

depth for various durations.

As a result of comparative study for the duration from 3-day to 7-day, the duration of 5-day having the highest correlation coefficient on the above conditions was determined as the optimum duration of design rainfall.

For simulating a flood runoff, storage function method was applied to the runoff calculation. All the parameters calibrated on the basis of 1983, 1984 and 1986 flooding as given in Tables III.3.2 and III.3.3.

3.2 Probable Flood at Guillemard Bridge

The daily rainfall data in the upstream basin for the period of flooding at Guillemard Bridge are not available before 1970, while the records of annual maximum flood peak discharge at Guillemard Bridge are available for the period from 1941 to 1986. The number of samples of annual maximum peak discharge is about two times more than that of basin mean rainfall data. The results of frequency analysis of the annual maximum peak discharge at Guillemard Bridge is shown on Fig.III.3.4.

Furthermore, the second, third and fifth largest floods were recorded in a series of annual maximum peak discharges, while the basin mean rainfall is unable to estimate for those floods because of no rainfall data in the upstream basin.

In the Master Plan Study, probable rainfall depth of 5-day basin mean was estimated to enlarge the recorded hourly hyetographs. The recorded hyetographs during the flood in December 1983, December 1984 and November 1986 were enlarged up to the 5-day rainfall depth with the selected return period from which the simulated peak discharge is derived corresponding to the probable peak discharge at Guillemard Bridge.

The probable rainfall depth and probable flood peak discharges at storage damsites, Kuala Krai and Guillemard Bridge are enumerated in Table III.3.4.

According to the probable distribution of annual peak discharge at Guillemard Bridge, the peak discharge of 15,589 m³/sec in 1967 corresponds to the probability of once in about 50-year. The simulated 50-year probable flood hydrograph is verified with the flood hydrograph recorded at Guillemard Bridge in 1967 as shown in Fig.III.3.5. The concurrent 50-year probable flood hydrographs at the storage damsites are also simulated as shown in Figs.III.3.6 to III.3.7.

3.3 Probable Flood at Damsite

The following methods are applied to estimate the probable flood at damsites;

- (i) Method-1

To estimate the probable peak discharge by the frequency analysis on the basis of the annual maximum peak discharge at damsite.

(ii) Method-2

To estimate the probable peak discharge and its shape of hydrograph on the basis of the probable basin mean rainfall of the catchment of proposed dam. The pattern of observed hourly rainfall is applied to the probable basin mean rainfall.

Method-1 is generally adopted to estimate the probable flood peak discharge. However, the numbers of data of annual maximum peak discharge is limited at Lebir damsite, and none of water level gauging station locates at Kemubu damsite. Thus, the estimation of probable peak discharge by Method-1 is abandoned.

Method-2 is to generate the basin mean rainfall depth on the basis of the correlation analysis among the stations in and around the basin. In case the rainfall data are missing, those data are obtained by multiplying the correlation coefficient between stations. Five-day rainfall depth at the representative 14 rainfall stations are collected on the basis of the date when the annual maximum peak discharge occurred at Guillemard Bridge. The observation of water level at Guillemard Bridge, however, commenced in 1960 by DID, and the observation of rainfall in the upstream basin has carried out since 1960's. The basin mean five-day rainfall depth during flooding is then calculated for the period from 1960 through 1986. The basin mean five-day rainfall depth during flooding is summarized in Table III.3.5. The data show that the basin mean rainfall depth of more than 500 mm occurred in 1966 (during 1967 flood).

The basin mean 5-day rainfall depth for the catchment of Kemubu and Lebir dams is estimated by the Thiessen's method as given in Tables III.3.6 and III.3.7. The results of frequency analysis are enumerated below.

(Unit:mm)

Return period (years)	Damsite	
	Kemubu	Lebir
200	469	850
100	420	767
50	370	683
30	333	622
20	304	572
10	253	486
5	200	397

In order to simulate the probable peak discharge and its hydrograph, the recorded hyetographs in 1983, 1984 and 1986 were

herefore enlarged up to the estimated probable basin mean rainfall depth for various probabilities. The results of calculation are summarized in Table III.3.8 for Kemubu dam and Table III.3.9 for Lebir dam. Among three types of hyetograph, the largest simulated peak discharge for each return period was adopted for the probable peak discharge at damsite as enumerated below.

(Unit:m³/sec)

Return period (years)	Damsite	
	Kemubu	Lebir
200	9,600	10,400
100	8,300	9,100
50	6,900	7,800
30	6,000	6,800
20	5,300	6,000
10	4,200	4,800
5	3,000	3,400

4 SPILLWAY DESIGN FLOOD

4.1 Probable Maximum Precipitation (PMP)

The one day probable maximum precipitation is estimated by Hershfield's method recommended by World Meteorological Organization (WMO) for the area having sparse rainfall data.

Since the records of less than ten years should not be used for the above method, the records at six stations are applied to the method.

The results are given below. The adjustment factor of 1.16 for the observation period of 24 hours is multiplied, and the ratio of PMP to the 100-year probable rainfall is regarded as the maximization factor as shown below:

Station	PMP (mm)	100-yr Probable Rainfall (mm)	Maximization Factor
Kuala Pertang	1,489	518	2.875
Lubok Bungor	1,493	463	3.225
Dabong	883	300	2.941
Bertam	817	254	3.215
Kuala Krai	1,669	481	3.470
Machang	2,067	667	3.100
Average			3.138

The maximization factor of 3.138 for 100-year probable point rainfall is applied to the estimation of point PMP for the

remaining stations. Furthermore, the point PMP is converted to basin mean PMP by multiplying the reduction factor considering areal distribution of heavy rainfall. The above factor is applied to the 100-year probable point rainfall for the duration of more than one day. The basin mean 5-day PMP was then estimated by the following procedures:

- (i) The one day PMP is arranged at third day at the centre of duration.
- (ii) The difference between one-day and two-day PMP is arranged at second day.
- (iii) As well as the arrangement of second day, the difference between two-day and three-day PMP is arranged at fourth day.
- (iv) Finally, the difference between 3-day and 5-day PMP is arranged at first and fifth days.

The adopted PMP for the duration of five days is summarized in Table II.4.11.

As for PMP hyetograph, the arithmetic average of recorded hourly rainfall of more than 300 mm/day in the Kelantan River basin was applied to the third day, while the uniformly distributed hyetograph is assumed for the remaining days.

4.2 Probable Maximum Flood (PMF)

Probable maximum flood was estimated on the basis of the probable maximum precipitation. The magnitude of probable maximum flood is evaluated referring to the following modified Creager's equation:

$$q = C \cdot A^b \dots\dots\dots (Eq.4.1)$$

$$b = A^{-0.05} - 1 \dots\dots\dots (Eq.4.2)$$

where, q : specific discharge in $m^3/sec/km^2$,
 A : catchment area in km^2 , and
 C : Coefficient depending upon the characteristic of the basin.

The envelope curve for $C = 100$ gives the general trend of all the world maximum flood records with a few exceptions, while it is known that the maximum floods recorded in a region covering Malaysia, Indonesia and Thailand correspond to the envelope curve for $C = 34$. The Creager's coefficient of the probable maximum flood for storage damsite is enumerated below:

Proposed Damsite	C.A. (km ²)	PMF (cms)	Creager's Coefficient
Nenggiri	3,690	6,394	27
Kemubu	5,630	10,325	38
Lower Pergau	1,280	4,339	29
Dabong	7,480	12,061	40
Lebir	2,480	10,247	55

4.3 Spillway Design Flood

The probable maximum floods for storage dams are, however, less reliable since the heavy rainfall data in the upstream basin are limited. The magnitude of probable maximum floods is then evaluated under the following criteria:

- (i) recorded maximum peak discharge
- (ii) 200-year probable peak discharge, and
- (iii) peak discharge referring to the largest Creager's coefficient in and around the basin.

The largest peak discharge among the above three floods is adopted to the spillway design flood of concrete gravity dam, while the safety factor of 1.2 is multiplied by the peak discharge for the rockfill type dam according to the dam construction code in Japan.

The comparison of above three peak discharges is given in Table III.5.1. The largest value was adopted for the spillway design flood as follows:

Proposed Damsite	Spillway Design Flood	
	Peak Discharge (cms)	Volume (MCM)
Nenggiri	15,500	2,367
Kemubu	15,000	4,747
Lower Pergau	9,900	4,158
Dabong	16,600	6,057
Lebir	12,400	2,933

The spillway design flood hydrographs for Kemubu and Lebir dams are shown in Fig.III.5.1. These specific peak discharges for spillway design flood are compared with those of the other dam schemes in the Peninsular Malaysia and other asian countries as shown in Fig.III.5.2.

Table III.3.1 Area of Thiessen's Polygon contributed to Sub-basin

(Unit: sq. km)

No. of Sub-basin	Biau G. Musang	Chiku	Aring	Gemala	Bertam	Dabong	L. Bungor	Lalok K. Kerai	Jeli Machang	Lawang K. Pertang	Total	
1	719										719	
2	508	10									518	
3	388			136							524	
4		18		225							243	
5				683							683	
6				607			35				642	
7				318	109						427	
8	125	358	87		156						570	
9		318	96		183						570	
10			16		279						450	
11		251			84						279	
12					347						431	
13						353		373		28	754	
14					188	342					530	
15					140						140	
16					194			115			309	
17			619								619	
18			283								283	
19		170	251								421	
20		264	230								494	
21			299		66		298				663	
22					10		535				545	
23							84	199	30		313	
24								140			140	
25								93	8	323	424	
26								44	66	107	389	
Total	1,740	704	868	1,969	887	869	840	917	591	373	415	12,080

Table III.3.2 Runoff Parameter for Sub-basin

No.	Name of Basin	C.A. (sq.km)	River Length (km)	River Gradient	K	P	TL (hours)	Base Flow (cms)
1	Berok	719	40.4	1/	30	42.9	0.500	1.0
2	Chenderoh	518	23.6	1/	200	24.3	0.500	1.0
3	Betis	524	55.4	1/	350	20.5	0.500	2.0
4	Chepuan	243	16.2	1/	20	48.4	0.500	0.0
5	Perias	683	54.6	1/	30	42.9	0.500	2.0
6	Puian	642	45.6	1/	40	39.3	0.500	2.0
7	Wias	427	24.8	1/	20	48.4	0.500	1.0
8	Upper Galas	570	45.4	1/	70	33.3	0.500	2.0
9	Middle Galas	570	28.6	1/	35	41.0	0.500	1.0
10	Chiku	450	61.2	1/	120	28.3	0.500	2.0
11	Lower Galas 1	433	22.0	1/	20	48.4	0.500	0.0
12	Lower Galas 2	277	26.0	1/	20	48.4	0.500	1.0
13	Upper Pergau	754	68.4	1/	60	34.8	0.500	3.0
14	Middle Pergau	530	24.6	1/	20	48.4	0.500	1.0
15	Lower Pergau	140	18.0	1/	20	48.4	0.500	28.0
16	Teku	309	22.0	1/	50	36.8	0.500	62.0
17	Upper Lebir	619	34.4	1/	30	42.9	0.500	1.0
18	Kielinsar	283	18.4	1/	35	41.0	0.500	0.0
19	Aring	421	74.4	1/	90	30.9	0.500	3.0
20	Relai	494	77.6	1/	50	36.8	0.500	25.0
21	Chalil	663	22.8	1/	300	21.5	0.500	1.0
22	Rek	545	22.4	1/	30	42.9	0.500	109.0
23	Pahi	313	28.8	1/	35	41.0	0.500	63.0
24	Taku	140	18.8	1/	70	33.3	0.500	14.0
25	Nalu	424	34.0	1/	60	34.8	0.500	21.0
26	Sokor	389	31.4	1/	60	34.8	0.500	1.0
Total		12,080						86.0

Table III.3.3 Runoff Parameter for Sub-divided River Channel

No.	Name of Channel	River		K	P	TL (hours)	Remarks
		Length (km)	Gradient				
1	Upper Nenggiri	49.2	1/ 600	34.0	0.50	1.0	
2	Middle Nenggiri	30.4	1/ 800	42.0	0.65	1.0	
3	Lower Nenggiri	32.0	1/ 1000	58.0	0.75	1.0	
4	Upper Galas	45.0	1/ 900	63.0	0.60	1.0	
5	Middle Galas 1	41.4	1/ 1900	106.0	0.76	1.0	Q<2,500
				53.0	0.95	1.0	Q>2,500
6	Middle Galas 2	25.0	1/ 2300	85.0	0.76	0.0	Q<2,500
				45.0	0.95	1.0	Q>2,500
7	Middle Pergau	18.6	1/ 4000	108.0	0.85	1.0	Q<1,800
				26.0	1.10	2.0	Q>1,800
8	Lower Pergau	15.0	1/ 4000	110.0	0.85	0.0	Q<1,800
				28.0	1.10	0.0	Q>1,800
9	Lower Galas	36.8	1/ 2500	87.0	0.71	1.0	
10	Upper Lebir	26.0	1/ 540	142.0	0.74	0.0	
11	Middle Lebir	39.6	1/ 1700	150.0	0.79	1.0	
12	Lower Lebir-1	16.4	1/ 3000	114.0	0.70	1.0	
13	Lower Lebir-2	20.4	1/ 4000	125.0	0.72	1.0	
14	Kelantan-1	18.8	1/ 5000	142.0	0.60	1.0	Q<6,000
				71.0	0.75	1.0	Q>6,000
15	Kelantan-2	25.4	1/ 5800	152.0	0.60	1.0	Q<7,000
				76.0	0.75	1.0	Q>7,000

Table III.3.4 Comparison of Probable Rainfall Depth and Probable Flood Peak Discharges

Return Period (years)	Basin Mean Rainfall (mm)	Hyetograph		Probable Flood Peak Discharge (cms)							
		Type	Depth (mm)	Ratio of Expansion	Nenggiri Damsite	Kemubu Damsite	Pergau Damsite	Dabong Damsite	Lebir Damsite	Kuala Krai	Guillemard Bridge
100	699	1983	475.7	1.47	4,204	5,597	3,462	9,451	6,231	18,841	18,331
	580	1984	300.6	1.93	5,527	5,255	2,961	8,559	8,052	19,669	18,373
	695	1986	289.7	2.40	3,432	5,205	3,084	8,626	7,039	18,806	18,382
50	633	1983	475.7	1.33	3,482	4,943	3,145	8,431	5,561	16,831	16,383
	530	1984	300.6	1.76	4,668	4,624	2,698	7,648	7,102	17,490	16,369
	626	1986	289.7	2.16	2,959	4,559	2,837	7,682	6,201	16,696	16,314
30	576	1983	475.7	1.21	2,901	4,352	2,907	7,557	4,997	15,110	14,714
	490	1984	300.6	1.63	3,957	4,134	2,519	6,911	6,342	15,758	14,768
	571	1986	289.7	1.97	2,556	4,078	2,666	6,995	5,539	15,092	14,749
20	533	1983	475.7	1.12	2,486	3,939	2,715	6,918	4,559	13,826	13,468
	450	1984	300.6	1.50	3,248	3,796	2,392	6,402	5,604	14,318	13,437
	524	1986	289.7	1.81	2,212	3,716	2,503	6,444	4,983	13,777	13,466
10	-	1983	475.7	-	-	-	-	-	-	-	-
	395	1984	300.6	1.31	2,327	3,152	2,159	5,497	4,626	12,095	11,422
	452	1986	289.7	1.56	1,584	3,102	2,248	5,542	4,104	11,685	11,429
5	-	1983	475.7	-	-	-	-	-	-	-	-
	316	1984	300.6	1.05	1,204	2,409	1,791	4,383	3,259	9,184	8,665
	351	1986	289.7	1.21	868	2,363	1,871	4,393	2,893	8,878	8,680

Note : The above values are calculated on the basis of the return period at Guillemard Bridge.

