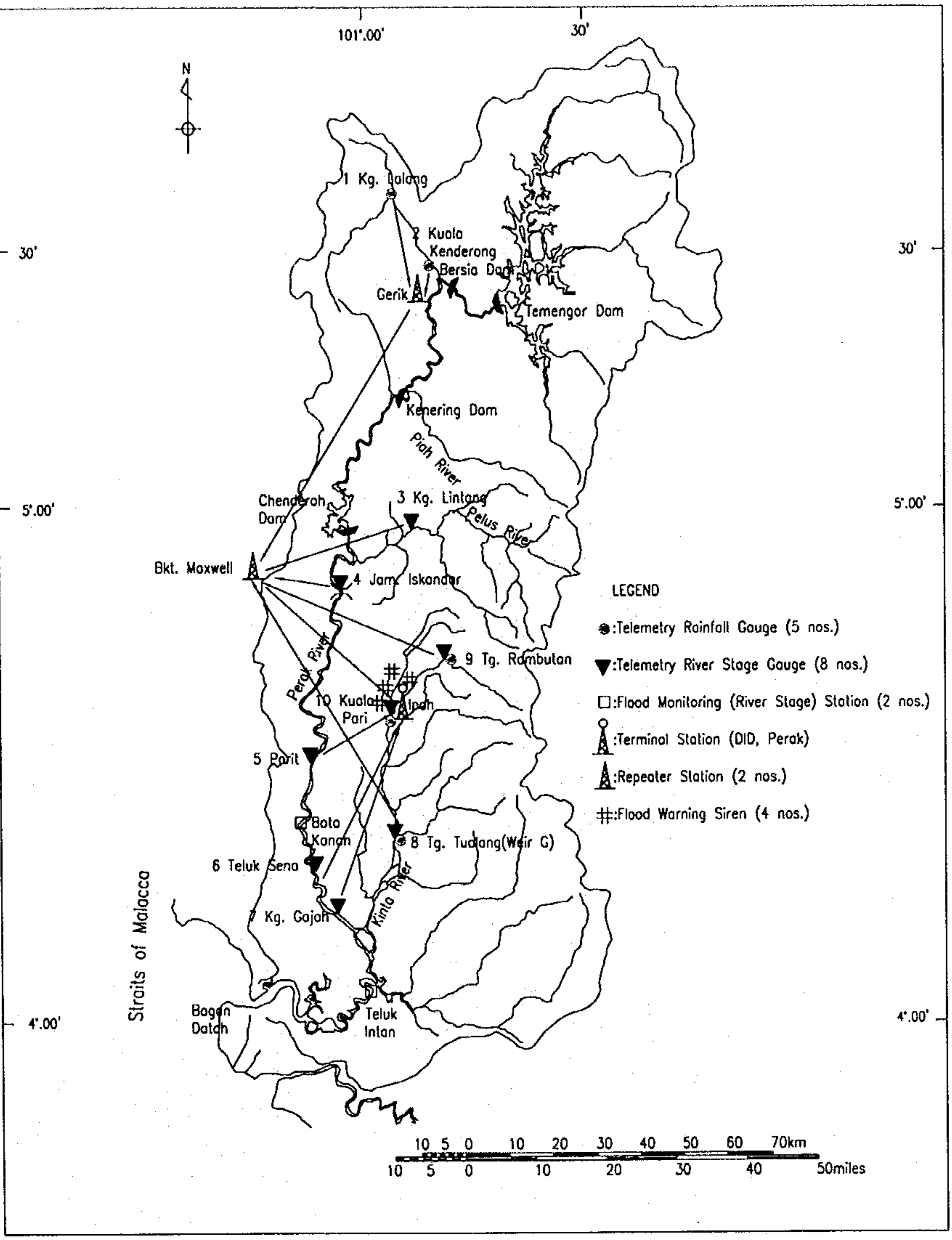
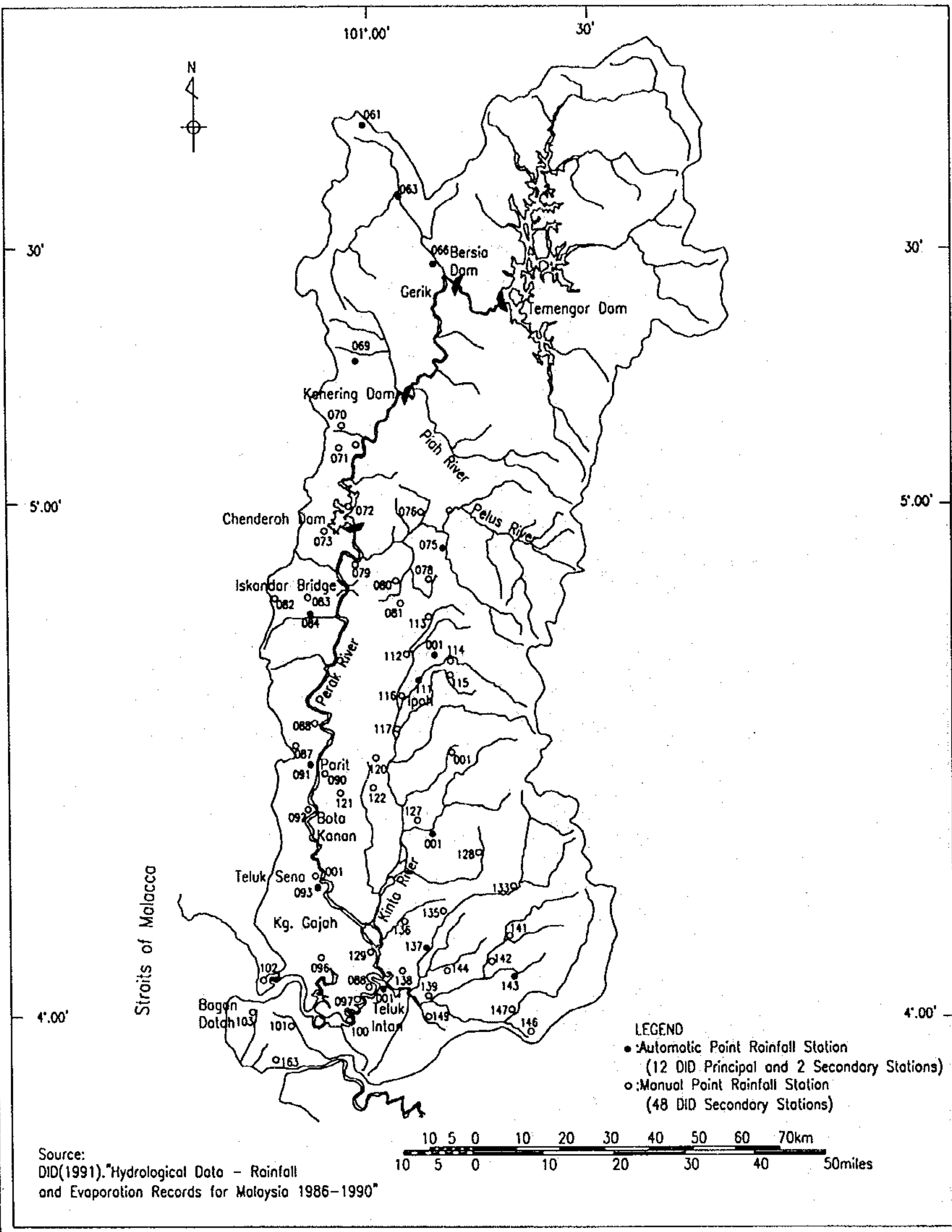
FIGURE



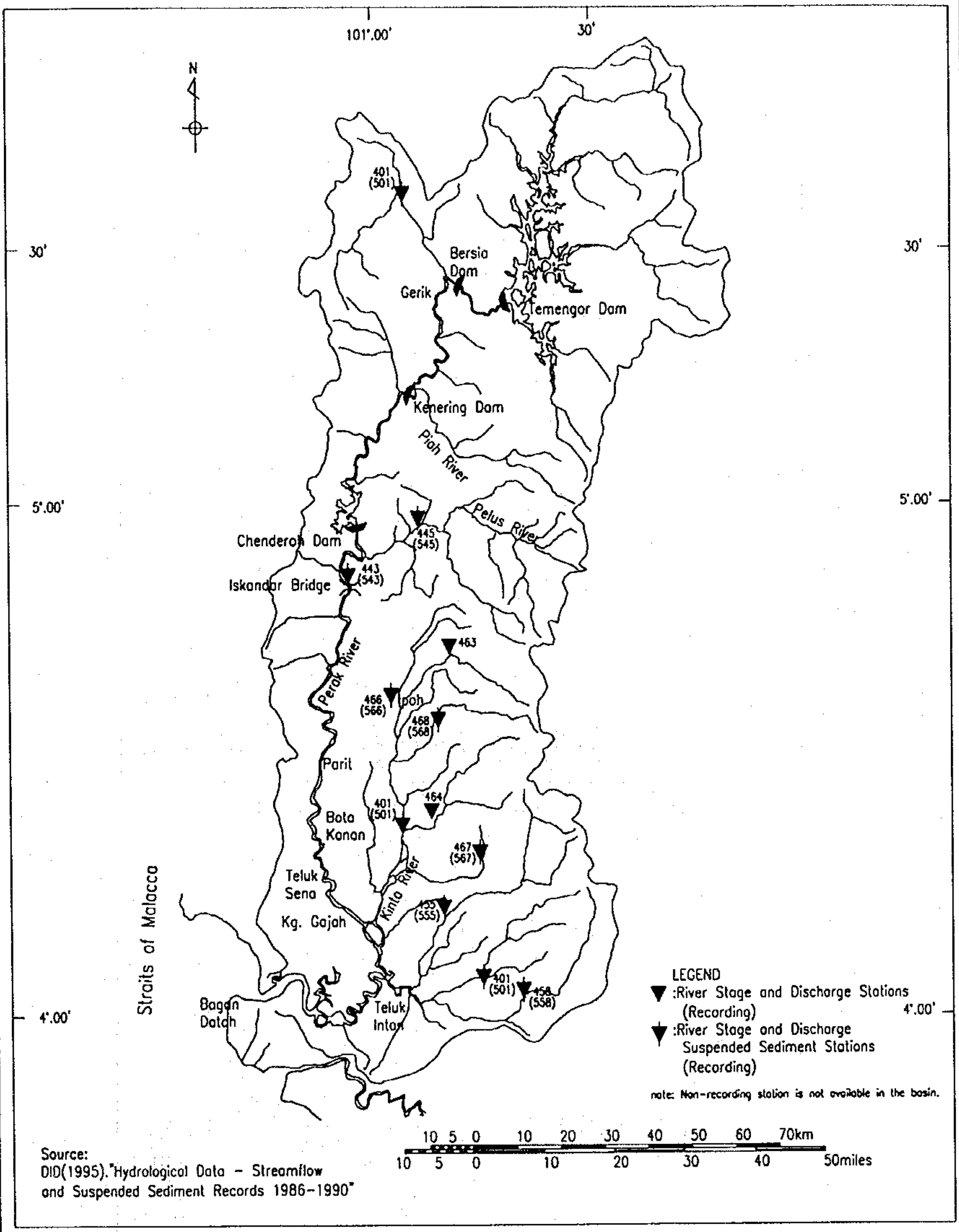
THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-1 EXISTING DID FLOOD FORECASTING AND WARNING SYSTEM
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

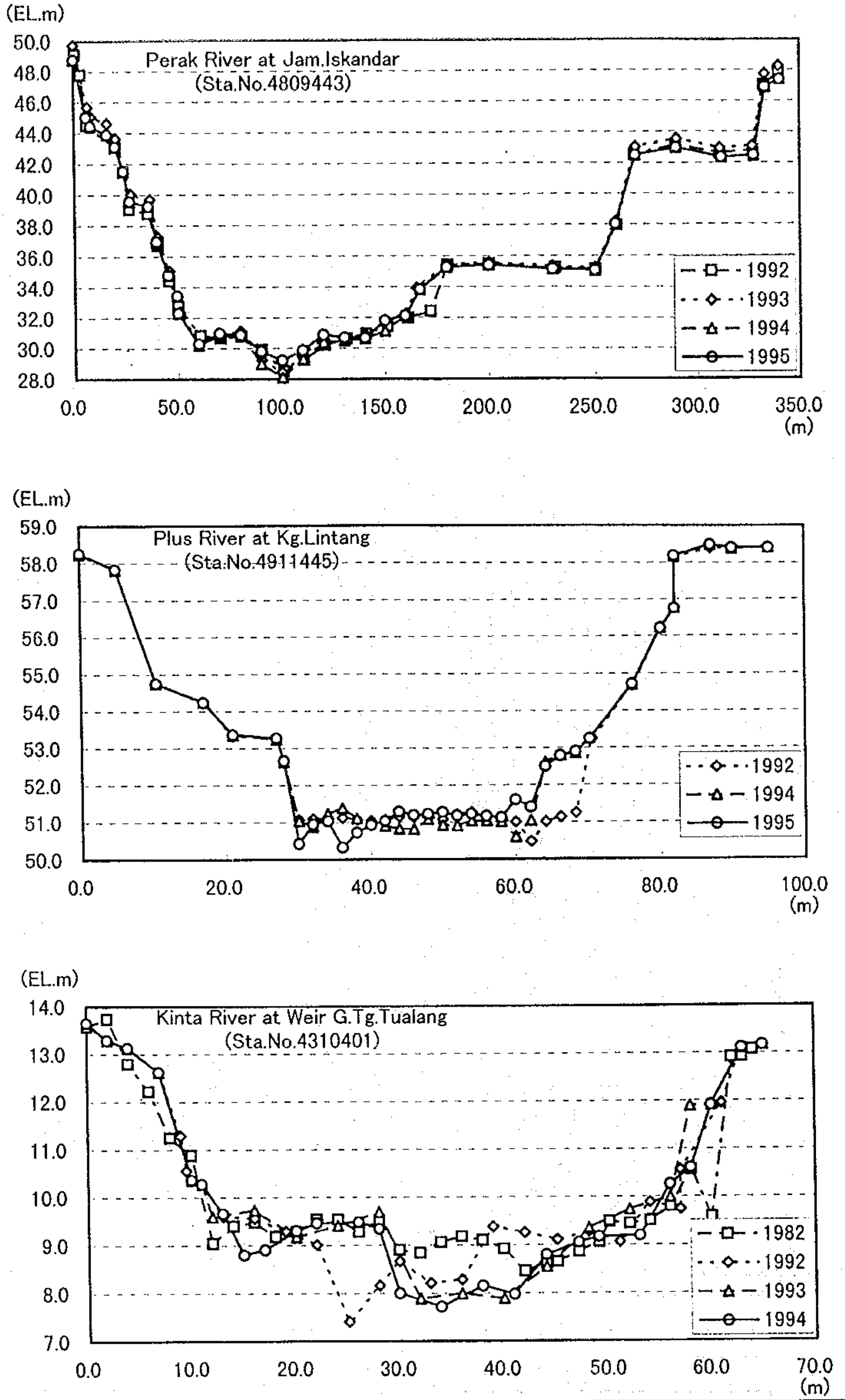
Fig. I-2 LOCATION OF DID RAINFALL STATIONS



