = 0.293 Wh
Temperature	°C = (°F - 32)·5/9	°F = 1.8°C + 32
Derived Measures	1 m^3/s = 35.3 cusec 1 kg/cm^2 = 14.2 psi 1 ton/ha = 891 lb/acre 10^6 m^3 = 810.7 acre-ft 1 m^3/s = 19.0 mgd	1 cusec = 0.0283 m^3/s 1 psi = 0.703 kg/cm^2 1 lb/acre = 1.12 kg/ha 1 acre-ft = 1,233.5 m^3 1 mgd = 0.0526 m^3/s
Local Measures	1 lit = 0.220 gantang 1 kg = 1.65 kati 1 ton = 16.5 pikul	1 gantang = 4.55 lit 1 kati = 0.606 kg 1 pikul = 60.6 kg

Exchange Rate

(at the end of 1983)

US$1 = M$2.312
¥100 = M$0.998

ANNEX E
METEOROLOGY AND HYDROLOGY

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1. INTRODUCTION

The meteoro-hydrological study of the Region has been conducted in Part 1 Study. Daily runoff data at key stations of the Region have been prepared for 20 years from 1961 up to 1980 and runoffs in sub-basins were estimated on the basis of the key station runoff. A preliminary flood study was also carried out in Part 1 Study to estimate the design flood discharge for the 6 proposed damsites in the Region including the Beris damsite.

For Part 2 Study of Perlis-Kedah-Pulau Pinang Regional Water Resources Study, a feasibility study of the Beris dam is executed. This report describes the results of the meteoro-hydrological study for the feasibility study.

The major objectives of the study are;

(1) to update the river runoff data for the Kedah-Muda integrated water supply and demand balance system,

(2) to estimate a probable maximum flood (PMF) for dam design and a diversion flood discharge, and

(3) to evaluate the maximum headwater level of the Beris reservoir in case of PMF.

Section 2 summarizes the meteoro-hydrological conditions of the Region and the damsite area. The river runoff study for extension of runoff data up to 1983 is discussed in Section 3, in which the procedure applied for river runoff estimate for this study is the same as that for Part 1 Study.

On the other hand, the flood study of Part 1 Study was revised in detail as described in Section 4, in which floods with various probabilities and the probable maximum flood were estimated for the Beris damsite. The sedimentation study in Section 5 is a reproduction of Part 1 Study because it was judged no revision was required in this study.

2. BACKGROUND

2.1 Study Area

The Study area (the Region) covers the States of Perlis, Kedah and Pulau Pinang and a northern part of the State of Perak as described in Annex E, "Meteorology and Hydrology" for Part 1 Study.

In Part 2 Study for the feasibility study of the Beris dam, however, the object areas were limited to the catchment areas of the Kedah, Muda and Perai rivers and the Pinang island, because other parts of the Region have no influence to the effect of the Beris dam.

The Kedah river basin, having a catchment area of 3,600 km^2, occupies the northern half of the state of Kedah. The main stream above Alor Setar is named as the Sg. Padang Terap. The Pedu dam is located in the upstream of the Padang Terap river and is connected with the Muda dam by the Saiong tunnel, through which water stored in the Muda reservoir is conveyed to the Pedu reservoir. The operation of the Pedu-Muda dam system was started in 1969. The Pedu dam regulates the water from the Muda reservoir, whose catchment area is 984 km^2 and inflow from its own catchment area of 171 km^2. In the downstream of the Kedah river system, there is the MADA irrigation scheme of about 96,000 ha. Most of the water released from the Pedu dam is collected at the Pelubang barrage, located on the Padang Terap river 15 km northeast of Alor Setar, together with the uncontrolled flow and is diverted to the MADA irrigation scheme.

The Muda river is the largest river system in the State of Kedah The catchment area is 4,300 km^2 occupying the southern half of the State. The catchment of the Muda dam of 984 km^2, however, contributes little to the Muda river system because the catchment water is diverted to the Pedu dam through the Saiong tunnel.

The Perai river of 410 km^2 in catchment area occupies the southwestern part of the State of Kedah and the State of Pulau Pinang except the Pinang island. It consists of 3 major tributaries of the Kulim, Jarak and Kerah rivers. In the upstream of the Kulim river, the Mengkuang dam is now under construction to supply urban water to the Sungai Dua water supply system.

The Muda river is interconnected with the Perai river through the Sungai Muda canal and some irrigation canals. The Sungai Muda canal supplies domestic and industrial water for the Pinang island through a submarine pipeline system.

The proposed Beris damsite is located on the Beris river, one of tributaries of the Muda river. It originates from the northwestern slope of a low ridge dividing the basin from the Ketil river basin. The catchment area is 116 km^2 at the damsite.

2.2 Meteoro-hydrology

Figure 1 shows an isohyetal map of the Region which is prepared on the basis of 1961 - 1980 rainfall records at selected 67 gauges.

The mean annual rainfall in the Region ranges from 1,800 mm in the northern boundary to 3,400 mm at Mt. Jerai. The annual rainfall in the proposed Beris catchment is about 2,400 mm on an average.

There are 2 principal and 15 secondary meteorological stations in the Region.

Annual open water evaporation in the Region ranges from 1,700 mm to 2,000 mm. It is about 1,780 mm at Batu Seketol in the catchment of the Beris dam and 1,790 mm at Alor Setar. The highest evaporation is observed in March and April while the lowest is in November and December. Table 1 shows the average monthly evaporation at selected stations.

Annual mean air temperature is 26.6°C at Batu Seketol, a little lower than 27.8°C of Alor Setar. It ranges from 26.3°C to 28.0°C in the Region except high land area such as Penang Hill whose temperature is 22.2°C and the altitude is 732 m above the seawater level. The mean monthly temperature has a small variation throughout the year, from 25.5°C in December and January to 27.7°C in April at Batu Seketol. Table 2 shows the monthly mean temperature at some selected stations including Alor Setar and Batu Seketol.

The monthly mean relative humidity is also tabulated in Table 3 for these stations. The annual mean is 62.0% at Batu Seketol and 69.1% at Alor Setar. The monthly variation is from 49.1% in February to 70.7% in November at Batu Seketol.

According to the information of MMS (Malaysian Meteorological Service), MMS has been conducting cloud seeding in the catchment areas of Pedu and Muda dams since 1977. The cloud seeding was usually carried out in the rainy season when cloud appeared over the catchment area and the resulting runoff run into the Muda and Pedu reservoirs. The effect of the cloud seeding, however, have not been measured because there are no rain gauges in the affected area. Since the cloud seeding is still under trial operation and there are no way to measure the effect, this hydrological study does not take the effect into consideration.

3. RUNOFF STUDIES

3.1 Objective

In Part 1 Study, runoff data at various locations in the Region were prepared on 5-day basis for 20-year period from 1961 to 1980.

The objective of this study is to extend the above-mentioned runoff data for 3 years upto the end of 1983.

3.2 Outline of Runoff Study in Part 1 Study

(1) Key station

For each major river system, one hydrological station was chosen as a key station of the river basin and is considered to be representative of the runoff characteristics of the basin. The key stations thus selected are;

River basin	Key station
Kedah	Lengkuas (6204421)
Muda	Jeniang (5806414)
Perai	Ara Kuda (5405421)

(2) Interpolation of interrupted runoff records

The daily runoff records of the selected key stations are more or less interrupted. Lacking period is interpolated by assuming linear increase or decrease in runoff, if the interrupted period is short, principally less than one month. If the interrupted period is longer than one month, the runoff records at the key station were supplemented by generated runoff by the Tank model from daily basin rainfall data. The parameters of the Tank model for a basin were determined so that the model satisfactorily represented the characteristics of the rainfall-runoff process of the basin on the basis of daily rainfall and runoff records.

The procedure of simulation study is described in detail in Annex E "Meteorology and Hydrology" for Part 1 Study.

(3) Sub-basin

In order to estimate the 5-day runoff at an arbitrary location from the runoff data at key stations, the river systems were divided into several sub-basins as shown in Fig. 2. The runoff depth in an arbitrary location of a sub-basin was estimated by using the rainfall-loss relation of the sub-basin assuming the runoff depth is uniform over the sub-basin.

3.3 Runoff Data Extension

The runoff data for the three key stations were extended for 3 years upto the end of 1983 based mainly on actual records, but supplemented by data generated from rainfall records by means of the Tank Models of which parameters were determined in Part 1 Study.

(1) Lengkuas station

No runoff has been observed at Lengkuas since 1968 because the station was closed in that year due to the construction of the Pelubang barrage. There is no other reliable station in the Kedah river basin for long term observations. Thus the runoff at the Lengkuas station was generated from daily rainfall records of Kuala Nerang and Ladang Tanjong Pauh gauges.

(2) Jeniang station

Daily runoff records were available till July 1983 while the records after July was still under processing. The runoff after July 1983 at Jeniang was generated from rainfall records of Sik and Kg. Gajah Puteh gauges.

(3) Ara Kuda station

Although runoff has been recorded at Ara Kuda, water stage record observed in the dry season seems extremely high in and after 1978. It is considered that the station is affected by the operation of the downstream weir or there is some error in the stage-discharge curve as guessed in Part 1 Study. Therefore all the records for 3 years upto the end of 1983 were also replaced by those generated from rainfall data at Kelang Baharu Kulim and Rumah Sakit Kulim as the records between 1978 and 1980 were done in Part 1 Study.

The runoff data processed as above-mentioned are compiled in Tables 5 to 13 on 5-day basis. Because the catchment area of the Jeniang station after the completion of Muda dam in 1969 was reduced from 1,740 km^2 to 756 km^2, the runoffs in Tables 8 to 10 show the values corresponding to the catchment area of 1,740 km^2. The values were derived by multiplying the runoff from 756 km^2 by the conversion ratio of 2.037 which was obtained assuming the runoff depth was in proportion to the average annual rainfall less the average annual rainfall loss in the catchments of 1,740 km^2 and 756 km^2.

4. FLOOD STUDIES

4.1 General

The objective of the flood study is to estimate floods with various probabilities and the probable maximum flood at the proposed Beris damsite for determining capacities of the diversion tunnel and the spillway and for estimating the maximum headwater level of the Beris reservoir.

Since no flood runoff has been observed on the Beris river, the flood hydrographs at the damsite were estimated on the basis of the storm rainfall analysis and flood records at Jeniang.

4.2 Storm Analysis

4.2.1 Available data

There is no rainfall station in the catchment of the Beris dam. On the other hand, a sufficient length of hourly rainfall data are available at the following three stations near the Beris damsite.

Rainfall Station		Record period
Jeniang	(5806066)	1953/54 - 1982/83
Alor Setar	(6103047)	1946/47 - 1977/78
Kuala Nerang	(6206035)	1952/53 - 1978/79

Tables 14 to 16 show the annual maximum rainfall by duration. In addition, 48 and 72 hour rainfall data are also shown for the Jeniang station.

The Jeniang station is the nearest station to the Beris damsite and there is no datum to be rejected from the rainfall data of the station, because they involve no datum with the extremely big value, compared with the other two stations. Thus, the storm analysis was mainly based on the data of the Jeniang station.

4.2.2 Rainfall probability

A frequency analysis of the storm rainfall was carried out assuming the extreme value Type I distribution which is commonly called the Gumbel distribution and has been used widely for the frequency analysis of extreme values of meteorological data.

Tables 17 to 19 show the results of frequency analysis of Jeniang, Alor Setar and Kuala Nerang stations.

4.2.3 Depth-duration curve

The biggest 10 storms observed at the Jeniang station between 1970 and 1980 were extracted for examining their depth-duration curves. Table 20 shows the hourly rainfall heights of these storms, of which rainfall depth-duration curves are illustrated in Fig. 3.

As shown in Fig. 3, the maximum duration is 14 hours and a storm with a duration less than 6 hours occurred frequently, but a typical duration curve of storm rainfall at the Jeniang site cannot be found.

4.3 Probable Maximum Precipitation

4.3.1 Available data

The probable maximum precipitation (PMP) was estimated by maximizing and transposing the actual maximum storms to the Beris damsite. As meteorological data for maximization, storm rainfall and dew point data were available at principal meteorological stations in Peninsular Malaysia on the daily basis, which is complied in "Monthly Abstract of Meteorological Observations" published by Malaysian Meteorological Service (Ref. E 1). In addition, hourly meteorological records were collected for some selected big storms between 1967 and 1983 at Alor Setar station from MMS.

4.3.2 Storm maximization

For a storm maximization, 5 biggest storms shown in Table 21 were extracted from the records of principal meteorological stations in the west coast of Peninsular Malaysia. The data of the east coast was not used because the meteorological conditions of the east coast seem significantly different from those in the west coast.

According to the daily dew point data observed at the above-mentioned stations, the highest daily dew point was 26.5°C and the value was recorded at Alor Setar. On the other hand, hourly dew point records were available at Alor Setar since 1972 and the heighest record was 27°C, and the 12 hour maximum persistent dew point was a little lower than 27°C. Thus, 27°C was assumed to be the 12 hour maximum persistent dew point for the stations in the west coast, and it was applied to the Beris damsite.

The selected 5 storms were maximized for the Beris damsite by the moisture adjustment and storms transposition method by assuming 27°C of the maximum 12 hour persistent dew point applying the procedure given in "Manual for Estimation of Probable Maximum Precipitation", WMO (Ref. E 2). Table 21 shows the procedure and the results of the maximization. The largest estimate was 350 mm/d which was a little bigger than the probable rainfall of 1 in 10,000 year return period for 24 hour duration at Jeniang station.

4.4 Design Storm

Assuming that a temporal pattern of each 24 hour probable rainfall has the peak in the first hour and the hourly rainfall decreases as time goes by, the dimensionless duration curves with various return periods shown in Table 22 were created by using 1, 3, 6, 12 and 24 hour probable rainfalls with the corresponding return periods.

There is no significant difference among these curves. Compared with the actual duration curves shown in Fig. 3, the curves belong to the temporal pattern generating the steep flood runoff hydrograph at the Jeniang site.

Thus, the hourly distribution of the 24 hour design storm was derived from the above-mentioned dimensionless duration curve of the corresponding return period. It was assumed that the areal reduction factor was 0.96 for a 24-hour storm for the Beris catchment referring to the values suggested by U.S.W.B. (Ref. E 3).

Figure 4 shows the temporal pattern of the areal probable maximum precipitation of which dimensionless curve is assumed to be the same as that of the probable rainfall for 1 in 10,000 return period.

4.5 Flood Analysis

4.5.1 Available data

No runoff observation has been conducted in the Beris catchment. The Jeniang hydrological station is the nearest about 15 km southwest of the Beris damsite. The catchment area of the station is 756 km^2 excluding the Muda dam catchment. Hourly discharge data is available at the Jeniang station since 1970. For estimate of flood hydrograph at the Jeniang site, four actual hydrographs which have one single peak were selected as shown in Fig. 5.

4.5.2 Unit graph

The dimensionless hydrograph method was applied for estimate of the hydrograph at Jeniang and for transposition to the Beris damsite (Refs. E 4 and E 5).

Referring to the Hydrological Procedure (HP) No. 11 (Ref. E 5), the selected flood hydrographs were analyzed as shown in Table 23. The average values of parameters characterizing the flood hydrographs at Jeniang site are very similar to those classified into the Group 2 flood hydrographs in the above-mentioned HP No. 11 as shown in Table 24.

Since no rainfall data corresponding to the selected floods at Jeniang was available, the catchment lag of the Jeniang site was estimated by the following equation recommended for the Group 2 floods in HP NO. 11.

$$Lg = 4.0 \times (L \times Lc/\sqrt{s})^{0.35} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 1$$

$$= 25.3 \text{ (h)}$$

where, Lg : catchment lag (h)
L : main stream length from the outlet to the watershed = 43.4 (miles)
Lc : main stream length from the outlet to the catchment centroid = 18.6 (miles)
s : weighted main stream slope = 17.3 (ft/mile)

Figure 6 shows the average dimensionless hydrograph constructed at the Jeniang site.

The Beris damsite has the catchment area of 116 km^2 which occupies a part of the Jeniang catchment. Assuming that the dimensionless hydrograph at the Beris damsite is the same as that the Jeniang site, the unitgraph of 1 hour - 1 mm for the Beris damsite was derived as shown in Fig. 7. The catchment lag of the factor for deriving unitgraph was estimated at 8 hours by applying Eq. 1 for Group 2 floods as follows.

$$Lg = 4.0 \times (L \times Lc/\sqrt{s})^{0.35} = 8 \text{ (h)} \quad \ldots\ldots\ldots\ldots \quad 2$$

where, L = 13.35 (miles)
Lc = 4.60 (miles)
s = 73.58 (ft/mile)

4.5.3 Rainfall loss

The rainfall loss is defined as the difference between the storm rainfall and the effective rainfall. Since no actual record on the rainfall loss was available at the Jeniang site, it was estimated on the basis of the record in other basins in Peninsular Malaysia.