Table III.3.5 Five (5) Days Rainfall Depth during Annual Maximum Peak Discharge

(Unit:mm)

Year	Blau	G. Musang	Chiku	Aring	Gemala	Bertam	Dabong	L. Bungor	Lalok	K. Krai	Kg. Jeli	Pertang	Machang	Lawang	Average
1960	73.1	110.1	119.4	276.9	121.1	152.6	193.5	157.5*	216.4	221.7	236.8	247.3*	450.4	227.5	168.6
1961	64.4	88.1	73.9	229.4	106.0	101.2	176.8	151.8*	145.9	143.6	175.7	163.8*	379.7	147.7	133.1
1962	71.9	107.2	113.4	270.7	119.1	145.9	191.3	107.5*	207.2	211.5	228.8	236.4*	441.1	217.1	160.5
1963	68.4	98.1	94.6	251.1	112.9	124.6	184.4	136.6*	178.1	179.2	203.5	201.9*	411.9	184.1	148.1
1964	57.6	71.0	38.6	192.6	94.3	61.3	163.8	146.2*	91.2	82.9	128.3	99.0*	324.9	85.7	105.4
1965	38.1	21.6	261.0	424.8	142.5	148.6	40.2	328.9*	435.9	465.1	426.9	507.3*	187.7*	476.1	238.2
1966	127.2	247.0	402.6	572.6	581.2	455.0	701.9	676.9	631.2	708.4	617.0	767.2	1028.9*	724.6	510.3
1967	104.8	190.3	263.2	427.1	140.8	218.2	215.3	542.4*	439.3	468.9	316.5	356.4*	207.0*	331.8	280.8
1968	52.1	56.9	26.3	179.8	104.4	10.1	175.0*	180.9*	72.2	61.9	169.2	154.9*	185.6*	139.2	102.7
1969	77.1	120.2	140.3	298.8	129.6	182.1	202.9*	340.0*	248.9	257.8	271.3	294.5*	271.6*	272.6	197.7
1970	110.3	204.4	164.1	323.7	178.7	139.4*	257.1*	330.2*	285.8	298.7*	260.2	279.4*	242.6*	258.2	224.3
1971	63.6	86.1	69.8	225.2	149.5	208.8*	224.9*	224.6*	139.6*	136.6*	137.7	111.8*	90.7*	98.0	149.5
1972	111.1	206.3*	277.1	441.6	236.6	187.9*	321.1*	619.4*	460.9*	492.8*	621.0	772.7*	773.4*	729.8	346.3
1973	129.5	253.0	323.1	489.7	288.7	272.4*	378.7*	882.6*	474.0*	571.9*	523.0*	734.1*	862.2	692.9	399.6
1974	47.0	44.0*	152.7	311.7	67.3	190.2*	134.0*	74.5*	268.1*	279.0*	386.0*	413.0*	655.0*	385.9	172.2
1975	76.2	118.1*	80.0	235.8	139.2	108.1*	213.5*	229.0*	155.4*	154.1*	141.0*	462.0*	155.5*	432.8	164.0
1976	46.2	42.0*	60.1	215.1	30.6	68.4	58.0*	130.5*	101.0*	120.0*	200.0*	130.5*	188.0*	115.9	93.6
1977	43.5	35.1*	58.4	115.0*	31.1	102.7	94.0*	97.5*	148.0*	117.0*	97.0*	146.5*	139.0*	131.2	82.1
1978	49.0	49.0*	164.0*	323.5*	74.5*	99.8*	142.0*	339.0*	144.0*	298.5*	292.0*	287.0*	483.9*	265.5	170.9
1979	146.0*	309.0*	186.5*	530.0*	319.8*	399.0*	413.0*	665.5*	509.0*	342.5*	328.5*	282.5*	197.5*	261.2	364.0
1980	65.7*	91.4*	80.8	236.6	12.5*	109.0	89.0*	0.0*	156.6	155.5*	185.0*	176.5*	390.5	159.8	105.7
1981	14.5	34.0*	71.0	118.0*	57.3	62.6*	123.0*	202.0*	91.0*	58.5*	277.0*	225.0*	431.5*	206.2	93.6
1982	113.0*	138.0*	218.0*	259.0*	118.5*	249.5*	216.0*	431.0*	308.0*	418.5*	322.0*	477.0*	669.0*	362.0*	237.9
1983	150.0*	278.0*	461.3*	641.0*	254.0*	505.8*	648.0*	638.7*	701.0*	790.0*	576.9*	683.6*	892.5*	567.0*	475.7
1984	76.5*	137.0*	232.9*	381.0*	209.0*	243.0*	273.0*	349.0*	498.0*	607.6*	506.6*	641.5*	586.0*	600.0*	300.6
1985	82.5*	134.0*	2.5*	209.0*	88.1*	36.5*	157.0*	269.5*	88.0*	85.0*	104.0*	53.0*	237.0*	44.5*	114.3
1986	28.0*	109.0*	192.2*	341.1*	154.0*	402.0*	289.5*	377.0*	558.5*	656.0*	471.5*	499.0*	567.0*	555.5*	289.7
Max.	150.0	309.0	461.3	641.0	581.2	505.8	701.9	882.6	701.0	790.0	621.0	772.7	1028.9	729.8	510.3
Min.	14.5	21.6	2.5	115.0	12.5	10.1	40.2	0.0	72.2	58.5	97.0	53.0	90.7	44.5	82.1
Ave.	77.3	125.1	160.3	315.6	150.4	184.6	232.5	319.6	287.2	310.5	303.8	348.3	424.1	321.2	215.9

Remarks : Mark '*' means recorded rainfall data.

Table III.3.6 5-day Rainfall for Kemabu Dam

(Unit:mm)

Year	Blau	Musang	Chiku	Aring	Gemala	Bertam	Bungor	Average
1960	73.1	110.1	119.4	276.9	121.1	152.6	157.5	109.5
1961	64.4	88.1	73.9	229.4	106.0	101.2	151.8	88.4
1962	71.9	107.2	113.4	270.7	119.1	145.9	107.5	106.4
1963	68.4	98.1	94.6	251.1	112.9	124.6	136.6	97.9
1964	57.6	71.0	38.6	192.6	94.3	61.3	146.2	72.1
1965	38.1	21.6	261.0	424.8	142.5	148.6	328.9	107.0
1966	127.2	247.0	402.6	572.6	581.2	455.0	676.0	369.4
1967	104.8	190.3	263.2	427.1	140.8	218.0	542.4	158.6
1968	52.1	56.9	26.3	179.8	104.4	10.1	180.9	64.8
1969	77.1	120.2	140.3	298.8	129.6	182.0	340.0	121.6
1970	110.3	204.4	164.1	323.7	178.7	139.4	330.2	155.9
1971	63.6	86.1	69.8	225.2	149.5	208.8	224.6	117.2
1972	111.1	206.3	277.1	441.6	236.6	187.9	619.4	193.8
1973	129.5	253.0	323.1	489.7	288.7	272.4	882.6	239.8
1974	47.0	44.0	152.7	311.7	67.3	190.2	74.5	81.3
1975	76.2	118.1	80.0	235.8	139.2	108.1	229.0	109.3
1976	46.2	42.0	60.1	215.1	30.6	68.4	130.5	45.2
1977	43.5	35.1	58.4	115.0	31.1	102.7	97.5	47.4
1978	49.0	49.0	164.0	323.5	74.5	99.8	339.0	75.9
1979	146.0	309.0	186.5	530.0	319.8	399.0	665.5	267.4
1980	65.7	91.4	80.8	236.6	12.5	109.0	0.0	57.1
1981	14.5	34.0	71.0	118.0	57.3	62.6	202.0	44.0
1982	113.0	138.0	218.0	259.0	118.5	249.5	431.0	146.2
1983	150.0	278.0	461.3	641.0	254.0	505.8	638.7	276.9
1984	76.5	137.0	232.9	381.0	209.0	243.0	349.0	166.6
1985	82.5	134.0	2.5	209.0	88.1	36.5	269.5	80.3
1986	28.0	109.0	192.2	341.1	154.0	402.0	377.0	146.3
Max.	150.0	309.0	461.3	641.0	581.2	505.8	882.6	369.4
Min.	14.5	21.6	2.5	115.0	12.5	10.1	0.0	44.0
Ave.	77.3	125.1	160.3	315.6	150.4	184.6	319.5	131.3

Table III.3.7 5-day Rainfall for Lebir Dam

(Unit:mm)

Year	Chiku	Aring	Bertam	Lalok	Average
1960	119.4	276.9	152.6	216.4	238.8
1961	73.9	229.4	101.2	145.9	188.7
1962	113.4	270.7	145.9	207.2	232.2
1963	94.6	251.1	124.6	178.1	211.6
1964	38.6	192.6	61.3	91.2	150.0
1965	261.0	424.8	148.6	435.9	390.1
1966	402.6	572.6	455.0	631.2	546.8
1967	263.2	427.1	218.0	439.3	394.3
1968	26.3	179.8	10.1	72.2	135.5
1969	140.3	298.8	182.0	248.9	262.0
1970	164.1	323.7	139.4	285.8	286.3
1971	69.8	225.2	208.8	139.6	187.3
1972	277.1	441.6	187.9	460.9	408.4
1973	323.1	489.7	272.4	474.0	452.9
1974	152.7	311.7	190.2	268.1	275.4
1975	80.0	235.8	108.1	155.4	195.5
1976	60.1	215.1	68.4	101.0	170.4
1977	58.4	115.0	102.7	148.0	108.7
1978	164.0	323.5	99.8	144.0	268.1
1979	186.5	530.0	399.0	509.0	463.9
1980	80.8	236.6	109.0	156.6	196.3
1981	71.0	118.0	62.6	91.0	105.1
1982	218.0	259.0	249.5	308.0	257.5
1983	461.3	641.0	505.8	701.0	613.2
1984	232.9	381.0	243.0	498.0	365.5
1985	2.5	209.0	36.5	88.0	153.7
1986	192.2	341.1	402.0	558.5	342.8
Max.	461.3	641.0	505.8	701.0	613.2
Min.	2.5	115.0	10.1	72.2	105.1
Ave.	160.3	315.6	184.6	287.2	281.5

Table III.3.8 Probable Flood Peak Discharge at Kembu Damsite

Year	1983 Flood		1984 Flood		1986 Flood		
	Rainfall Depth (mm)	Ratio Peak	Ratio Peak	Ratio Peak	Ratio Peak	Ratio Peak	
200	469	1.69	7,237	2.81	9,536	3.21	7,914
100	420	1.52	6,309	2.51	8,268	2.88	6,637
50	370	1.34	5,350	2.22	6,854	2.53	5,651
30	333	1.20	4,652	1.99	5,932	2.28	4,989
20	304	1.10	4,156	1.82	5,241	2.08	4,451
10	253	0.91	3,210	1.51	4,118	1.73	3,764
5	200	0.72	2,505	1.20	2,994	1.37	2,865
2	120	0.43	1,239	0.72	1,478	0.82	1,527

Note : Recorded 5-day rainfall depth in 1983 277 mm
in 1984 167 mm
in 1986 146 mm

Table III.3.9 Probable Flood Peak Discharge at Lebir Damsite

Year	1983 Flood		1984 Flood		1986 Flood		
	Rainfall Depth (mm)	Ratio Peak	Ratio Peak	Peak	Ratio Peak	Peak	
200	850	1.39	5,849	2.32	10,380	2.48	7,542
100	767	1.25	5,187	2.10	9,066	2.24	6,987
50	683	1.11	4,508	1.87	7,711	1.99	6,038
30	622	1.01	4,026	1.70	6,746	1.81	4,983
20	572	0.93	3,217	1.56	5,968	1.67	3,665
10	486	0.79	2,289	1.33	4,707	1.42	2,549
5	397	0.65	1,563	1.08	3,401	1.16	1,689
2	262	0.43	1,309	0.72	1,758	0.76	1,346

Note : Recorded 5-day rainfall depth in 1983 613 mm
in 1984 366 mm
in 1986 343 mm

Table III.5.1 Spillway Design Flood

Criteria	(Unit:m ³ /sec)	
	Damsite	
	Kemubu	Lebir
Catchment Area (sq.km)	5,630	2,480
(1) Recorded Largest Flood		
- Simulated (1967 Flood)	4,471	6,734
- Recorded	-	4,728
(2) 200-year Probable Flood		
- 1983 type	7,237	5,849
- 1984 type	9,536	10,380
- 1986 type	7,914	8,256
(3) Creager's coefficient (C=55)	15,000	12,400

Note : The safety factor of 1.2 was multiplied to the peak discharges of rockfill dams.

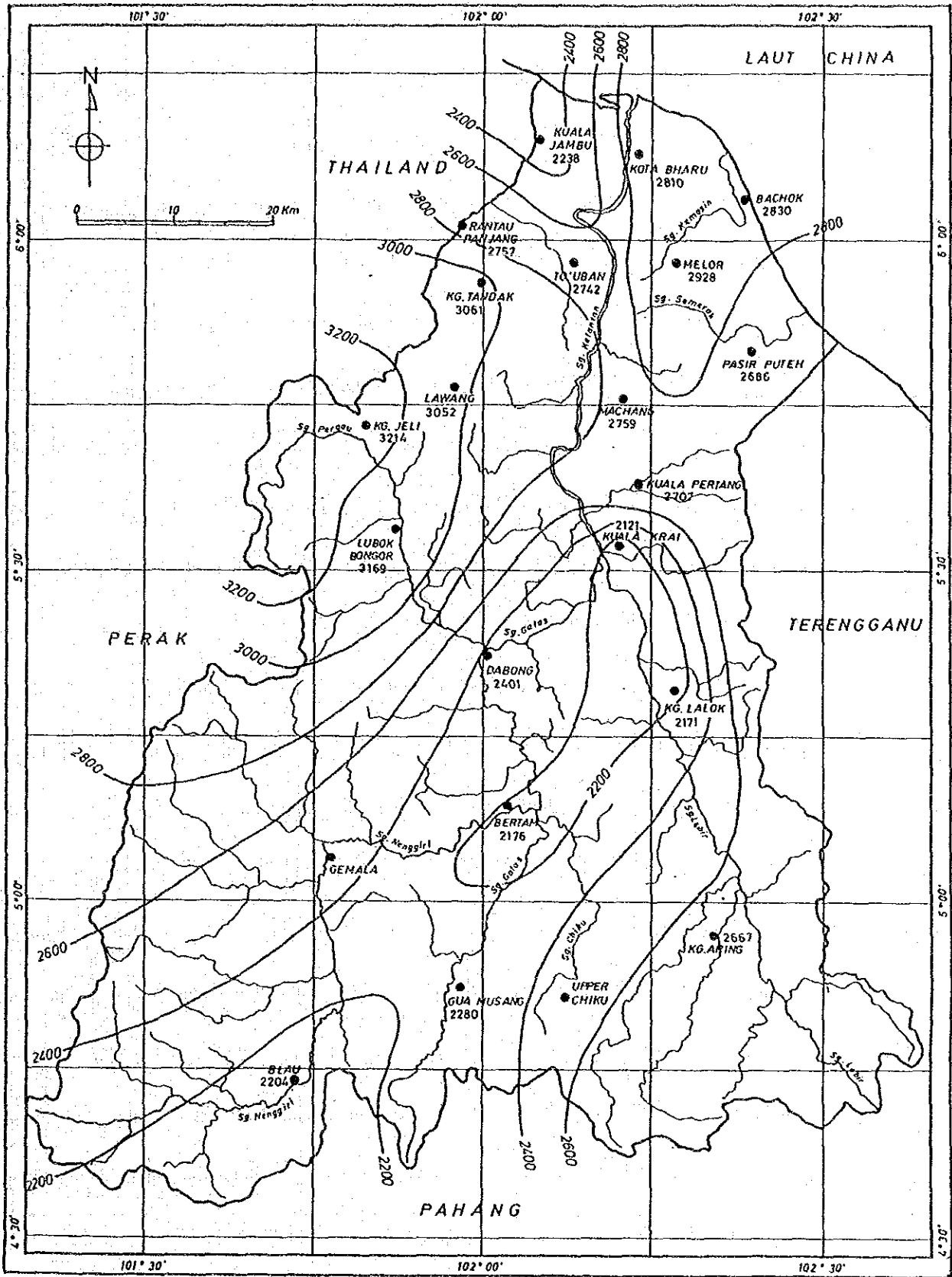


Fig. III.2.1

Isohyetal Map of Annual Mean Rainfall

GOVERNMENT OF MALAYSIA
 STUDY
 ON
 KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
 JAPAN INTERNATIONAL COOPERATION AGENCY

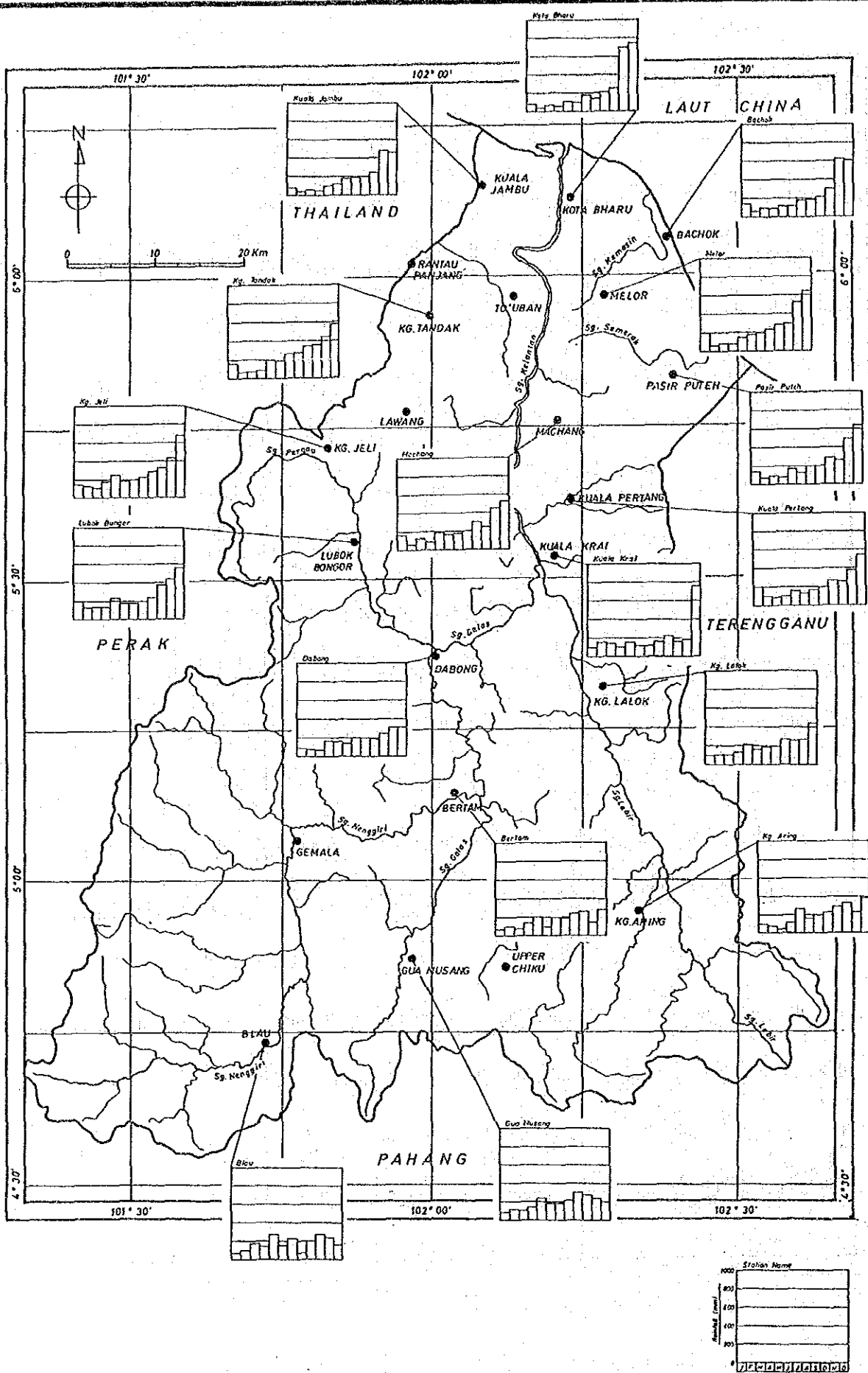


Fig. III.2.2
Monthly Mean Rainfall

GOVERNMENT OF MALAYSIA
STUDY
 ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
 JAPAN INTERNATIONAL COOPERATION AGENCY