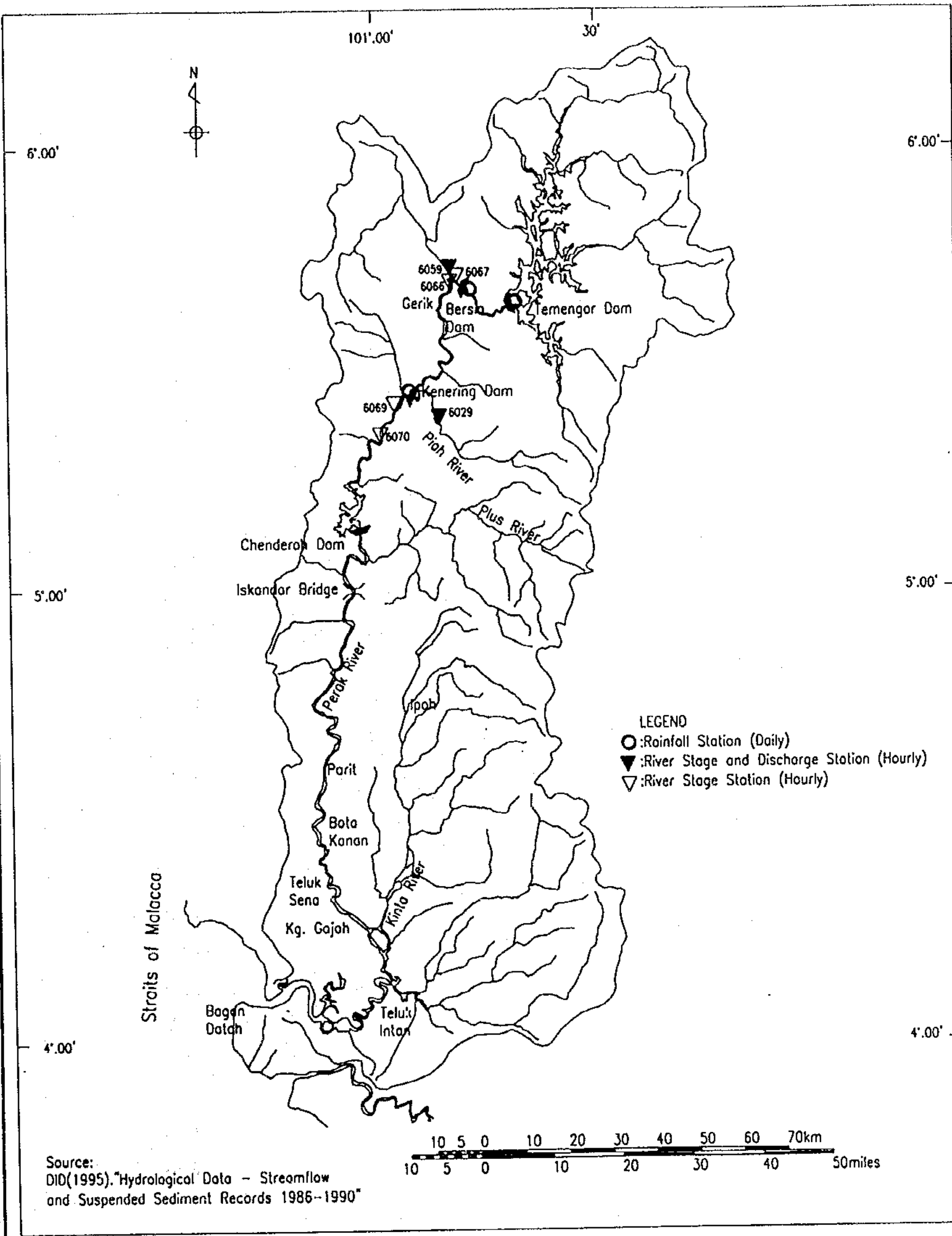
THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

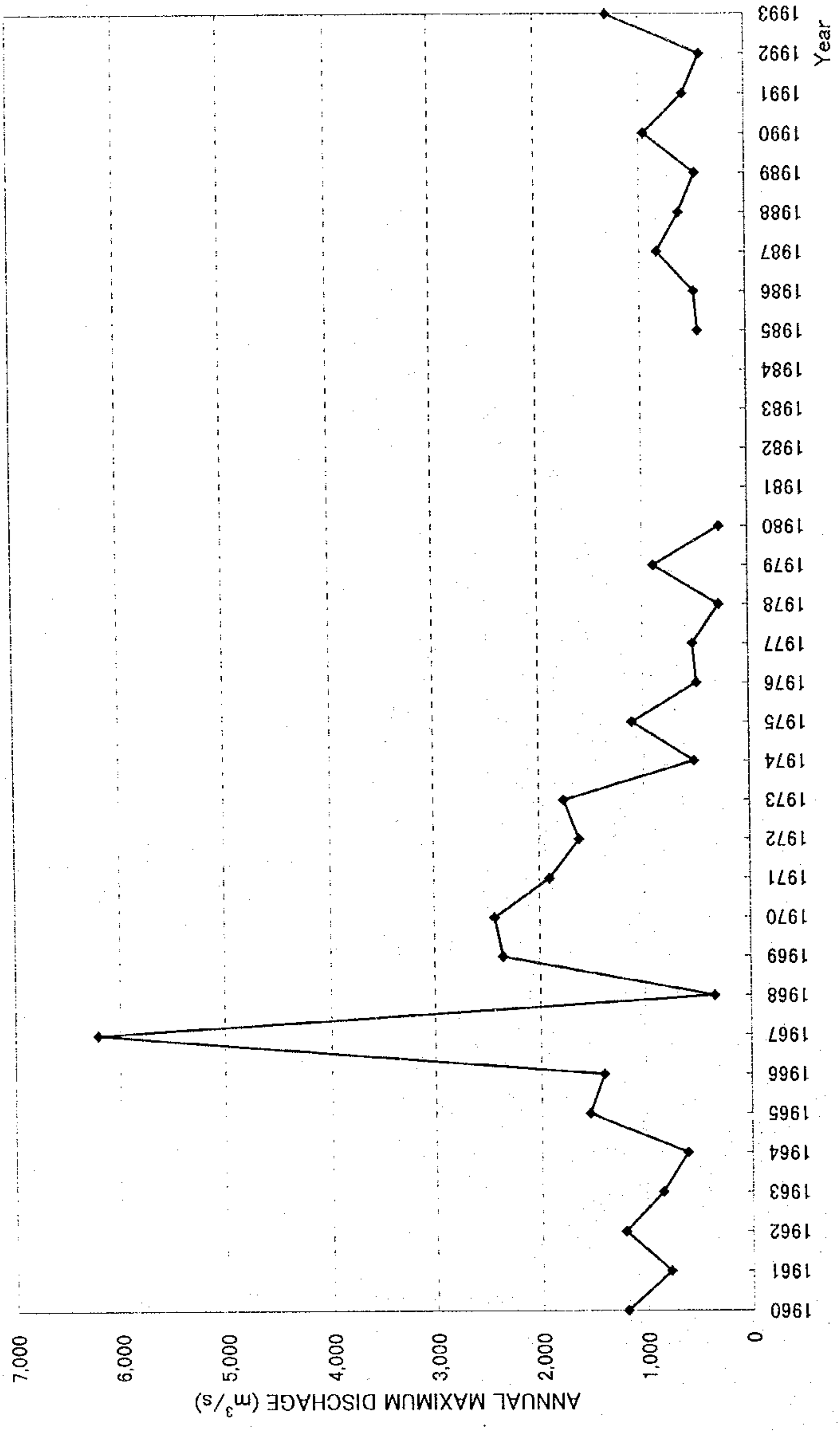
Fig. I-3 LOCATION OF DID RIVER DISCHARGE AND SUSPENDED SEDIMENT STATIONS



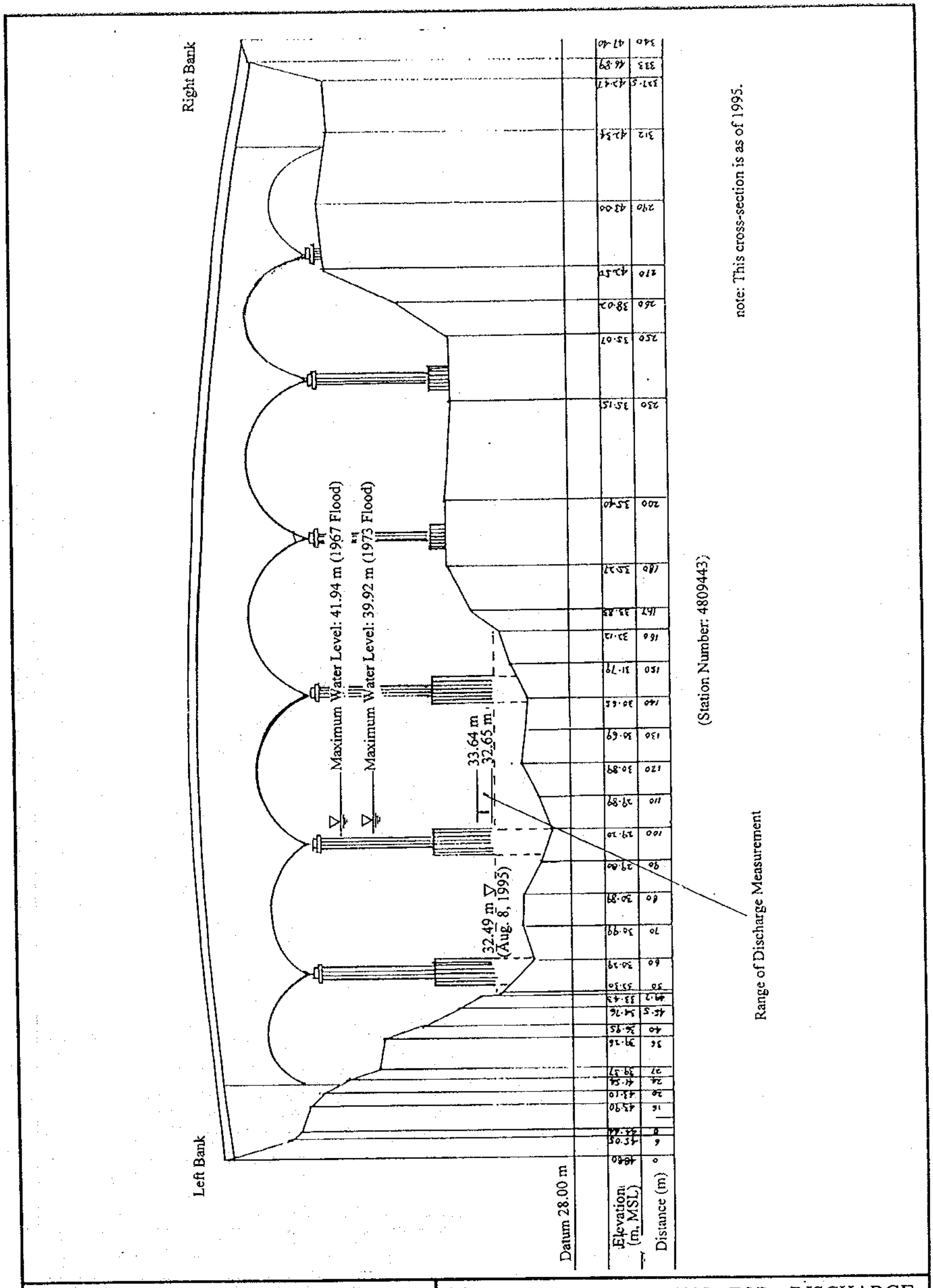
THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-4 CROSS-SECTIONS AT RIVER DISCHARGE GAUGING STATIONS
JAPAN INTERNATIONAL COOPERATION AGENCY	