Hydrological Procedure No. 11 (Ref. E 5) reports that the hourly loss rate of 6 to 13 mm/h is the most frequent for the catchments in Malaysia. In this study, the constant loss rate was assumed at 10 mm/h. The effective rainfall is obtained by deducting the constant loss from the storm rainfall. Applying the loss rate to the 24 hour PMP of 350 mm, the runoff coefficient of PMP is calculated to be 0.79.

According to HP No. 11, runoff coefficient is also averagely given by the following equation for the basins in Peninsular Malaysia.

$$Q = P^2/(P + 150) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 3$$

where, Q : direct runoff (mm)
P : storm rainfall (mm)

Eq. 3 gives the coefficient of 0.7 for the PMP.

4.5.4 Base flow

The base flow of floods at the Beris damsite was estimated at 5 mm/d or 6.7 m^3/s which was the average rate of low flow during the flood season at Beris damsite estimated referring to the hydrograph for 23 years based on daily discharge data at Jeniang site.

4.6 Design Flood

Flood hydrographs for various probabilities and PMF were derived applying the foregoing design storms, unitgraph, rainfall loss and base flow. The flood hydrograph of the probable maximum flood (PMF) was derived from the PMP. The peak discharge and the direct runoff volume of PMF were estimated at 897 m^3/s and 28.4 x 10^6 m^3, respectively. Figure 8 shows the resulting flood hydrographs and Table 25 summarizes the peak discharges of the design floods with various return periods and the PMF.

4.7 Flood Routine

4.7.1 General

The objective of the flood routine study was to estimate the maximum water level of the Beris reservoir due to the maximum flood inflow for the design of the spillway capacity. The water level was calculated for alternative sizes of spillway.

4.7.2 Flood inflow

The flood hydrographs given in the previous sections are estimated under the present conditions of the catchment area without the Beris dam. The concentration time of floods will, however, be significantly changed due to the impoundment of the proposed Beris reservoir because the reservoir will occupy about 14 km^2 of the surface area at the normal high water level which corresponds to 12% of the total catchment area at the damsite.

Thus the inflow hydrograph to the reservoir was estimated taking into account the change in catchment conditions due to impoundment in the following procedure;

(1) The catchment area excluding the reservoir area was divided into 3 sub-basins from the point of view of concentration time.

(2) The flood characteristics of these sub-basins were assumed to be represented by those of the Group 1 floods given in Table 24 because of their topographic conditions.

(3) The flood hydrographs from these 3 sub-basins were superposed each other assuming that the rainfall temporal pattern was the same for these 3 sub-basins.

(4) The rainfall on the reservoir surface was assumed to be directly converted to runoff of the inflow hydrograph.

The resulting inflow hydrograph of PMF is shown in Fig. 9 together with the PMF under the condition without dam.

4.7.3 Antecedent condition

According to the data for principal storms observed at the Jeniang station between 1970 and 1980, the maximum duration of the storms was 14 hours and no storm occurred more than twice consecutively within 24 hours.

In this study, it was assumed that the 24 hour design storm of 1 in 100 year return period occurred before the PMP.

Figure 10 shows the temporal distribution of the above-mentioned 2 big storms having 2 peaks with 24 hour interval and the resulting flood hydrograph.

4.7.4 Maximum reservoir water level

A reservoir routine study was carried out to examine the maximum reservoir water level for some spillway widths.

The initial reserovir water level was set at El. 85 m which was the same as the crest height of the nongated spillway weir. Table 26 shows the results for three selected spillway widths of 20, 30 and 40 m.

As shown in Table 26, there is little difference among three maximum reservoir water levels, of which the maximum value is 87.7 m. On the other hand, the peak overflow discharge through the spillway with the crest length of 20 m is 196 m^3/s and the increase of the peak overflow discharge results in about 70 m^3/s per 10 m of increase in crest length.

5. SEDIMENT STUDIES

In part 1 Study the average specific annual yield was estimated to be 220 $m^3/km^2/y$ for the Muda river basin. The estimate was based on the analysis of suspended load measured at the Jam. Syed Oman hydrological station located in the middle reaches of the Muda river.

Because no additional data was available for Part 2 Study, the above specific yield was applied for the estimates of the sediment inflow to the Beris reservoir.

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E 4. DESIGN OF SMALL DAMS, 1968, U.S. Department of Interior, Bureau of Reclamation

E 5. DESIGN FLOOD HYDROGRAPH ESTIMATION FOR RURAL CATCHMENTS IN PENINSULAR MALAYSIA, 1980, Hydrological Procedure No. 11, MDA

TABLES

Table 1 MONTHLY OPEN WATER EVAPORATION

Unit: mm

Station	Method	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Kangar	H	144	153	180	161	153	137	142	147	141	138	128	132	1,756
Jpt. Kangar	AP	160	176	200	174	143	123	126	128	121	119	112	123	1,705
Jitra	AP	166	185	200	170	150	130	134	138	136	129	118	131	1,787
Telaga Batu	AP	167	175	193	167	148	127	141	139	129	128	123	143	1,780
Pedu Dam	H	148	155	179	174	159	150	154	157	146	143	131	130	1,826
Pedu Dam	AP	196	199	214	172	146	124	139	140	129	126	120	142	1,847
Alor Setar	P	151	152	177	175	155	145	146	147	143	136	130	130	1,787
Gajah Mati	H	154	159	189	168	169	154	160	164	150	148	135	141	1,891
Gajah Mati	AP	161	179	197	171	143	119	133	133	123	121	141	129	1,723
Muda Dam	H	141	147	176	162	166	143	146	144	133	121	122	117	1,718
Muda Dam	AP	186	191	207	173	145	134	146	145	134	124	106	143	1,834
Sala Kanan	H	144	146	171	154	140	131	140	140	131	127	121	121	1,666
Batu Seketul	H	149	152	179	169	150	142	161	142	144	143	122	124	1,777
Kuala Sala	AP	178	173	185	155	140	129	136	141	129	120	123	136	1,745
Simpang Tiga	AP	162	171	186	168	155	136	156	149	141	134	127	134	1,819
Charok Padang	H	155	160	187	183	182	171	176	178	169	167	152	151	2,031
Baling	H	163	161	194	177	179	169	173	180	167	165	149	151	2,028
Sungai Patani	H	156	159	185	172	172	163	169	173	161	157	140	142	1,949
Kulim	H	151	153	174	159	158	153	158	161	151	148	135	135	1,836
Bumbong Lima	H	138	133	159	151	154	141	150	154	136	138	121	132	1,707
Bumbong Lima	AP	171	181	189	154	152	131	147	140	137	136	125	139	1,802
Butterworth	H	148	147	168	156	152	145	154	157	140	142	129	134	1,772
Bukit Mertajam	H	154	155	182	166	165	161	165	162	159	155	140	143	1,907
Penang Hill	H	112	109	127	108	104	100	102	102	95	97	88	94	1,238
Penang Hospital	H	158	161	182	168	159	154	157	159	147	146	139	144	1,374
Bayan Lepas	P	158	154	176	168	151	147	147	147	142	138	136	137	1,801

Remark : Estimate Method

P - Penman H - Hargreaves AP - Class A Evaporation Pan

Table 2 MONTHLY MEAN AIR TEMPERATURE

Unit: ^{o}C

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Kangar	26.9	27.8	28.4	28.8	28.3	28.4	27.6	27.4	27.3	27.3	27.1	26.9	27.7
Pedu Dam	26.5	27.5	28.0	28.3	27.9	27.4	27.1	26.9	26.7	26.9	26.5	26.4	27.3
Alor Setar	27.2	28.4	28.8	28.8	28.4	27.8	27.6	27.5	27.3	27.5	27.2	26.9	27.8
Gajah Mati	26.8	27.9	28.2	28.5	28.0	27.5	27.1	27.2	26.8	27.1	26.7	26.5	27.4
Muda Dam	26.0	27.1	28.1	28.2	27.9	27.2	26.9	26.8	26.7	26.9	26.3	26.0	27.0
Sala Kanan	26.5	27.5	27.8	27.8	27.5	27.3	27.1	27.1	26.9	27.0	27.0	26.7	27.2
Batu Seketul	25.5	26.9	27.3	27.7	27.4	26.8	26.4	26.6	26.5	26.5	26.1	25.5	26.6
Charok Padang	26.0	27.0	27.6	28.0	27.7	27.4	22.6	22.6	26.8	26.9	26.7	26.3	26.3
Baling	26.8	27.4	28.0	27.8	27.5	27.2	27.0	26.9	26.8	26.9	26.9	26.9	27.2
Sungai Patani	27.7	28.3	28.4	27.9	28.2	27.9	28.6	27.8	27.5	27.4	27.5	27.6	27.9
Kulim	26.7	27.6	27.9	27.9	27.9	27.8	27.5	27.5	27.0	26.9	26.8	26.7	27.4
Bumbong Lima	26.4	27.1	27.8	27.9	27.8	27.4	27.1	27.1	26.8	27.0	26.9	26.6	27.2
Butterworth	26.8	27.4	27.7	27.9	27.8	27.6	27.4	27.1	26.8	26.7	26.7	26.8	27.2
Bukit Mertajam	27.6	28.2	28.3	28.5	28.6	28.4	28.3	27.9	27.8	27.5	27.5	27.5	28.0
Penang Hill	22.4	23.1	23.3	23.4	23.2	22.9	22.5	22.4	22.3	22.3	22.4	22.2	22.7
Penang Hospital	27.8	28.5	28.6	28.8	28.4	28.0	27.8	27.5	27.2	27.1	27.3	27.5	27.9
Bayan Lepas	27.6	27.7	28.0	28.0	27.9	27.6	27.3	27.2	26.9	27.0	27.0	27.4	27.5

Table 3 MONTHLY MEAN RELATIVE HUMIDITY AT 2:00 P.M.

Unit: %

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Kangar	63.6	57.7	57.5	62.0	69.2	72.0	73.3	72.9	73.5	74.1	72.2	69.3	68.0
Pedu Dam	57.4	52.7	52.5	57.6	61.0	67.5	66.3	66.8	69.5	69.4	70.4	65.7	63.2
Alor Setar	58.3	55.1	58.9	66.5	74.0	75.4	75.6	75.0	76.4	74.8	73.6	66.0	69.1
Gajah Mati	56.3	51.8	52.3	57.1	63.8	66.4	65.8	66.5	70.3	68.0	69.6	64.4	62.3
Muda Dam	57.7	51.0	50.0	56.9	64.7	68.9	63.9	66.0	68.6	68.9	68.9	63.6	62.6
Sala Kanan	67.7	64.9	64.0	68.5	73.1	75.4	74.5	74.3	75.0	75.3	74.0	74.1	72.7
Batu Seketul	52.3	49.1	51.8	58.7	65.9	66.6	66.6	66.0	70.1	69.1	70.7	64.3	62.0
Charok Padang	56.9	51.5	52.2	52.2	55.9	57.7	58.8	61.0	60.7	60.0	62.2	56.8	54.4
Baling	53.1	49.8	48.7	55.6	58.3	57.7	57.2	57.2	60.3	61.3	61.1	58.0	56.1
Sungai Patani	54.9	51.4	54.2	59.1	62.5	62.1	63.4	62.4	61.9	65.8	65.1	62.1	60.5
Kulim	58.4	56.3	57.9	64.6	65.2	63.8	60.9	63.9	67.1	68.1	67.6	65.2	63.1
Bumbong Lima	62.1	63.4	62.7	67.3	71.3	70.9	69.9	68.1	72.0	70.6	71.0	65.8	68.1
Butterworth	59.5	54.9	62.5	66.5	69.8	67.6	66.3	67.4	71.9	70.7	70.8	64.5	66.3
Bukit Mertajam	59.0	57.1	58.1	62.4	63.6	59.7	62.1	63.8	65.9	67.1	70.6	62.8	62.1
Penang Hill	73.7	71.0	75.3	81.8	84.1	83.4	83.6	85.0	86.3	85.7	84.6	80.2	81.8
Penang Hospital	57.3	54.4	56.8	62.2	66.5	66.3	66.0	67.2	70.3	70.8	68.3	63.5	64.0
Bayan Lepas	61.8	65.6	69.5	73.9	75.4	74.8	74.2	76.0	77.5	77.1	74.3	66.1	72.1

Table 4 ANNUAL RUNOFF BALANCE

Basin	Catchment Area (km^2)	Rainfall ($10^6 m^3$)	Runoff ($10^6 m^3$)	Loss ($10^6 m^3$)
Kedah	3,593	7,754	2,704	5,050
Muda	4,355	10,168	4,356	5,812
Perai	411	1,003	437	566
Total	8,359	18,925	7,497	11,428

Table 5 5-DAY NATURAL RUNOFF AT LENGKUAS (6204421) (1/3)

Basin: Kedah Catchment Area: 1,270 km^2

UNIT : CMS

YEAR : 1961

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	5.2	2.7	4.1	4.4	21.5	3.2	5.9	2.9	3.4	15.8	45.6	9.9
6-10	7.9	2.5	6.0	4.5	25.5	2.7	3.1	2.6	3.8	13.4	43.7	5.7
11-15	8.0	2.3	6.8	17.0	17.6	2.9	3.0	3.3	3.9	30.7	13.7	3.6
16-20	4.7	6.4	7.7	14.5	7.7	11.6	3.1	3.2	3.5	33.6	10.5	4.8
21-25	3.8	2.6	7.0	8.0	8.0	5.2	3.3	3.2	15.1	61.3	9.9	11.4
26-END	3.4	3.8	7.1	7.8	2.7	23.9	3.4	3.5	16.1	66.6	44.7	63.0

YEAR : 1962

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	42.8	3.1	2.7	2.4	11.4	2.4	9.3	11.1	17.6	9.1	75.1	2.9
6-10	15.5	3.1	6.0	3.3	12.7	2.4	49.1	2.7	137.1	35.2	39.6	1.9
11-15	7.9	2.6	4.8	2.6	41.0	2.2	28.3	2.3	45.5	86.9	34.6	4.1
16-20	5.6	2.2	2.8	11.6	48.5	2.5	15.1	7.2	39.0	120.5	15.5	4.8
21-25	3.6	2.8	2.2	4.3	17.9	13.1	4.6	13.2	13.8	146.8	7.3	1.9
26-END	3.1	2.9	2.0	2.5	5.2	8.8	2.4	35.9	5.6	109.5	4.0	2.2

YEAR : 1963

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	2.5	1.5	0.2	0.8	0.6	0.6	0.5	0.7	1.1	17.7	48.5	25.4
6-10	3.7	2.0	0.7	0.7	2.3	0.5	0.8	1.9	10.4	25.4	81.8	17.6
11-15	2.2	1.5	0.6	0.8	4.6	0.8	0.9	0.7	3.2	42.5	56.4	2.8
16-20	2.2	1.4	0.6	0.9	4.1	0.4	0.9	0.8	0.8	88.6	32.1	1.9
21-25	2.2	1.5	2.2	1.0	6.2	0.7	2.2	0.9	8.1	70.7	17.4	1.2
26-END	2.3	1.3	1.6	1.1	4.8	0.4	5.8	0.6	36.5	42.7	57.0	0.9

YEAR : 1964

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	0.9	0.3	0.3	0.9	1.6	2.0	1.4	3.4	30.6	14.9	74.4	28.6
6-10	0.9	0.3	0.4	0.7	1.6	2.9	1.5	5.0	54.1	6.2	45.0	10.7
11-15	0.7	0.3	0.5	0.9	7.1	7.9	1.5	3.6	35.4	12.1	90.3	8.1
16-20	0.6	0.3	1.3	1.5	11.2	3.6	2.9	3.1	18.2	11.9	63.3	8.1
21-25	0.5	0.3	1.0	1.5	17.5	3.2	8.2	2.6	8.1	41.1	51.6	4.0
26-END	0.3	0.3	0.9	1.5	5.6	4.8	16.7	3.8	16.3	61.8	24.1	2.2

YEAR : 1965

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	1.5	1.0	3.0	3.6	7.7	2.9	4.0	4.7	24.8	26.9	182.4	87.6
6-10	2.0	0.9	2.7	7.6	8.3	2.7	3.9	5.7	20.1	39.1	132.8	57.5
11-15	0.9	0.9	3.4	3.3	8.4	3.1	3.9	9.1	42.9	78.1	59.0	131.9
16-20	1.1	0.9	3.5	2.8	8.8	1.9	4.5	14.9	63.7	66.3	52.8	111.4
21-25	1.1	0.9	3.0	5.5	6.4	2.3	4.9	18.3	33.0	80.7	34.0	108.5
26-END	0.9	0.9	3.3	12.4	3.7	2.6	4.6	61.4	37.9	116.6	23.8	65.4

YEAR : 1966

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	23.3	5.1	4.6	3.7	4.8	18.3	9.3	4.9	4.6	40.9	20.1	75.2
6-10	17.4	4.9	4.6	3.9	6.3	55.6	4.3	4.6	4.6	26.4	34.3	124.5
11-15	10.5	5.6	3.8	3.4	10.0	11.3	3.1	4.4	7.4	59.8	37.0	41.6
16-20	6.6	4.3	3.8	3.8	38.0	4.0	4.8	5.3	23.1	163.1	75.9	36.0
21-25	12.3	9.8	9.3	5.8	9.1	6.2	4.8	4.4	13.2	109.0	114.4	18.1
26-END	12.5	4.7	5.2	8.8	4.0	15.1	4.6	4.8	70.9	39.8	85.2	14.8

YEAR : 1967

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	25.5	5.5	4.6	4.6	9.7	4.6	39.8	18.7	9.6	88.6	76.8	77.4
6-10	157.3	4.7	4.8	4.8	33.3	4.9	27.7	20.5	11.6	164.8	46.1	36.8
11-15	58.0	5.1	4.3	4.9	25.5	4.9	11.7	11.4	19.3	63.7	92.5	28.2
16-20	16.7	4.8	4.2	4.6	32.3	22.1	20.5	10.8	33.0	52.4	25.8	25.8
21-25	9.4	4.4	4.4	5.8	36.6	35.6	13.0	15.5	33.9	93.0	30.0	25.3
26-END	8.8	4.7	4.6	15.5	6.9	59.8	25.2	21.7	44.8	104.4	74.6	25.6

YEAR : 1968

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	12.4*	5.8*	2.8*	20.4*	13.0*	9.6*	4.9*	9.1*	43.7*	29.9*	38.5*	59.9*
6-10	10.5*	5.1*	2.3*	8.3*	11.3*	8.6*	4.6*	10.3*	20.1*	67.0*	30.5*	26.5*
11-15	9.1*	4.5*	2.0*	5.7*	10.6*	7.3*	4.6*	10.7*	16.0*	86.8*	27.7*	19.5*
16-20	8.1*	4.1*	1.7*	84.4*	10.6*	6.3*	15.2*	15.2*	24.8*	52.6*	26.0*	50.6*
21-25	7.3*	3.6*	1.6*	45.6*	13.2*	5.3*	14.2*	12.6*	17.4*	32.0*	24.0*	31.7*
26-END	6.5*	3.2*	41.5*	21.1*	10.7*	5.0*	10.0*	12.8*	41.1*	37.8*	68.4*	18.2*

REMARKS : ASTERISK (*) MEANS SIMULATED VALUE.