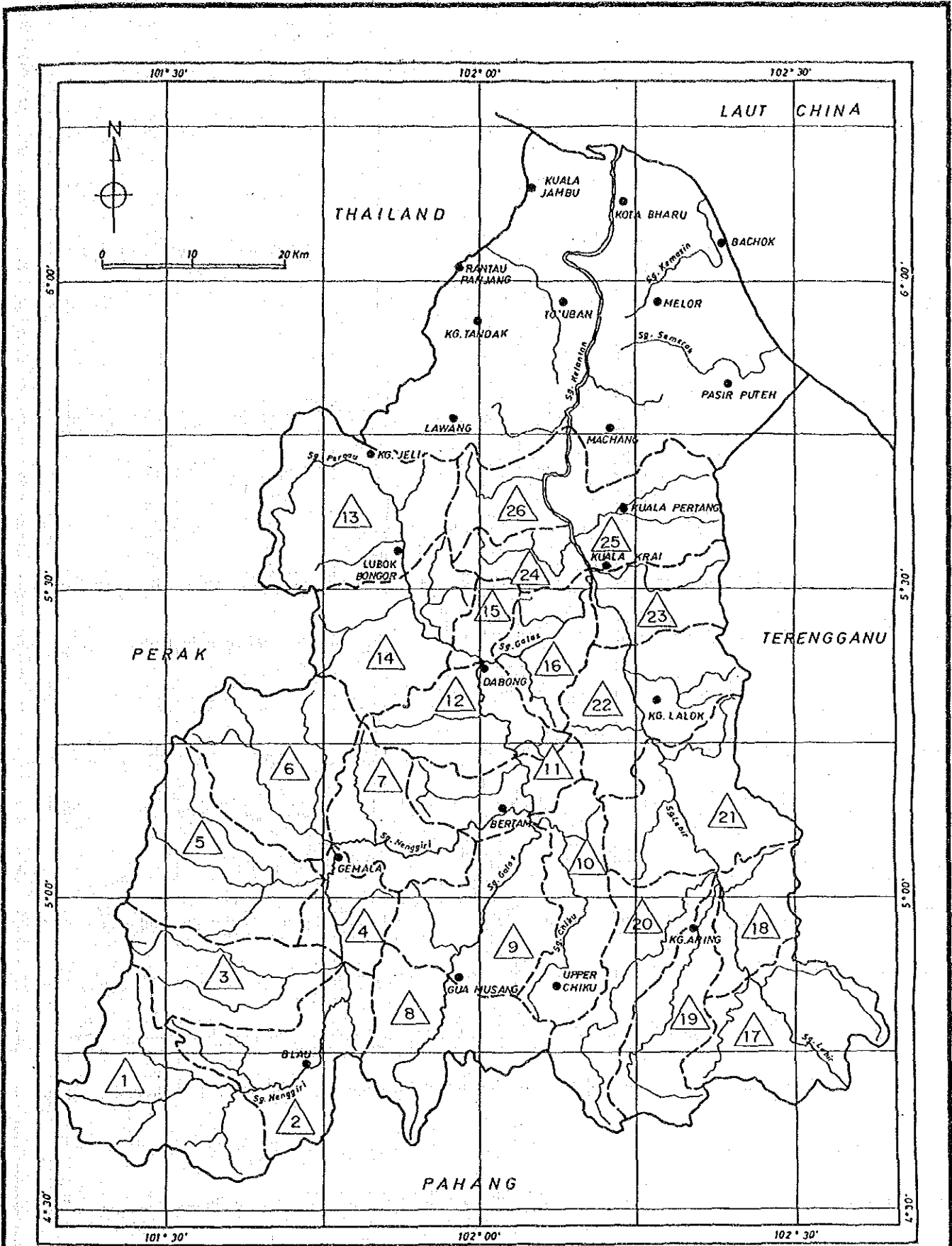


Fig.III.3.1
Location Map of Sub-basin

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY

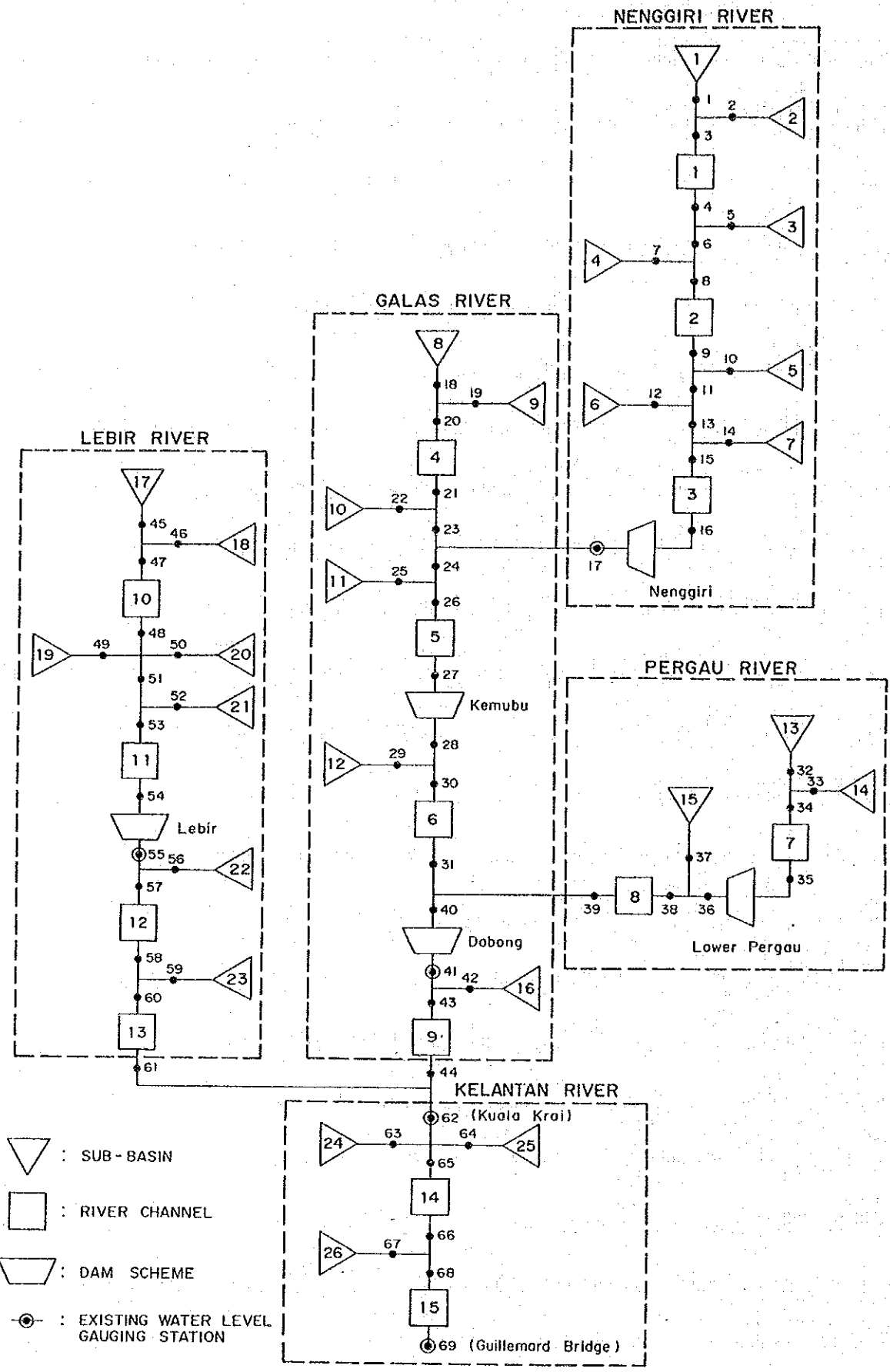


Fig.III.3.2

River Basin Model

GOVERNMENT OF MALAYSIA
 STUDY
 ON
 KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
 JAPAN INTERNATIONAL COOPERATION AGENCY

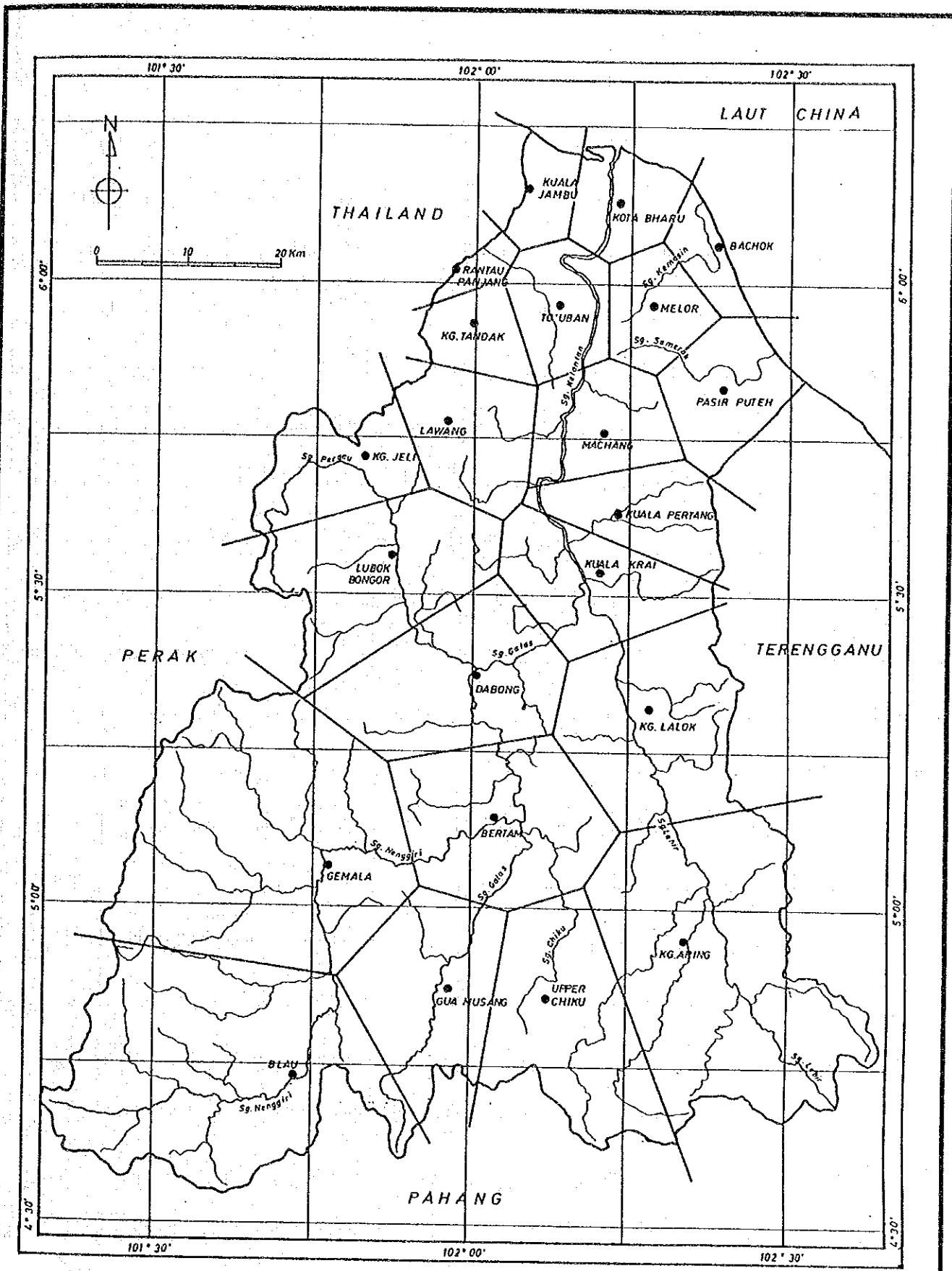


Fig. III.3.3
Arrangement of Thiessen's Polygon

GOVERNMENT OF MALAYSIA
STUDY
 ON
 KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
 JAPAN INTERNATIONAL COOPERATION AGENCY

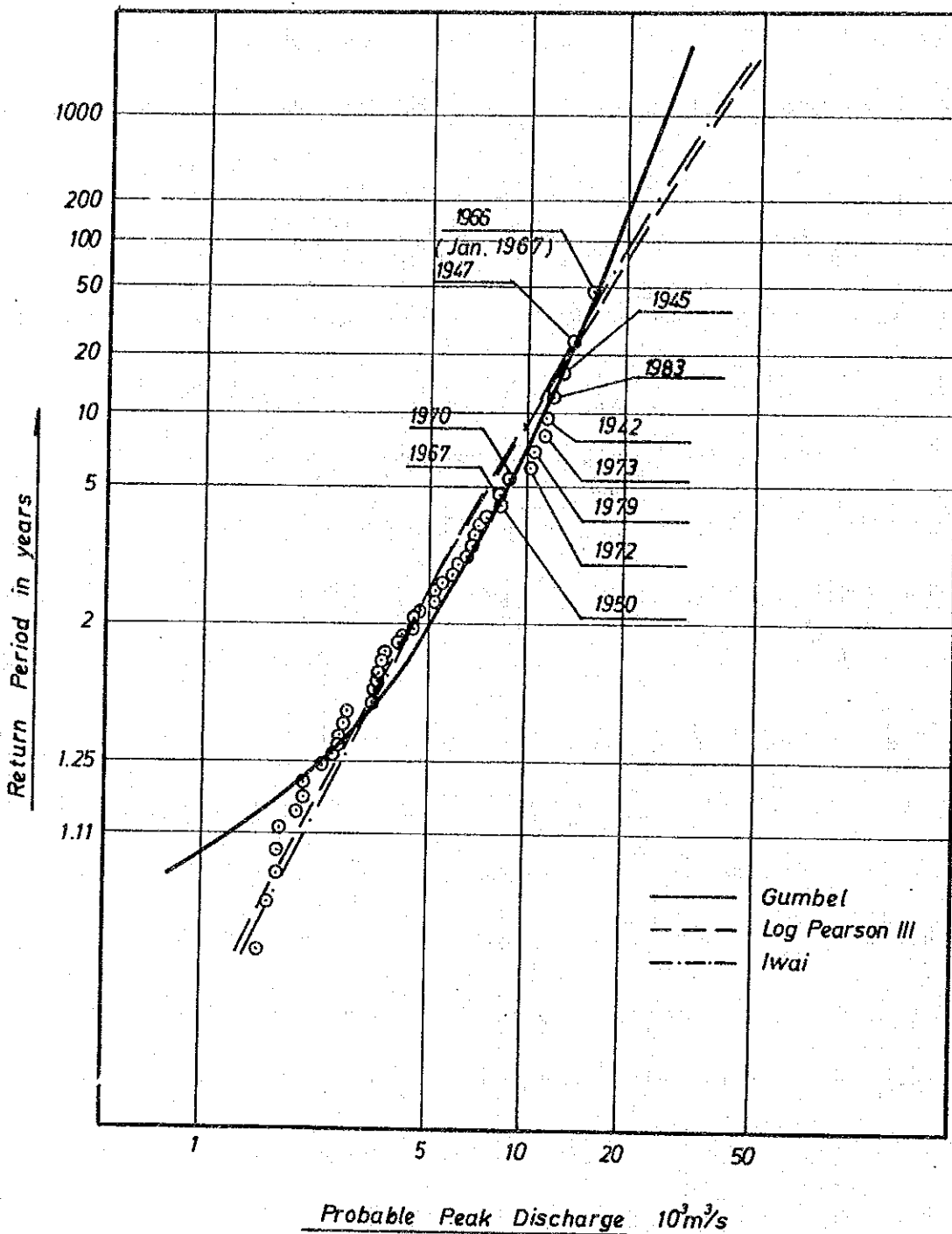


Fig. III.3.4

Probable Distribution of Annual Maximum Peak Discharge at Guillemard Bridge

GOVERNMENT OF MALAYSIA
 STUDY
 ON
 KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
 JAPAN INTERNATIONAL COOPERATION AGENCY