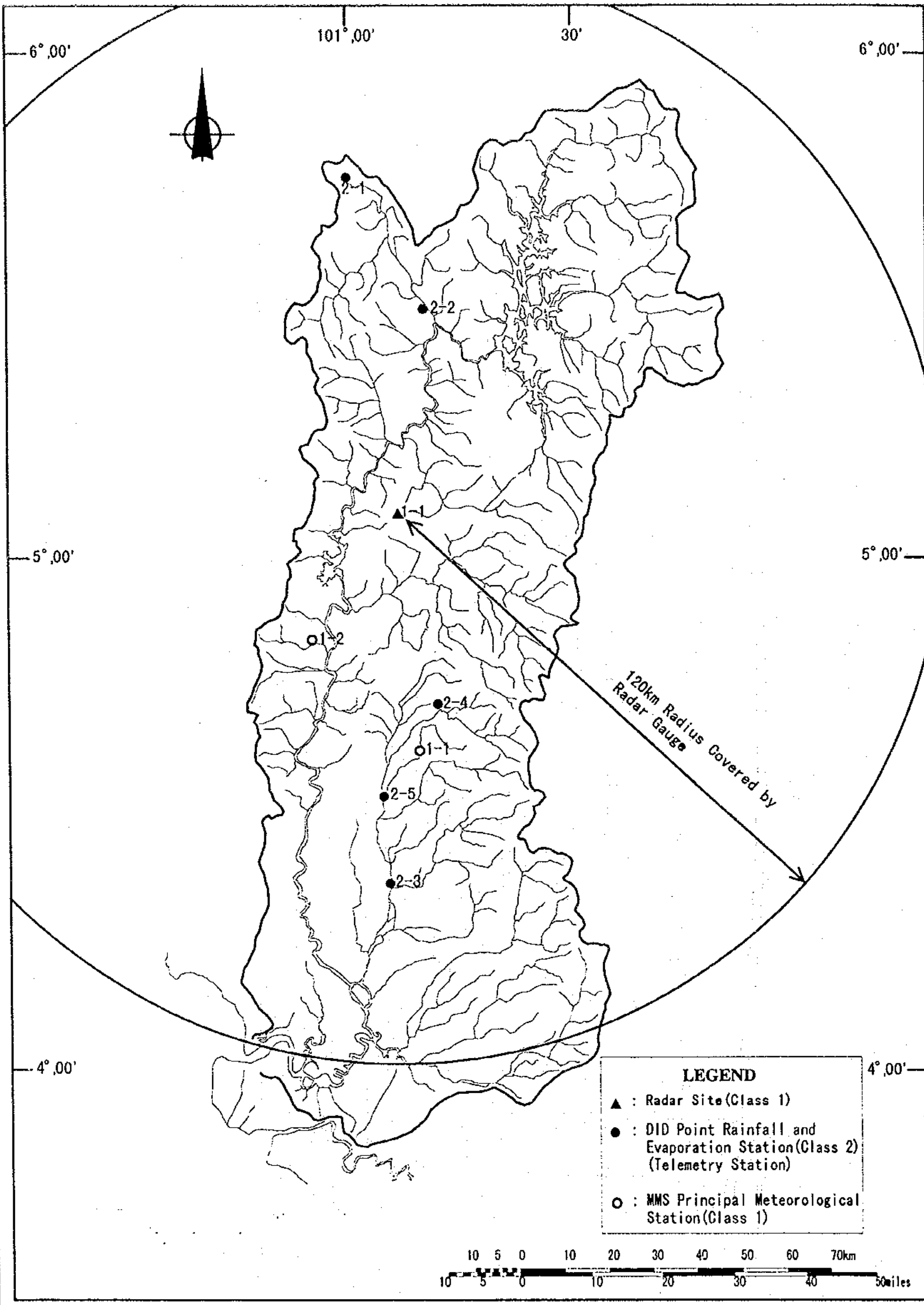
THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-5 LOCATION OF EXISTING TNB HYDROLOGICAL GAUGING STATIONS
JAPAN INTERNATIONAL COOPERATION AGENCY	



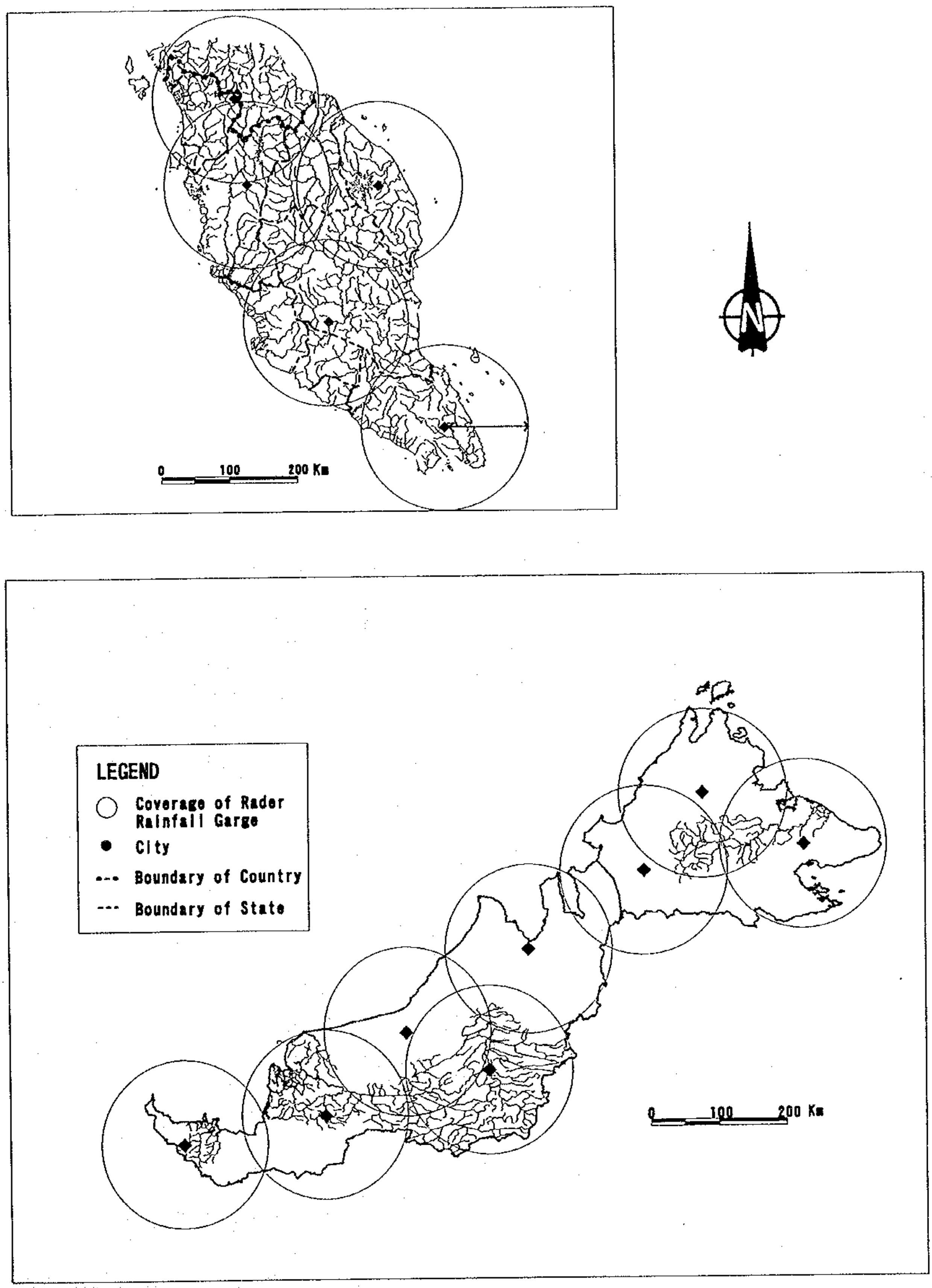
THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-6 ANNUAL PEAK DISCHARGE AT ISKANDAR BRIDGE
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-7 CROSS-SECTION FOR DISCHARGE MEASUREMENT AT ISKANDAR BRIDGE
JAPAN INTERNATIONAL COOPERATION AGENCY	



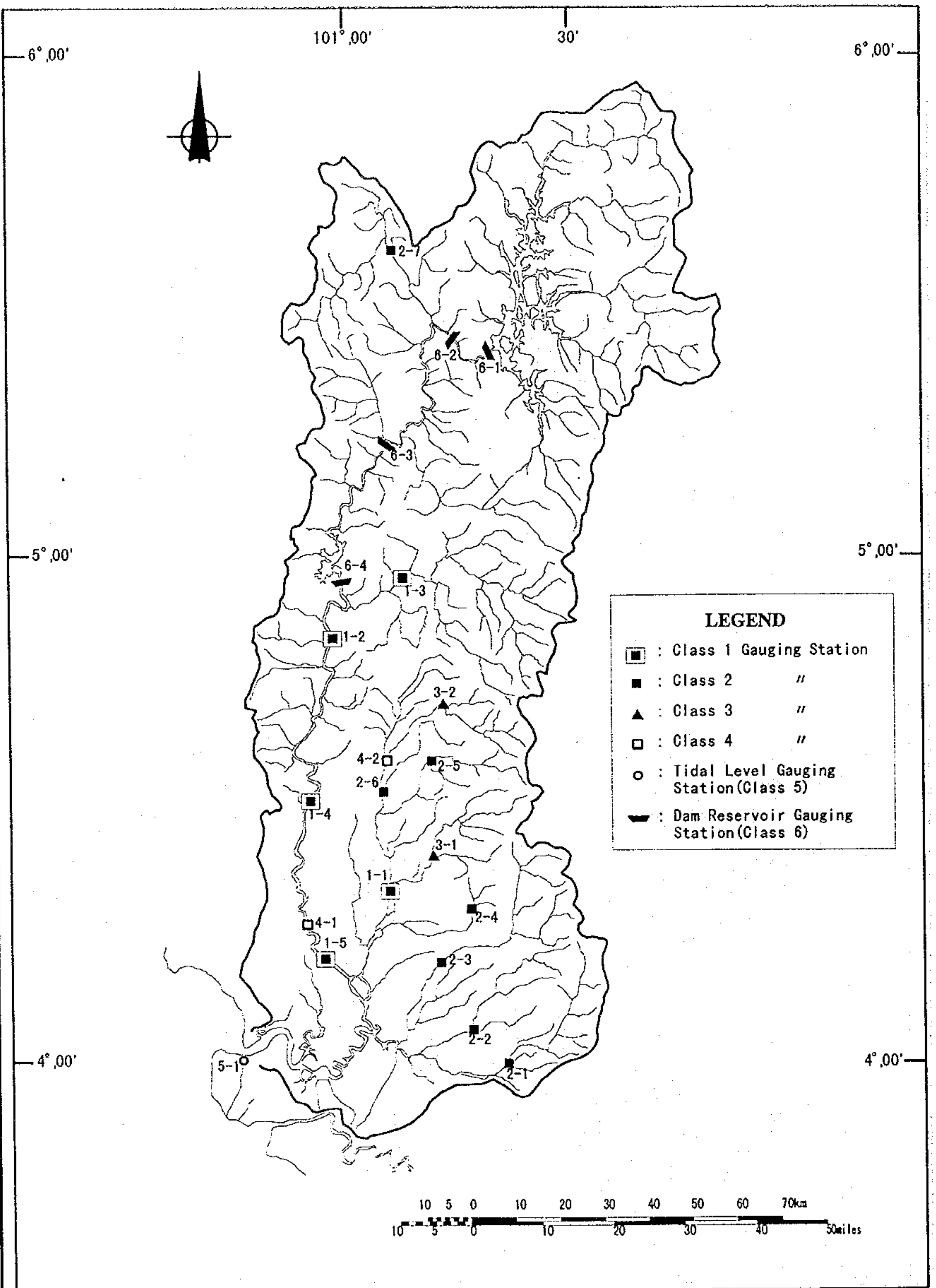
THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-8 LOCATION OF RAINFALL STATIONS PROPOSED FOR MASTER PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY	



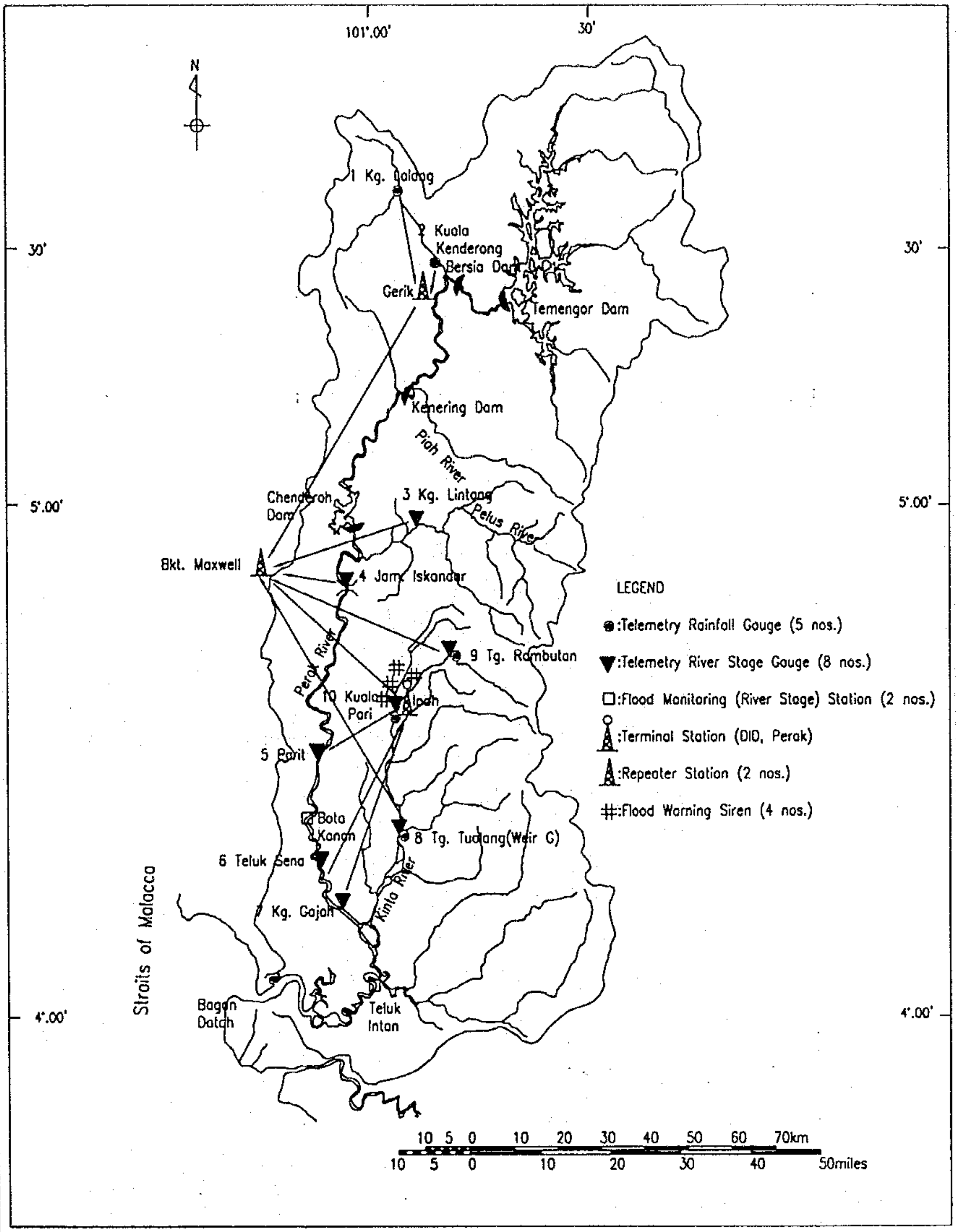
THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