Table 6 5-DAY NATURAL RUNOFF AT LENGKUAS (6204421) (2/3)

Basin: Kedah Catchment Area: 1,270 km^2

UNIT : CMS

YEAR : 1969

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	16.2*	9.2*	4.8*	3.0*	1.7*	3.9*	23.1*	8.7*	65.5*	22.2*	89.5*	67.3*
6-10	31.6*	8.0*	4.3*	3.1*	1.9*	3.7*	13.4*	7.3*	28.8*	33.3*	47.8*	41.1*
11-15	17.9*	7.1*	3.9*	2.8*	2.8*	26.6*	11.8*	6.1*	23.0*	68.1*	43.7*	34.8*
16-20	14.6*	6.5*	3.6*	2.4*	3.5*	15.3*	11.4*	117.4*	21.6*	58.4*	131.6*	31.4*
21-25	12.8*	5.8*	3.2*	2.3*	3.8*	9.5*	11.0*	128.5*	20.3*	46.3*	56.3*	28.2*
26-END	10.9*	5.3*	2.9*	1.8*	4.0*	11.0*	10.1*	63.3*	25.6*	43.9*	73.6*	24.7*

YEAR : 1970

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	21.1*	9.8*	5.2*	2.5*	1.8*	11.2*	19.7*	24.4*	16.0*	33.3*	37.6*	42.1*
6-10	18.2*	9.0*	4.5*	2.2*	2.0*	10.1*	16.4*	23.2*	17.6*	38.6*	52.1*	34.9*
11-15	15.7*	8.1*	4.1*	2.0*	34.8*	10.1*	10.5*	20.9*	17.1*	55.4*	45.1*	32.8*
16-20	13.6*	7.3*	3.8*	1.8*	19.5*	9.7*	9.1*	18.9*	32.2*	66.5*	40.2*	29.3*
21-25	12.0*	6.4*	3.4*	1.6*	10.0*	9.0*	8.2*	30.4*	57.8*	37.0*	33.1*	27.1*
26-END	10.7*	5.8*	2.9*	1.6*	11.3*	8.3*	15.0*	18.1*	40.9*	36.5*	46.6*	53.5*

YEAR : 1971

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	31.0*	12.6*	120.5*	13.6*	4.8*	6.1*	24.7*	11.4*	18.9*	27.2*	116.6*	62.6*
6-10	25.0*	11.0*	54.1*	11.6*	4.3*	5.7*	15.2*	20.6*	17.2*	47.7*	53.3*	40.7*
11-15	22.3*	9.9*	22.9*	9.6*	4.2*	6.9*	13.3*	17.6*	20.3*	63.3*	59.4*	35.5*
16-20	20.0*	9.0*	17.3*	7.8*	4.8*	40.2*	15.5*	48.7*	125.3*	185.7*	53.3*	34.6*
21-25	17.5*	12.6*	13.6*	6.4*	5.2*	28.4*	18.4*	71.9*	115.2*	68.3*	57.5*	32.8*
26-END	14.8*	55.1*	15.5*	5.4*	6.3*	36.1*	13.2*	27.5*	44.1*	80.0*	53.5*	29.3*

YEAR : 1972

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	26.4*	12.1*	8.2*	4.6*	38.8*	11.6*	4.9*	2.9*	20.1*	58.6*	105.1*	41.9*
6-10	23.7*	11.1*	7.3*	4.2*	19.8*	10.0*	4.5*	5.7*	209.1*	37.6*	53.4*	39.2*
11-15	20.9*	10.1*	6.3*	76.2*	16.7*	8.4*	4.2*	5.0*	195.3*	34.3*	67.5*	37.5*
16-20	18.1*	9.2*	14.9*	29.4*	16.1*	7.2*	3.9*	4.2*	120.7*	32.5*	84.6*	130.7*
21-25	15.7*	9.0*	7.5*	58.2*	15.2*	6.1*	3.6*	3.9*	129.2*	46.7*	102.8*	53.2*
26-END	13.6*	8.7*	5.5*	150.8*	13.6*	5.4*	3.2*	3.3*	124.5*	80.8*	51.8*	36.1*

YEAR : 1973

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	31.0*	14.4*	8.4*	4.4*	30.7*	124.4*	21.0*	24.7*	17.3*	89.7*	39.0*	32.9*
6-10	27.8*	12.9*	7.6*	6.2*	26.0*	48.7*	18.7*	16.4*	43.5*	106.4*	59.2*	102.4*
11-15	24.6*	11.8*	6.8*	5.6*	21.6*	31.4*	16.5*	12.4*	23.6*	38.1*	164.0*	82.6*
16-20	21.5*	10.8*	6.1*	8.8*	68.8*	27.5*	14.4*	11.4*	19.4*	39.6*	63.5*	39.7*
21-25	19.0*	9.9*	5.4*	39.8*	38.2*	25.5*	12.4*	74.6*	18.1*	68.8*	38.8*	31.1*
26-END	16.5*	9.2*	4.8*	63.2*	40.9*	23.3*	10.7*	30.6*	18.5*	60.5*	35.5*	27.7*

YEAR : 1974

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	24.9*	16.8*	8.0*	4.4*	63.9*	21.7*	14.3*	30.6*	13.3*	158.0*	39.7*	26.4*
6-10	22.2*	13.3*	7.3*	4.1*	105.0*	19.1*	12.7*	25.9*	13.0*	54.7*	34.9*	24.2*
11-15	19.3*	11.6*	6.8*	3.8*	29.0*	17.9*	11.3*	14.3*	12.8*	35.7*	30.7*	21.8*
16-20	16.6*	10.1*	6.1*	3.5*	15.4*	16.5*	10.4*	12.6*	58.0*	32.2*	33.5*	19.5*
21-25	14.3*	9.1*	5.5*	3.2*	69.4*	15.3*	9.5*	14.3*	165.5*	52.3*	32.6*	17.2*
26-END	29.8*	8.6*	4.9*	2.9*	38.5*	16.3*	10.4*	14.4*	228.5*	39.3*	28.6*	14.9*

YEAR : 1975

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	13.0*	8.9*	7.2*	3.8*	3.7*	3.8*	6.7*	10.6*	12.5*	14.7*	54.3*	23.3*
6-10	31.8*	8.0*	6.5*	3.5*	3.8*	3.8*	6.0*	10.1*	66.5*	14.1*	29.3*	22.3*
11-15	21.0*	7.3*	5.5*	3.3*	3.7*	3.7*	5.5*	10.5*	21.0*	24.6*	24.8*	24.2*
16-20	13.5*	6.9*	4.8*	3.1*	3.4*	4.7*	5.1*	10.6*	14.7*	41.5*	23.6*	55.2*
21-25	11.6*	6.4*	4.3*	3.0*	3.0*	6.8*	10.2*	10.1*	16.6*	40.6*	26.7*	155.0*
26-END	10.2*	6.1*	4.1*	3.6*	2.8*	9.5*	17.0*	9.2*	15.1*	93.3*	26.9*	43.8*

YEAR : 1976

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	25.8*	10.1*	5.1*	2.5*	181.7*	17.6*	15.1*	29.8*	13.0*	116.3*	44.6*	45.0*
6-10	22.1*	8.8*	4.5*	2.2*	79.5*	16.4*	58.5*	18.3*	11.7*	59.0*	65.7*	35.6*
11-15	19.8*	8.0*	4.1*	2.0*	26.4*	14.8*	40.7*	15.5*	10.7*	144.7*	43.4*	32.0*
16-20	17.3*	7.2*	3.7*	1.9*	18.5*	13.1*	17.4*	13.7*	192.6*	70.5*	38.0*	29.0*
21-25	14.8*	6.4*	3.3*	11.3*	31.0*	11.2*	13.8*	15.9*	86.0*	40.0*	58.5*	26.1*
26-END	12.2*	5.8*	2.9*	30.1*	20.3*	29.2*	76.1*	14.3*	34.3*	43.0*	87.0*	22.9*

REMARK : ASTERISK (*) MEANS SIMULATED VALUE.

Table 7 5-DAY NATURAL RUNOFF AT LENGKUAS (6204421) (3/3)

Basin: Kedah Catchment Area: 1,270 km^2

UNIT : CMS

YEAR : 1977

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	19.9*	9.5*	4.9*	2.2*	1.7*	4.1*	1.6*	1.3*	12.5*	19.8*	35.8*	18.2*
6-10	17.4*	8.7*	4.4*	2.0*	1.7*	3.3*	1.5*	1.5*	18.0*	75.9*	29.3*	15.6*
11-15	15.0*	7.8*	4.0*	1.9*	30.7*	2.7*	1.5*	1.7*	10.7*	99.2*	27.3*	13.1*
16-20	13.1*	6.9*	3.5*	1.9*	27.5*	2.3*	1.4*	22.5*	17.9*	35.7*	25.6*	11.0*
21-25	11.6*	6.1*	3.1*	1.8*	8.3*	2.0*	1.4*	20.7*	17.2*	60.4*	23.5*	9.3*
26-END	10.5*	5.5*	2.6*	1.8*	5.0*	1.8*	1.4*	7.2*	33.8*	41.7*	20.9*	7.9*

YEAR : 1978

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	7.1*	3.6*	1.3*	1.0*	0.9*	4.2*	40.5*	18.6*	18.2*	17.4*	21.0*	13.8*
6-10	6.4*	3.1*	1.2*	1.0*	1.0*	3.7*	21.3*	12.8*	126.0*	16.2*	19.0*	44.4*
11-15	5.7*	2.6*	1.1*	0.9*	6.1*	70.1*	10.1*	11.3*	84.7*	19.5*	18.1*	19.2*
16-20	5.1*	2.2*	1.1*	0.9*	5.2*	16.2*	8.3*	10.8*	27.2*	47.4*	17.8*	13.3*
21-25	4.5*	1.8*	1.0*	0.9*	5.0*	6.6*	8.3*	10.0*	23.4*	94.2*	16.8*	11.2*
26-END	4.1*	1.5*	1.0*	0.9*	4.5*	4.6*	29.8*	9.7*	19.1*	33.4*	15.5*	9.4*

YEAR : 1979

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	7.7*	3.4*	1.1*	0.7*	36.5*	10.3*	7.8*	9.8*	36.2*	21.0*	19.5*	34.7*
6-10	6.5*	2.9*	0.9*	0.6*	13.8*	10.0*	7.1*	9.1*	56.6*	19.8*	33.3*	26.9*
11-15	5.6*	2.4*	0.9*	0.7*	17.0*	9.7*	17.9*	9.4*	74.3*	18.6*	35.2*	24.3*
16-20	5.0*	2.0*	0.8*	0.9*	14.5*	11.0*	12.1*	8.8*	33.4*	17.2*	69.4*	22.1*
21-25	4.4*	1.6*	0.8*	1.7*	12.3*	9.8*	8.2*	9.2*	23.2*	15.6*	55.8*	19.6*
26-END	4.0*	1.3*	0.7*	49.7*	11.5*	8.8*	16.3*	22.7*	21.7*	28.4*	76.0*	16.6*

YEAR : 1980

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	13.7*	5.5*	2.3*	0.9*	2.5*	2.4*	2.3*	4.3*	13.5*	76.1*	92.4*	40.4*
6-10	11.3*	4.8*	2.0*	0.9*	2.3*	2.1*	3.4*	7.9*	30.0*	122.3*	76.8*	80.3*
11-15	9.4*	4.2*	1.7*	0.8*	2.5*	1.8*	3.1*	9.0*	18.8*	82.5*	76.9*	56.4*
16-20	8.0*	3.7*	1.6*	1.0*	2.6*	1.5*	2.9*	6.1*	14.5*	118.2*	44.8*	37.5*
21-25	7.1*	3.2*	1.2*	2.7*	2.4*	1.2*	4.2*	22.7*	20.1*	51.0*	60.1*	32.6*
26-END	6.3*	2.8*	1.0*	2.5*	2.2*	1.0*	4.4*	17.5*	80.9*	38.5*	42.8*	28.9*

YEAR : 1981

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	25.6*	11.2*	6.2*	2.6*	41.5*	23.5*	7.7*	3.3*	1.6*	8.7*	10.2*	11.5*
6-10	22.5*	10.3*	5.4*	2.3*	46.5*	16.2*	6.2*	3.0*	1.4*	8.1*	10.3*	10.9*
11-15	19.7*	9.3*	4.6*	2.1*	54.1*	14.3*	5.0*	2.7*	1.3*	7.5*	9.4*	9.9*
16-20	17.1*	8.4*	4.1*	22.8*	35.7*	12.9*	4.3*	2.4*	25.5*	6.6*	14.4*	8.7*
21-25	14.8*	7.5*	3.7*	19.6*	16.6*	11.1*	3.9*	2.1*	10.2*	5.5*	12.4*	7.3*
26-END	12.7*	6.8*	3.1*	5.9*	38.9*	9.3*	3.6*	1.9*	9.4*	19.7*	11.7*	5.7*

YEAR : 1982

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	4.4*	1.5*	0.8*	1.0*	37.4*	30.3*	15.2*	13.1*	85.8*	16.8*	11.8*	20.8*
6-10	3.8*	1.2*	4.0*	3.2*	16.0*	23.5*	13.4*	11.6*	40.0*	13.2*	11.0*	17.9*
11-15	3.3*	1.0*	8.3*	5.1*	14.0*	22.7*	11.8*	10.4*	15.8*	12.8*	21.4*	17.0*
16-20	2.8*	0.9*	3.6*	11.0*	147.8*	21.3*	58.2*	9.1*	11.6*	13.6*	15.6*	16.1*
21-25	2.4*	0.8*	2.4*	13.7*	98.2*	19.6*	47.2*	8.0*	10.6*	12.7*	18.0*	15.1*
26-END	1.9*	0.8*	1.5*	15.9*	36.5*	17.5*	18.1*	7.1*	15.3*	12.3*	26.5*	13.5*

YEAR : 1983

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	11.6*	4.2*	1.6*	1.4*	0.6*	51.2*	10.4*	78.0*	13.8*	25.8*	32.1*	133.6*
6-10	9.8*	3.8*	1.3*	1.1*	0.6*	15.9*	9.1*	61.3*	13.8*	20.7*	30.0*	249.3*
11-15	8.0*	3.2*	1.1*	0.9*	0.6*	20.4*	9.0*	20.6*	15.3*	50.1*	50.3*	66.7*
16-20	6.5*	2.7*	0.9*	0.8*	4.5*	30.9*	8.0*	34.1*	20.2*	177.2*	41.0*	33.9*
21-25	5.4*	2.3*	2.4*	0.7*	5.3*	15.0*	6.9*	19.1*	21.8*	114.1*	32.5*	26.9*
26-END	4.7*	1.9*	2.0*	0.7*	41.2*	11.9*	5.8*	15.0*	44.7*	44.8*	29.4*	23.6*

REMARK : ASTERISK (*) MEANS SIMULATED VALUE.