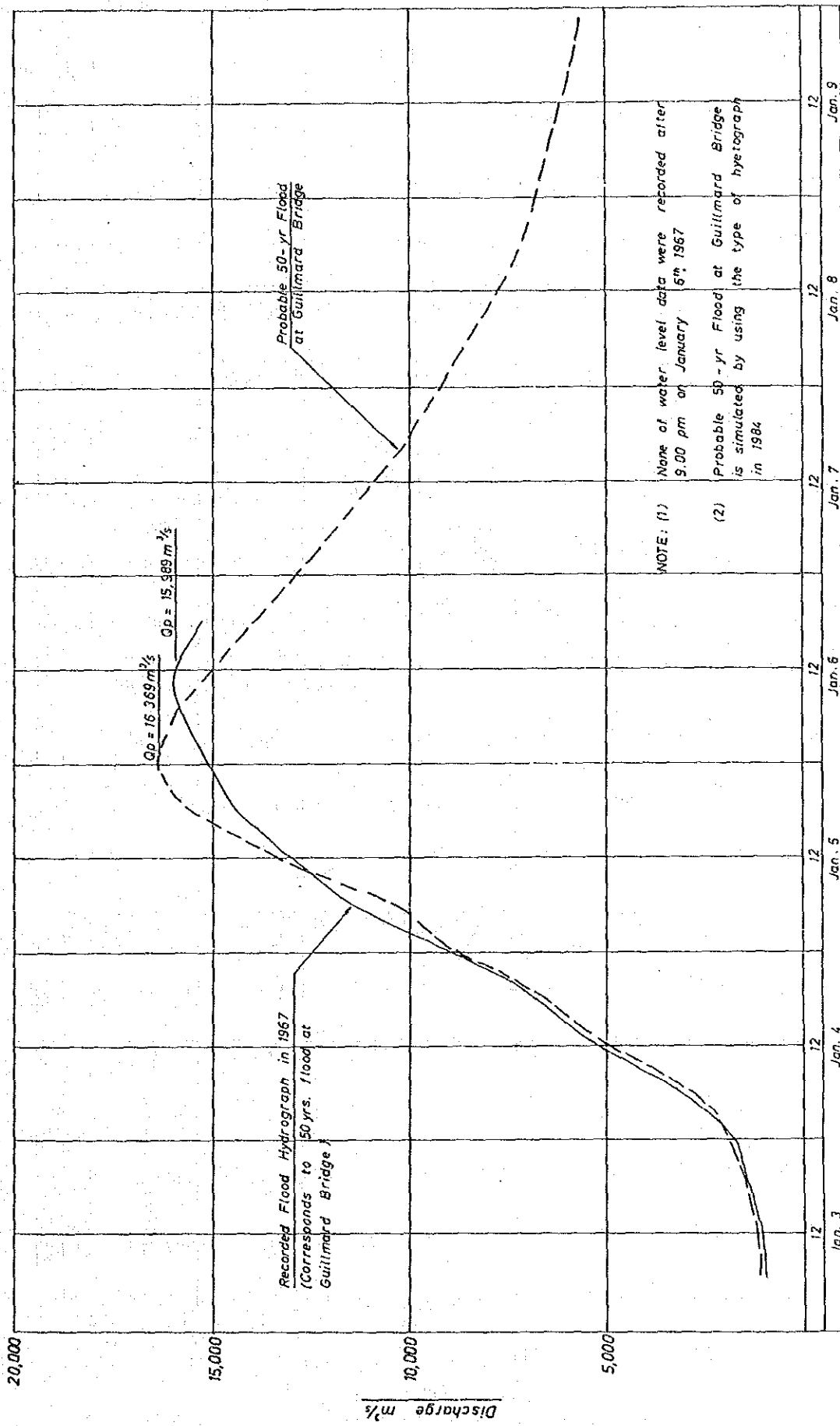


Fig. III.3.5

Comparison between 50-year Probable Flood and Recorded Flood Hydrograph in 1967

GOVERNMENT OF MALAYSIA
 STUDY
 ON
 KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
 JAPAN INTERNATIONAL COOPERATION AGENCY

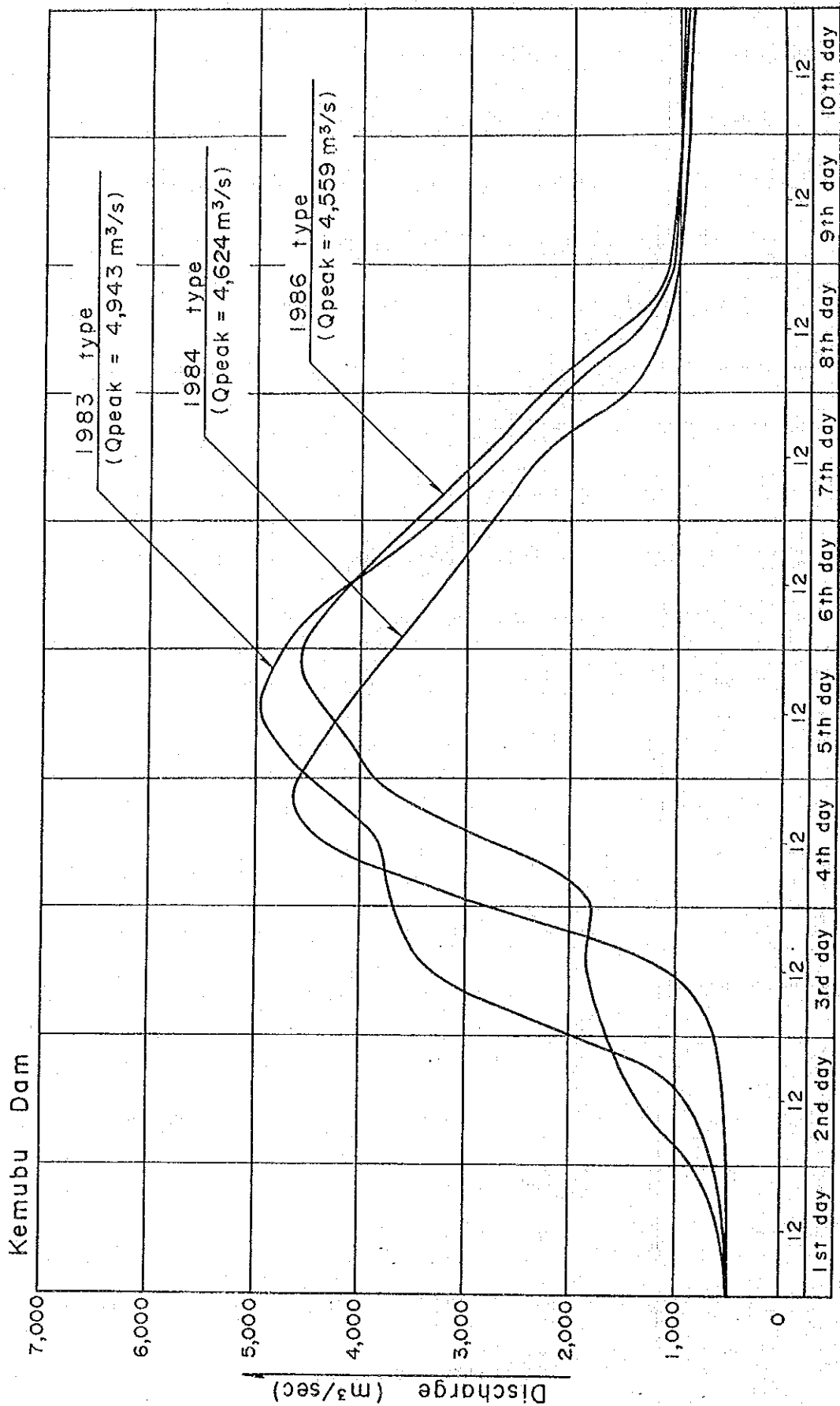


Fig.III.3.6

Probable Flood Hydrograph
at Kemubu Damsite

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY

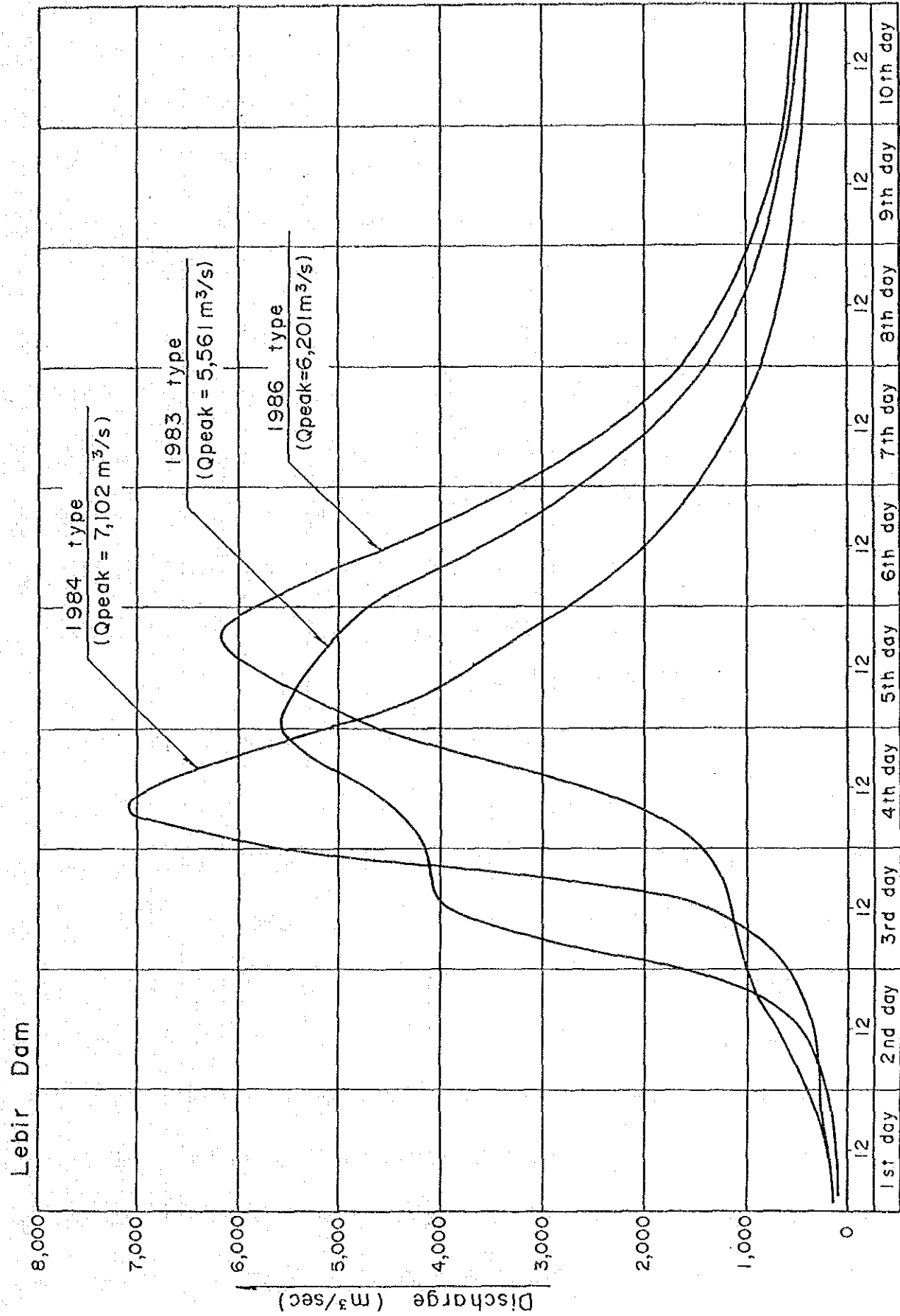


Fig.III.3.7

Probable Flood Hydrograph
at Lebir Damsite

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY

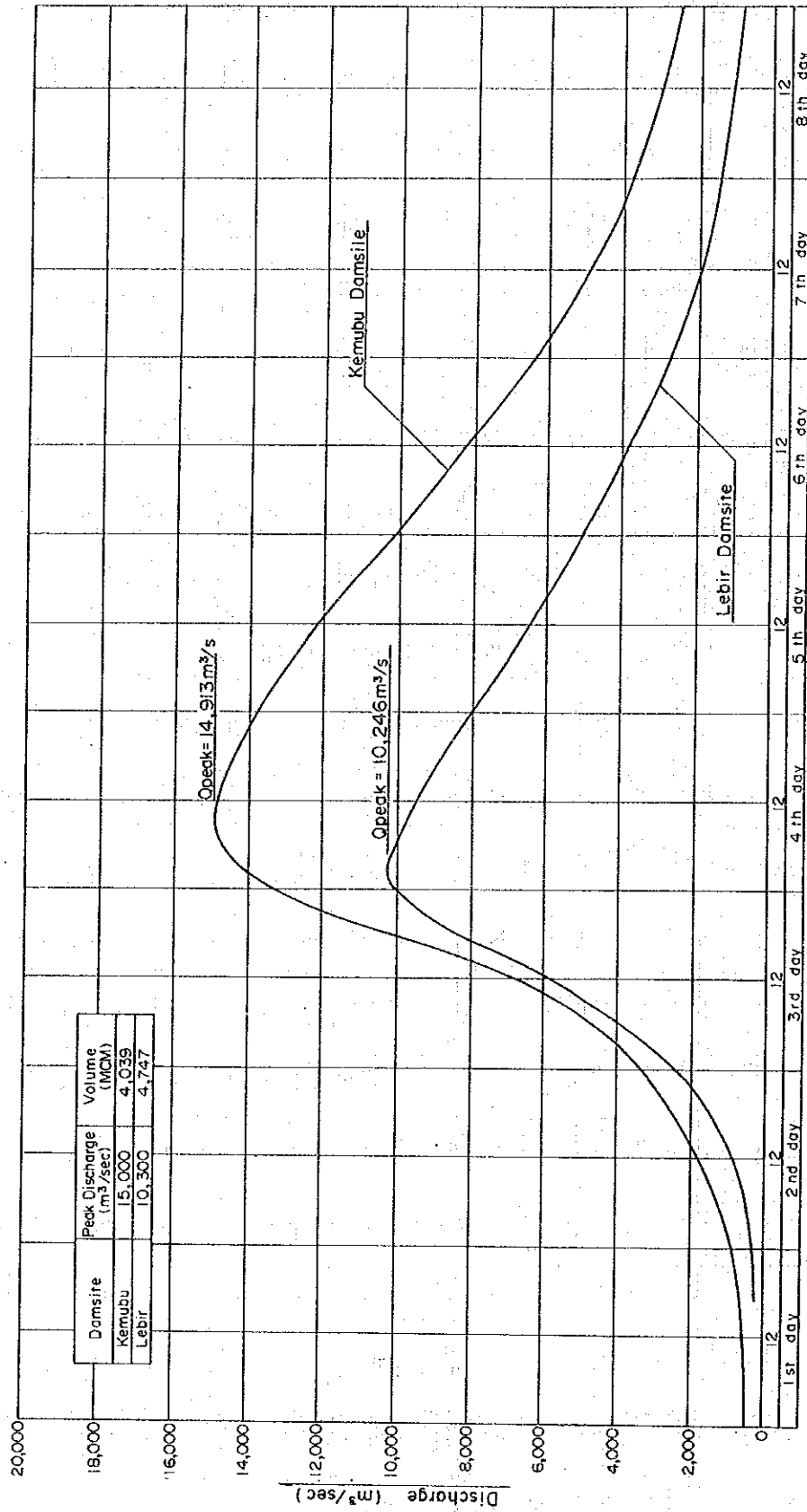


Fig. III.5.1

Spillway Design Flood Hydrograph

GOVERNMENT OF MALAYSIA
 STUDY
 ON
 KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
 JAPAN INTERNATIONAL COOPERATION AGENCY