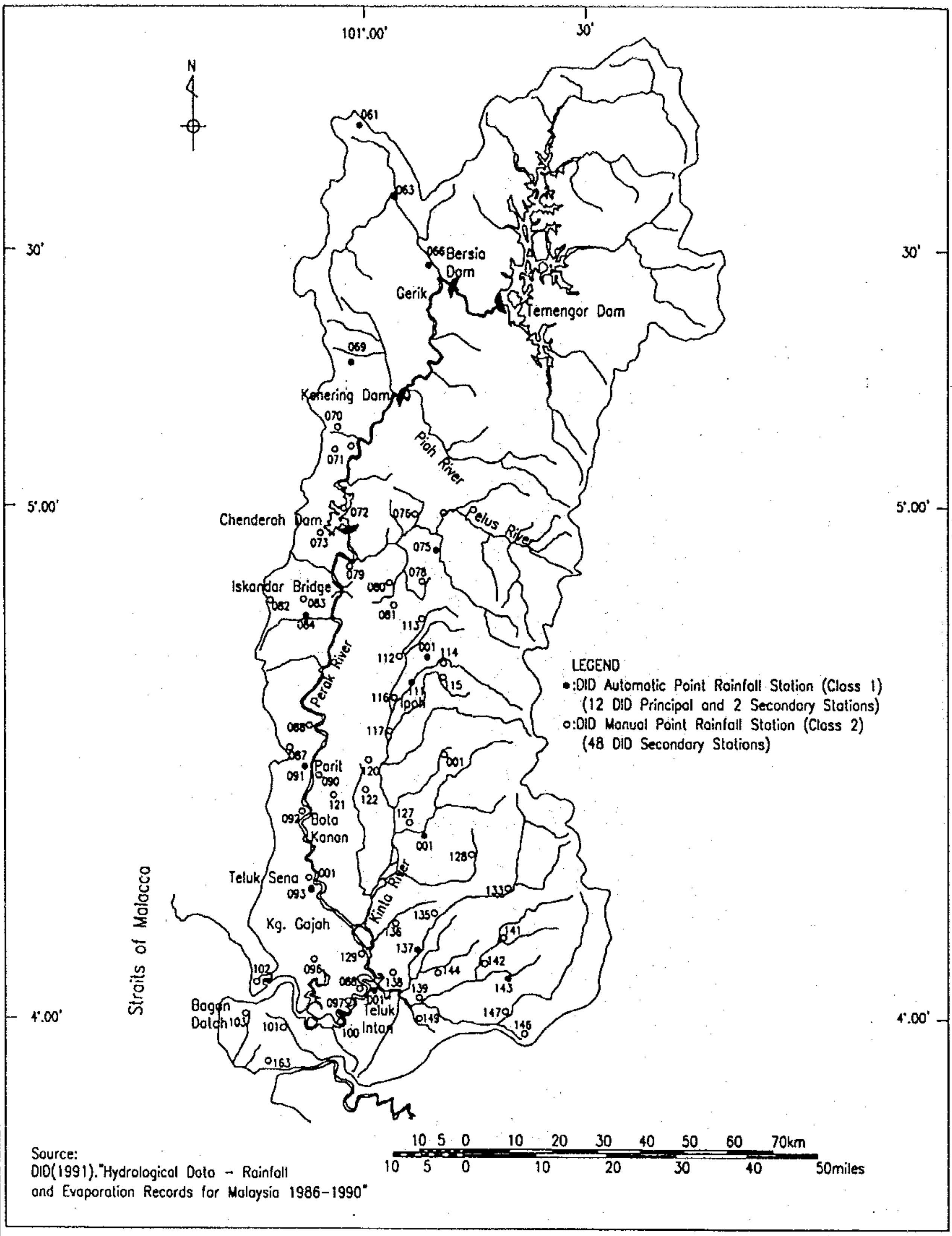
Fig. I-9 PROPOSED NATIONWIDE RADAR RAINFALL SITES IN MALAYSIA



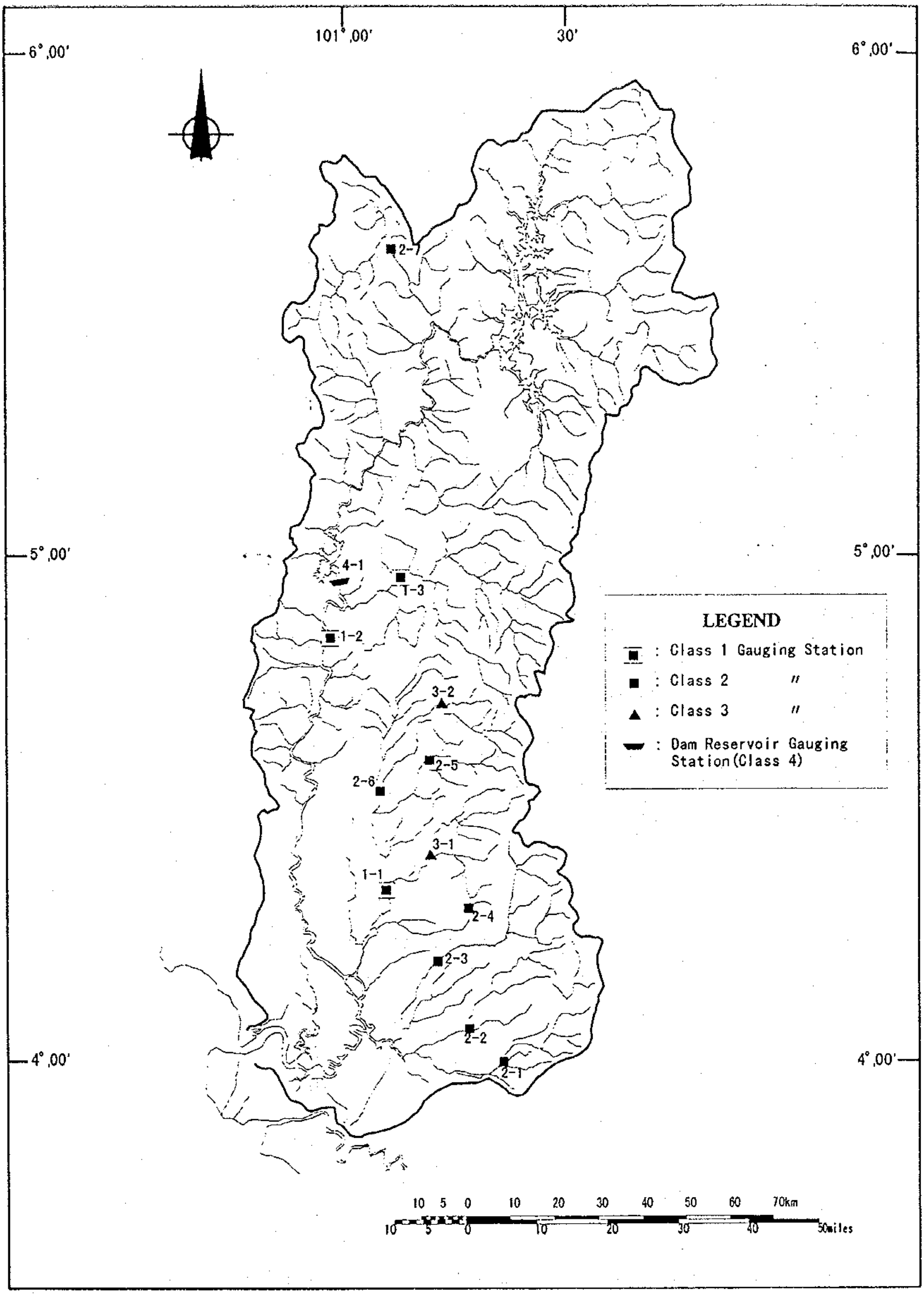
THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-10 LOCATION OF STREAM GAUGING STATIONS PROPOSED FOR MASTER PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY	



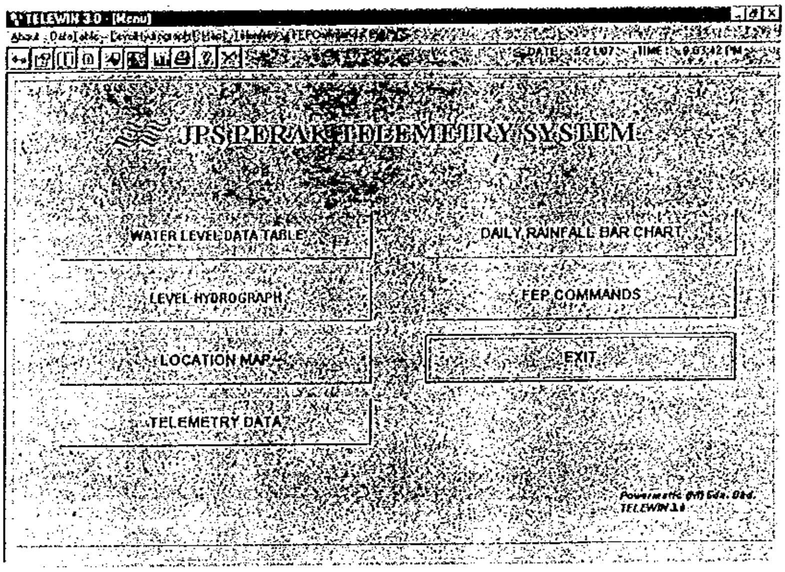
THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-11 LOCATION OF REAL-TIME HYDROLOGICAL STATIONS FOR OPERATIONAL SYSTEM
JAPAN INTERNATIONAL COOPERATION AGENCY	

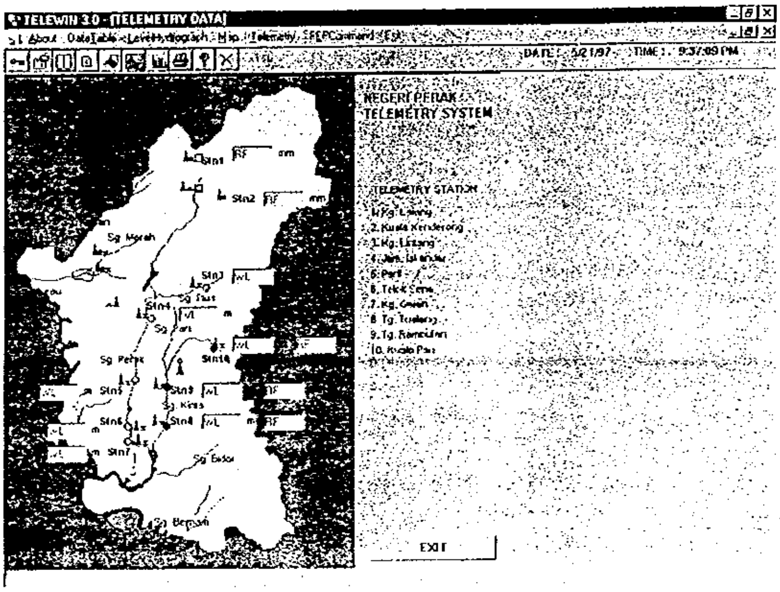


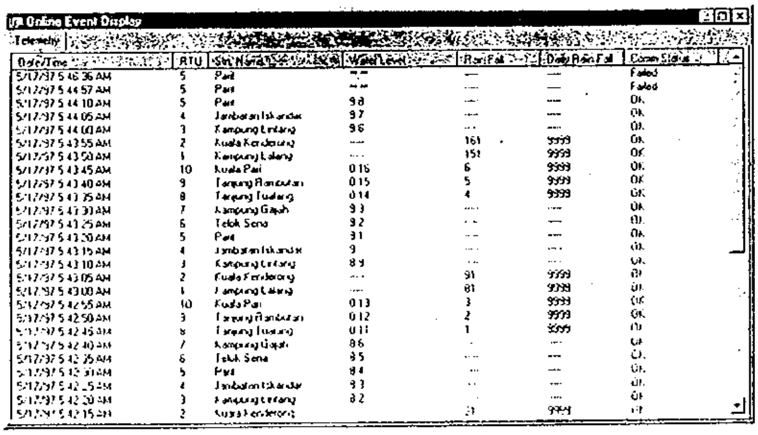
THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-12 LOCATION OF NON REAL-TIME RAINFALL STATIONS FOR OPERATIONAL SYSTEM
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-13 LOCATION OF NON REAL-TIME STREAM GAUGING STATIONS FOR OPERATIONAL SYSTEM
JAPAN INTERNATIONAL COOPERATION AGENCY	