Table 8 5-DAY NATURAL RUNOFF AT JENIANG (5806414) (1/3)

Basin: Muda Catchment Area: 1,740 km^2

UNIT : CMS

YEAR : 1961

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	32.3	16.1	15.9	13.9	52.1	30.7	25.8	22.6	11.5	51.2	96.1	35.6
6-10	32.9	16.3	19.8	13.6	49.5	16.5	21.0	22.2	17.5	36.6	96.2	27.0
11-15	35.9	16.6	16.0	23.0	50.7	22.1	21.0	21.1	17.7	39.5	52.8	22.9
16-20	25.1	33.0	15.0	22.9	32.0	45.2	19.8	21.9	26.9	52.3	48.5	29.0
21-25	19.1	17.4	14.7	36.5	21.6	48.0	20.3	16.6	30.4	113.3	55.0	25.8
26-END	16.6	15.4	16.7	44.5	16.8	43.1	32.2	12.1	25.9	110.1	53.9	70.8

YEAR : 1962

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	63.4	15.1	11.4	14.4	55.2	29.7	36.8	31.7	40.7	30.9	78.2	32.5
6-10	33.4	14.6	20.5	23.1	30.7	26.1	56.8	28.9	102.2	52.4	58.1	30.7
11-15	25.0	13.8	24.5	16.9	48.2	23.6	40.6	37.0	51.9	115.2	47.1	28.5
16-20	24.6	12.1	20.6	22.5	72.5	23.2	44.0	50.2	40.4	164.3	41.3	47.7
21-25	20.9	11.3	13.1	21.8	49.8	35.3	32.7	41.9	27.4	146.5	34.4	36.2
26-END	16.8	12.2	16.5	20.9	34.3	36.3	26.9	48.4	24.0	115.5	30.9	26.4

YEAR : 1963

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	35.3	18.1	7.4	9.2	18.1	35.6	32.3	48.6	47.4	61.9	124.8	99.6
6-10	37.6	15.9	7.3	9.2	42.0	32.1	27.8	45.8	60.4	70.7	190.5	96.6
11-15	29.1	13.9	8.1	9.2	41.8	31.7	29.9	36.4	56.4	128.6	145.2	68.1
16-20	25.4	12.5	7.6	9.2	53.7	29.5	32.9	30.7	79.2	206.4	128.6	51.9
21-25	21.9	11.9	13.4	9.2	74.8	29.4	34.9	32.4	83.0	179.1	102.1	45.4
26-END	20.8	10.6	9.2	10.4	46.2	35.5	51.5	37.0	89.2	142.7	126.7	38.4

YEAR : 1964

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	30.0	12.6	10.8	10.6	28.0	34.9	22.0	47.9	55.4	37.6	114.1	57.6
6-10	27.0	10.6	10.6	10.5	37.0	32.2	31.9	38.2	94.7	29.6	132.3	42.5
11-15	22.3	12.2	10.6	10.6	37.0	55.6	33.5	22.7	77.3	43.5	177.9	39.4
16-20	21.5	12.1	9.3	14.8	39.4	34.4	41.5	22.0	46.8	38.9	113.4	36.4
21-25	20.2	11.1	9.2	11.3	73.3	27.1	65.1	21.0	35.1	91.6	88.2	28.8
26-END	15.7	10.6	9.6	15.9	34.5	24.7	88.1	20.0	42.4	99.5	61.7	25.8

YEAR : 1965

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	22.5	12.6	10.2	29.8	57.3	29.1	12.2	13.3	45.0	50.6	185.3	189.3
6-10	19.8	11.3	10.4	36.6	45.9	25.9	14.5	19.3	41.6	41.0	139.1	106.1
11-15	19.5	10.4	10.0	29.0	42.8	19.1	27.5	26.0	62.4	71.1	94.9	149.8
16-20	18.1	10.7	8.8	21.6	44.3	14.3	18.8	34.3	46.4	133.9	109.8	98.9
21-25	15.9	10.5	8.8	22.0	53.8	12.8	16.8	50.4	38.8	132.7	90.0	149.5
26-END	14.2	10.1	10.8	19.7	45.9	12.4	15.1	92.0	70.2	196.6	73.6	95.0

YEAR : 1966

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	63.4	30.6	23.1	19.4	24.6	64.5	46.1	28.4	20.5	62.6	84.2	124.1
6-10	53.6	27.4	26.8	19.3	34.4	114.9	37.8	21.9	20.3	51.6	99.5	129.5
11-15	45.4	24.7	20.1	19.1	60.5	56.6	35.2	25.0	22.2	127.1	108.4	95.8
16-20	36.7	23.8	21.0	20.6	112.7	34.6	25.4	25.2	35.0	217.8	182.6	96.1
21-25	41.9	61.1	29.2	33.4	42.0	29.9	24.4	23.6	61.1	134.8	151.8	83.5
26-END	40.1	27.2	20.0	45.5	35.4	26.4	23.6	23.4	133.6	89.3	122.2	69.2

YEAR : 1967

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	133.9	49.3	26.1	15.1	29.6	18.4	74.7	25.3	27.6	99.5	67.6	80.7
6-10	316.4	41.2	23.5	16.9	58.5	17.1	44.2	19.6	25.5	139.3	46.8	45.5
11-15	130.9	35.0	23.2	17.2	58.4	26.0	36.1	22.4	32.9	46.1	40.7	32.4
16-20	95.5	33.7	18.9	17.2	69.9	46.6	44.9	33.3	42.6	32.4	69.0	28.6
21-25	76.0	29.8	16.7	20.0	54.1	52.4	35.9	25.7	35.5	85.6	42.1	25.1
26-END	60.4	24.1	15.8	31.0	25.0	105.5	24.8	67.5	36.9	90.7	99.5	22.5

YEAR : 1968

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	17.4*	10.4*	6.9*	4.7*	5.9*	3.9*	10.2*	39.4*	46.8*	54.1*	92.8*	40.3*
6-10	15.1*	9.7*	6.4*	4.5*	5.9*	3.8*	12.6*	41.2*	42.1*	105.9*	71.3*	34.7*
11-15	13.5*	9.1*	6.0*	4.4*	5.8*	4.0*	27.5*	97.4*	37.6*	108.3*	63.7*	29.7*
16-20	12.6*	8.5*	5.7*	4.2*	5.6*	4.2*	40.5*	80.2*	38.4*	67.1*	58.3*	25.8*
21-25	11.9*	7.9*	5.4*	4.1*	4.9*	4.6*	42.1*	53.5*	34.0*	82.5*	52.4*	22.7*
26-END	11.1*	7.4*	5.0*	5.8*	4.3*	9.1*	30.5*	45.4*	31.2*	145.4*	46.4*	21.6*

REMARK : ASTERISK (*) MEANS SIMULATED VALUE.

Table 9 5-DAY NATURAL RUNOFF AT JENTANG (5806414) (2/3)

Basin: Muda Catchment Area: 1,740 km^2

UNIT : CMS

YEAR : 1969

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	21.7*	24.5*	12.7*	121.4*	18.8*	38.6*	36.2*	23.6*	71.5*	80.1*	157.7*	180.3*
6-10	42.0*	21.2*	12.2*	56.4*	15.5*	36.3*	33.1*	20.4*	58.5*	80.1*	103.3*	95.8*
11-15	29.6*	17.9*	12.8*	34.0*	51.4*	34.3*	31.7*	31.2*	53.7*	183.6*	97.9*	77.2*
16-20	32.0*	15.4*	13.7*	30.0*	3[illegible].2*	31.2*	37.3*	96.9*	47.7*	139.7*	125.9*	68.8*
21-25	30.1*	13.7*	14.0*	26.6*	30.0*	30.8*	34.9*	131.3*	40.8*	128.1*	96.0*	61.1*
26-END	27.4*	12.9*	29.8*	22.6*	62.2*	30.3*	27.6*	174.2*	131.6*	246.5*	153.3*	52.7*

YEAR : 1970

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	44.5*	23.4*	16.7*	22.8*	71.8*	106.9*	114.4*	31.1*	36.7*	94.1*	77.2*	79.7*
6-10	38.1*	22.2*	15.6*	24.5*	57.0*	65.2*	84.7*	31.2*	39.5*	129.5*	128.2*	72.7*
11-15	32.9*	21.0*	14.5*	20.7*	32.3*	57.3*	45.8*	28.9*	170.1*	91.3*	156.2*	64.4*
16-20	29.2*	19.8*	13.5*	19.6*	33.2*	51.8*	38.4*	27.6*	79.9*	105.9*	130.4*	55.8*
21-25	26.7*	18.6*	12.5*	18.5*	74.6*	46.7*	34.7*	42.9*	117.6*	81.3*	100.0*	47.6*
26-END	24.8*	17.7*	19.9*	21.3*	114.9*	39.7*	32.0*	41.3*	78.1*	98.1*	85.8*	87.3*

YEAR : 1971

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	50.4*	23.9*	33.1*	15.7*	9.5*	9.3*	44.4*	25.9*	41.5*	51.9*	75.0*	54.6*
6-10	41.2*	22.3*	28.4*	13.7*	11.8*	8.3*	32.1*	23.2*	42.6*	56.1*	75.4*	49.9*
11-15	37.7*	21.1*	26.2*	12.3*	12.5*	10.2*	28.7*	42.6*	40.5*	103.7*	80.6*	44.9*
16-20	34.1*	19.9*	24.5*	11.4*	11.4*	50.2*	26.0*	29.1*	275.6*	87.5*	73.6*	80.3*
21-25	30.2*	18.8*	21.9*	10.6*	11.2*	33.7*	23.5*	60.1*	182.3*	79.1*	65.9*	81.3*
26-END	26.6*	24.8*	18.6*	10.0*	10.3*	103.7*	20.6*	41.2*	71.2*	115.0*	59.6*	48.0*

YEAR : 1972

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	41.5*	19.7*	14.1*	10.3*	13.3*	9.3*	25.4*	9.5*	18.0*	49.8*	222.5*	112.1*
6-10	38.1*	18.5*	13.2*	12.8*	12.3*	9.3*	24.6*	12.7*	45.0*	78.3*	363.3*	96.6*
11-15	33.9*	17.5*	12.4*	14.3*	10.6*	14.6*	22.4*	14.0*	62.3*	63.6*	219.5*	86.3*
16-20	29.3*	16.6*	11.5*	13.1*	8.9*	24.8*	18.8*	14.6*	41.8*	89.5*	172.7*	79.7*
21-25	25.1*	15.7*	10.7*	13.2*	8.5*	38.3*	15.2*	14.4*	53.2*	109.8*	168.8*	68.3*
26-END	21.8*	14.9*	9.9*	13.7*	10.0*	25.7*	11.9*	13.9*	66.0*	98.7*	122.9*	57.7*

YEAR : 1973

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	48.1*	24.0*	17.3*	11.3*	34.0*	48.8*	24.6*	215.0*	42.9*	139.0*	81.3*	54.2*
6-10	40.6*	22.8*	16.1*	11.7*	30.3*	35.7*	21.4*	119.5*	40.1*	77.8*	75.8*	134.8*
11-15	34.7*	21.6*	15.1*	11.4*	28.6*	31.4*	19.5*	56.2*	36.6*	42.6*	94.8*	82.5*
16-20	30.3*	20.4*	14.0*	11.4*	25.8*	30.6*	17.7*	47.2*	34.1*	73.6*	69.2*	58.7*
21-25	27.6*	19.2*	13.0*	76.4*	22.8*	28.5*	15.9*	72.6*	30.8*	101.7*	61.7*	53.6*
26-END	25.6*	18.3*	12.0*	63.8*	27.5*	25.1*	48.7*	52.4*	28.4*	83.1*	56.1*	50.5*

YEAR : 1974

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	45.7*	19.5*	14.4*	9.5*	19.5*	25.6*	11.0*	25.6*	22.7*	100.4*	58.3*	54.2*
6-10	40.0*	18.4*	13.4*	16.2*	19.1*	22.6*	10.4*	20.5*	31.4*	69.9*	61.1*	50.0*
11-15	33.9*	17.4*	12.6*	13.9*	16.2*	18.4*	9.8*	31.8*	44.5*	59.7*	58.7*	44.4*
16-20	28.5*	16.5*	11.7*	13.7*	62.3*	14.5*	9.2*	34.4*	48.0*	54.5*	62.9*	38.1*
21-25	24.3*	16.0*	10.9*	13.7*	32.2*	12.5*	8.5*	27.6*	95.2*	50.2*	61.1*	32.2*
26-END	21.4*	15.4*	10.1*	10.7*	27.0*	11.4*	19.6*	24.8*	96.1*	56.3*	58.0*	26.9*

YEAR : 1975

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	22.7*	25.4*	27.1*	15.3*	24.2*	19.6*	10.3*	41.3*	76.8*	66.6*	84.6*	60.4*
6-10	21.2*	22.3*	32.6*	45.3*	30.0*	17.5*	42.1*	35.6*	67.8*	58.4*	75.0*	101.6*
11-15	22.4*	19.4*	27.3*	30.5*	27.3*	16.1*	22.4*	33.0*	40.5*	111.4*	64.2*	101.7*
16-20	88.1*	17.0*	24.1*	19.9*	25.5*	14.7*	18.7*	31.5*	145.1*	113.7*	76.4*	94.4*
21-25	43.4*	28.1*	21.9*	22.3*	23.4*	13.2*	48.9*	27.6*	128.3*	87.0*	70.9*	169.6*
26-END	29.1*	50.4*	18.7*	24.5*	20.8*	11.6*	72.3*	24.4*	111.4*	65.1*	65.1*	83.9*

YEAR : 1976

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	65.4	34.2	17.9	8.1	92.5	51.3	30.8	48.7	31.8	148.5	187.2*	112.2
6-10	59.7	34.6	11.2	8.1	81.9	76.0	102.1	29.1	20.8	165.8	288.0*	73.7
11-15	40.1	29.5	16.3	10.8	92.5	50.3	50.3	22.8	20.8	341.2	115.3	54.6
16-20	38.1	22.0	16.1	9.8	45.4	28.5	26.9	26.5	155.4	178.8	95.3	47.3
21-25	38.3	16.5	14.7	24.2	97.0	23.2	38.9	61.7	175.8	151.3	98.2	45.6
26-END	36.3	15.5	23.0	89.6	43.6	26.9	79.4	41.8	101.9	147.5*	193.5	52.1

REMARK : ASTERISK (*) MEANS SIMULATED VALUE.