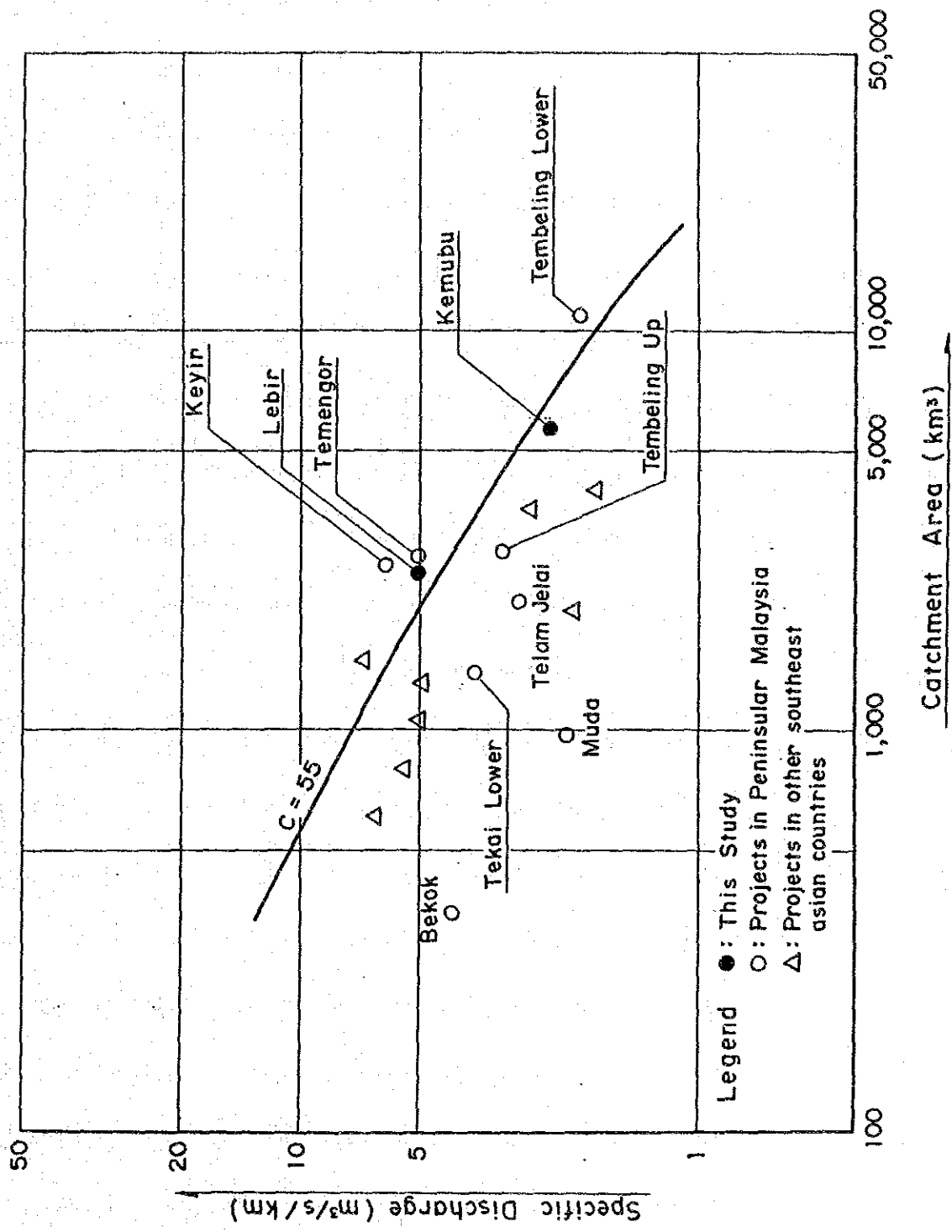


Fig. III.5.2

Regional Specific Peak Discharge for Spillway Design Flood

GOVERNMENT OF MALAYSIA
 STUDY
 ON
 KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
 JAPAN INTERNATIONAL COOPERATION AGENCY

ANNEX IV

SOCIO-ECONOMY

TABLE OF CONTENTS

	Page
1. INTRODUCTION	IV-1
2. PROJECT BACKGROUND	IV-1
2.1 Administrative Conditions	IV-1
2.1.1 Administrative divisions	IV-2
2.1.2 Institutions concerned	IV-2
2.1.3 Development budget	IV-3
2.2 Population and Labour Force	IV-3
2.2.1 Population	IV-3
2.2.2 Labour force	IV-4
2.3 Economic Profiles	IV-5
2.3.1 Agriculture	IV-5
2.3.2 Industry, commerce and service	IV-5
2.4 Gross Domestic Product	IV-6
2.5 Transportation	IV-7
2.6 Land Use	IV-8
2.6.1 General	IV-8
2.6.2 Land Use	IV-8
3. BASIN DEVELOPMENT FRAMEWORK	IV-9
3.1 Basin's Role in the Region	IV-9
3.1.1 Existing development plans	IV-9
3.1.2 Development potentials and flood mitigation ..	IV-10
3.2 Socio-economic Impacts of Flood Mitigation	IV-11
3.2.1 Impacts on development budget	IV-11
3.2.2 Negative socio-economic impacts	IV-12
3.2.3 Positive socio-economic impacts	IV-13
3.3 Socio-economic Projections	IV-14
3.3.1 Population	IV-14
3.3.2 Gross domestic product	IV-15

	Page
3.4 Land Use Plan	IV-15
3.4.1 General	IV-15
3.4.2 Land use plan	IV-16

LIST OF TABLES

Table No.	Title	Page
IV.2.1	Fifth Plan Allocations, 1986-1990	IV-18
IV.2.2	Population of Kelantan, 1970 to 1980	IV-19
IV.2.3	Population Density of Kelantan, 1970 to 1988 ...	IV-20
IV.2.4	Employment of Kelantan by Sector, 1980 to 1988 .	IV-21
IV.2.5	GDP of Kelantan by Sector, 1980 to 1988	IV-22
IV.2.6	Land Use, Kelantan, 1966 to 1988	IV-23
IV.3.1	Impacts of Project Cost on Development Budget ..	IV-24
IV.3.2	Villages and Population to be Affected by Lebir Reservoir Development	IV-25
IV.3.3	Villages and Population to be Affected by Kemubu Reservoir Development	IV-26
IV.3.4	Negative Socio-economic Impacts from the Perspective Districts	IV-27
IV.3.5	Negative Socio-economic Impacts from Regional Perspective	IV-28
IV.3.6	Negative Socio-economic Impact	IV-29
IV.3.7	Annual Loss of Income from Plantations due to Reservoir Development	IV-30
IV.3.8	Population Forecast, Kelantan (1/3)	IV-31
IV.3.8	Population Forecast, Kelantan (2/3)	IV-32
IV.3.8	Population Forecast, Kelantan (3/3)	IV-33
IV.3.9	GDP Forecast, Kelantan	IV-34
IV.3.10	Land Use Forecast, Kelantan	IV-35

LIST OF FIGURES

Fig. No.	Title	Page
IV.2.1	Districts of Kelantan	IV-36
IV.2.2	Present Land Use (1/2)	IV-37
IV.2.2	Present Land Use (2/2)	IV-38
IV.3.1	Development Plan of Majilis Perbandaran Kota Bharu	IV-39

IV. SOCIO-ECONOMY

1. INTRODUCTION

The State of Kelantan lies at an eastern part of Peninsular Malaysia with a land area of 14,943 km², accounting for 4.5% of the total land area of Malaysia.

The State has an estimated population of 1,091,756 as of 1988, out of which 78.8% live in the northern sub-region occupying 16.4% of the total land area in the State. On the other hand, the southern sub-region with 83.6% of the State area is the abode of 21.2% of the State people. The population of the State corresponds to 6.4% of the national population.

The State economy is dominated by agriculture with 70% of population, 50% of work force and 30% of GDP. The area of 65% in North Kelantan is used as agricultural land, while 86% of South Kelantan is covered with forests.

One difficulty that the economy of the State confronts is low productivity of the agricultural sector due to an adherence to the traditional farming practices. Another bottleneck is the narrow base of the manufacturing sector; that is, this sector shares 7.3% and 4.5% of State employment and GDP, respectively.

The GDP of the State is estimated at M\$2,684.4 million in 1988 at market prices, accounting for 3.4% of the national GDP. Per capita GDP works out at M\$2,459, which is only a half compared with the national average, resulting from a backwardness of the productive sectors as mentioned above.

The majority of the Kelantan people reside on both sides of the Kelantan River practising agriculture. The Kelantan River can bring enormous benefits to the people as a source of water supply, irrigation and power generation.

On the contrary, the Kelantan River annually brings extensive economic losses and human sufferings by flooding. Furthermore, the threat of floods contributes to such negative psychological attitudes that farmers tend to be reluctant to adopt modern agricultural technology, and industrialists refrain from investing in flood prone areas.

The harnessing of the Kelantan River for flood mitigation as well as for other purposes is therefore the prerequisite to develop the State into a modern economy.

2. PROJECT BACKGROUND

2.1 Administrative Conditions

Malaysia with a land area of 329,745 km² is composed of Peninsular Malaysia and the two Regions of Sabah and Sarawak. The State of Kelantan is one of eleven States in Peninsular Malaysia.

2.1.1 Administrative divisions

The State of Kelantan is composed of ten Districts as shown in Fig.IV.2.1; Bachok, Kota Bharu, Machang, Pasir Mas, Pasir Puteh and Tumpat in North Kelantan and Tanah Merah, Jeli, Gua Musang and Kuala Krai in South Kelantan. Each District comprises several Daerahs.

Kota Bharu is the capital of Kelantan as well as the development centre of North Kelantan. Gua Musang is on the other hand the development centre of South Kelantan. Six Daerahs including Bandar Kota Bharu in Kota Bharu District are under the jurisdiction of MPKB (Majlis Perbandaran Kota Bharu) or Kota Bharu Municipal Council.

The State Government consists of 15 departments and offices as shown below:

Departments and offices of Kelantan State

- (1) Office of Chief Minister (Menteri Besar) and State Secretary
- (2) State Assembly Office
- (3) Land and Mine Office
- (4) Ten-District Office
- (5) Forestry Department
- (6) Drainage and Irrigation Department
- (7) Agriculture Department
- (8) Public Works Department
- (9) Islamic Affairs Department
- (10) Welfare Department
- (11) Public Service Commission
- (12) Town and Country Planning Department
- (13) State Treasury Department
- (14) Veterinary Department
- (15) State Development Office

The State Government is headed by Chief Minister (Menteri Besar). Chief Minister's office is responsible for overall planning, administration and financing for the State of Kelantan. The State Government considers that the future of Kelantan hinges on the development of agriculture, infrastructure and human resources.

2.1.2 Institutions concerned

The institutions/organizations in the local government which are directly and indirectly related to flood mitigation projects are SEPU, DID, Agriculture Department, Town and Country Planning Department, Public Works Department, KESEDAR and Forestry Department, while National Electricity Board, Geological Survey Department and Department of Environment as well as EPU and DID headquarters are directly and indirectly related in the federal level. Out of them, SEPU and DID are two major institutions directly connected with flood mitigation projects.

SEPU is an organization under State Secretary Office. Basic/principal functions of SEPU are co-ordination of planning processes for project implementation to determine priorities of programmes and projects towards distribution of financial allocations, to prepare economic, technical and financial analysis in project implementation and to review State development requirements in co-operation with the relevant authorities at Federal Level.

DID is a department belonging to the federal and local governments. In the federal level, DID is placed under the Ministry of Agriculture, while six sections including Federal Unit and Planning Section are organized under Director in the local level. Federal Unit implements Federal development projects. Main functions of Planning Section are planning and designing of proposed irrigation and drainage projects, carrying out surveys and investigations for proposed projects, updating progress of projects, collection/processing of hydrological data, flood forecasting and investigation of water resources.

2.1.3 Development budget

The Fifth Malaysia Plan (1986-1990) allocations for Kelantan stand at M\$1,807 million as of May 1988, accounting for 6.5% of the national allocations as shown in Table IV.2.1. This budgetary share for Kelantan matches with the populational share for the State. The Fifth Plan allocations are small compared with the Fourth Plan (1981-1985) allocations of M\$2,653 million. This situation is in line with the Government policy of privatization, where the role of the private sector is stressed and pushed as the leader in the management of the economy, while the government is put in a position of the coordinator.

Most of the allocations to the economic sector in the State are spent on agriculture and infrastructure. And most of the allocations to the social sector are spent on education. A clear picture emerges from the above that the development strategy of the State Government centres on the development of agriculture, human resources and infrastructure.

As regards to the sources of the budgetary funds, about 20% come from the State's own coffer and the rest are provided by the Federal Government in the form of grants or soft loans.

2.2 Population and Labour Force

2.2.1 Population

The population of Kelantan is estimated at 1,091,756 in 1988 as shown in Table IV.2.2. District-wise, Kota Bharu District has the biggest population of 357,995, accounting for 32.8% or almost one third of the State population. Gua Musang District has the smallest population of 28,198, corresponding to 2.8% of the total population in Kelantan.

Kota Bharu is the capital of Kelantan. The population under the jurisdiction of Kota Bharu town council, MPKB, is estimated at 224,719 in 1988, constituting 20.6% or one fifth of the population of Kelantan.

North Kelantan accounting for 16.4% of the total land use area in Kelantan accommodates the population reaching 859,369, or 78.7% of the State population. Conversely, South Kelantan covering 83.6% of the total land use area in the State is however inhabited by a fewer people of 232,387, accounting for only 21.3% of the State population.

The population of Kelantan grew during the last inter-censal period of 1970 to 1980 at the average annual rate of 2.6% (refer to Table IV.2.1). It is estimated that population is growing at the average annual rate of 2.5% since 1980.

Population growths in all Districts in South Kelantan are greater than the State average. The average annual growth rate in the whole of South Kelantan works out at 3.8% from 1980 to 1988. In contrast, population of all Districts in North Kelantan except Kota Bharu District is growing at a lesser rate than the State average. The population in the whole of North Kelantan is growing at the average annual rate of 2.2% since 1980. The population of Kota Bharu District has grown from 1980 to 1988 at an average annual rate of 2.8%, while a slightly higher rate of 2.9% for the area under MPKB.

It can be said from the above that there are two major streams of intra-State migration; in-migration to the city of Kota Bharu from other parts of the State and migration from North Kelantan to South Kelantan.

The average density of population in Kelantan is estimated at 72 per km² in 1988 as shown in Table IV.2.3. District-wise, Kota Bharu District has the highest population density of 889 per km². The average density of population in North Kelantan works out at 84 per km², while 16 per km² in South Kelantan. There is a clear contrast in the density of population between the two sub-regions. Population density of MPKB is 1,782 per km², which is by far higher than that of any District or Daerah.

The population of the whole of Malaysia in 1988 is estimated at 16,968,000, of which the population of Kelantan accounts for 6.4%.

2.2.2 Labour force

The total number of employees in Kelantan is estimated at 327,659, in 1988, occupying 30.0% of the total population as shown in Table IV.2.4. Out of it, 158,329 or 48.3% fall under the agricultural, forestry and fishery sectors. The government services sector is the second biggest sector employing 57,545 persons or 17.6% of the workforce.

The estimated overall employment structure of Kelantan in 1988 is 48.3% for the primary industry, 15.5% for the secondary industry and 36.2% for the tertiary industry. The estimated employment structure of Malaysia in the same year is 35.3% for the primary industry, 21.6% for the secondary industry and 43.1% for the tertiary industry. It can be said from the above that the proportion of the employment in the primary industry in the State is markedly higher than that in the nation, while the proportion of the employment in the secondary industry in the State is substantially lower than that in the nation.

2.3 Economic Profiles

2.3.1 Agriculture

Supporting 70% of population, employing 50% of workforce, producing 30% of GDP and using 20% of land area, the agricultural sector plays a major role for the socio-economy of the State.

There are four main crops, i.e. paddy, tobacco, rubber and oil palm. Paddy is the most important crop in the State with the annual planted area of around 70,000 ha and the annual production of about 200,000 tons. The State's share to national paddy production is as much as 13.5%. Paddy is not only consumed within the State, but also exported to other States.

Tobacco is grown under the Federal guidance to lift the economic status of the farmers concerned. Green tobacco leaves of 7 to 9 million tons are annually produced with the planted area of around 10,000 ha. Kelantan's share of 80% or so.

Rubber is one of traditional crops in the State. Now replanting of the crop is in progress, and 60% out of 130,000 ha has been replaced with young plants. The State shares about 30% to the total production of rubber with the annual average production of 45,000 tons.

Oil palm is grown like rubber mainly for export. In 1988, Kelantan is estimated to produce 84,000 tons of palm oil over the planted area of 60,000 ha, which will correspond to 1.7% of the total production in Malaysia.

Other important crops are coconut, cocoa, groundnut, vegetables, fruits and so on.

Livestocks, a non-crop product belonging to the primary industry, are important as a supplementary income source to the farmers in Kelantan. In 1988, the State is estimated to have cattle and buffalo population of around 130,000, which will correspond to 15% of the said population over the whole Malaysia. Up to 1988, grazing reserves of 4,178 ha have been developed.

2.3.2 Industry, commerce and service

In 1988 the manufacturing industry in Kelantan is expected

to produce the added value of M\$121 million and to employ workforce of 23,954. GDP and employment of the manufacturing industry are estimated to be 4.5% and 7.3% for the State total respectively.

Most of the manufacturing industries in the State fall under the category of the so-called agro-industry or the like, i.e wood, rubber, food and tobacco industries. Undergoing only a primary processing, the resultant products are not high in terms of the added value.

The number of registered industrial establishments in the State is estimated at 624 for 1988 and the average number of workers per such an establishment is 25. Actually, it is estimated that there exist about 5,000 establishments when the so-called cottage industries are taken into account. Then, the average number of workers per establishment is reduced to 5.

In 1988 commerce and service industries in Kelantan are expected to produce the added value of M\$825 million with the total employment of 50,537. The industries comprise wholesale, retail, transport, restaurant, storage, banks, insurance and real estate. GDP and employment are estimated to be 30.7% and 15.4% for the State total respectively. The estimated number of establishments under this sector is 8,854 and the number of workers per establishment works out at 6.

2.4 Gross domestic product

The Gross Domestic Product (GDP) of Kelantan for 1988 is estimated at M\$2,684.4 million at market prices as shown in Table IV.2.5, while GDP of Malaysia is estimated at M\$78,458 million at market prices for the same year. Therefore, the State GDP as percentage of the national GDP is 3.4%. This ratio is much smaller than the populational ratio of 6.4% as well as the areal ratio of 4.5%. Kelantan is implied to be economically a "developing" State in Malaysia.