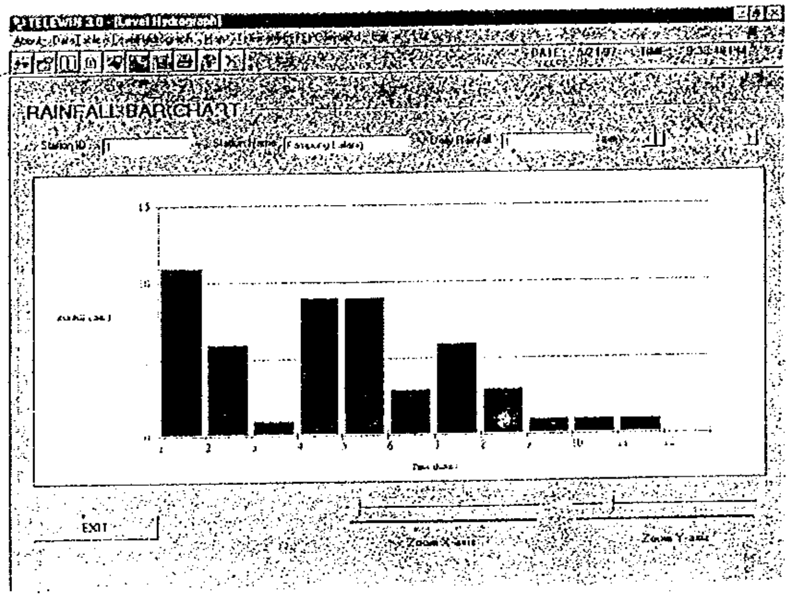


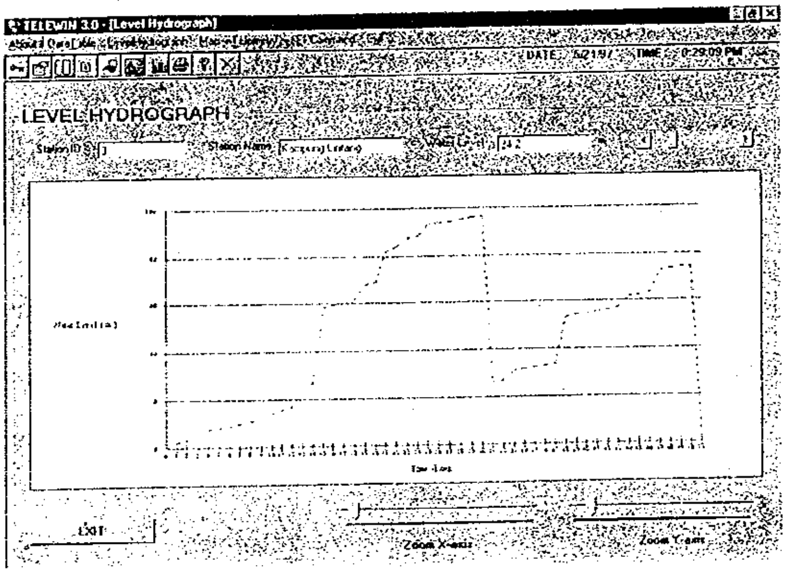


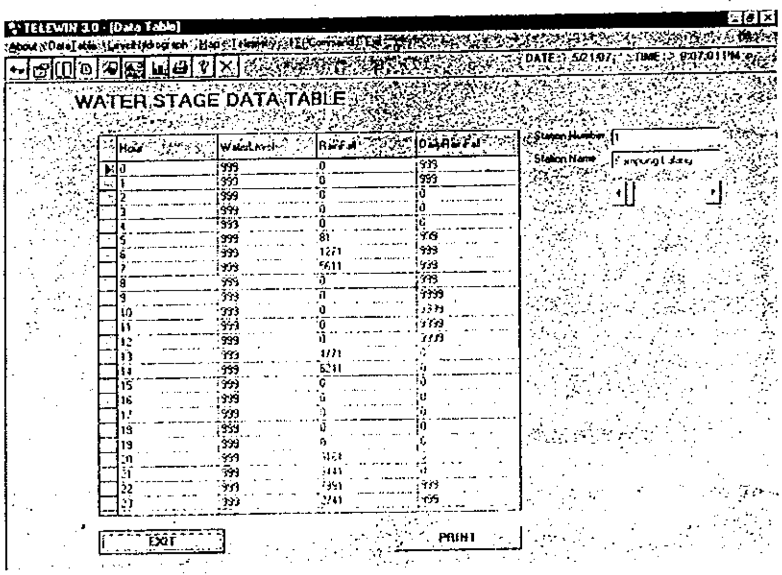


Source : Powermatic Sdn. Bhd. "Training Manual, JPS Perak Telemetry System - TeleWin32 Ver 3.0"

THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-14 (1/2) DISPLAY IMAGE OF REAL-TIME HYDROLOGICAL INFORMATION
JAPAN INTERNATIONAL COOPERATION AGENCY	







Source : Powermatic Sdn. Bhd.
"Training Manual, JPS Perak
Telemetry System
- TeleWin32 Ver 3.0"

THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-14 (2/2) DISPLAY IMAGE OF REAL-TIME HYDROLOGICAL INFORMATION
JAPAN INTERNATIONAL COOPERATION AGENCY	

Monthly Table

Rain mm

Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Day																									
1	-	-	-	2.1	0.5	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.6
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	1.0	-	-	-	-	-	-	-	1.6
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	1.0
5	2.1	1.6	1.0	0.5	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.7
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6	0.5	-	-	2.1
8	-	-	0.5	1.0	1.0	1.0	0.5	-	-	-	3.1	3.1	2.6	2.1	1.6	1.0	-	-	-	-	-	-	-	-	17.3
9	-	-	-	-	-	-	-	-	2.1	2.6	3.6	4.2	4.7	4.7	2.1	-	-	-	-	0.5	-	-	-	0.5	24.5
10	-	-	-	-	0.5	-	-	0.5	-	0.5	-	-	-	-	2.1	2.1	3.6	3.1	3.6	2.1	2.6	2.1	1.6	0.5	25.0
11	0.5	0.5	0.5	1.6	3.6	7.3	7.3	6.3	4.7	4.2	5.2	5.2	3.6	4.2	2.6	2.1	0.5	3.1	0.5	1.0	-	0.5	0.5	-	64.6
12	-	-	0.5	3.1	0.5	0.5	-	-	-	-	-	1.0	1.6	-	1.6	-	-	-	-	-	-	-	-	0.5	9.4
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	1.0
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-	1.0	1.6	1.6	1.0	0.5	1.6	1.0	1.0	1.6	2.1	2.1	2.6	17.7
22	2.6	3.1	2.1	2.6	3.6	2.6	3.1	4.7	4.2	4.7	2.1	2.1	2.6	1.6	1.6	0.5	0.5	1.0	0.5	1.0	0.5	1.6	1.0	0.5	56.0
23	0.5	-	0.5	1.0	1.6	4.2	2.1	2.6	0.5	0.5	0.5	1.0	3.1	3.6	5.2	4.3	5.7	6.3	3.7	4.7	3.6	4.2	4.2	4.7	74.5
24	7.3	5.2	6.8	8.3	7.3	6.3	5.2	3.6	4.2	3.1	2.6	2.6	1.0	0.5	0.5	-	1.6	-	-	-	0.5	1.0	-	-	67.7
25	-	-	-	1.0	0.5	0.5	0.5	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.1
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	0.5	0.5	0.5	-	1.0	-	-	-	-	-	-	-	-	2.6
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tot	13.0	10.4	12.0	21.4	19.3	23.4	19.3	17.7	15.6	16.2	17.7	19.8	20.3	14.8	19.3	16.2	13.5	14.1	11.3	10.4	10.4	12.0	9.9	10.4	372.5

Annual Table

Daily means   Year 1993   site 4809443 PERAK at JAM. ISKANDAR, PERAK
Flow m3/s

Day	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec	
1	137.28	140.23	133.51	?	168.61	262.57	218.36	148.35	124.48	259.44	200.92	329.65	
2	145.48	195.56	120.44	139.15	165.50	308.09	197.04	162.22	125.90	261.10	220.49	322.17	
3	142.28	222.84	148.41	139.60	182.86	300.75	153.63	183.25	124.40	241.68	302.28	368.26	
4	163.15	191.11	120.42	124.87	?	261.04	113.45	160.26	124.43	209.51	327.81	318.81	
5	203.74	149.50	121.12	144.24	?	152.54	171.61	166.72	129.76	239.99	207.12	248.76	
6	217.66	123.31	120.78	161.81	?	166.13	164.25	124.19	148.90	235.20	230.83	472.54	
7	204.18	130.85	119.55	125.23	?	232.38	161.03	118.41	177.01	255.34	165.17	409.14	
8	169.95	179.52	120.07	129.56	?	293.06	164.76	116.37	204.95	243.14	305.51	351.07	
9	141.40	186.34	125.06	121.68	?	276.88	176.08	111.07	206.33	254.88	351.31	355.16	
10	132.59	189.94	125.75	106.86	?	221.67	129.12	107.21	144.14	185.62	368.10	352.17	
11	173.73	195.81	123.70	181.13	?	240.84	124.73	125.51	143.49	239.92	344.94	355.19	
12	181.49	201.18	125.37	231.41	?	206.47	159.17	111.51	134.38	253.64	348.08	365.20	
13	215.18	143.64	178.39	206.77	?	145.81	239.44	119.42	135.59	230.27	426.77	327.24	
14	209.78	158.15	150.91	178.79	?	175.00	246.83	119.70	237.42	245.16	466.15	264.43	
15	210.50	185.39	170.88	218.03	?	215.22	201.36	121.97	211.31	277.33	338.82	332.87	
16	189.92	217.03	223.08	209.56	?	202.52	171.41	133.18	173.06	358.39	328.49	286.99	
17	147.70	219.18	234.01	182.30	?	196.80	199.24	140.36	176.30	330.11	317.23	196.27	
18	154.46	253.77	209.58	146.32	?	238.55	170.52	127.24	116.31	253.68	296.33	289.73	
19	211.03	194.29	136.43	172.61	?	196.26	192.43	125.56	132.67	333.04	188.57	289.96	
20	172.49	152.77	135.80	158.31	?	238.99	255.72	122.66	99.51	430.25	208.36	282.38	
21	131.19	137.83	130.33	157.99	249.90	160.27	222.50	124.34	251.49	422.29	374.33	187.65	
22	150.06	135.10	130.70	153.01	281.86	194.87	237.00	125.97	186.69	397.01	341.27	325.60	
23	149.27	132.64	?	168.85	259.77	225.15	166.26	118.05	161.00	383.94	243.09	433.78	
24	138.47	130.37	?	187.25	213.82	130.89	156.60	119.00	237.85	342.46	185.85	*	
25	138.48	147.86	?	185.08	251.31	150.65	153.09	138.45	326.46	320.39	238.55	*	
26	134.86	124.21	?	173.28	239.88	166.27	151.31	152.56	215.37	269.77	318.30	*	
27	161.52	137.50	?	241.69	326.86	139.88	177.61	143.82	203.40	254.55	342.60	936.57	
28	181.56	130.07	?	184.86	292.92	192.51	193.39	130.22	244.82	256.73	335.25	911.66	
29	200.48		?	201.21	231.72	181.99	211.71	121.93	204.84	318.12	313.20	828.16	
30	177.62		?	196.39	259.31	185.36	180.89	125.82	212.65	320.36	301.02	760.18	
31	138.87		?		172.28		145.74	131.96		170.26		?	
Min	131.19	123.31	119.55	106.86	165.50	130.89	113.45	107.21	99.51	170.26	165.17	187.65	99.51
Mean	168.59	168.07	145.65	169.93	234.04	208.65	180.85	131.46	177.18	282.95	297.89	474.70	221.21
Max	217.66	253.77	234.01	241.69	326.86	308.09	255.72	183.25	326.46	430.25	466.15	*	1151.74

Source : Outputs retrieved from "Hydrological Data Bank System" in DID

THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-15 (1/3) DISPLAY IMAGE OF STATISTICAL HYDROLOGICAL INFORMATION
JAPAN INTERNATIONAL COOPERATION AGENCY	

Annual Table

Monthly totals 1959 to 1980 site 4010001 JPS. TELOK INTAN at PERAK

Rain mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec	Total
1959	?	141.9	323.0	372.6	256.6	63.9	157.4	149.1	?	?	208.8	169.2	1842.5?
1960	179.0	247.4	272.0	133.8	56.6	50.1	135.4	88.9	131.2	315.0	399.6	171.5	2180.3
1961	111.6	157.2	93.3	271.7	26.0	114.7	143.4	64.3	116.1	345.3	373.5	156.5	1973.7
1962	135.0	125.3	291.6	333.0	261.5	82.8	47.9	253.0	186.5	291.8	199.3	51.6	2259.3
1963	176.3	231.6	326.7	67.5	284.2	87.2	158.8	230.3	272.0	292.4	606.8	177.1	2911.0
1964	226.2	300.8	154.3	318.0	129.6	132.7	205.7	121.9	150.0	380.2	163.7	266.2	2549.3
1965	30.3	172.2	157.5	331.7	207.4	62.9	26.8	207.7	81.3	326.0	399.5	411.9	2415.3
1966	124.2	258.5	196.2	295.1	64.1	304.2	98.2	99.0	159.3	258.3	371.0	422.3	2650.3
1967	174.5	175.3	218.9	209.3	179.7	96.8	14.5	22.3	246.5	483.4	331.6	104.9	2257.8
1968	102.5	56.5	215.8	261.7	245.7	172.5	45.6	216.0	145.0	237.8	207.3	359.3	2265.6
1969	93.7	110.7	199.1	83.4	338.2	25.2	103.3	176.6	154.6	363.6	370.2	437.4	2456.2
1970	235.6	64.0	256.1	373.6	191.1	110.5	143.3	63.2	194.4	258.3	295.9	190.3	2376.3
1971	161.9	246.8	85.6	206.6	99.5	16.0	42.5	146.7	120.5	165.3	372.6	336.8	2000.9
1972	147.2	84.5	97.0	231.0	56.2	179.8	69.1	43.0	187.5	496.6	323.2	144.7	2059.8
1973	245.9	92.3	237.7	311.9	286.0	75.6	69.2	161.6	103.4	402.7	160.9	231.5	2378.8
1974	90.7	198.2	28.6	306.9	164.7	123.0	166.8	21.6	173.6	30.3	131.7	87.3	1523.4
1975	132.8	142.7	257.2	254.5	176.5	37.1	207.9	81.8	200.7	113.5	375.5	134.8	2115.0
1976	142.7	50.4	226.8	159.5	130.5	137.3	127.9	185.9	69.9	186.0	140.5	270.7	1828.0
1977	194.0	199.7	71.4	61.4	59.4	78.3	67.2	120.0	328.2	410.3	356.5	413.0	2357.3
1978	135.0	119.1	235.9	253.0	151.0	89.5	43.0	83.5	104.6	360.0	172.8	242.3	1989.8
1979	81.3	232.5	84.5	298.8	96.1	232.8	107.5	106.8	322.2	314.3	285.7	228.0	2370.6
1980	220.0	185.0	273.7	137.7	198.2	142.4	163.0	121.0	256.5	144.5	319.5	?	2161.5?
Min.	30.3	50.4	28.6	61.4	26.0	16.0	14.5	21.6	69.9	30.3	131.7	51.6	1523.4
Mean	148.6	163.3	195.6	239.7	166.3	109.8	106.6	125.7	176.3	294.1	298.5	238.4	2245.9
Max.	245.9	300.8	326.7	373.6	338.2	304.2	207.9	253.0	326.2	496.6	606.8	437.4	2911.0

Annual Minimum and Maximum Values

Source is /d/wlpm4897.mtd Site 4809443 PERAK at JAM ISKANDAR, PERAK
From 600701 60000 to 931231 103000
Interval = 0
Rating applied
Flow m3/s