Table 10 5-DAY NATURAL RUNOFF AT JENIANG (5806414) (3/3)

Basin: Muda Catchment Area: 1,740 km^2

UNIT : CMS

YEAR : 1977

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	36.5	14.1	9.0	3.7	5.1	10.6	7.5	7.7	51.3	130.0	120.6	30.4
6-10	46.0	12.0	6.3	3.5	10.2	20.2	5.7*	11.2	68.9	196.4	183.0*	29.7
11-15	25.5	12.4	5.7	3.5	15.5	24.0	13.4	9.6	28.1	259.1	101.9*	20.6
16-20	20.6	8.8	4.9	4.1	7.7	30.1	7.3	55.2	44.8	166.8	66.8	17.7
21-25	13.9	6.5	4.3*	3.7	4.7	12.6	5.7	71.5	41.8	167.2	64.8	14.5
26-END	14.9	7.5	3.9	9.0	9.4	7.3	7.7	27.3	68.0	161.5	45.0	12.6

YEAR : 1978

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	10.8*	4.5	2.9	7.5	14.5	15.3	67.8	38.7	65.8	23.8	106.1	31.8
6-10	8.6*	3.9	6.3	11.4	21.0	18.9	44.6	23.6	167.0	46.2	76.6	49.7
11-15	6.5	3.7	4.9	14.5	67.0	33.0	33.6	43.6	71.3	89.0	69.9	20.4
16-20	14.9	3.5	8.4	31.4	45.8	14.1	41.6	43.8	40.7	99.6	112.8	15.3
21-25	8.1	3.5*	6.1	26.9	36.9	13.9	47.5	19.1	42.4	126.1	64.8	12.8
26-END	5.7	3.1*	7.1	13.0	19.4	23.0	55.8	29.3	30.8	105.7	36.1	10.0

YEAR : 1979

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	7.3	3.7	3.1	3.5	57.0	10.6	7.7	24.0	87.0	33.8	67.8	61.9
6-10	6.1	3.5*	2.9	17.1	42.8	39.9	6.5	35.9	88.8	35.9	89.6	35.9
11-15	5.1	3.3	2.9	10.2	20.2	98.8	12.0	28.9	152.6	37.9	156.2	26.1
16-20	4.5	3.1	2.9	7.1	6.7	48.3	22.8	18.1	151.3	41.6	119.8	16.5
21-25	4.1	2.9	2.9	18.1	16.5	21.2	35.4	14.1	73.7	45.0	107.8	11.0
26-END	4.3	3.7	2.9	89.0	12.0	11.0	69.7	51.5	57.6	85.4	159.5	8.6

YEAR : 1980

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	9.6	5.3	15.3	5.1	14.3	50.1*	13.0	77.6	171.7	124.7	129.3	108.6
6-10	7.5	4.9	14.9	7.9	18.7	46.4*	12.2	57.9	88.8	414.7	144.4	148.5
11-15	6.9	4.5	6.1	13.0	14.7*	50.5	7.3	88.2	85.6	314.3	155.4	93.1
16-20	7.3	4.1	9.0	14.9	15.7*	25.5	9.2	68.9	44.2	241.4	143.0	65.6
21-25	7.1	6.1	8.1	10.4	16.1*	17.7	46.6	50.1	107.8	171.7	149.9	51.5
26-END	6.1	5.9	5.1	16.7	78.8*	28.7	44.4	82.7	133.8	142.2	105.7	40.7

YEAR : 1981

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	30.8	15.7	10.6	32.4	37.7	156.7	31.4	18.7	14.9	29.9	37.8	49.0
6-10	37.3	11.6	7.6	30.7	50.6	60.8	21.4	11.6	64.5	21.8	49.8	27.4
11-15	25.9	10.5	6.5	31.6	94.5	54.5	24.9	9.3	50.6	22.6	42.8	22.2
16-20	21.6	9.9	2.1	34.9	123.6	26.5	21.0	7.6	61.6	27.0	52.2	12.0
21-25	18.1	9.9	4.4	48.6	63.9	19.3	21.4	12.5	75.6	43.0	47.1	8.9
26-END	14.1	11.4	7.6	12.9	204.4	54.1	36.3	23.8	49.2	6.4	26.0	7.8

YEAR : 1982

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	6.6	3.3	1.5	4.3	136.5	84.6	24.1	11.0	144.4	167.8	123.7	116.1
6-10	6.1	2.7	1.8	14.8	47.0	53.0	26.2	19.9	83.5	129.5	184.8	74.0
11-15	5.3	2.9	4.2	9.5	82.5	45.9	18.0	18.8	48.7	91.2	221.2	80.5
16-20	4.7	2.8	4.1	41.7	170.1	35.1	43.0	14.5	71.5	77.3	158.9	94.3
21-25	4.2	2.8	3.0	57.7	224.1	22.9	48.1	12.9	93.0	73.7	124.3	138.0
26-END	4.3	3.7	3.9	42.5	164.3	19.0	18.3	25.5	158.1	86.2	157.8	68.0

YEAR : 1983

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	28.6	9.0	4.4	2.4	28.2	31.7	10.7	32.6*	163.2*	74.8*	60.2*	125.0*
6-10	23.5	7.9	3.5	2.6	19.3	14.1	33.4	40.3*	106.4*	66.7*	55.0*	123.0*
11-15	19.2	7.3	3.4	3.2	22.7	32.8	50.9	56.4*	70.0*	61.3*	50.7*	55.3*
16-20	15.9	6.0	2.9	3.6	35.3	37.6	21.8	38.5*	102.6*	118.1*	48.2*	45.4*
21-25	13.0	6.9	7.8	3.0	19.0	16.0	10.7	34.9*	86.0*	116.1*	43.9*	42.1*
26-END	11.2	4.7	4.9	6.5	31.6	8.3	22.3	35.0*	89.0*	70.1*	40.4*	38.4*

REMARK : ASTERISK (*) MEANS SIMULATED VALUE.

Table 11 5-DAY NATURAL RUNOFF AT ARA KUDA (5405421) (1/3)

Basin: Perai Catchment Area: 129 km^2

UNIT : CMS

YEAR : 1961

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	6.1	3.2	3.3	4.2	7.0	2.7	2.1	2.6	2.6	4.1	7.1	19.6
6-10	7.0	2.6	5.0	4.8	9.3	2.3	1.9	3.9	2.6	2.7	13.0	6.6
11-15	6.6	2.9	5.4	7.1	9.1	3.2	3.5	3.0	2.8	10.5	17.7	5.9
16-20	3.8	6.9	4.7	5.7	5.1	3.7	3.1	2.5	2.2	9.3	18.9	15.0
21-25	3.4	5.1	4.2	7.6	3.5	3.4	2.6	1.9	3.6	8.7	13.3	14.0
26-END	3.3	3.7	7.8	8.2	3.1	2.2	6.6	1.7	2.5	7.0	12.5	10.6

YEAR : 1962

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	23.8	6.6	4.6	5.9	7.3	4.8	6.2	5.1	5.1	5.2	10.7	8.9
6-10	14.5	5.8	5.4	9.4	8.7	5.6	6.9	4.2	5.1	12.3	20.0	9.2
11-15	10.5	5.3	5.2	6.2	11.9	4.6	4.7	4.3	4.1	26.1	9.0	6.0
16-20	15.7	4.8	5.2	12.3	12.8	4.5	4.3	4.8	3.7	15.6	8.8	6.0
21-25	9.9	5.0	5.4	6.7	7.8	6.5	4.3	4.8	3.8	41.6	7.7	5.9
26-END	7.8	4.6	4.9	7.8	5.7	7.4	6.7	5.0	3.7	21.4	5.9	4.6

YEAR : 1963

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	9.4	3.3	2.8	3.5	2.4	4.1	2.6	2.7	2.7	2.4	11.0	20.9
6-10	7.7	3.1	7.3	3.4	3.5	3.6	2.3	2.6	2.7	14.6	13.1	12.6
11-15	4.7	3.1	3.8	3.1	5.3	2.9	2.3	2.6	2.6	7.7	35.8	12.9
16-20	4.4	2.9	3.6	3.0	4.4	2.7	2.3	2.5	3.4	8.3	32.7	8.9
21-25	3.5	2.8	3.7	3.1	8.8	2.5	2.6	2.7	3.0	8.2	16.4	7.1
26-END	3.3	2.9	3.9	2.7	4.2	2.4	2.9	2.7	2.6	15.3	13.0	7.1

YEAR : 1964

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	4.4	2.9	2.8	2.1	4.8	3.7	2.3	7.2	15.6	10.6	7.9	4.9
6-10	3.8	2.7	2.6	2.7	4.2	3.5	2.5	4.4	34.8	8.6	14.0	4.3
11-15	4.5	2.7	2.4	3.5	11.5	3.2	3.3	3.9	20.9	9.3	13.8	4.6
16-20	7.3	2.9	2.3	3.6	5.8	2.8	4.3	3.6	10.0	15.6	9.6	4.3
21-25	4.2	2.7	2.0	3.5	11.0	2.6	5.5	3.8	12.8	22.0	6.8	4.3
26-END	4.0	2.7	1.8	6.8	4.0	2.3	13.2	4.4	25.2	12.7	4.8	4.2

YEAR : 1965

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	3.7	1.9	1.8	2.8	5.8	2.5	1.1*	1.5*	5.9*	7.6*	12.3*	7.5*
6-10	3.6	1.8	2.1	3.0	3.0	2.3	1.1*	1.4*	4.4*	4.3*	7.7*	7.8*
11-15	3.5	1.7	1.9	2.8	2.9	2.0	1.1*	4.0*	3.9*	12.8*	7.6*	8.8*
16-20	2.6	1.8	1.8	2.7	4.1	2.0	8.8*	3.2*	3.8*	12.1*	20.2*	20.1*
21-25	2.0	1.7	1.7	2.8	2.7	1.9	4.8*	8.8*	3.8*	14.0*	23.0*	29.6*
26-END	2.0	1.7	3.7	3.6	2.6	1.8	2.0*	6.2*	11.6*	16.6*	10.8*	13.0*

YEAR : 1966

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	7.5*	4.1*	4.9*	8.8*	5.4*	7.2*	4.9*	3.7*	3.3	6.5	6.2	6.5
6-10	6.4*	3.7*	4.5*	6.4*	6.0*	6.4*	4.1*	3.4*	3.3	5.7	6.2	8.1
11-15	5.7*	3.4*	4.4*	5.7*	5.8*	4.3*	5.8*	3.2*	3.9	10.7	6.7	12.9
16-20	5.1*	5.1*	4.9*	5.3*	5.6*	3.8*	5.0*	2.9*	4.6	12.5	9.0	7.8
21-25	5.0*	5.1*	5.5*	8.2*	4.7*	3.6*	4.1*	5.6*	5.9	9.9	9.1	7.4
26-END	5.1*	3.8*	4.5*	8.2*	4.2*	3.2*	3.8*	4.1*	5.9	7.5	6.6	10.6

YEAR : 1967

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	9.6	6.9	4.8	5.4	8.5	6.3	6.2	6.3	4.1	11.3	11.2	9.4
6-10	9.6	6.2	4.6	6.4	11.9	5.4	5.4	3.9	3.8	6.4	9.0	7.6
11-15	8.6	6.0	5.0	7.1	13.1	5.7	5.6	3.4	4.8	6.2	8.6	6.2
16-20	7.0	5.9	4.4	7.4	9.9	6.3	6.1	3.3	5.3	5.7	10.2	6.0
21-25	6.2	5.9	4.0	8.2	12.8	5.6	4.7	3.2	4.9	7.7	10.2	5.9
26-END	7.3	5.4	5.6	10.0	7.2	7.2	5.1	5.2	4.6	12.1	12.3	5.7

YEAR : 1968

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	3.7	2.9	1.9	3.5	6.5	3.6	3.9	4.8	4.2	3.6	10.0	5.6
6-10	4.7	2.8	1.8	5.4	6.2	3.4	4.1	5.9	3.6	3.6	9.5	5.8
11-15	4.6	2.7	1.9	6.9	7.0	3.2	4.4	5.0	2.8	5.6	9.5	7.0
16-20	3.8	2.4	2.2	6.6	8.5	3.9	4.8	4.4	4.5	4.6	7.9	5.5
21-25	4.5	2.3	3.3	9.0	5.9	4.0	4.6	4.6	4.3	4.5	5.7	4.6
26-END	3.5	2.0	3.5	8.8	4.5	3.6	4.4	4.3	3.9	10.8	5.2	5.7

REMARK : ASTERISK (*) MEANS SIMULATED VALUE.

Table 12 5-DAY NATURAL RUNOFF AT ARA KUDA (5405421) (2/3)

Basin: Perai Catchment Area: 129 km^2

UNIT : CMS

YEAR : 1969

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	4.8	3.6	4.5	5.7*	2.2*	5.5	4.6	2.8	4.2	4.1	9.9	8.8
6-10	4.1	3.1	4.1	3.6*	6.8*	5.0	4.0	2.7	3.9	8.4	7.4	8.7
11-15	4.1	3.4	3.8	3.1*	7.6*	8.0	3.6	3.3	3.0	18.2	7.2	7.9
16-20	6.7	2.4	3.8	2.9*	4.5*	5.2	3.7	4.2	2.7	17.2	7.6	8.3
21-25	5.5	2.9	3.1	2.7*	6.2*	6.2	3.4	6.8	3.0	12.1	7.8	6.5
26-END	4.1	3.6	3.5	2.4*	11.7*	5.0	2.9	8.9	5.3	11.9	8.4	5.1

YEAR : 1970

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	7.8	3.9	2.7	1.9*	6.7*	5.0*	15.1	4.4	5.1	6.2	12.9	11.7
6-10	9.5	3.3	2.6	2.3*	5.1*	4.4*	6.7	4.1	6.2	18.1	26.0	13.7
11-15	8.1	3.7	2.7	6.4*	12.8*	3.9*	4.9	4.9	26.0	19.8	20.2	9.0
16-20	6.7	3.3	2.8	9.8*	7.3*	3.9*	6.7	4.7	6.9	25.3	24.5	10.0
21-25	5.2	3.2	2.0	11.9*	5.2*	3.7*	4.7	3.8	6.0	18.7	24.1	7.7
26-END	4.8	2.9	2.1	7.9*	5.1*	3.3*	4.7	3.7	4.5	22.8	12.9	12.1

YEAR : 1971

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	7.3	4.3	8.8	6.0	3.9	3.5	2.9	4.1	4.8	4.0	5.4	7.9
6-10	6.3	3.9	5.2	5.6	3.6	3.1	2.9	3.1	5.1	3.4	5.8	8.1
11-15	5.2	3.8	3.9	4.0	4.6	3.2	2.9	3.6	4.7	26.3	6.7	9.6
16-20	5.8	4.9	4.0	3.6	4.0	4.2	2.8	4.2	16.9	9.6	3.9	9.2
21-25	4.4	9.3	4.9	3.1	3.3	2.8	3.0	14.5	9.8	10.3	3.7	10.9
26-END	3.9	7.4	4.9	5.2	3.3	3.7	3.0	4.6	4.9	6.0	7.5*	7.5

YEAR : 1972

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	4.8	3.6	3.1	6.3*	6.2	4.8	2.9	3.0	2.9	3.4	15.4	11.9
6-10	8.5	4.5	2.8	4.6*	5.2	3.4	2.6	2.9	2.8	4.9	11.9	10.6
11-15	4.9	5.7	2.7	3.4*	4.2	3.5	2.6	2.8	9.6	6.0	16.2	7.7
16-20	4.1	3.8	2.7	6.3	3.7	3.9	3.0	2.3	4.1	12.8	14.9	8.4
21-25	3.7	3.8	3.0	12.3	3.8	3.6	2.9	2.4	7.1	18.0	11.3	15.1
26-END	3.3	4.1	3.1	11.2	3.9	3.1	2.7	2.4	4.6	21.3	11.0	6.5

YEAR : 1973

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	5.2	3.1	2.6	4.6	5.1	7.6	5.5	9.3	4.3	8.1	26.4	21.2
6-10	4.6	2.9	3.1	4.4	4.5	9.3	4.5	4.6	4.0	5.0	9.3	9.8
11-15	4.1	2.9	3.9	3.8	4.3	5.6	3.8	4.6	4.3	4.4	10.0	6.8
16-20	4.4	3.4	2.8	4.2	5.2	4.6	3.3	4.6	4.4	5.1	6.2	17.5
21-25	4.9	2.9	3.9	11.8	8.2	5.4	3.5	5.0	4.0	10.7	6.3	7.6
26-END	3.6	3.3	6.4	7.4	16.6	5.3	6.3	4.9	4.1	16.7	8.7	5.6

YEAR : 1974

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	5.0	3.9	3.3	4.8	6.3	3.1	3.1	4.3	2.8	7.3	5.2	4.3
6-10	4.5	3.5	3.4	9.0	5.4	3.1	2.8	3.2	3.0	4.1	4.1	3.7
11-15	4.0	3.0	2.8	5.9	7.9	2.9	2.9	2.9	2.8	3.6	4.8	3.4
16-20	3.6	7.6	2.9	5.9	6.7	3.0	2.8	2.8	7.1	3.5	5.7	4.0
21-25	3.7	5.0	2.6	4.9	4.4	3.1	3.6	2.8	6.2	3.4	6.0	3.2
26-END	4.4	4.0	3.8	4.9	3.8	3.2	3.4	2.6	5.5	7.2	6.7	3.2

YEAR : 1975

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	3.9	4.3	8.4	10.4	6.1	4.9	4.8	3.2	5.2	3.6	6.9	5.7
6-10	8.0	5.3	6.8	8.7	5.8	4.6	4.0	3.3	4.2	3.4	6.0	9.2
11-15	6.7	6.0	5.3	10.9	5.3	5.2	2.6	3.3	3.6	3.6	10.1	6.3
16-20	5.5	5.5	8.3	8.4	5.1	5.3	4.9	2.9	6.6	4.7	8.2	4.8
21-25	5.0	5.2	8.8	9.9	4.7	4.6	5.5	3.4	5.7	4.4	17.2	8.5
26-END	4.5	10.7	7.7	7.0	5.7	5.0	4.7	3.4	4.4	4.8	6.7	11.6

YEAR : 1976

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	5.9	3.2	3.0	3.0	8.2	3.2	2.3	2.4	4.0	11.9	9.1	5.6
6-10	5.0	3.1	2.7	2.8	5.1	3.9	2.5	2.0	2.6	20.2	8.2	4.5
11-15	4.1	2.7	4.4	3.0	3.7	3.2	2.2	1.9	2.9	15.4	7.6	5.4
16-20	3.6	2.8	2.9	2.8	3.6	3.0	1.9	2.2	20.6	7.5	8.7	5.5
21-25	3.2	2.6	4.7	3.8	4.3	2.6	2.2	3.8	11.7	6.8	7.8	7.8
26-END	3.1	2.6	3.9	6.8	3.2	3.0	3.0	4.6	6.8	9.5	9.8	6.4

REMARK : ASTERISK (*) MEANS SIMULATED VALUE.