Sector-wise, the agricultural, forestry and fishery sectors will produce an amount of M\$772.3 million in 1988, accounting for 28.8% of the State GDP. This sector is the single biggest contributor to the economy of the State. The government services sector is placed second, producing M\$677.9 million and sharing 25.2% of the State GDP. The third and fourth places are occupied by the banks, insurance and real estates sector and the transport, restaurants and storage sector, respectively. The added value of the former will be M\$334.0 million, accounting for 12.4% of the State GDP. And that of the latter will be M\$273.3 million, accounting for 10.2% of the State GDP. The manufacturing sector's contribution to the economy of Kelantan is confined to 4.5%.

The overall industrial structure of Kelantan is estimated at 28.8% for the primary industry, 11.0% for the secondary industry and 60.2% for the tertiary industry in 1988, while 21% for the primary industry, 37% for the secondary industry and 42% for the

tertiary industry in the nation in the same year. One striking feature of the State economy is that the secondary sector is in the low level compared with the primary sector.

The primary industry's contribution to the State employment is 48.3%, while the same sector's contribution to the State economy is 28.8%. It means that the labour productivity of the primary industry in the State is in a great degree lower than the State average. Also, the secondary industry's share in the State employment is 15.5%, while the same sector's share in the State GDP is 11.0%. It implies that labour productivity of the secondary industry in the State is markedly lower than the State average.

Economy of Kelantan is estimated to have grown from 1980 up to 1988 at an average annual rate of 6.1%.

The per capita GDP of Kelantan is estimated at M\$2,459 (refer to Table IV.2.5) at market prices in 1988, which is equivalent to US\$983 at an exchange rate of M\$2.50 to US\$1.00. This standard of living might be equal or higher than per capita GDP's in most of the ASEAN countries. But, the per capita GDP of Malaysia in 1988 is estimated at M\$4,624 and the living standard of the State is therefore only a half compared with that of the nation.

The per capita GDP of the State is estimated to have grown at an average annual rate of 3.5% since 1980.

2.5 Transportation

Infrastructural deficiency in both quantity and quality has been habitually cited as one of major factors retarding the economic growth of the State, confirming it to the traditional agriculture-based self-sufficient economy. The Government has persistently placed the highest priority on infrastructural development against such background.

Road length in 1987 is 2,004 km, out of which 1,225 km is State roads and 749 km is Federal roads. Noteworthy events for the last few years are the development of the Kuala Krai-Gua Musang-Kuala Lipis Highway, Jeli-Dabong-Gua Musang road and East-West Highway. The Kuala Krai Highway links the northern sub-region with the southern sub-region as well as with other States.

The Jeli road connects the Sg. Pergau - Sg. Galas Valley with the new growth centre of Gua Musang, and the East-West Highway links not only Kelantan but also the East Coast with the northern West Coast of Peninsular Malaysia.

Railway runs in parallel with the Kelantan River starting from Tumpat down to Gua Musang and beyond. The total length within the State is 207 km. Besides the highway and railway networks, there is an air system which connects Kota Bharu with major cities in Malaysia with several daily flights.

2.6 Land Use

2.6.1 General

74.4% of the State area of 1,504,009 ha is covered with forest, and another 21.3% is planted with agricultural crops in 1988 as shown in Table IV.2.6 and Fig. IV.2.2.; that is, 95.7% of the State areas are occupied by forest and agricultural lands.

When Kelantan is divided into the northern and southern sub-regions, another aspect emerges. North Kelantan has the land areas of 246,364 ha, accounting for 16.4% of the total State area. Out of it, 160,379 ha or 65.1% is agricultural land, and 49,434 ha or 20.1% is forest and related land. South Kelantan commands a land area reaching 1,257,645 ha, accounting for 83.6% of the total State area. Out of it, 1,086,088 ha or 86.4% is forest and related land, and 160,204 ha or 12.7% is agricultural land. North Kelantan is dominated by agriculture, while South Kelantan is virtually a forest land.

2.6.2 Land use

Urban and associated areas composed of urban, estate buildings, mining and power line and other associated areas are estimated at 5,365 ha as of 1988, accounting for 0.4% of the total State land area. Kota Bharu with 2,381 ha occupies 44.4% of the total State urban and associated area.

Out of 320,583 ha of agricultural land areas in 1988, 129,413 ha or 40.4% is the rubber plantation area, followed by 71,248 ha or 22.2% of paddy fields and 61,261 ha or 19.1% of oil palm plantations. The combined acreage of these three major crops works out at 261,922 ha, accounting for 81.7% of the total State agricultural land area.

Since 1981, the outward expansion of rubber land has stopped. And now an emphasis is upon the intensive utilization of the existing rubber areas by replanting. Distributed all over Kelantan, rubber areas are especially concentrated in the three southern Districts of Kuala Krai, Tanah Merah and Gua Musang.

During 22 years from 1966 to 1988, oil palm plantations have multiplied 123 times from 497 ha to 61,261 ha. This trend will be kept up into future. District-wise, 74.6% of the total oil palm areas in the State are shared by Gua Musang District.

Paddy fields are distributed all over Kelantan, but three Districts of Pasir Mas, Kota Bharu and Pasir Puteh distinguish themselves with more than 10,000 ha of paddy areas. North Kelantan shares 89.5% of total paddy areas in the State.

Tobacco is normally grown in paddy areas. The acreage of tobacco for 1988 is 8,219 ha. District-wise, Bachok, Pasir Puteh and Pasir Mas have the acreage of more than 1,000 ha. North Kelantan dominates in tobacco planting areas with the share of

95.8%.

The Government is making a great effort to develop grazing reserves considering the important place of Kelantan in livestock farming. As of 1988, 4,178 ha has been developed, of which 2,385 ha or 57.1% belongs to Pasir Mas District. North Kelantan shares 89.9% of pasture reserves.

Forest is decreasing along with grasslands and swamps at an average annual rate of 0.4% since 1966. The trend will be maintained or intensified in future as the economic development of Kelantan progresses.

3. BASIN DEVELOPMENT FRAMEWORK

3.1 Basin's Role in the Region

About 87% of the State is covered by the Kelantan River basin. The rest forms the basins of minor rivers in the coastal region.

3.1.1 Existing development plans

Agriculture and forestry sectors form the nuclei to achieve socio-economic parity for the Kelantan people. The centerpiece for the development of North Kelantan is more intensive use of agricultural land along with diversification of crops. The development strategy for South Kelantan centres on more extensive use of land for agriculture as well as more systematic approaches for the preservation and utilization of forest.

Kelantan Agricultural Development Authority (KADA) was set up in 1972 to promote, assist and initiate the social and economic development of farmers in North Kelantan. KADA has succeeded in increasing yields for paddy and other crops through introduction of irrigation network and other modern technologies. Now about 50% of paddy area is under KADA.

South Kelantan Regional Development Authority (KESEDAR) was formed in 1978 to fully develop the region's resources and to ensure a more equitable sharing of benefits of economic and social development. It has developed and will continue to develop agricultural land for rubber, oil palm and other crops. It is aiming at a better management of permanent revenue forest and permanent forest reserves. It has moved and will continue to move farmers from North Kelantan for settlement in South Kelantan.

There are other Federal agencies playing an important role for agricultural development such as Federal Land Consolidation and Rehabilitation Authority (FELCRA), Rubber Industry Smallholders Development Authority (RISDA) and Federal Land Development Authority (FELDA).

A key for the resolution of Kelantan's backwardness is to come out of its semi-autarky economy through the development of transport and communication systems. And the Government has persistently given high priority to the transport sector in its execution of Malaysia Plan.

The major road network expansion in Kelantan is the East-West Highway and the Kuala Krai-Gua Musang Highway, each of which is 115 km long. Both Highways are now opened to traffic. In the highway programme emphasis will be placed on aspects of organisation, repair as well as upgrading of roads besides constructing new roads. A Master Plan of electric railway with a double-track and standard gauge has been completed for linking Kota Bharu with Kuala Trengganu, Kuantan and Kuala Lumpur. The expansion of Kota Bharu Airport to enable the landing of larger airplanes such as Air Bus and Boeing 747.

Manufacturing in the State is still relatively undeveloped with only 7.3% of total employment. As an effort to improve and expand economic activities in the State, SEDC was accorded a key role in several high priority industrial and commercial undertakings. Efforts are being made to develop "foot-loose" industries, providing training facilities and practical structures for industrialists, expanding industrial opportunities based on agriculture and local sources.

The district development strategy revolves around the provision of basic amenities primarily for the northern region and the expansion of the southern region.

An example of major projects is the Development Project at Kubang Kerian (South-east end of MPKB jurisdiction), a new town area, according to the concept of the Federal Government, involving an area of 50 ha consisting of the construction of shophouses, business complexes, residential houses, schools and recreational centres.

In the southern district the New Town Development of both Gua Musang and Jeli is now in progress. Also, there is the Development of Kelantan South-West Region bordering Perak and Pahang States, aiming at the opening-up of new opportunities for economic activity by the private party.

3.1.2 Development potentials and flood mitigation

"The 5th Malaysia Plan for Kelantan" states as follows:

- (1) There is still imbalance in the development of Kelantan as compared with that of other States.
- (2) There is imbalance in the development between Sub-region I and II in Kelantan.
- (3) There are insufficient basic amenities for the provision of services for socio-economic development.

- (4) The State government cannot afford to support development projects with State revenue.

All the above statements can be boiled down to one expression, i.e. underdeveloped economy of the State.

Actually the State of Kelantan has rich and abundant potentials in terms of human, agricultural, forestry, mining, water and tourism resources. Only they have not been properly or fully developed.

The Federal and State Governments, cognizant of the socio-economic status of Kelantan, have strenuously and consistently taken the policy for elevating quantitative and qualitative levels of infrastructures in the State. As a result, discrepancies existing between Kelantan and other States are being rapidly narrowed; that is, the circumstances confining the State to the existing status are now being removed.

However, one major obstacle still remained is flooding in the Kelantan River. Habitual flooding of the coastal plain brings extensive economic losses in terms of damages to crops and property. Moreover, farmers have no positive inclination towards the adoption of new agricultural technology, which contributes to perpetuating the traditional low productivity of the agricultural sector.

Also, flood threat has depressed and dampened the investment climate in the State. Entrepreneurs and businessmen are in no way willing to invest in flood prone areas. Thus, flood mitigation is crucial for long-term industrial development and economic progress of Kelantan.

3.2 Socio-economic Impacts of Flood Mitigation

Various socio-economic impacts will arise when the proposed project is implemented. The following is the description and analysis of each aspect of such impacts.

3.2.1 Impacts on development budget

The allocations for the Fifth Malaysia Plan (1986-1990) were M\$24,982 million as of 1987, while in the Fourth Malaysia Plan (1981-1985) M\$48,860 were disbursed. The allocations to the State of Kelantan dropped sharply in like manner. This is a result of the economic policy of privatization as already stated. It is likely that the Government will continue to pursue this policy in future.

It is assumed therefore that there will not be a drastically high growth of development budget from now on, and that the annual development budget may grow at least at the same rate as the target economic growth rate of 5% in the Fifth Malaysia Plan.

Also, it is assumed that the future share of the State of

Kelantan in the national development budget will be 6.5% based on the Fifth Plan. In like manner the future share of the "energy and public utilities" sector consisting of "electricity", "water supply" and "drainage and flood mitigation" in the national development budget will be 12.0%.

Upon the above assumptions the allocations to the State of Kelantan in the Sixth (1991-1995) to Ninth Malaysia Plan (2006-2010) period work out at M\$2,072 to 4,309 million, and the allocations to the "energy and public utilities" sector (Kelantan) in the same periods work out at M\$249 to 517 million as shown in Table IV.3.1. On the other hand, the estimated project cost in the Sixth to Ninth Malaysia Plan period ranges from M\$169 to 582 million.

The shares of the project cost in the allocations to the State of Kelantan in the above periods range from 5.0% to 22.0%. In like manner the shares of the project cost in the allocations to the "energy and public utilities" sector (Kelantan) vary from 41.7% to 183.6%. However, the project cost as percentage of the total national development budget is calculated at 0.3% to 1.4%.

The average shares of the project cost in the allocations to the said State and sector in the four Malaysia Plan periods work out at 10.6% and 88.6%, respectively. Likewise, 0.7% of the national development budget will be on the average spent for the project.

3.2.2 Negative socio-economic impacts

As a result of the Master Plan Study, the pre-feasibility study of the Lebir and Kemubu dams has been ultimately proposed. Large reservoirs will be formed when the dams are constructed, inundating properties and necessitating resettlement of affected people.

(1) Non-agricultural

The formation of Lebir dam reservoir is estimated to inundate 19 villages, affecting 785 people or 156 households as given in Table IV.3.2. Likewise, Kemubu dam reservoir will inundate 17 villages, affecting 5,030 people or 1,000 households. (Refer to Table IV.3.3.) The number of people to be affected by Lebir reservoir corresponds to 2.8% of the population of Gua Musang District. The number of people to be affected by Kemubu reservoir corresponds to 4.0% of the combined population of Kuala Krai and Jeli District (refer to Table IV.3.4).

The combined number of people and houses to be affected comes to 5,815 and 1,156, respectively. This number of people accounts 2.5 of the population of South Kelantan. It also accounts for 0.5% of the State population. (Refer to Table IV.3.5.)

The railway track of some 16 km will have to be shifted to a

higher elevation before the formation of Kemubu dam reservoir. It means that 7.7% of the railway track within the State will be involved. Public road length to be submerged will sum up to 12 km, which constitutes 0.7% of the total public road length within the State. Feeder road to be submerged will add up to 91 km. Thus, the combined road length involved will reach 100 km (Refer to Table IV.3.6.). Mention must be made of the Chiku-Aring 3 Timur 3-K/Brang road now at a planning stage. This proposed road to the east of Gua Musang with the length of 45 km within the State will be affected by the construction of Lebir dam unless the course is changed.

(2) Agricultural

The formation of Lebir dam reservoir is estimated to inundate 5,650 ha of oil palm area, 3,050 ha of rubber area and 5,300 ha of forest area. It means 12.4% of oil palm area, 27.8% of rubber area and 0.7% of forest area in Gua Musang district will be lost. Likewise, Kemubu dam reservoir will inundate 450 ha of rubber area and 790 ha of forest area. It means 1.0% of rubber area and 0.3% of forest area in the two Districts of Kuala Krai and Jeli will be lost. (Refer to Tables IV.3.4 and IV.3.5.)

The total area of oil palm, rubber and forest to be inundated comes to 5,650 ha, 3,500 ha and 6,090 ha, respectively. In other words, 9.5% of oil palm area, 4.2% of rubber area and 0.6% of forest area in South Kelantan will disappear. Thus, from the viewpoint of the whole State 9.2% of oil palm area, 2.7% of rubber area and 0.5% of forest area will disappear. Combined area of oil palm and rubber to be lost accounts for 6.4% of the corresponding area in South Kelantan. It also accounts for 4.8% of the corresponding area in the State. Further, combined area of oil palm, rubber and forest to be lost accounts for 1.2% of the corresponding area in South Kelantan. It also accounts for 1.1% of the corresponding area in the State. (Refer to Tables IV.3.4 to IV.3.6.)

The permanent submergence of 5,650 ha of oil palm area and 3,500 ha of rubber area will invite combined annual income loss of M\$25 million as shown in Table IV.3.7. It corresponds to 3.2% of the primary sector GDP in the State for 1988. Also, it corresponds to 0.9% of the State GDP for the same year.

3.2.3 Positive socio-economic impacts

As direct benefits of project implementation damages to properties, agricultural crops, etc. due to inundation in time of flood will be avoided or reduced, power will be generated for domestic and industrial use, and water will be produced for irrigation. These benefits have been incorporated in economic evaluation.

Other benefits such as indirect and intangible benefits will be treated here.

The greatest indirect benefits will be the emergence and subsequent pervasion of positive mental climate among farmers,

industrialists and businessmen. Especially this climate will be beneficial for a greater productivity and expansion of the primary and secondary sectors. However, all sectors will be eventually benefited, resulting in a higher growth of the State economy.

Also, the related construction works will create employment opportunities for labourers. After completion of the works, permanent jobs will be created for operation and maintenance of equipment and facilities.

The project will facilitate and accelerate urbanization of the basin, which in turn will transform land use pattern, raising the value of land.

Through a heightened pace of intensive and extensive use of agricultural land, productivity and production of agricultural crops will go up, which will lead to an increased export of related agricultural products, thereby contributing towards an increase of foreign exchange earnings.

Flood mitigation will provide an amenity to the inhabitants by removing or alleviating psychological burdens. Furthermore, scenic beauty of the basin brings positive effects on tourism.

3.3 Socio-economic Projection

3.3.1 Population

The population of Kelantan is estimated at 1,091,756 in 1988 based on SEPU forecast in "5th Malaysia Plan for Kelantan". According to the forecast, the State population will grow from 893.8 thousand to 1,147.0 thousand during the period of 1980 to 1990 at an average annual rate of 2.5% as shown in Table IV.3.2. The JICA Study Team assumed that the same growth rate would be maintained from 1990 onward.

Looking back to the past, the population of Kelantan grew from 690.8 thousand to 893.8 thousand during the last inter-censal period of 1970 to 1980 at an average annual rate of 2.6%.

The population of Districts and Daerahs was forecasted based on the growth rates of population by Daerahs during the last inter-censal period.