Year	Minimum				Maximum			
1960	53.8240	at	600810	60000	1189.80	at	601211	60000
1961	57.3750	at	611117	60000	778.804	at	610113	180000
1962	79.0360	at	620203	180000	1204.20	at	621219	60000
1963	53.8240	at	630704	60000	849.858	at	631020	60000
1964	53.8240	at	640409	60000	609.199	at	640729	180000
1965	53.8240	at	650324	60000	1540.56	at	651204	60000
1966	67.9580	at	660727	60000	1398.89	at	661015	60000
1967	54.7170	at	670825	60000	6214.91	at	670106	60000
1968	34.5460	at	680311	120000	340.921	at	681229	180000
1969	40.2090	at	690305	120000	2355.12	at	691201	60000
1970	43.0400	at	700321	120000	2431.19	at	701227	225103
1971	41.3900	at	710809	102356	1907.68	at	711220	152407
1972	11.8080	at	721122	5715	1619.89	at	721219	43824
1973	25.4380	at	730505	100633	1768.93	at	731216	170745
1974	25.6580	at	740930	143018	518.152	at	741124	123609
1975	45.6420	at	751018	64041	1107.28	at	751225	62727
1976	12.0990	at	760322	120000	489.742	at	760104	180400
1977	12.0990	at	770829	30000	525.404	at	771025	203620
1978	10.1070	at	780120	60000	272.433	at	781103	203146
1979	16.1550	at	790131	101001	894.193	at	791128	64441
1980	19.0200	at	800116	123200	264.843	at	800128	14155
1981	No values for this year							
1982	No values for this year							
1983	No values for this year							
1984	No values for this year							
1985	183.247	at	851227	215918	451.403	at	851201	93126
1986	98.6970	at	860411	41627	486.080	at	861104	212425
1987	111.852	at	870718	122127	639.316	at	871214	190236
1988	182.971	at	880117	122349	626.196	at	881123	110001
1989	68.3600	at	890518	33037	471.888	at	890106	170537
1990	74.0120	at	900625	21836	957.737	at	901102	203941
1991	64.7740	at	910407	215455	584.932	at	910526	172427
1992	53.4340	at	920916	73853	420.089	at	921114	63349
1993	90.8570	at	930704	31707	1311.63	at	931224	165516

MINIMUM IS 10.1070 AT 780120 60000
MAXIMUM IS 6214.91 AT 670106 60000

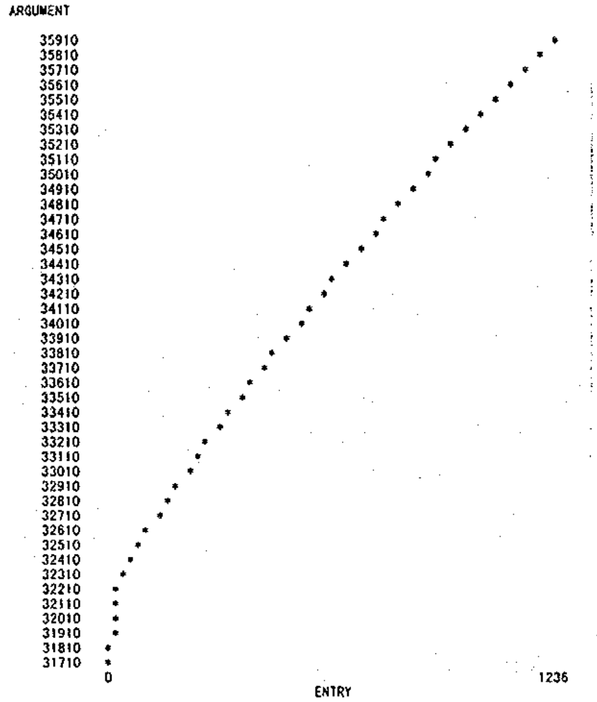
Source : Outputs retrieved from "Hydrological Data Bank System" in DID

THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-15 (2/3) DISPLAY IMAGE OF STATISTICAL HYDROLOGICAL INFORMATION
JAPAN INTERNATIONAL COOPERATION AGENCY	

Discharge Rating Table

Site 4809443 PERAK at JAM. ISKANDAR, PERAK
Rating at 841231 240000

	0	1	2	3	4	5	6	7	8	9
31700		0	0	1	1	2	2	3	3	4
31800	4	5	6	6	7	7	8	8	9	10
31900	10	11	11	12	12	13	14	14	15	16
32000	16	17	17	18	19	19	20	21	21	22
32100	23	23	24	25	25	26	27	27	28	29
32200	30	30	31	32	33	33	34	35	35	36
32300	37	38	39	40	41	43	45	47	50	53
32400	56	59	61	64	66	69	71	74	77	79
32500	82	84	87	90	92	95	97	100	103	105
32600	108	111	113	116	118	121	124	126	129	132
32700	134	137	140	143	145	148	151	153	156	159
32800	162	164	167	170	173	175	178	181	184	186
32900	189	192	195	197	200	203	206	209	211	214
33000	217	220	223	226	228	231	234	237	240	243
33100	246	248	251	254	257	260	263	266	269	272
33200	274	277	280	283	286	289	292	295	298	301
33300	304	307	310	313	316	319	322	325	328	331
33400	334	337	340	343	346	349	352	355	358	361
33500	364	367	370	373	376	379	382	386	389	392
33600	395	398	401	404	407	410	414	417	420	423
33700	426	429	432	436	439	442	445	448	451	455
33800	458	461	464	467	471	474	477	480	483	487
33900	490	493	496	500	503	506	510	513	516	519
34000	523	526	529	533	536	539	542	546	549	552
34100	556	559	562	566	569	572	576	579	583	586
34200	589	593	596	599	603	606	610	613	617	620
34300	623	627	630	634	637	641	644	648	651	654
34400	658	661	665	668	672	675	679	682	686	689
34500	693	696	700	703	707	711	714	718	721	725
34600	728	732	735	739	743	746	750	753	757	761
34700	764	768	771	775	779	782	786	790	793	797
34800	801	804	808	812	815	819	823	826	830	834
34900	837	841	845	849	852	856	860	864	867	871
35000	875	879	882	886	890	894	897	901	905	909
35100	913	916	920	924	928	932	935	939	943	947
35200	951	955	959	962	966	970	974	978	982	986
35300	990	993	997							
Multiply following by 10										
35300				100	101	101	101	102	102	102
35400	103	103	104	104	104	105	105	106	106	106
35500	107	107	108	108	108	109	109	110	110	110
35600	111	111	112	112	112	113	113	114	114	114
35700	115	115	116	116	117	117	117	118	118	119
35800	119	119	120	120	121	121	121	122	122	123
35900	123	124	124	124	125	125	126	126	127	127

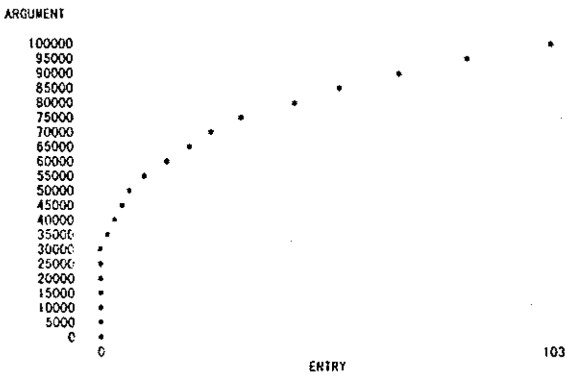


Sediment-discharge Rating Table

Site 4809543 SG. PERAK at AM. ISKANDAR, PERAK
Rating at 841231 240000
Multiply arguments in this table by 1000

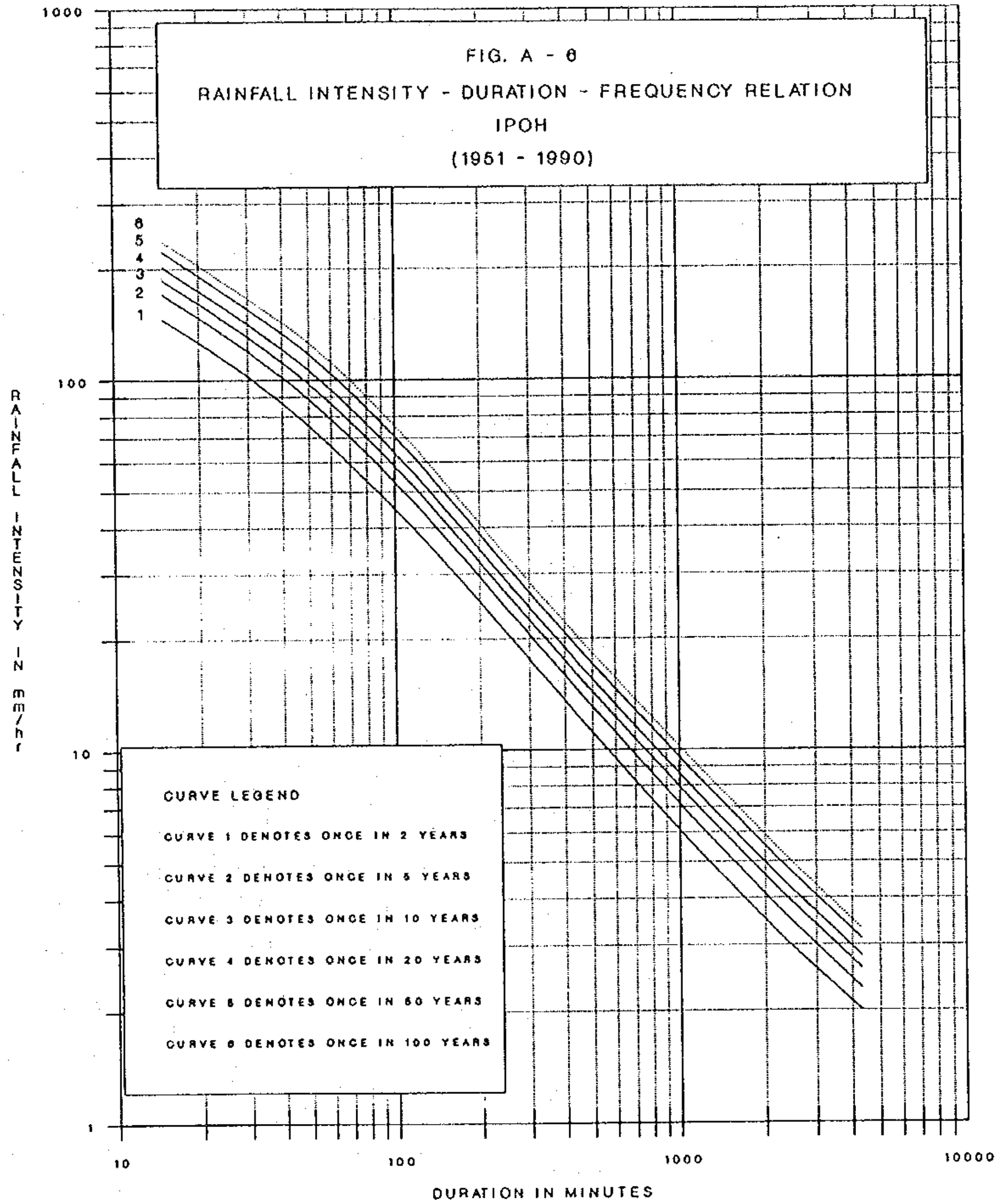
	0	1	2	3	4	5	6	7	8	9
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
30	0	1	1	1	1	1	2	2	2	2
40	3	3	3	4	4	5	5	6	6	7
50	7	8	9	9	10	11	12	12	13	14
60	15	16	17	18	19	20	21	22	23	24
70	26	27	28	30	32	33	35	37	39	41
80	44	46	48	50	53	55	58	61	63	66
90	69	72	75	78	81	84	87	91	95	99
100	103	108	112	117	122					

1



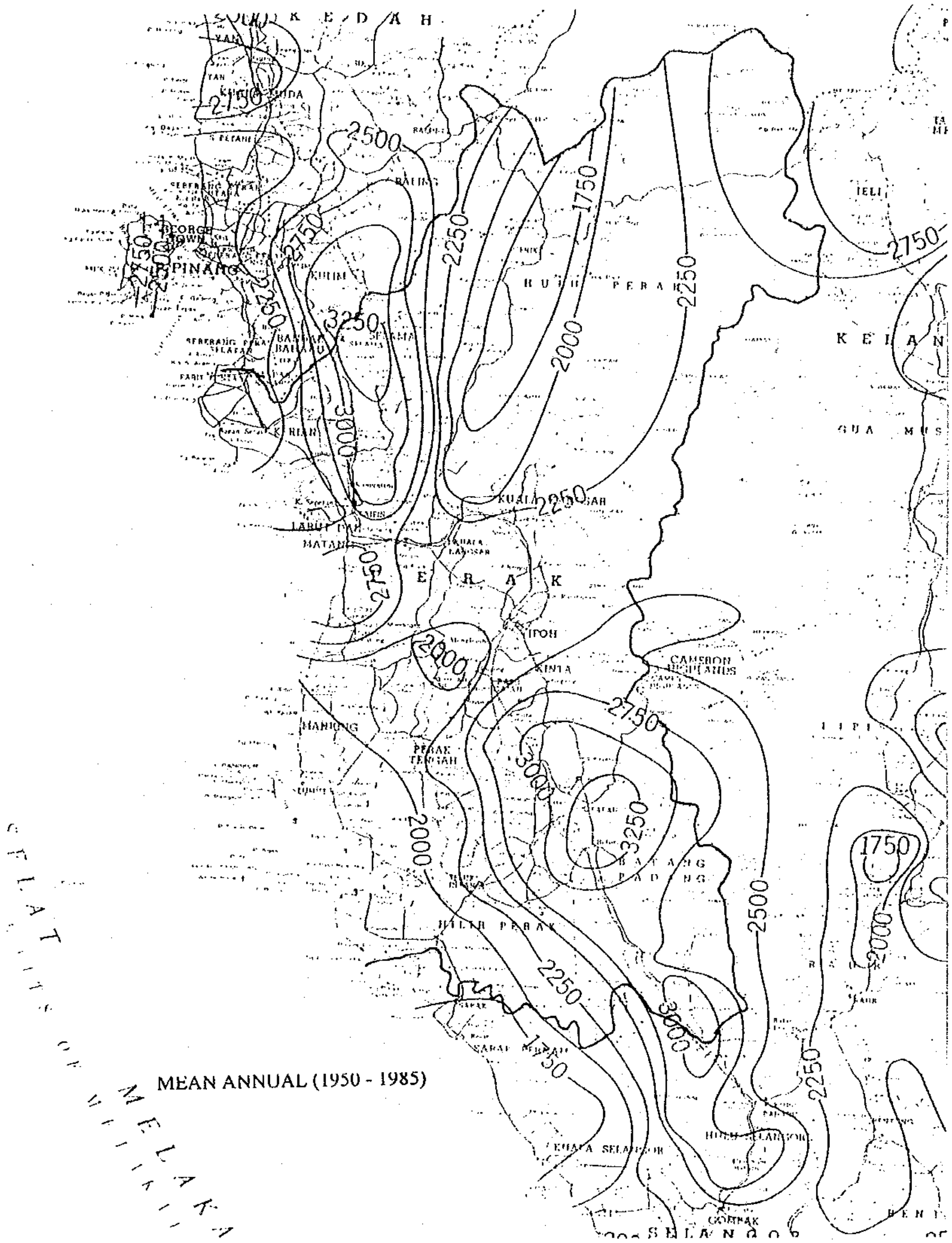
Source : Outputs retrieved from "Hydrological Data Bank System" in DID

THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-15 (3/3) DISPLAY IMAGE OF STATISTICAL HYDROLOGICAL INFORMATION
JAPAN INTERNATIONAL COOPERATION AGENCY	



Source : DID (1991). "Hydrological Data - Rainfall and Evaporation Records for Malaysia, 1986 - 1990".