Table 13 5-DAY NATURAL RUNOFF AT ARA KUDA (5405421) (3/3)

Basin: Perai Catchment Area: 129 km^2

UNIT : CMS

YEAR : 1977

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	7.7	3.8	2.3	1.9	3.4	2.5	1.9	1.5	4.8	22.6	12.0	9.1
6-10	7.6	2.9	2.0	2.0	3.0	3.7	2.5	1.3	4.7	11.3	9.6	8.5
11-15	4.4	3.4	1.9	1.6	3.9	2.9	2.0	2.0	2.9	7.6	6.5	8.9
16-20	3.6	3.1	2.1	2.7	4.8	2.5	1.7	4.3	4.5	14.4	7.8	9.0
21-25	3.4	2.6	1.9	2.2	2.6	2.5	1.7	2.6	9.0	13.5	7.5	6.3
26-END	3.1	2.6	1.9	2.3	2.4	1.9	1.4	3.2	8.0	13.0	9.2	7.5

YEAR : 1978

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	4.6*	2.4*	1.9*	2.2*	5.8*	4.1*	2.4*	1.8*	5.2*	3.3*	5.8*	2.9*
6-10	4.3*	2.3*	1.9*	2.1*	7.1*	3.5*	2.1*	1.7*	5.4*	4.1*	4.8*	2.5*
11-15	3.8*	2.1*	1.9*	1.9*	12.4*	3.2*	2.0*	4.2*	3.9*	7.1*	4.4*	2.1*
16-20	3.4*	2.0*	2.1*	4.5*	7.1*	2.7*	1.9*	3.3*	3.5*	4.8*	4.1*	1.9*
21-25	3.0*	1.9*	3.3*	8.1*	5.1*	2.3*	3.1*	2.3*	3.5*	13.4*	3.7*	1.7*
26-END	2.7*	1.9*	2.4*	3.7*	4.5*	2.1*	2.1*	4.0*	3.4*	13.1*	3.3*	1.6*

YEAR : 1979

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	1.5*	1.1*	0.8*	0.9*	4.8*	1.9*	2.1*	1.7*	16.2*	5.3*	4.8*	8.5*
6-10	1.4*	1.1*	0.8*	1.1*	3.2*	4.9*	1.8*	1.7*	10.7*	4.6*	15.0*	8.3*
11-15	1.3*	1.0*	0.7*	3.3*	3.1*	4.1*	1.6*	1.5*	12.4*	5.4*	19.0*	6.9*
16-20	1.3*	0.9*	0.7*	2.1*	2.9*	2.5*	1.4*	2.9*	7.0*	6.9*	24.5*	6.1*
21-25	1.2*	0.9*	0.7*	4.3*	2.7*	2.3*	3.8*	4.8*	8.3*	4.1*	17.9*	5.3*
26-END	1.2*	0.9*	0.6*	9.2*	2.3*	2.3*	2.0*	10.2*	6.4*	10.5*	12.3*	4.6*

YEAR : 1980

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	3.6*	2.4*	1.7*	1.5*	2.7*	9.5*	2.2*	13.6*	7.8*	11.3*	6.1*	9.3*
6-10	3.0*	2.2*	1.7*	2.6*	2.5*	6.1*	1.9*	12.9*	13.8*	10.6*	10.2*	16.8*
11-15	2.6*	2.0*	1.7*	3.8*	3.4*	3.6*	1.8*	7.7*	8.4*	8.1*	19.3*	13.5*
16-20	2.3*	1.9*	2.0*	2.4*	3.2*	3.1*	2.1*	5.5*	6.1*	15.6*	13.2*	10.5*
21-25	2.1*	1.7*	1.8*	2.2*	2.4*	2.9*	2.3*	5.0*	9.6*	8.3*	13.4*	9.5*
26-END	4.1*	1.6*	1.7*	2.2*	2.4*	2.6*	2.1*	7.9*	18.0*	6.7*	11.3*	7.7*

YEAR : 1981

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	6.7*	3.0*	6.3*	5.0*	10.2*	10.0*	2.4*	3.9*	10.8*	5.3*	10.3*	3.3*
6-10	6.0*	2.7*	3.3*	6.8*	11.9*	5.1*	2.1*	2.6*	19.1*	4.7*	5.6*	2.9*
11-15	5.2*	2.5*	2.8*	6.5*	6.1*	4.2*	1.8*	2.0*	14.5*	4.3*	4.8*	2.5*
16-20	4.6*	2.4*	2.7*	4.2*	5.1*	3.7*	1.8*	2.1*	7.8*	4.0*	4.6*	2.2*
21-25	4.0*	2.3*	2.6*	4.0*	4.6*	3.3*	1.8*	8.2*	8.5*	3.3*	4.1*	1.9*
26-END	3.4*	9.5*	2.4*	9.2*	8.3*	2.9*	5.2*	6.3*	6.0*	11.5*	3.7*	1.7*

YEAR : 1982

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	1.6*	1.1*	0.8*	0.6*	19.3*	4.6*	1.9*	1.3*	9.4*	9.4*	8.4*	18.3*
6-10	1.5*	1.1*	0.8*	0.8*	6.0*	3.6*	1.9*	1.2*	3.2*	6.9*	10.2*	10.0*
11-15	1.4*	1.0*	0.8*	2.5*	4.6*	3.1*	1.7*	1.1*	2.3*	5.7*	13.9*	8.4*
16-20	1.3*	1.0*	0.7*	2.7*	9.2*	2.7*	1.7*	1.0*	2.4*	6.0*	15.8*	7.6*
21-25	1.3*	0.9*	0.7*	2.7*	6.2*	2.7*	1.6*	1.2*	2.4*	11.1*	18.0*	6.9*
26-END	1.2*	0.9*	0.7*	6.5*	6.7*	2.1*	1.5*	1.2*	2.9*	13.5*	14.3*	7.1*

YEAR : 1983

PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1- 5	12.5*	3.0*	2.7*	1.9*	9.9*	4.1*	3.3*	2.2*	16.0*	4.8*	4.3*	4.9*
6-10	8.0*	2.7*	2.2*	1.7*	6.3*	3.7*	2.9*	2.0*	10.5*	4.3*	3.4*	7.2*
11-15	5.6*	2.4*	2.1*	1.6*	7.5*	8.6*	3.5*	1.8*	11.9*	3.7*	3.9*	3.5*
16-20	4.7*	2.2*	2.2*	1.4*	7.7*	8.0*	4.3*	1.7*	9.0*	6.1*	3.5*	2.9*
21-25	4.1*	2.1*	2.5*	1.3*	4.9*	4.9*	2.7*	1.6*	5.7*	4.8*	3.3*	2.6*
26-END	3.5*	2.6*	2.0*	3.5*	5.1*	3.7*	2.3*	1.6*	5.1*	5.5*	3.1*	3.5*

REMARK : ASTERISK (*) MEANS SIMULATED VALUE.

Table 14 ANNUAL MAXIMUM RAINFALL BY DURATION
AT JENIANG (5806066)

Record period: 1- 3 hours 1957/58 - 1977/78
6-12 hours 1957/58 - 1980/81
24-72 hours 1953/54 - 1982/83

Unit: mm

No.	Rainfall Duration						
	1 hour	3 hours	6 hours	12 hours	24 hours	48 hours	72 hours
1	94	138	162	166	184	324	340
2	94	132	138	150	166	181	247
3	90	117	133	138	154	180	220
4	89	110	117	133	144	177	216
5	77	94	110	117	131	175	201
6	74	91	101	111	130	170	200
7	74	89	97	105	122	158	188
8	69	82	96	97	112	157	185
9	65	82	95	97	109	157	181
10	64	81	91	96	106	154	175
11	64	78	87	96	105	148	170
12	64	78	85	94	100	147	168
13	63	77	84	92	98	133	168
14	63	72	83	91	97	130	156
15	61	69	81	85	97	126	150
16	56	60	78	84	97	125	148
17	56	60	69	78	96	122	147
18	52	59	66	75	96	121	142
19	48	56	65	73	95	121	140
20	45	55	63	73	92	118	140
21	43	53	59	59	85	117	137
22	-	-	59	59	85	116	136
23	-	-	54	54	84	113	134
24	-	-	46	51	82	110	132
25	-	-	-	-	80	106	130
26	-	-	-	-	80	105	128
27	-	-	-	-	75	102	124
28	-	-	-	-	73	96	114
29	-	-	-	-	70	93	110
30	-	-	-	-	69	92	105

Table 15 ANNUAL MAXIMUM RAINFALL BY DURATION
AT ALOR SETAR (6103047)

Record period: 1-12 hours 1965/66 - 1977/78
24 hours 1946/47 - 1977/78

Unit: mm

No.	Rainfall Duration				
	1 hour	3 hours	6 hours	12 hours	24 hours
1	85	141	142	149	198
2	84	111	130	142	193
3	76	104	114	137	192
4	76	93	111	134	184
5	75	92	104	115	153
6	74	91	102	114	149
7	73	87	94	104	144
8	72	84	94	97	140
9	68	83	87	94	139
10	65	77	81	94	137
11	63	77	78	89	127
12	53	69	69	80	125
13	36	57	64	78	118
14	-	-	-	-	115
15	-	-	-	-	114
16	-	-	-	-	114
17	-	-	-	-	110
18	-	-	-	-	106
19	-	-	-	-	104
20	-	-	-	-	102
21	-	-	-	-	102
22	-	-	-	-	98
23	-	-	-	-	98
24	-	-	-	-	94
25	-	-	-	-	93
26	-	-	-	-	91
27	-	-	-	-	91
28	-	-	-	-	87
29	-	-	-	-	81
30	-	-	-	-	80
31	-	-	-	-	78

Table 16 ANNUAL MAXIMUM RAINFALL BY DURATION
AT KUALA NERANG (6206035)

Record period: 1-12 hours 1957/58 - 1978/79
24 hours 1952/53 - 1978/79

Unit: mm

No.	Rainfall Duration				
	1 hour	3 hours	6 hours	12 hours	24 hours
1	83	132	157	157	158
2	78	125	133	133	133
3	76	109	112	112	128
4	76	107	108	108	117
5	76	102	103	103	112
6	71	95	98	102	108
7	70	86	95	95	103
8	70	83	89	93	102
9	68	81	85	89	100
10	68	79	84	87	98
11	67	78	84	85	95
12	61	76	82	85	95
13	61	75	82	85	93
14	59	72	81	84	93
15	56	67	78	84	86
16	56	67	72	81	86
17	48	67	70	76	86
18	47	64	70	74	85
19	43	64	65	72	85
20	39	55	64	70	83
21	39	50	62	66	82
22	28	49	50	50	75
23	-	-	-	-	75
24	-	-	-	-	73
25	-	-	-	-	70
26	-	-	-	-	56

Table 17 PROBABLE RAINFALL BY DURATION
AT JENIANG (5806066)

Unit: mm

Return Period	Rainfall Duration						
	1 hour	3 hours	6 hours	12 hours	24 hours	48 hours	72 hours
2	65	79	85	91	100	132	157
5	81	104	113	121	128	177	205
10	91	121	133	141	147	206	237
20	101	137	151	161	165	234	268
50	114	158	175	185	189	271	307
100	124	174	192	204	206	298	337
200	133	189	210	223	224	326	366
1,000	156	225	252	265	265	389	434
10,000	188	277	311	323	323	479	532

Table 18 PROBABLE RAINFALL BY DURATION
AT ALOR SETAR (6103047)

Unit: mm

Return Period	Rainfall Duration				
	1 hour	3 hours	6 hours	12 hours	24 hours
2	67	87	95	107	116
5	82	110	120	133	150
10	91	125	136	150	173
20	100	139	152	167	195
50	112	158	173	189	223
100	121	172	188	205	245
200	130	186	203	221	266
1,000	150	218	239	258	315
10,000	179	265	290	312	385

Table 19 PROBABLE RAINFALL BY DURATION
AT KUALA NERANG (6206035)

Unit: mm

Return Period	Rainfall Duration				
	1 hour	3 hours	6 hours	12 hours	24 hours
2	59	78	84	87	92
5	74	101	109	111	114
10	84	116	126	126	129
20	94	131	142	142	143
50	107	150	162	162	162
100	116	164	178	178	178
200	125	179	193	193	193
1,000	147	212	229	229	229
10,000	178	259	280	280	280

Table 20 SELECTED STORMS AT JENIANG (5806066)

Storm No. 1

Date: Nov. 12, 1970
Total Rainfall: 91.0 mm

Time (h)	Rainfall (mm/h)
1	54.4
2	27.0
3	7.1
4	1.3
5	1.2

Storm No. 2

Date: Aug. 21, 1971
Total Rainfall: 92.2 mm

Time (h)	Rainfall (mm/h)
1	4.9
2	9.6
3	15.8
4	30.1
5	8.2
6	1.2
7	1.9
8	10.3
9	3.1
10	3.0
11	1.0
12	1.0
13	2.1

Storm No. 3

Date: Sep. 18, 1971
Total Rainfall: 108.2 mm

Time (h)	Rainfall (mm/h)
1	20.2
2	29.6
3	7.4
4	7.2
5	7.3
6	9.0
7	7.8
8	11.3
9	1.4
10	1.4
11	1.1
12	1.2
13	0.1
14	3.2

Storm No. 4

Date: Nov. 19, 1972
Total Rainfall: 97.0 mm

Time (h)	Rainfall (mm/h)
1	36.0
2	47.6
3	5.8
4	2.4
5	4.3
6	0.9

Storm No. 5

Date: Feb. 12, 1975
Total Rainfall: 96.5 mm

Time (h)	Rainfall (mm/h)
1	10.7
2	53.3
3	0.0
4	18.5
5	14.0

Storm No. 6

Date: Sep. 3, 1975
Total Rainfall: 93.6 mm

Time (h)	Rainfall (mm/h)
1	11.9
2	44.1
3	37.6

Storm No. 7

Date: Sep. 30, 1977
Total Rainfall: 122.6 mm

Time (h)	Rainfall (mm/h)
1	87.1
2	33.2
3	2.3

Storm No. 8

Date: Nov. 3, 1978
Total Rainfall: 149.9 mm

Time (h)	Rainfall (mm/h)
1	3.4
2	17.9
3	6.1
4	23.4
5	25.7
6	2.7
7	25.6
8	14.7
9	7.7
10	9.5
11	10.6
12	2.6

Storm No. 9

Date: Jun. 9, 1979
Total Rainfall: 87.5 mm

Time (h)	Rainfall (mm/h)
1	2.0
2	22.1
3	29.2
4	23.7
5	10.0
6	0.5

Storm No. 10

Date: Oct. 9, 1980
Total Rainfall: 166.1 mm

Time (h)	Rainfall (mm/h)
1	31.9
2	35.8
3	42.3
4	47.2
5	2.4
6	2.4
7	4.1

Table 21 PMP ESTIMATION AT BERIS DAMSITE

Storm No.	Date	Rain Gauge Station Name	Rain Gauge Station Altitude (El. m)	Observed 24-hour Rainfall: R (mm)	Dew Point (°C) Measured value at each Station	Dew Point (°C) Their converted value at sea level /1	Precipitable Water (mm) /4 Above sea level: P_1	Precipitable Water (mm) /4 Below level of Station: P_2	Precipitable Water (mm) /4 Above level of Station: $P=P_1-P_2$	Precipitable water conversion factor to site: C /2	Point daily rainfall at Beris dam: R*C (mm)
1	6/6/1979	Malacca Airport	8.5	283.1	24.0	24.0	74.0	0.2	73.8	1.23	350
2	20/1/1980	Johore International Airport	37.8	189.7	22.7	22.9	67.5	0.8	66.7	1.36	260
3	13/10/1979	Sitiawan	7.0	138.6	24.1	24.1	74.7	0.1	74.6	1.22	170
4	18/9/1979	Johore International Airport	37.8	136.3	23.8	24.0	74.0	0.8	73.2	1.24	170
5	19/3/1983	Alor Setar Airport	3.9	119.9	24.1	24.1	74.7	0.1	74.6	1.22	150

Remarks; /1: Reduction of dew point at a rate of 0.4°C per 100 m of increase in altitude is assumed.