The population of Kota Bharu District is estimated at 357,995 in 1988, occupying 32.8% of the State population. In the target year of 2010 the population of the same District is forecasted to reach 658,152, accounting for 35.0% of the State population. During the same period the population of area under MPKB will grow from 224,719 (20.6%) to 429,550 (22.9%). It means that migration and concentration of population to the State capital will accelerate in future.

The population of North Kelantan adds up to 859,369 in 1988, sharing 78.7% of the State population. It will grow to 1,354,442

in 2010, but its share will drop to 72.1%. On the other hand, the population of South Kelantan totals 232,387 in 1988, accounting for 21.3% of the population of Kelantan, and it will increase to 525,046 in 2010, raising its share to 27.9%.

Population density of Kelantan is calculated at 72 per km² in 1988, and will rise to 125 per km² in 2010.

3.3.2 Gross domestic product

The Gross Domestic Product (GDP) of Kelantan is estimated to be M\$2,684.4 million at market prices in 1988 based on SEPU forecast in "5th Malaysia Plan for Kelantan". According to the forecast, the State economy will grow from M\$1,668.6 million to M\$3,060.0 million during the period of 1980 to 1990 at an average annual rate of 6.25% as shown in Table IV.3.4. The JICA Study Team assumed that the slightly lower growth rate of 6.0% would be appropriate from 1990 onward.

Despite the dominant place of the primary industry in population and employment, this industry's contribution to the economy of the State is estimated at 28.8% in 1988 or less than one third. Furthermore, it will decline in 2010 to 21.9% or less than one fourth. The share of the manufacturing sector in 1988 is only 4.5% and this level will keep more or less in the future. Overall contribution of the secondary industry to the State GDP is 11.0% and the ratio is forecasted to be maintained in the future. The contribution of tertiary industry will increase from 60.2% to 67.3% during the period of 1988 to 2010. It is noted that this forecast on the future industrial structure of Kelantan is based on the assumption that no major projects related to infrastructural improvement such as the flood mitigation project will be undertaken in the future.

In a period of 22 years from 1988 to 2010, economy of Kelantan is forecasted to grow from M\$2,684.4 to M\$9,816.8 million (3.66 times).

Living standard in terms of per capita GDP It is expected to grow from M\$2,459 in 1988 to M\$5,223 in 2010 (2.12 times) at an average annual rate of 3.5%.

3.4 Land Use Plan

3.4.1 General

Urban areas will continue to expand in future due to the migration of rural population seeking better employment opportunities as well as to the natural increase of urban population.

Agricultural land will also increase mainly owing to the further development of oil palm plantations. However, the acreages under other major crops such as paddy, rubber and tobacco will not change so much in the future because an emphasis

and direction of the Government policy towards them are intensive use of the existing areas and elevation of productivity.

Pasture reserves will continue to be developed because of an important place of animal husbandry in farmers' earnings.

Permanent revenue forests and permanent forest reserves will be preserved, but forest area itself will be bit by bit nibbled away before urban and agricultural development. Grasslands, swamps, etc. will also decrease as the development of Kelantan progresses.

3.4.2 Land use plan

(1) Urban development

During the period of 1966 to 1981 the urban and associated areas in Kelantan increased at an average annual rate of 2.2%. This rate was adopted in projecting the increase of the said areas from 1988 onward. The urban and associated areas will expand from 5,365 ha in 1988 to 8,743 ha in 2010 as shown in Table IV.3.5.

The area managed by MPKB was at the same time declared to be urbanized as the development centre of the State. The development plan of MPKB toward year 2000 as given in Fig.IV.3.1 consists of three development centres with corridors; Bandar Kota Bharu, Kubang Kerian and Pengkalan Chepa. Bandar Kota Bharu will have a function as a pivot of these three development centres as well as the centre of commerce and trading.

The development of Kubang Kerian includes the residential and industrial areas as well as Istana Negeri (State Palace) and the campus and hospital of Science University of Malaysia. The development centre of Pengkalan Chepa area will be an airport with the industrial estate, army camp and residential area.

(2) Rural development

Rubber acreage is assumed to increase by 1,000 ha every year. Thus, it will increase from 129,413 ha in 1988 to 151,416 ha in 2010. The policy of intensive use of the existing rubber areas by replanting will continue to be followed. RISDA's yearly replanting target is 7,000 acres (2,856 ha). Rubber land is desired to be managed on mini-estate basis to raise productivity.

Development of oil palm plantations in South Kelantan will be further stepped up, and oil palm acreage will jump up from 61,261 ha in 1988 to 140,013 ha in 2010, which would be almost maximum. Thus, the share of oil palm acreage in the total State areas will rise from 4.1% to 9.3%.

The intensive use of paddy areas through modern agricultural technology will be pursued further under KADA's guidance and initiative. KADA's policy target during the 5th Malaysia Plan period is to increase paddy yields by 0.1 ton per ha per year.

Furthermore, the development of KADA granary area is still in progress with the target level of 500 ha a year.

As the national rice policy, rice production will be concentrated on the granary areas; that is, paddy lands in Kelantan will be developed only in the KADA project area as one of eight granary areas in Malaysia. Considering the government policy, it is assumed that the development of paddy area is confined to the KADA granary area, and therefore it is projected that the acreage will increase from 71,248 ha in 1988 to about 82,250 ha in 2010.

The overall policy for tobacco growing lies in an intensive utilization of the existing area rather than in expansion of acreage. National Tobacco Board does not draw a rosy picture for future demand of tobacco because of its supposed ill effects on health. Thus, it is projected that the acreage will stay at the level of 8,219 ha in 1988 in future.

Pasture reserves are projected to increase from 4,178 ha in 1988 to 5,200 ha in 2010 at an average annual rate of 1% based on the estimated growth rate of livestock population.

Summing up, agricultural land will grow from 320,583 ha in 1988 to 441,862 ha in 2010, and during this period the share of this land use category to the total area of the State will expand from 21.3% to 29.4%.

The combined areas of grasslands, swamps, unused land and unclassified land are projected to decrease from 58,985 ha in 1988 to 55,391 ha in 2010 at an average annual rate of 0.3% based on the 1974-1981 records.

Lastly, forest areas are projected as the balance between the total land use areas and the combined areas mentioned above to decline from 1,119,076 ha in 1988 to 998,013 ha in 2010 at an average annual rate of 0.5%. As a result, the share of this land use category to the total area of the State will drop from 74.4% to 66.3%.

Table IV.2.1 Fifth Plan Allocations, 1986 - 1990

Sector	Fifth Plan Original Allocation		Fifth Plan Revised Allocation/ <u>1</u>	
	Malaysia	Kelantan	Malaysia	Kelantan
<u>A. Economic</u>	<u>23,548</u>	<u>2,388</u>	<u>15,280</u>	<u>1,123</u>
Agriculture and Rural Development	10,560	1,499	6,458	808
Mineral Resources Development	48	n.a.	45	0
Commerce and Industry	3,239	177	1,678	70
Transport	4,522	441	2,850	157
Communications	134	3	815	0
Energy and Public Utilities	4,591	267	3,001	87
Feasibility Study	54	0.1	33	0.4
Research and Development	400	n.a.	400	0
<u>B. Social</u>	<u>9,035</u>	<u>570</u>	<u>6,379</u>	<u>344</u>
Education and Training	5,583	402	4,453	282
Health and Population	715	36	464	27
Information and Broadcasting	52	n.a.	25	0
Housing	1,980	104	1,026	24
Sewerage	n.a.	n.a.	n.a.	n.a.
Culture, Youth and Sports	216	7	124	0.4
Local and Town Council, Welfare and Community System	237	15	170	7
Village and Community Development	252	6	114	33
Purchase of Land	n.a.	n.a.	3	0
<u>C. Security</u>	<u>4,704</u>	<u>155</u>	<u>2,288</u>	<u>76</u>
Defense	2,803	82	1,210	15
Internal Security	1,901	73	1,078	61
<u>D. Administration</u>	<u>2,788</u>	<u>48</u>	<u>1,035</u>	<u>71</u>
Total	40,075	3,161	24,982	1,614
Kelantan / Malaysia (%)	-	7.9	-	6.5

Note : /1 - Revised allocations as of 1987

Source : Kelantan Development Statistics, 1987

Table IV.2.2 Population of Kelantan, 1970 to 1980

Item	1970	Annual Growth	1980	Annual Growth	1988/ <u>1</u>
State of Kelantan	690,800 (100.0%)	2.6%	893,800 (100.0%)	2.5%	1,091,756 (100.0%)
Bachok	62,593 (9.1%)	2.1%	76,991 (8.6%)	2.0%	90,549 (8.3%)
Kota Bharu	209,210 (30.3%)	3.2%	286,742 (32.1%)	2.8%	357,995 (32.8%)
Machang	51,977 (7.5%)	1.5%	60,436 (6.8%)	1.5%	67,930 (6.2%)
Pasir Mas	101,354 (14.7%)	2.0%	123,026 (13.8%)	1.9%	142,867 (13.1%)
Pasir Puteh	71,608 (10.4%)	1.6%	84,317 (9.4%)	1.6%	95,536 (8.8%)
Tanah Merah	49,318 (7.1%)	2.7%	64,568 (7.2%)	2.7%	79,942 (7.3%)
Jeli	14,477 (2.1%)	5.3%	24,321 (2.7%)	5.4%	37,120 (3.4%)
Tumpat	73,533 (10.6%)	2.0%	89,516 (10.0%)	2.0%	104,492 (9.6%)
Gua Masang	12,578 (1.8%)	4.4%	19,349 (2.2%)	4.8%	28,198 (2.6%)
Kuala Krai	44,152 (6.4%)	3.9%	64,534 (7.2%)	3.8%	87,127 (8.0%)
MPKB	127,290 (18.4%)	3.5%	179,307 (20.1%)	2.9%	224,719 (20.6%)

Note : 1) /1 = Estimate

2) Figures for 1970 are adjusted figures based on Population Census.

3) Figures in parentheses are shares by District.

Sources : Population Census 1970 & 1980, 5th Malaysia Plan for Kelantan and JICA

Table IV.2.3 Population Density of Kelantan, 1970 to 1988

Item	Area	Population Density (persons/km ²)		
		1970	1980	1988/ <u>1</u>
State of Kelantan	1,504,009 (100.0%)	46	59	72
Bachok	27,893 (1.9%)	224	276	324
Kota Bharu	40,242 (2.7%)	520	713	889
Machang	53,022 (3.5%)	98	114	128
Pasir Mas	64,516 (4.3%)	157	191	221
Pasir Puteh	42,564 (2.8%)	168	198	224
Tanak Merah	79,843 (5.3%)	62	81	100
Jeli	132,407 (8.8%)	11	18	28
Tumpat	18,127 (1.2%)	406	494	576
Gua Musang	818,090 (54.4%)	2	2	3
Kuala Krai	227,305 (15.1%)	19	28	38
MPKB	12,610	1,009	1,422	1,782

Note : 1) /1 = Estimate

2) Figures in parentheses are shares by District.

Sources : Agricultural Department, Kelantan

Table IV.2.4 Employment of Kelantan by Sector, 1980 to 1988

Sector	1980		1988/ <u>1</u>		Average Annual Growth Rate(%)
	Employment (Persons)	Distribution(%)	Employment	Distribution(%)	
Agriculture, Forestry & Fishery	160,021	56.5	158,329	48.3	-0.1
Mining & Quarrying	254	0.1	174	0.1	-4.6
Manufacturing	19,471	6.9	23,954	7.3	2.6
Construction	11,513	4.1	26,607	8.1	11.0
Utility	800	0.3	848	0.3	-0.7
Transport, Restaurants & Storage	8,352	2.9	15,772	4.8	8.3
Wholesale & Retail	30,900	10.9	32,402	9.9	0.6
Banks, Insurance & Real Estates	1,538	0.6	2,363	0.7	5.5
Government Services	40,646	14.2	57,545	17.6	4.4
Other Services	9,800	3.5	9,665	2.9	-0.2
Total	283,295	100.0	327,659	100.0	1.8

Note : /1 - Estimate

Sources : 5th Malaysia Plan for Kelantan and JICA

Table IV.2.5 GDP of Kelantan by Sector, 1980 to 1988

(at 1988 prices)

Sector	1980		1988/1		Average Annual Growth Rate(%)
	Amount (M\$ Million)	% Dist. (%)	Amount (M\$ Million)	% Dist. (%)	
Agriculture, Forestry & Fishery	616.2	36.9	772.3	28.8	2.9
Mining & Quarrying	24.1	1.4	26.4	1.0	1.1
Manufacturing	77.6	4.6	120.9	4.5	5.7
Construction	58.6	3.6	146.7	5.5	12.2
Utility	45.0	2.7	63.7	2.4	4.4
Transport, Restaurants & Storage	110.8	6.7	273.3	10.2	11.9
Wholesale & Retail	172.6	10.3	217.2	8.1	2.9
Banks, Insurance & Real Estates	190.0	11.4	334.0	12.4	7.3
Government Services	336.6	20.2	677.9	25.2	9.1
Other Services	37.1	2.2	52.0	1.9	4.3
Total	1,668.6	100.0	2,684.4	100.0	6.1
Population (1,000)	893.8		1,091.8		2.5
Per Capita GDP (M\$)	1,866.9		2,458.7		3.5

Sources : 5th Malaysia Plan for Kelantan and JICA

Note : The figures for 1988 are estimates. This table is made based on Table Biii-37 in the 5th Malaysian Plan for Kelantan. The base year of prices has been changed from 1970 to 1988.

Table IV.2.6 Land Use, Kelantan 1966 to 1988

(Unit : ha)

Item	1966	1974	1981	1988
1. Urban and Associated Areas	3,292	3,601	4,593	5,365 (0.4%)
2. Agricultural Land	212,055	258,904	280,755	320,593 (21.3%)
1) Horticulture	32,930	34,687	35,115	36,183 (2.4%)
2) Permanent Crops	99,674	144,913	166,540	200,194 (13.3%)
(1) Rubber	91,285	130,652	142,209	129,413 (8.6%)
(2) Oil Palm	497	5,302	15,362	61,261 (4.1%)
(3) Other Permanent Crops	7,892	8,959	8,969	9,520 (0.6%)
3) Cropland	79,451	79,304	78,772	80,028 (5.3%)
(1) Paddy	76,871	75,849	75,626	71,248 (4.7%)
(2) Other Annual Crops	2,580	3,455	3,146	8,780 (0.6%)
4) Pasture Reserves	0	0	328	4,178 (0.3%)
3. Grasslands	27,593	18,812	18,116	17,446 (1.2%)
4. Swamps	26,404	26,166	25,503	25,093 (1.7%)
5. Forest	1,215,961	1,179,819	1,158,466	1,119,076 (74.4%)
6. Unused Land	6,392	1,890	1,871	1,852 (0.1%)
7. Unclassified Land	12,312	14,817	14,705	14,594 (1.0%)
Total	1,504,009	1,504,009	1,504,009	1,504,009 (100%)

Source : Department of Agriculture, KADA, RISDA, FELCRA,
KESEDAR, SEPU & JICA

Table IV.3.1 Impacts of Project Cost on Development Budget

(Unit : M\$ million)

Item	Malaysia Plan				
	6th(1991-1995)	7th(1996-2000)	8th(2001-2005)	9th(2006-2010)	Total
1. Project Cost	387	430	130	356	1,302
2. Development budget					
1) Malaysia	31,884	40,693	51,936	66,285	190,798
2) Kelantan	2,072	2,645	3,376	4,309	12,402
3) Energy and public utilities	3,826	4,883	6,232	7,954	22,895
3. 1. / 2.1)	1.2%	1.1%	0.3%	0.6%	0.7%
4. 1. / 2.2)	18.7%	16.2%	3.9%	8.8%	10.5%
5. 1. / 2.3)	10.1%	8.8%	2.1%	4.8%	5.7%

Note : Development budget of the whole of Malaysia is assumed to increase by 5% per annum. Also, it is assumed that the shares of the State of Kelantan and the "energy and public utilities" sector in the national development budget are 6.5% and 12.0%, respectively. These assumptions are based on 5th Malaysia Plan (1986-1990).