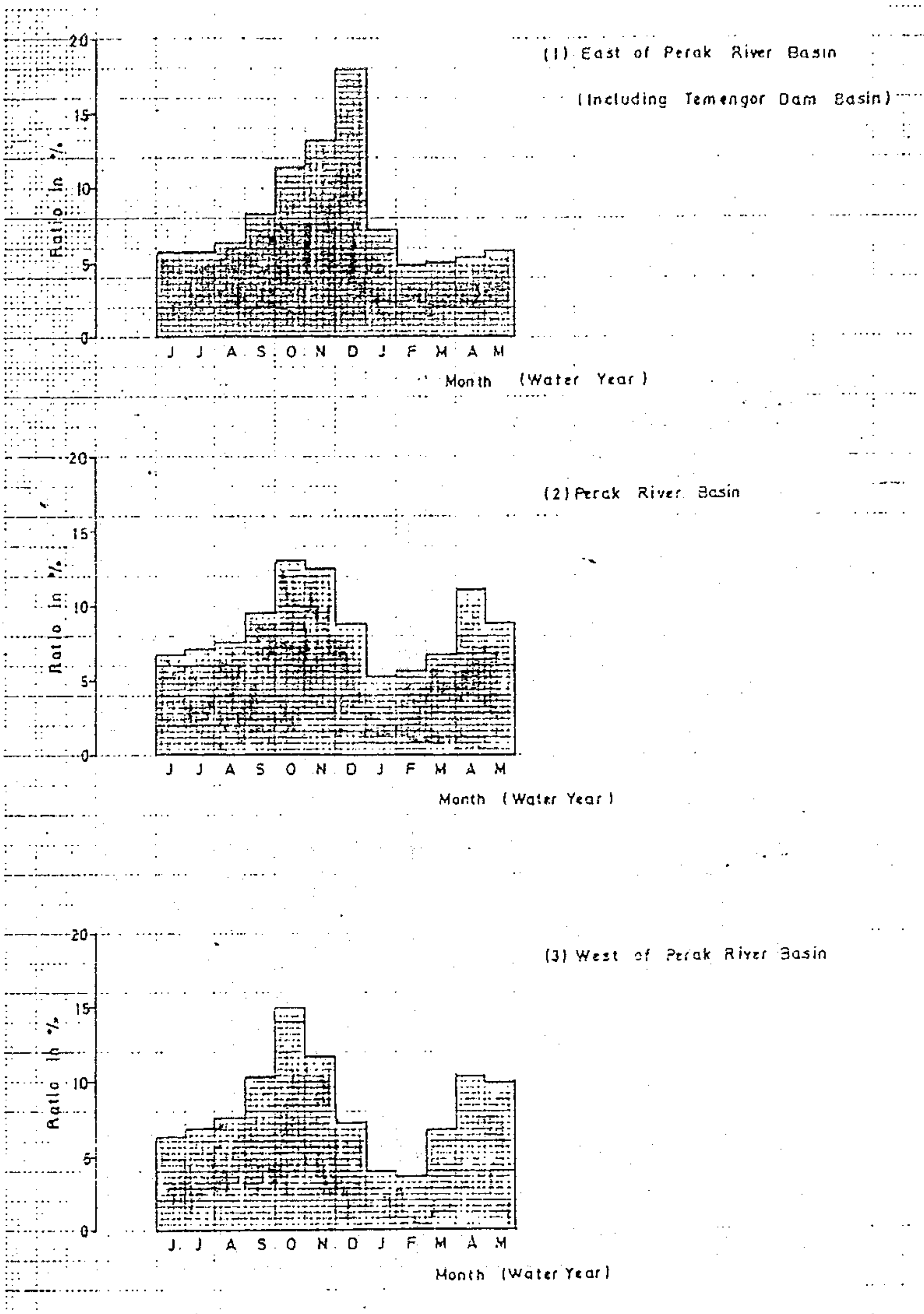
THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-16 (1/3) DISPLAY IMAGE OF PROCESSED HYDROLOGICAL INFORMATION
JAPAN INTERNATIONAL COOPERATION AGENCY	



Source : DID. "Water Resources Publication No. 19 - Maps on Mean Monthly, Mean Seasonal and Mean Annual Rainfall for Peninsular Malaysia (1950 -1985)"

note : The maps on mean N. E. Monsoon, S. W. Monsoon, November and December will also be inputted to the operational system.

THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. I-16 (2/3) DISPLAY IMAGE OF PROCESSED HYDROLOGICAL INFORMATION



Source : JICA. (1980, October). "Lower Perak Flood Mitigation Study - Draft Final Report"

THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA	Fig. I-16 (3/3) DISPLAY IMAGE OF PROCESSED HYDROLOGICAL INFORMATION
JAPAN INTERNATIONAL COOPERATION AGENCY	

MONTHLY METEOROLOGICAL OBSERVATIONS

Station : Ipoh Airport

Year	Month	Mean Daily Temperature (°C)	Mean Daily Relative Humidity (%)	Mean Dayly Sunshine (hr.)	Total Rainfall (mm)	Mean Daily Evaporation (mm)
1995	Nov					
1995	Dec					
1996	Jan					
1996	Feb					
1996	Mar					
1996	Apr					
1996	May					
1996	Jun		(Input Example)			
1996	Jul	25.2	82	6.23	207.8	4.1
1996	Aug					
1996	Sep					
1996	Oct					
1996	Nov					
1996	Dec					
1997	Jan					
1997	Feb					
1997	Mar					
1997	Apr					
1997	May					
1997	Jun					
1997	Jul					
1997	Aug					
1997	Sep					
1997	Oct					
1997	Nov					
1997	Dec					
1998	Jan					
1998	Feb					

THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. I-17 DISPLAY IMAGE OF METEOROLOGICAL INFORMATION

SECTOR II

RIVER MANAGEMENT

SUPPORTING REPORT

SECTOR II

RIVER MANAGEMENT

TABLE OF CONTENTS

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LIST OF FIGURES

CHAPTER 1 INTRODUCTION

This Supporting Report, Sector II, River Management, presents the major issues of river management for the Perak River and the results of the Master Plan Study and the Study on the Operational System. The Master Plan Study aims at setting up the long-term development plan for establishment of the river basin information system (hereinafter referred to as "RBIS"). However, it will take a substantial period to establish such long-term development plan, while the present basin dynamic land development in Malaysia will require the early service of a river basin information. To make up for such shortcoming, the Study on the Operational System was also made to install a pilot river basin information system and to carry out the initial system operation.

This Sector consists of six (6) chapters. The contents of the succeeding chapters are as mentioned below.

- Chapter 2 describes the natural and socio-economic conditions of the Perak river basin, highlighting particularities of the river as compared with other major rivers in Malaysia.

- Chapter 3 describes the present major issues and problems on river management for the Perak river basin.

- Chapter 4 describes the results of Master Plan Study, highlighting the objective information for RBIS in particular.

- Chapter 5 describes the results of the Study on the Operational System, highlighting the presently available information as the objectives for the Operational System.

- Chapter 6 describes the results of case study on the actual usage of information provided by RBIS.

CHAPTER 2 PRESENT CONDITION OF THE PERAK RIVER BASIN

2.1 Natural and Social Features of Perak River Basin

The Perak River originates in the northern mountain range of more than EL. 4,000 feet (about 1,200 m). It runs southward and finally flows into the Strait of Malacca (refer to Fig. II-1). The river has a catchment area of about 14,700 km^2 which covers about 70% of Perak State. The northern watershed boundary of the river borders on Thailand, while the eastern watershed boundary is on Kelantan State. The major tributaries are the Pelus River, the Kinta River and the Bidor River. Among these tributaries, the Kinta River flows down through Ipoh, the State Capital.

The present land use conditions of the Perak river basin are as shown in Fig. II-2 and Table II-1. The forest land spreads out in the upper reaches covering 60% of the river basin, while agricultural lands are developed on the alluvial plain in the middle and lower reaches covering 30%. The first major crop area in the basin is the rubber plantation (taking about 13% of the basin), and the second is the palm oil plantation area (about 7% of the basin). There are many previous mining ponds, particularly in the lower reaches, which cover about 3% of the basin, and some of them are now being used for aqua-culture.

The Perak river basin is administratively divided into six (6) districts (refer to Fig. II-3). The total basin population in 1996 was estimated at about 1,162,000 which was shared by the districts as below.

Name of District	Area (km^2)	Population (in thousands)	Population Density (person/km^2)
1. Hulu Perak	6,563	82 (7%)	13
2. Kuala Kangsar	2,541	147 (13%)	57
3. Kinta	1,985	628 (54%)	316
4. Perak Tengah	1,279	76 (7%)	59
5. Batang Pandang	1,651	94 (8%)	57
6. Hilir Perak	1,161	136 (12%)	117
Basin Total	15,180	1,162 (100%)	77

The basin population tends to concentrate in the Kinta river basin and the lower reaches of Perak river basin as shown in the population density of the Kinta and Hilir Perak districts. The Kinta District includes the City of Ipoh, the state capital of Perak State, and almost half of the basin total population is in the district. In contrast to the Kinta and Hilir Perak districts, the Hulu Perak District which covers the forest reserve area in the upper reaches has a remarkably low population density.

2.2 Particular Features of Perak River Basin Compared to Other Major River Basins in Malaysia

The particular features of the Perak river basin has been clarified through comparison with the other fourteen (14) major river basins in Malaysia, as described below:

(1) Land Use, Population and Hydrological Conditions

The Perak river basin has the fourth largest catchment area of 14,700 km2 following the Rejang river basin (51,315 km2), the Phang river basin (29,300 km2), and the Kinabatangan river basin (16,800 km2). One of the particular features of the Perak river basin is the settlement area taking about 6% of the whole catchment area, which is the second highest rate next to the Klang river basin (refer to Table II-2). The settlement area of Perak river basin has developed particularly in and around Ipoh which has the second largest urban population of about 469,000 next to Kuala Lumpur. The basin total population is also the second largest next to the Klang river basin (refer to Table II-3).

In spite of the high urbanization of Perak river basin, the forest area is well preserved as seen in the coverage rate of forest area in the Perak river basin which almost corresponds to the average value of the major river basins in Malaysia (refer to Table II-2). Such a wide forest area in Perak river basin leads to the rather low population density as a whole. The population density of the Perak river basin is 77 person/km^2, which is only the sixth highest among the river basins in Malaysia. Thus, land use in the Perak river basin is characterized by such conditions that the basin is already urbanized in the lower reaches while the upper reaches is still well preserved by the forest area.

The Perak river basin has an annual rainfall of about 2,300 mm which is higher than those of river basins in the south-west coast (less than 2,000 mm) but lower than those in the north-east coast (more than 2,500 mm). The Perak river basin is likely to have two (2) rainy periods during the inter-transitional monsoon seasons; from April to May and from October to November. The maximum monthly rainfall of Perak river basin usually occurs from October to November.

(2) River Conditions

River channels in Malaysia have a very gentle slope of less than 1/5,000 in the downstream and around 1/2,000 in the middle-stream. The channel slope of Perak River is also classified in this general pattern, and its river channel with less than 1/5,000 stretches from the river mouth up to about 250 km upstream. Due to such long gentle river channel, Perak River tends to accumulate excessive sediment leading to the shallow riverbed. The sedimentation of the river has also been accelerated by the current logging activities in the upper reaches and the previous large sand volume dumped from tin mining sites in the basin.

Among the fifteen (15) major river basins, Klang River is evaluated to be seriously polluted, and only five (5) of the rivers are clean as indicated by the annual water quality index (WQI) prepared by DOE (refer to Table II-4). The water quality of Perak River is now slightly polluted and tends to gradually worsen. DOE as well as the Perak Water Board (PWB) agree that the turbidity of Perak river water is serious causing difficulties in treating the river water for domestic and industrial water supply. However, the annual loads estimated by DOE in 1998 do not indicate the notable value of suspended solids (SS) that was assumed to be high, if ever the Perak River has a high turbidity (refer to Table II-4). At present, any notable deteriorated organic waste load is not seen in the water of Perak River (refer to Table II-5). As for the non-organic waste load, only the ammoniacal nitrogen ($NH3\text{-}N$) tends to increase recently, but is still within the tolerable range.

CHAPTER 3 PRESENT RIVER MANAGEMENT

3.1 Outline of River Basin Management in Malaysia

In Malaysia, various agencies are related to river basin management. The Department of Irrigation and Drainage (DID) undertakes gauging and management of river basin hydrology and river morphology, while the Department of Environment (DOE) carries out the monitoring and control for river water quality. However, a unified monitoring point for river flow discharge and river water quality made by the agencies concerned hardly exist. As a result, although the concentration rate of water quality is monitored at a certain water sampling point, the corresponding pollutant load is not estimated due to the lack of information on river flow discharge.

Basin land conservation and/or development works are also undertaken by various agencies such as the Forest Department (FD) for forest conservation, the Department of Agriculture (DOA) for development of agricultural land, and the Economic Planning Unit (EPU) for urban and industrial development. Information on basin land development is, however, hardly furnished to the agencies concerned in river gauging and management. Such limited information on basin land development/conservation causes difficulty in clarifying the relationship between (a) river gauging data such as river flow discharge and river water quality and (b) basin land development conditions.

The government agencies related to river basin management have established or are going to establish their own information management systems. Most of the systems have been developed by the federal government agencies, and their server-machines have been installed in Kuala Lumpur. Therefore, the federal government controls most of the basic information required for river basin management, but the actual river maintenance and/or management work is mainly undertaken by the state government based on the information provided by the federal government. Such centralized information system could serve a number of system operators, but the system also causes several inconveniences such as the delay of information to the state government.