/2: $C = \frac{\text{Precipitable Water above Average Altitude in Beris Dam Catchment}^{/3}}{\text{Precipitable Water above Level of Each Station (P)}}$

/3: This value can be obtained by the following manner:

(1) At Alor Setar airport (almost El. 0 m); Max. dew point = 27°C at sea level (1979 to 1983)
Precipitable water = 97 mm /4

(2) At Beris dam catchment: Average altitude = El. 245 m
Precipitable water below the average altitude = 6 mm /4

(3) Precipitable water above average altitude in Beris dam catchment = 97 mm - 6 mm = 91 mm

/4: The precipitable waters were obtained based on Annex I "Manual for Estimation of Probable Maximum Precipitation" (Ref. E 2)

Table 22 DIMENSIONLESS DURATION CURVES FOR PROBABLE RAINFALL AT JENIANG (5806066)

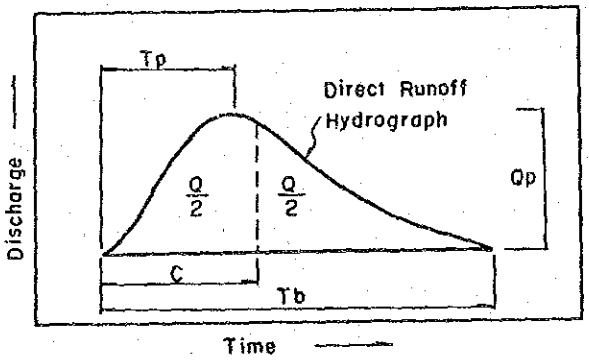
Unit: %

Return Period	Rainfall Depth by Duration				
	1 hour	3 hours	6 hours	12 hours	24 hours
2	65	79	85	91	100
5	63	81	88	95	100
10	62	82	90	96	100
20	61	83	92	98	100
50	60	84	93	98	100
100	60	84	93	99	100
200	59	84	94	100	100
1,000	59	85	95	100	100
10,000	58	86	96	100	100

Table 23 SUMMARY OF SELECTED DIRECT FLOOD HYDROGRAPHS OBSERVED AT JENIANG (5806066)

Flood No.	Date	Qp (m^3/s)	C (hours)	Dp	Tb (hours)	Tp (hours)	Tp/Tb
1	Oct. 17, 1970	160	23.7	0.963	2.53C	0.93C	0.37
2	Dec. 19, 1972	305	53.5	0.953	3.08C	0.90C	0.29
3	Dec. 10, 1973	572	65.2	0.829	2.58C	0.97C	0.38
4	Nov. 27, 1979	169	26.0	0.733	2.73C	0.88C	0.32
Mean				0.87	2.73C	0.92C	0.34

Remarks; Analysis of Direct Flood Runoff Hydrograph



where,

Q : direct runoff volume in m^3/s-hours

C : hours to Q/2

Tp : hours to peak

Tb : hours of direct runoff

Qp : direct runoff peak discharge in m^3/s

Dp : peak ordinate of dimensionless direct runoff hydrograph = Qp·C/Q

Table 24 CHARACTERISTICS OF DIRECT FLOOD RUNOFF IN PENINSULAR MALAYSIA

Catchment Type	Dp	Tb	Tp	Tp/Tb
Group 1	1.06	1.89C	0.94C	0.50
Group 2	0.89	2.24C	0.87C	0.39
Group 3	0.75	2.67C	0.58C	0.22

where; Group 1 - Whole catchment very steep and covered in virgin jungle

Group 2 - Upper catchment very steep and jungle covered, lower catchment reaches hilly and covered predominantly with rubber

Group 3 - Whole catchment undulating with variable vegetation including jungle, rubber and agricultural development

Table 25 DESIGN FLOOD DISCHARGE AT BERIS DAMSITE

Return Period (years)	Peak Discharge (m^3/s)
2	194
10	308
20	364
50	427
100	481
200	529
1,000	647
10,000	817
PMF	897

Remark; The peak discharges include the base flow component of 6.7 m^3/s.

Table 26 RESULTS OF FLOOD ROUTINE AT BERIS DAM

	Total Rainfall Depth (mm)	Ip (m^3/s)	B_E (m)	MWL (m)	Op (m^3/s)
100-year Rainfall with 24-hour Duration + 24-hour PMP	556	4,208	20	87.7	196
			30	87.5	270
			40	87.4	335

where, Ip: maximum inflow discharge to Beris dam in m^3/s

B_E: effective width of spillway in m

MWL: maximum reservoir water level in m

Op: peak overflow discharge from spillway weir in m^3/s

Remark; The crest elevation of the spillway weir is 85.0 m.

FIGURES

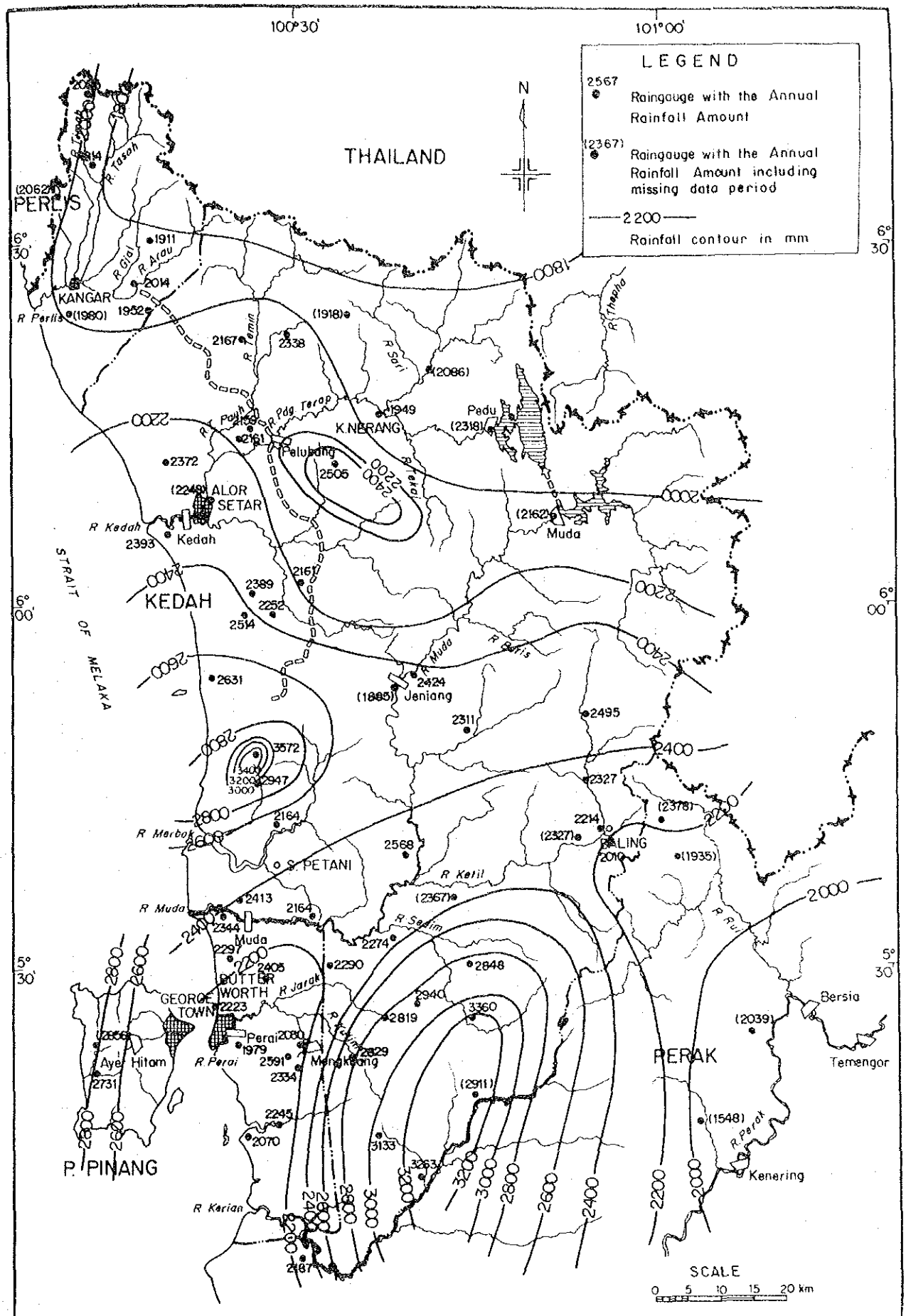


Fig. 1 Isohyetal Map of Annual Rainfall

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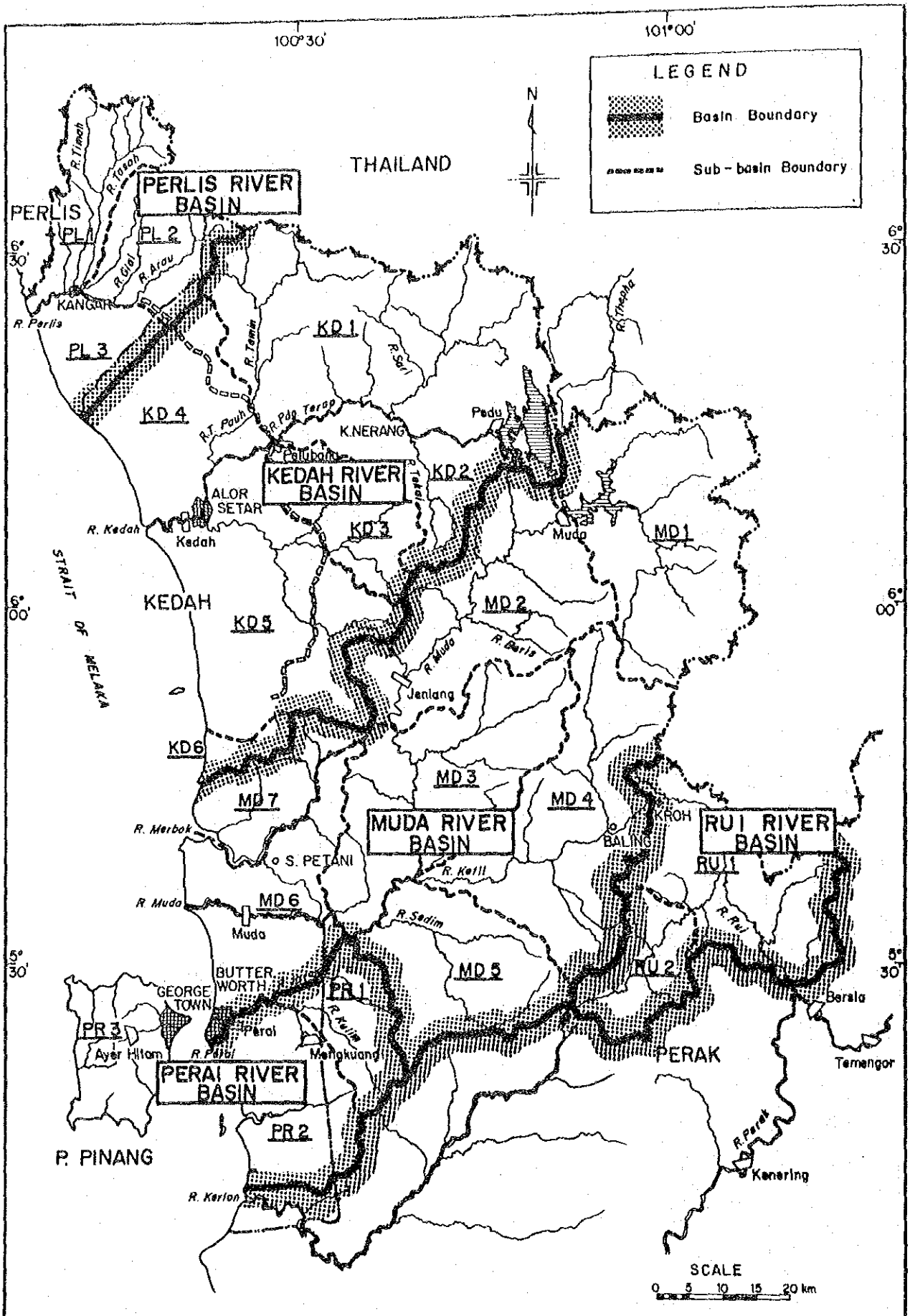

Fig. 2 Basin Division

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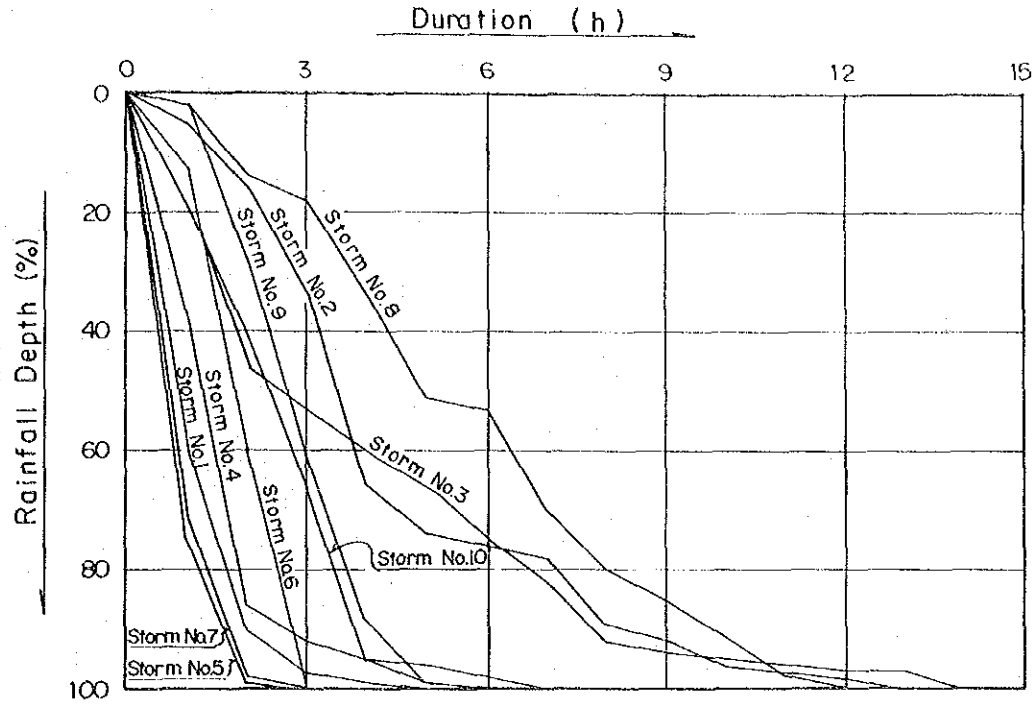

Fig. 3 Depth - Duration Curves of Selected Storms at Jeniang (5806066)