Table IV.3.2 Villages and Population to be Affected by
Lebir Reservoir Development 1/

Name of village	Population	Number of households
1. Jeram Panjang	90	18
2. Senawar	24	4
3. Kluang	28	6
4. Depak	70	14
5. Pasir Linggi	5	1
6. Susu Dara	52	10
7. Labut	14	3
8. Lepar	24	5
9. Laka	5	1
10. Pandan	66	13
11. Miak	19	4
12. Kijang	76	15
13. Kuala Aring	14	3
14. Betong	52	10
15. Bonggor	5	1
16. Landak	5	1
17. Chalil	71	14
18. Paloh 3	94	19
19. Lebir 1	71	14
Total	785	156

Note : 1/ Households to be submerged for the dam crest elevation of 84.9m

Table IV.3.3 Villages and Population to be Affected by
Kemubu Reservoir Development ^{1/}

Name of village	Population	Number of households
1. Binjai	167	33
2. Bau	31	6
3. Letong	86	17
4. Lulut	82	16
5. Jerok	486	97
6. Kerak	870	173
7. Bertam Bharu	1,907	378
8. Pasir Tumbuh	307	61
9. Pulau Layak	19	4
10. Meranto	147	29
11. Piek	105	21
12. Perak	58	12
13. Chegar	155	31
14. Tool	346	69
15. Star	132	26
16. Pasir Mayat	58	12
17. Pulat	74	15
Total	5,030	1,000

Note : ^{1/} Households to be submerged for the dam crest elevation of 73.4m

**Table IV.3.4 Negative Socio-economic Impacts
from the Perspective of Districts**

I. Lebir Dam

Item	Extent of impacts (A)	Existing status of Gua Musang District in 1988 (B)	A/B (%)
1. Oil palm (ha)	5,650	45,699	12.4
2. Rubber (ha)	3,050	10,982	27.8
3. Total-1 (1. + 2.)	8,700	56,681	15.3
4. Forest (ha)	5,300	752,633	0.7
5. Total-2 (3. + 4.)	14,100	809,314	1.7
6. Houses (nos)	156	5,609	2.8
7. Population	785	28,198	2.8

II. Kemubu Dam

Item	Extent of impacts (A)	Existing status of Gua Musang District in 1988 (B)	A/B (%)
1. Oil palm (ha)	0	3,788	0.0
2. Rubber (ha)	450	47,164	1.0
3. Total-1 (1. + 2.)	450	50,952	0.9
4. Forest (ha)	790	298,057	0.3
5. Total-2 (3. + 4.)	1,240	349,009	0.4
6. Houses (nos)	1,000	24,714	4.0
7. Population	5,030	124,247	4.0

Sources: Gua Musang, Kuala Krai and Jeli District Offices and JICA.

Table IV.3.5 Negative Socio-economic Impacts from Regional Perspective

Item	Extent of Existing status in 1988		Kelantan (B2)	A/B1 (%)	A/B2 (%)
	Impacts (A)	South Kelantan (B1)			
1. Oil Palm (ha)	5,650	59,357	61,261	9.5	9.2
2. Rubber (ha)	3,500	84,148	129,413	4.2	2.7
3. Total-1 (1. + 2.)	9,150	143,505	190,674	6.4	4.8
4. Forest (ha)	6,090	1,086,088	1,135,522	0.6	0.5
5. Total-2 (4. + 5.)	15,240	1,229,593	1,326,196	1.2	1.1
6. Houses (nos)	1,156	46,224	203,057	2.5	0.6
7. Population	5,815	232,387	1,091,756	2.5	0.5
8. Railway (km)	16	n.a.	207	-	7.7
9. Public Road (km)	14	n.a.	2,004	-	0.7

Sources : Gua Musang, Kuala Krai and Jeli District Offices
and JICA

Table IV.3.6 Negative Socio-economic Impact

Dam Scheme	Assumed Dam Crest Elevation (m)	Agricultural land (ha)				Non-agricultural items				
		Paddy	Oil Palm	Rubber	Forest	Houses	Population	Railway (km)	Tarmac	Rough Feeder
Lebir	84.9	5,650	3,050	5,300	156	785	-	5	-	86
Kemubu	73.4	-	450	790	1,000	5,030	16 ^{1/}	-	9	5
Total	-	5,650	3,500	6,090	1,156	5,815	16	5	9	91

Notes : 1/ Shifting the railway track to the higher elevation

Sources : Gua Musang, Kuala Krai and Jeli District Offices.

Table IV.3.7 Annual Loss of Income from Plantations
due to Reservoir Development

Item	Unit	Dam Scheme		Total
		Lebir	Kemubu	
Assumed dam crest elevation	El;m	84.9	73.4	
Area under oil palm to be submerged	ha	5,650.0	0.0	5,650.0
Average annual income per ha	M\$	1,628.0	1,628.0	
Annual loss of income due to submergence of oil palm area	10 ³ M\$	<u>9,198.2</u>	<u>0.0</u>	<u>9,198.2</u>
Area under rubber to be submerged	ha	3,050.0	450.0	3,500.0
Average annual income per ha	M\$	1,037.0	1,037.0	
Annual loss of income due to submergence of rubber area	10 ³ M\$	<u>3,162.9</u>	<u>466.7</u>	<u>3,629.6</u>
Total annual loss of income	10 ³ M\$	<u>12,361.1</u>	<u>466.7</u>	<u>12,827.8</u>

Table IV.3.8 Population Forecast, Kelantan (1/3)

Administrative Division	1988	1990	1995	2000	2005	2010
State of Kelantan	1,091,756	1,146,997	1,297,727	1,468,255	1,661,197	1,879,488
Bachock	90,549	93,961	102,902	112,402	122,443	132,938
Beklam	7,720	7,822	8,061	8,271	8,447	8,581
Gunong Timor	17,322	17,950	19,567	21,237	22,944	24,657
Gunong Barat	8,663	8,947	9,671	10,408	11,151	11,884
Perupok	15,143	15,517	16,446	17,356	18,231	19,049
Repek	11,214	11,541	12,368	13,196	14,015	14,806
Mentuan	18,395	19,317	21,770	24,428	27,285	30,315
Telong	5,632	6,132	7,563	9,288	11,354	13,807
Tanjong Pauh	6,460	6,735	7,456	8,218	9,016	9,839
Kota Bharu	357,995	379,384	437,724	503,386	576,826	658,152
MPKB	224,719	239,191	278,799	323,568	373,799	429,550
Banggu	16,131	17,060	19,569	22,351	25,410	28,736
Beta	8,524	8,876	9,795	10,761	11,769	12,803
Kadok	14,962	15,680	17,581	19,627	21,811	24,110
Limbat	7,001	7,225	7,798	8,379	8,962	9,535
Pangkal Kalong	31,759	34,462	42,152	51,337	62,235	75,048
Pendek	13,133	13,755	15,399	17,166	19,047	21,023
Peringat	16,623	17,164	18,543	19,946	21,357	22,747
Salor	9,985	10,250	10,914	11,571	12,211	12,818
Sering	15,158	15,721	17,174	18,680	20,225	21,782
Machang	67,930	69,692	74,163	78,698	83,247	87,725
Labok	9,749	9,895	10,241	10,554	10,826	11,046
Panyit	8,747	8,906	9,289	9,647	9,973	10,256
Pulai Chondong	11,777	12,014	12,590	13,138	13,646	14,099
Tanah Merah	8,512	8,584	8,743	8,867	8,951	8,988

Table IV.3.8 Population Forecast, Kelantan (2/3)

Administrative Division	1988	1990	1995	2000	2005	2010
Temangan	5,531	5,579	5,685	5,768	5,826	5,854
Ulu Sat	23,614	24,714	27,615	30,724	34,025	37,482
Pasir Mas	142,867	147,734	160,275	173,269	186,601	200,058
Alor Pasir	8,169	8,406	9,005	9,605	10,198	10,771
Bunut Susu	12,295	12,589	13,319	14,030	14,711	15,344
Chetok	12,423	12,762	13,614	14,460	15,289	16,081
Gual Periok	9,643	9,745	9,976	10,170	10,319	10,415
Kangkong	15,144	15,520	16,455	17,371	18,253	19,079
Kuala Lemal	9,362	9,715	10,626	11,573	12,546	13,529
Kubang Gadong	19,807	20,560	22,506	24,531	26,615	28,724
Kubang Sepat	11,911	12,313	13,341	14,393	15,457	16,512
Pasir Mas	23,145	23,992	26,173	28,430	30,740	33,063
Rantau Panjang	120,968	22,132	25,260	28,706	32,473	36,540
Pasir Puteh	95,536	98,180	104,866	111,601	118,300	124,822
Batu Sebutir	9,465	9,589	9,879	10,135	10,349	10,512
Bukit Abal	9,618	9,750	10,060	10,336	10,570	10,752
Bukit Awang	7,887	8,100	8,634	9,164	9,682	10,175
Bukit Jawa	18,258	18,721	19,875	21,010	22,108	23,140
Gong Datok	8,078	8,226	8,582	8,914	9,217	9,480
Jeram	8,124	8,329	8,838	9,338	9,820	10,273
Limbongan	15,641	16,182	17,569	18,993	20,439	21,879
Semerak	18,465	19,283	21,429	23,711	26,115	28,611
Tanah Merah	79,942	84,044	95,126	107,448	121,093	136,080
Kusial	33,719	35,175	38,987	43,026	47,265	51,648
Jedok	120,027	21,713	26,502	32,207	38,961	46,882
Ulu Kusial	119,524	210,158	21,774	23,417	25,069	26,696
Sokor	6,672	6,998	7,863	8,798	9,798	10,854

Table IV.3.8 Population Forecast, Kelantan (3/3)

Administrative Division	1988	1990	1995	2000	2005	2010
Jeli	37,120	41,169	53,360	69,178	89,654	116,035
Jeli	19,858	22,240	29,437	38,795	50,894	66,414
Belimbing	7,586	8,678	12,112	16,834	23,288	32,046
Kuala Balah	9,676	10,251	11,811	13,549	15,472	17,575
Tumpat	104,492	108,230	117,979	128,257	139,009	150,747
Jal Resar	9,860	10,188	11,025	11,880	12,742	13,595
Kebakat	11,539	11,987	13,148	14,358	15,609	16,879
Pengkalan Kubor	15,544	16,380	18,619	21,073	23,741	26,606
Sungai Pinang	14,763	15,077	15,849	16,589	17,284	17,913
Terbok	12,509	13,021	14,355	15,757	17,217	19,366
Tumpat	17,029	17,129	17,333	17,464	17,515	17,473
Wakaf Bharu	23,248	24,448	27,650	31,136	34,901	38,915
Gua Musang	28,198	31,020	39,626	51,028	66,154	86,179
Galas	16,039	18,337	25,556	35,463	48,985	67,306
Bertam	11,093	11,519	12,621	13,770	14,955	16,156
Ulu Lebir	1,066	1,164	1,449	1,795	2,214	2,717
Kuala Krai	87,127	93,583	111,706	132,988	157,870	186,752
Batu Mengkebang	53,820	57,233	66,555	77,063	88,819	101,828
Olak Jeram	23,330	25,723	32,744	41,503	52,362	65,714
Dabong	9,977	10,627	12,407	14,422	16,689	19,210

Sources : 5th Malaysia Plan for Kelantan and Population Census, 1970 and 1980

Table IV.3.9 GDP Forecast, Kelantan

(Unit : \$ million at 1988 prices)

Sector	1988	1990	1995	2000	2005	2010
Agriculture, Forestry & Fishery	772.3	808.2	1,039.3	1,330.5	1,696.7	2,154.0
Mining & Quarrying	26.4	26.8	34.2	43.7	55.5	70.2
Manufacturing	120.9	136.6	183.2	244.9	325.7	431.3
Construction	146.7	192.9	252.7	329.8	428.7	554.8
Utility	63.7	67.7	107.7	170.8	269.8	424.3
Transport, Restaurants & Storage	273.3	341.0	513.9	771.3	1,152.9	1,715.6
Wholesale & Retail	217.2	225.1	295.0	384.9	500.0	646.6
Banks, Insurance & Real Estates	334.0	376.7	532.0	748.6	1,048.5	1,461.9
Government Services	677.9	829.1	1,066.1	1,365.0	1,740.4	2,209.0
Other Services	52.0	55.9	71.8	92.0	117.4	149.1
Total	2,684.4	3,060.0	4,095.9	5,481.5	7,335.6	9,816.8
Population (1000)	1,091.8	1,147.0	1,297.7	1,468.3	1,661.2	1,879.5
Per Capita GDP (MS)	2,458.7	2,667.8	3,156.3	3,733.2	4,415.8	5,223.1

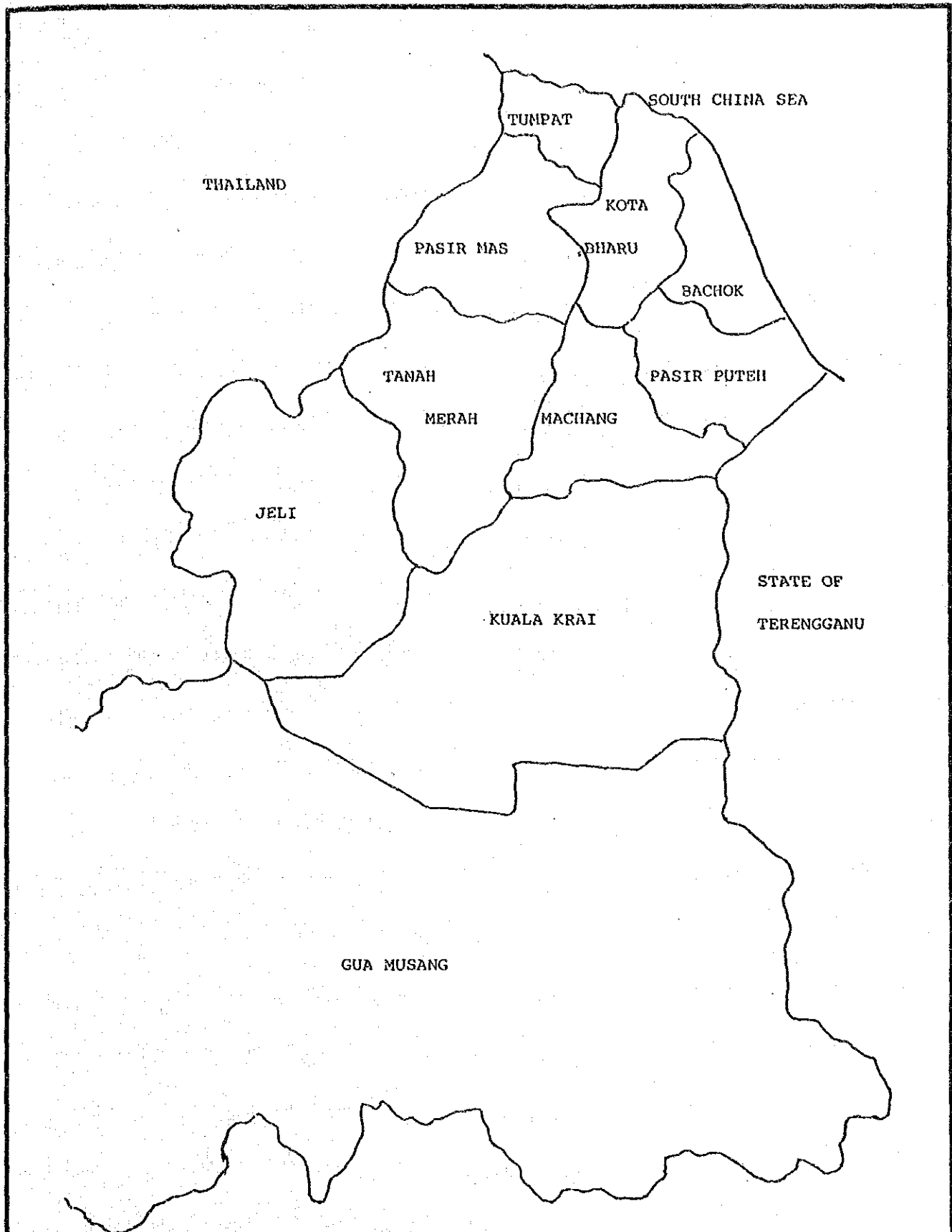
Sources : 5th Malaysia Plan for Kelantan and Kajian Pelan Struktur Kertas Teknikal No.2 : Asas Ekonomi

Table IV.3.10 Land Use Forecast, Kelantan

(Unit : ha)

Item	1988	1990	1995	2000	2005	2010	% Dist.
1. Urban and Associated Areas	5,365	5,609	6,267	7,003	7,825	8,743	(0.6%)
2. Agricultural Land	320,583	331,275	358,061	384,935	411,902	441,862	(29.4%)
1) Upland Crops	36,183	36,494	37,284	38,090	38,914	39,756	(2.6%)
2) Perennial Crops	200,194	209,259	231,921	254,599	277,297	302,912	(20.2%)
(1) Rubber	129,413	131,418	136,419	141,417	146,416	151,416	(10.1%)
(2) Oil Palm	61,261	68,157	85,397	102,637	119,877	140,013	(9.3%)
(3) Other Permanent Crops	9,520	9,684	10,105	10,545	11,004	11,483	(0.8%)
3) Annual Crops	80,028	81,260	84,377	87,538	90,743	93,994	(6.3%)
(1) Paddy	71,248	72,245	74,746	77,248	79,750	82,250	(5.5%)
(2) Other Annual Crops	8,780	9,015	9,631	10,290	10,993	11,744	(0.8%)
4) Pasture Reserves	4,178	4,262	4,479	4,708	4,948	5,200	(0.3%)
3. Grasslands	17,446	17,259	16,801	16,354	15,920	15,498	(1.0%)
4. Swamps	25,093	24,977	24,690	24,406	24,126	23,849	(1.6%)
5. Forest	1,119,076	1,108,480	1,081,873	1,055,085	1,028,101	998,013	(66.3%)
6. Unused Land	1,852	1,847	1,833	1,820	1,807	1,794	(0.1%)
7. Unclassified Land	14,594	14,562	14,484	14,406	14,328	14,250	(1.0%)
Total	1,504,009	1,504,009	1,504,009	1,504,009	1,504,009	1,504,009	(100.0%)

Sources : Fifth Malaysia Plan 1986 - 1990 for Kelantan (SEFU), KADA, RISDA & JICA



Source: Dpt. of Town & Country Planning, Kelantan

Fig. IV.2.1

Districts of Kelantan

GOVERNMENT OF MALAYSIA
 STUDY
 ON
 KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
 JAPAN INTERNATIONAL COOPERATION AGENCY