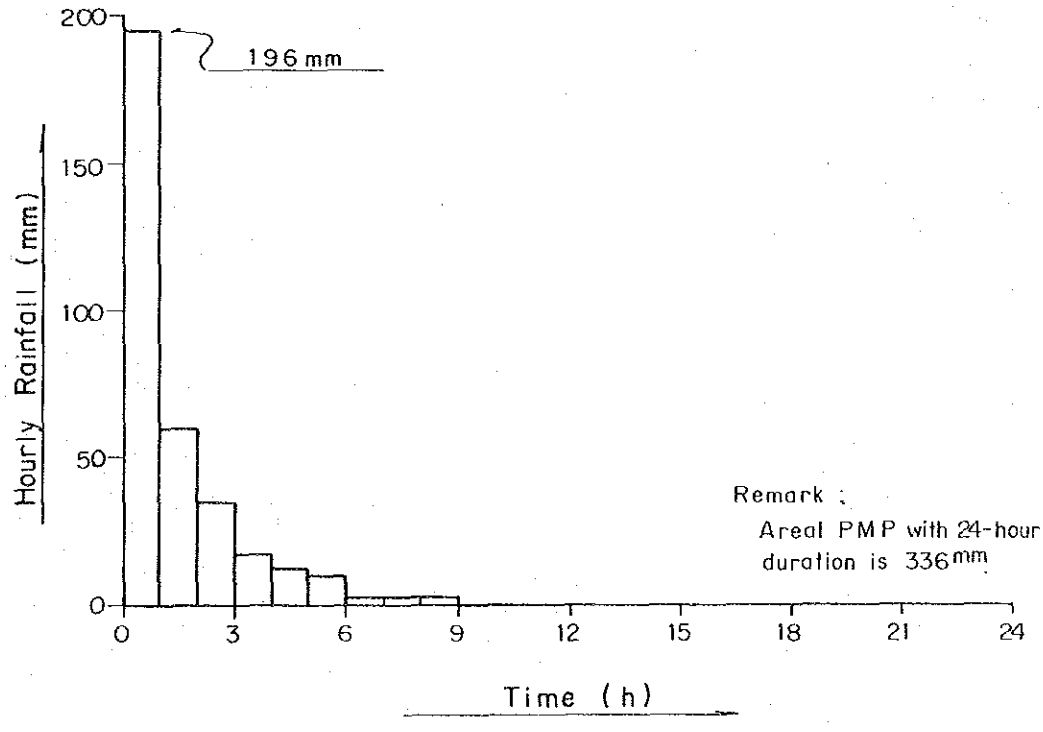

Fig. 4 Areal P M P Temporal Pattern in Beris Dam Catchment

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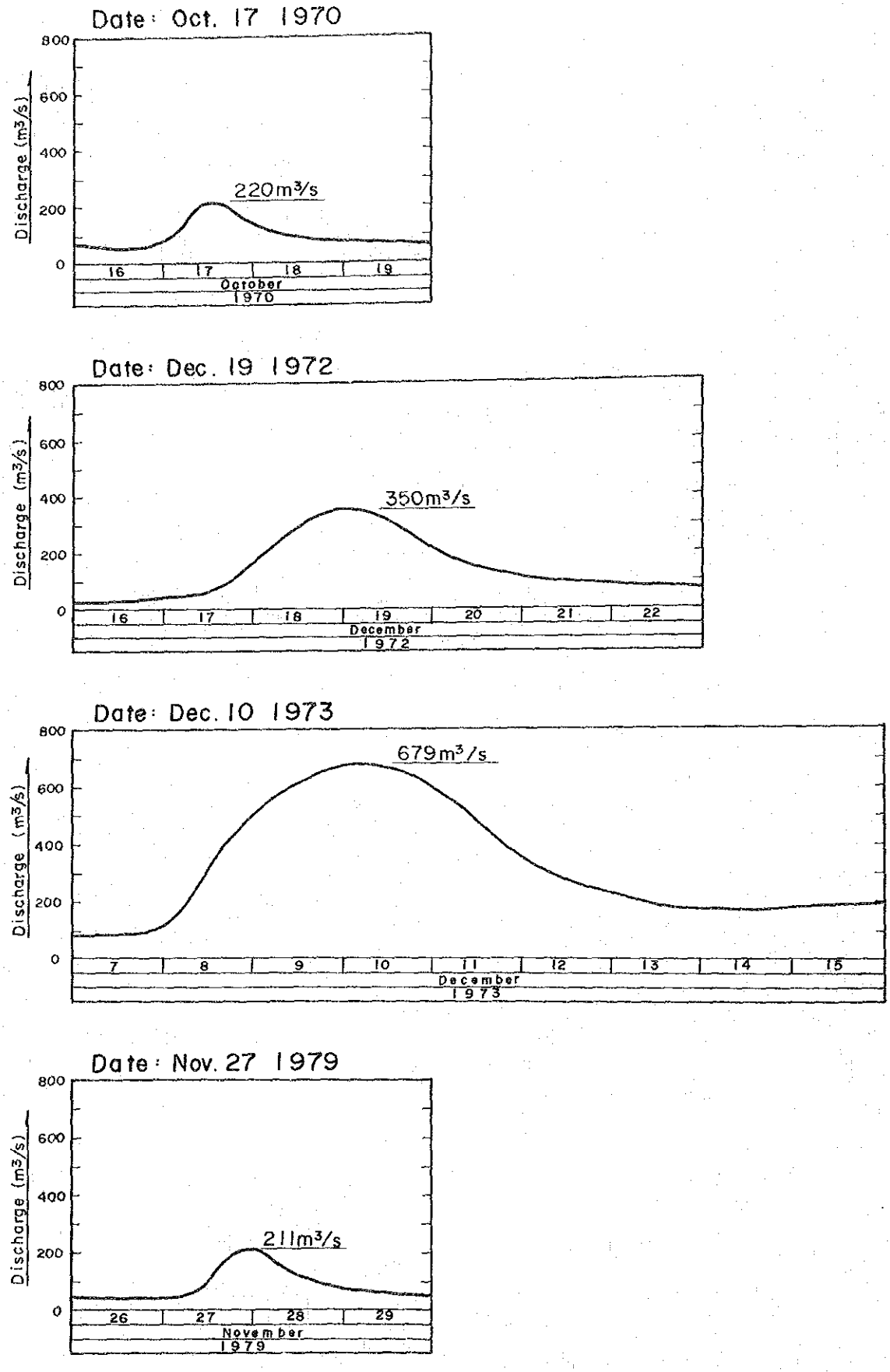

Fig. 5 Actual Hydrographs at Jeniang (5806066)

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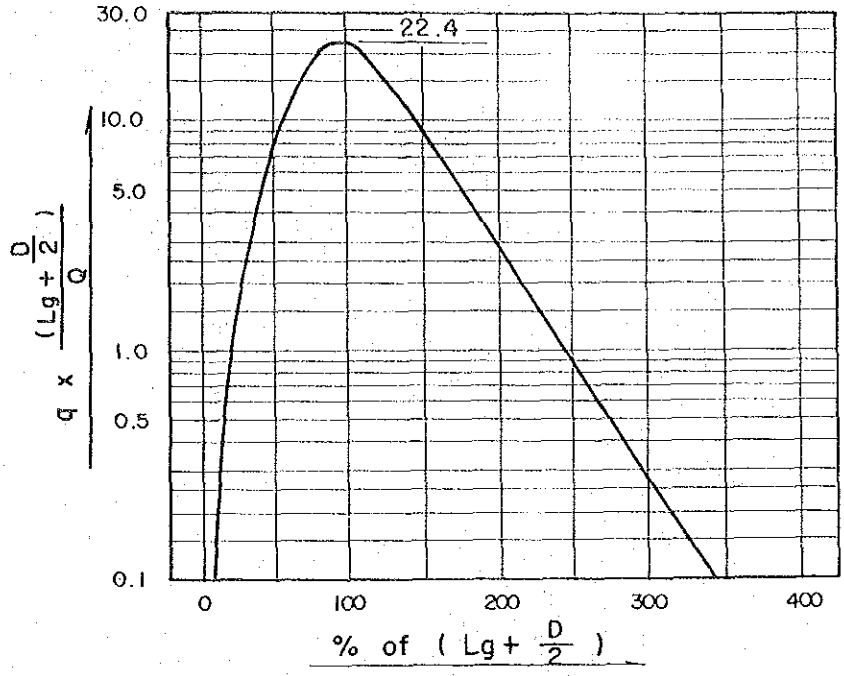

q : discharge of direct runoff (m^3/s)
Lg : catchment lag (h)
D : duration of rainfall excess (h)
Q : direct runoff volume (m^3/s - days)

Fig. 6 Dimensionless Hydrograph at Jeniang (5806066)

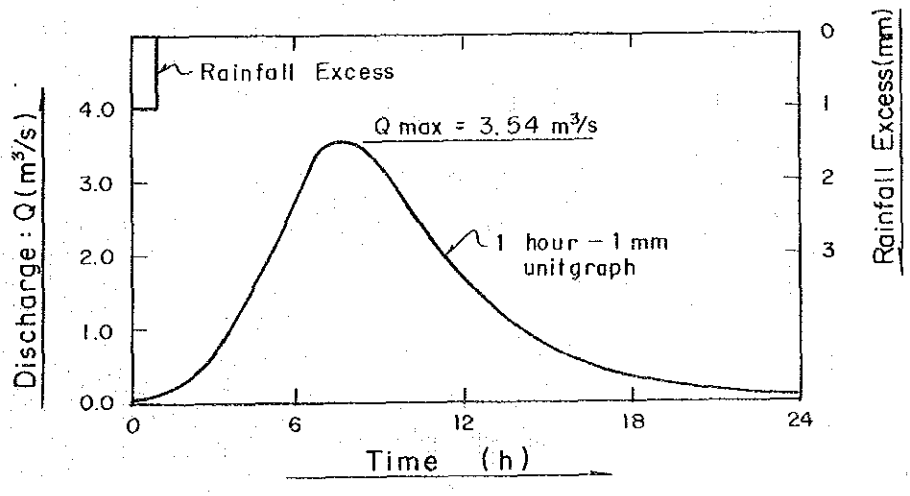

Fig. 7 Unitgraph at Beris Damsite (1 hour - 1mm)

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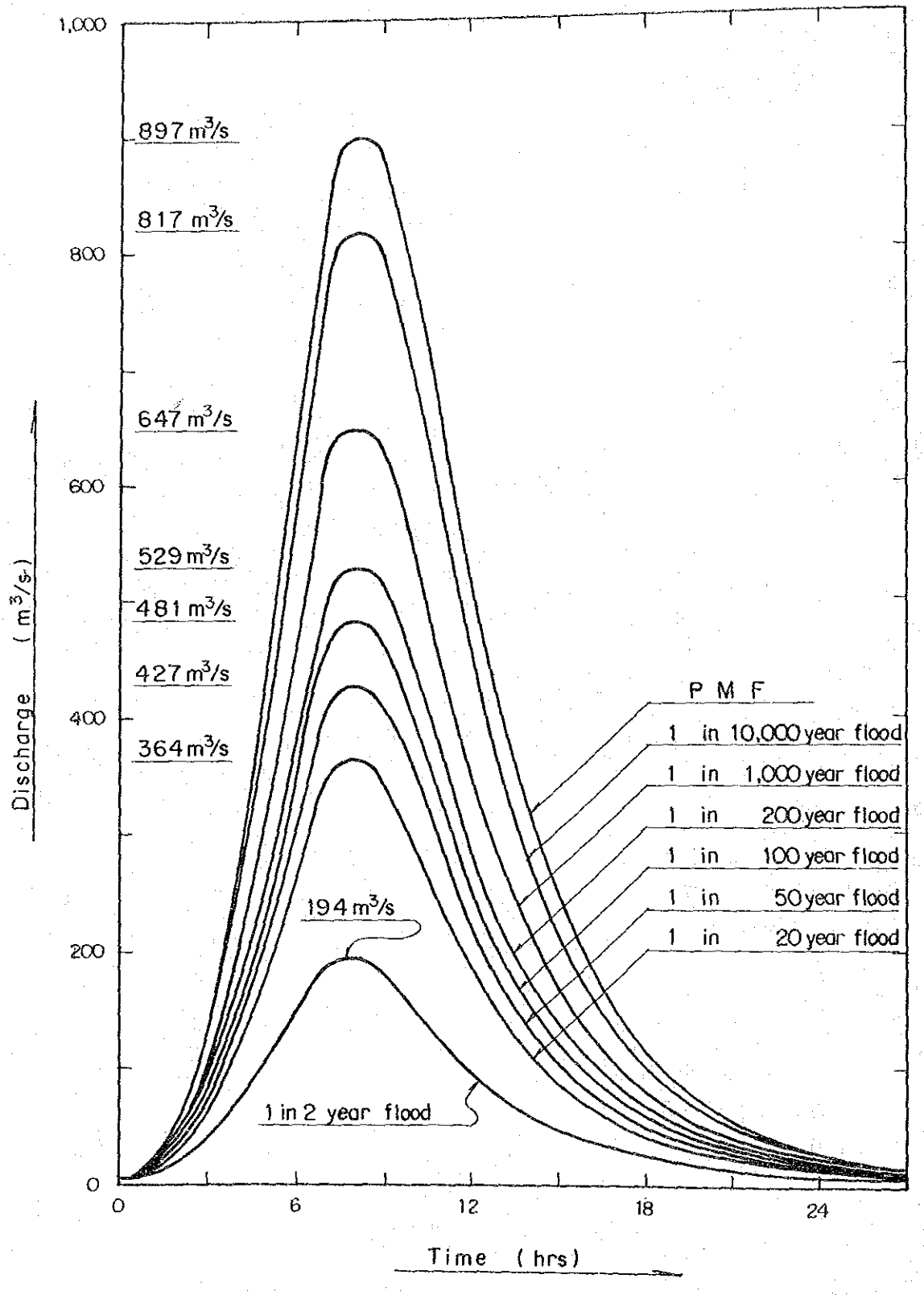

Fig. 8 Design Flood Hydrographs at Beris Damsite

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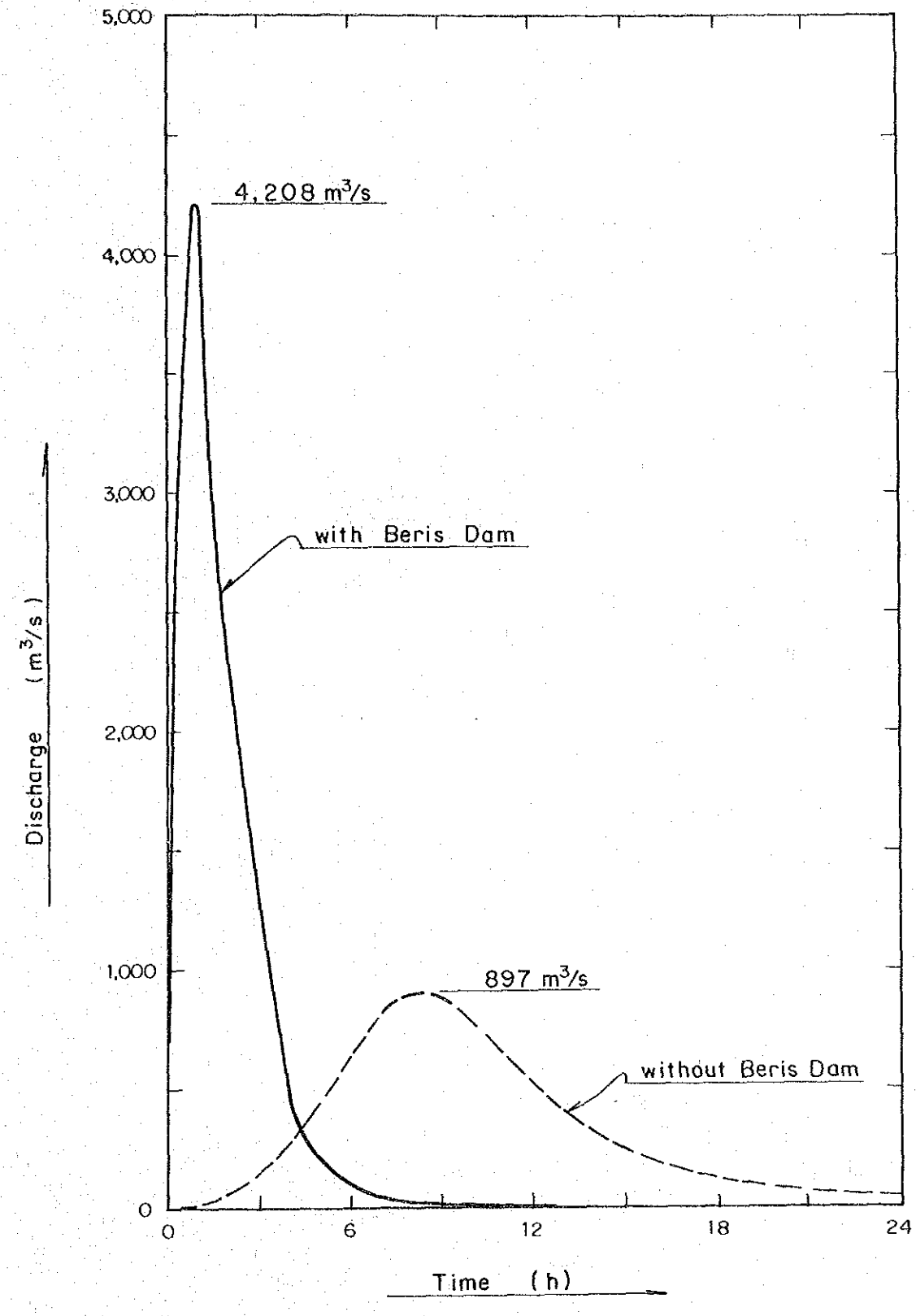

Fig. 9 PMF Hydrograph at Beris Dam

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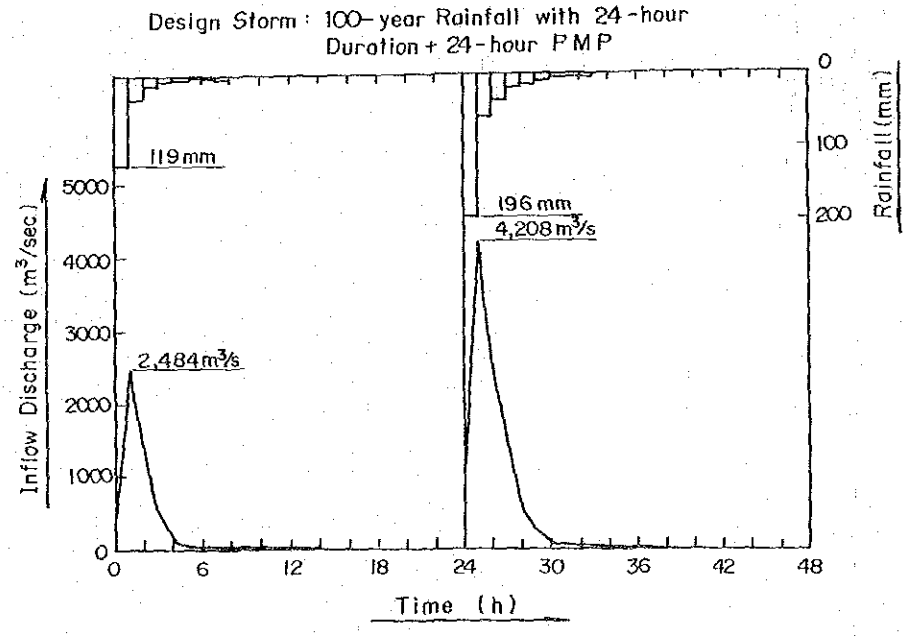

Fig. 10 Inflow Hydrograph for Flood Routine of Beris Reservoir

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