Different authorities of the federal and state governments also store non-digitized drawings and reports. That is, nationwide non-digitized data could be accessed through the federal government, while the local data could be accessed through the state government. Such non-digitized data are, however, not well compiled by both the federal and state governments, and are often scattered and lost due to the shortage of qualified personnel to manage the data.

As mentioned above, the major issues on the present river basin management are summarized into the following four (4) items:

(a) A consistent river monitoring is hardly made, e.g., the monitoring points for river flow discharge and river water quality are seldom unified, causing difficulty in clarifying the river flow conditions;

(b) Most of the existing database systems related to river basin management are for the exclusive use of a particular government agency and the information stored in the system is seldom exchanged with the other agencies. Such situation causes difficulty in obtaining a comprehensive river monitoring information and basin land development conditions.

(c) The federal government has control over most of the river basin information while the state government is the principal body executing the actual river basin management. Such a dual management system could cause delay in the transmission of information from the federal government to the state government and the difficulty in the execution of appropriate river basin management work unless an effective data transmission system is established.

(d) Non-digitized river basin information tend to be scattered and lost, and are not being used effectively.

3.2 Present River Management Works in Perak River Basin

3.2.1 Flood Management

(1) Dam Control

Tenaga Nasional Berhad (TNB) controls four (4) hydropower dams in the upper reaches of the Perak river basin; namely, Temengor, Bersia, Kenering and Chenderoh. The principal features of these dams are as tabulated below.

Name of Dam	Catchment Area (km^2)	Capacity at FSL ($m^3 10^6$)	Completion Year
1. Temengor	3,420	6,050	1978
2. Bersia	140	58	1983
3. Kenering	1,930	352	1984
4. Chenderoh	1,000	95	1932

Note The catchment area of each dam does not include the area of upstream dams.

Among these dams, the Temengor Dam at the uppermost stretch has the largest storage capacity of 6,050 million m^3, and the annual peak flood discharge as well as the inundation area has remarkably decreased since the dam was constructed in 1974 (refer to Fig. II-4). However, there is still the risk of flood overflowing the Perak River even after the hydropower dams were constructed in the upper reaches. Inundation still occurs in the lower reaches of Perak River and Kinta River as experienced in 1985, 1991 and 1994.

The reservoir operation of the existing four (4) dams is made on the basis of instructions given by the National Load Dispatch Center (NLDC) at the TNB headquarters in Kuala Lumpur. The NLDC monitors the overall power generation load in Peninsular Malaysia on real-time base. Based on the monitored information, the NLDC allocates the power load by the dams in the Perak river basin. Then, the Dam Group Center at the Bersia Dam executes the actual reservoir control in accordance with the instruction from NLDC. The remote gate operation is made, through the exclusive optical lines, to three (3) dams except the Chenderoh Dam. The Chenderoh Dam, the oldest in the Perak river basin, is not equipped with a remote control device and its gate operation is made at dam site on the basis of telephone instructions from the Dam Group Center.

During flood time, TNB informs the outflow discharge from Chenderoh Dam to DID, Police and other related agencies through the public telephone line. However, the dam outflow discharge is determined by NLDC without adequate coordination with DID and other agencies related to the flood management works. Thus, the dam outflow discharge is in principle determined according to the necessary power generation load, but not flood control for the downstream of Perak River.

(2) River Channel Management

According to the interview survey with the Perak State DID, sedimentation in the middle-stretch of the Perak River is in progress forming many sandbars in the river course and making the riverbed shallow. Such river sedimentation could reduce the channel flow capacity and increase the risk of flood overflow of the river channel.

The Study Team had confirmed the sandbars in the river course through field reconnaissance, but at the same time detected scouring of the bridge foundation as the possible evidence of river erosion. Inasmuch as regular channel survey for the entire river stretch has not been carried out since 1970 and the results of channel survey before 1970 have been substantially scattered, the results of channel survey could not accordingly prove the channel sedimentation.

The Study Team had also attempted to collect spot cross-sections at the three (3) discharge gauging stations controlled by DID; namely, Jam Iskandar on Perak River (Sta. No. 4809443), Weir G. Tg. Tualang on Kinta River (Sta. No. 4809543) and Kg. Lintang on Pelus River (Sta. No. 4911545). No definitive process of channel sedimentation were detected through the cross-sections recently surveyed from 1992 to 1995 (refer to Fig. II-5). Thus, it is difficult to conclude that sedimentation of the entire river stretch is in progress because of the presently limited information.

The Perak State DID assume that the sedimentation on the Perak River is produced by the excessive logging activities in the upper reaches, particularly, in the Pelus river basin. However, the details of logging activities as well as other land development in the upper reaches are not released to DID and the other concerned agencies for the river management. Accordingly, the agencies could not clarify the definite relationship between the logging activities/land development and the channel sedimentation.

As mentioned above, the databank for results of river channel survey is indispensable to clarify the progress of channel sedimentation. Moreover, the databank should also store the basin land activities such as logging activities and land development so as to assess their influence to the channel sedimentation.

(3) Flood Mitigation Works

In Malaysia, the criteria for design discharges of the flood mitigation plan are prepared in terms of recurrence probability such as 1/50 years for the urban area, 1/25 years for the agricultural area and 1/5 years for the non-urban and non-agricultural areas. In line with the criteria, several flood mitigation plans have been formulated, and some of them implemented since 1920's for the Perak River and its main tributary, the Kinta River.

The proposed and/or implemented flood mitigation schemes include various measures such as embankment, bund, diversion channel, and river channel dredging. However, there does not exist any databank integrating these previous flood mitigation schemes. Lack of integrated databank causes difficulties in figuring out the overall flood mitigation works and formulating a consistent flood mitigation plan for the river basin. From these viewpoints, it is indispensable to establish a database that could consistently compile the previous, ongoing and projected flood mitigation schemes.

(4) Management on Flood Hazard Area

Since the present river channel flow capacity could not be estimated due to lack of regular river channel survey, the Department of Irrigation and Drainage (DID), the authority concerned in flood management could not setup the probable flood inundation area along the river. Moreover, DID neither possess the land use information along the river nor the jurisdiction to control the excessive land development along the river. Under these conditions, it is practically difficult to execute an appropriate management on the flood hazard area.

(5) Flood Forecasting and Warning

The flood forecasting and warning system in Perak river basin was first set up by DID in 1976, and just upgraded in 1997 taking advantage of the recent big flood event in June 1994. The current system monitors the flood conditions through eight (8) rainfall gauging stations and eight (8) water level gauging stations (refer to Fig. II-6).

The flood information monitored by these hydrological gauging stations are collected on real-time base through either telemetry line or telephone line to the State DID Terminal Station located in Ipoh. State DID issues the warnings through the sirens and telephone to residents and/or the government agencies related to the flood evacuation and flood protection when the water level is predicted to reach the alert, warning and danger levels.

The outflow discharge from the existing hydropower dams controlled by TNB seriously influences the flood forecasting and warning in Perak river basin. As described above, however, TNB releases only the information on outflow discharge from the Chenderoh Dam through the public telephone line to State DID during flood time. Other information on outflow discharge from the other three dams as well as dam reservoir level is not released to the State DID. On the contrary the flood forecasting information as well as flood conditions in the lower reaches are seldom released to TNB. Thus, both DID and TNB could not effectively exchange their own real-time information during flood time.

Under the above situation, proper coordination between TNB and DID is required to exchange dam reservoir information and hydrological gauging information so as to effectively control the dam outflow discharge in view of flood mitigation in the lower reaches. Moreover, the dam outflow discharge is determined by NLDC in Kuala Lumpur and, therefore, inconvenience between NLDC and State DID is foreseen in exchanging the flood information and coordinating the control of dam outflow. From this point of view, it is deemed necessary for Federal DID to monitor the flood forecasting information in order to take immediate and appropriate coordination with NLDC.

3.2.2 Water Resources Management

(1) Management of River Maintenance Flow

TNB agreed with DID, in 1975, to guarantee a minimum flow discharge of 4,000 cusec (about 113 m3/s or 0.015 m3/s/km2) at Iskandar Bridge located about 23 km downstream from Chenderoh Dam. The discharge of 4,000 cusec is guaranteed by the outflow discharge from Chenderoh Dam together with the natural runoff discharge generated from Pelus River.

The Iskandar Bridge is one of the key gauging stations on the Perak River, and its daily flow discharge is being monitored by DID Hydrology Division. The gauged discharge data is, however, not transmitted to TNB. Moreover, the gauged data is not used even by DID to confirm if the discharge of 4,000 cusec is certainly guaranteed at Iskandar Bridge.

Since TNB could not monitor the flow discharge at Iskandar Bridge, it releases a maintenance discharge of 3,000 cusec (about 85 m3/s) from Chenderoh Dam instead of 4,000 cusec at Iskandar Bridge. Thus, there is a difference between the guaranteed discharge at Iskandar Bridge and maintenance discharge from Chenderoh Dam. This difference is supposed to be supplemented by the runoff discharge from Pelus River that joins Perak River at about 9 km downstream from Chenderoh Dam (i.e., 14 km upstream from Iskandar Bridge). However, the runoff discharge from Pelus River is a natural phenomenon and, therefore, the maintenance discharge from Chenderoh could not always promise the guaranteed discharge at Iskandar Bridge, particularly, in a serious drought year. Moreover, the guaranteed discharge was agreed more than 20 years ago, and the re-evaluation and/or periodical renewal of the discharge should have been made in due consideration of the updated water demand of the river. To cope with these issues, the following items are deemed necessary to be examined (refer to Chapter 8):

(a) Establishment of a monitoring system for both the discharge released from the Chenderoh Dam and the river flow discharge at Iskandar Bridge;

(b) Assurance of the guaranteed discharge based on daily monitoring of the above two objective discharges; and

(c) Updating the guaranteed discharge according to the current water demand of the river.

(2) Water Supply Management

There are 15 existing water intake facilities and 4 proposed intake facilities along the main stream of Perak River with a total intake capacity of 1,872 cusec or about 53 m3/s (refer to Fig. II-7 and Table II-6). In addition, there are 23 intake facilities along the tributaries of Perak River (refer to Fig. II-8 and Table II-7), but these intake facilities have a capacity of only 166.6 cusec (about 4.7m3/s) which corresponds to 8.9% of the intake capacity of facilities along the main stream.

Out of the 15 existing intake facilities along the main stream, 10 intake facilities with a total intake capacity of 1,855 cusec (about 53 m3/s) are located between Iskandar Bridge and the confluence with Kinta River. Thus, the major intake points concentrate on the main stream, particularly, the river stretch between Iskandar Bridge and the confluence with Kinta River.

The agreed guaranteed discharge of 4,000 cusec (113.2 m3/s) at Iskandar Bridge is likely to meet the above present water intake capacity of 53 m3/s. Difficulties in abstracting the river water by pump are, however, currently, being experienced due to low water stage during a drought period. Accordingly, the guaranteed discharge is also used as the river maintenance flow, which has already reached the critical minimum level to avail the pump abstraction.

The present intake facilities are independently managed by DID (for irrigation water supply) and the Perak Water Board (for domestic/industrial water supply), and information is not mutually exchanged between the two agencies. Thus, no unified government agency is presently monitoring and storing the overall water intake volume of the river basin and, as a result, no government agency could evaluate the adequacy of infinite water resources of the river as compared with the overall intake volume from the river. Moreover, water-right is not prescribed in Malaysia, and no government agency could rationally judge the applicability of the projected intake volume based on the clarification of infinite river water resources.

To cope with the aforesaid issues on water supply management, a unified agency is necessary, to coordinate the present water users and develop an integrated database for water intake features (intake volume, intake location, etc.) and the hydrological information on the low flow regime and water quality of the river. The details on usage of river basin management for such water supply management have been clarified, as described in Chapter 8.

(3) Drought Management

When extreme drought occurs and the existing water intake volume exceeds the river flow discharge, the following drought management is required on the real-time base:

(a) To declare the drought to all water users and start drought management;

(b) To determine the priorities of retrenchment of water intake; and

(c) To allocate the actual retrenchment rate of water intake to each water intake point.

As mentioned above, there is no unified agency to monitor and/or supervise the low flow discharge as well as the overall registered intake volume for domestic/industrial water supply and irrigation water supply in the Perak river basin. Under such a situation, the above drought management could be hardly executed.

The appropriate drought management will require a complex information including the real-time gauging information on the river flow regime and the database information (the non-real time monitoring system) on the registered water intake volume (refer to Chapter 8).

3.2.3 River Environmental Management

(1) Water Quality

DOE monitors the water quality of the Perak River and its tributaries at 53 sampling points (refer to Fig. II-9). Based on the monitoring of water quality, DOE presented the Water Quality Index (WQI) at these sampling points in 1996, as shown in Fig. II-9. It is herein noted that the WQI of more than 80 and between 80 and 60 mean clean and slightly polluted, respectively, while the WQI of less than 60 means very polluted. The water quality of the Perak mainstream is slightly polluted as indicated by the WQIs ranging from 78 to 86 as shown in Fig. II-9, while the water quality of Kinta River is deteriorated as indicated by the WQI at Sampling Sta. No. 4510672 on Serokai River located downstream of Ipoh City and Sta. No. 4510662 on Kinta River. Serokai River at Sampling Sta. No. 4510672 indicates the WQI of 44 containing high concentrations of BOD, COD, NH3-N and SS. Among them, the concentration of SS in particular is at extremely high levels of 2,500 to 11,000 mg/l. Likewise, the water quality of Kinta River at Sta. No. 4510662 has an aggravated BOD, COD, SS and DO, which is deemed to be caused by effluent from the urban drains in Ipoh City and/or the mining activities. The aggravation of water quality on Kinta River rather than Perak River is also seen in the annual trend of water quality of both rivers for five years from 1992 to 1996 (refer to Fig. II-10 and Table II-8).

As described above, the water of Kinta River and its adjacent rivers is rather polluted, while that of the main stream of Perak River is generally evaluated to be not so seriously polluted. However, all agencies related to river water quality such as DOE and PWB agreed that the major issue of water quality of the mainstream is the turbidity that causes difficulties in treating water for domestic and industrial water supply. The agencies attribute the major cause of turbidity to the excessive logging activities in the upper reaches, particularly, in the Pelus river basin. The recent results of water quality test collected by the Study Team also somewhat prove the turbidity from Pelus river basin. The results show high concentration of suspended solids (SS) in the Pelus and Perak rivers on December 03, 1996, as listed below:

River Name	Station No.	Sampling Date	SS (mg/l)
Pelus River	4909671	Apr. 04, 1996	40
		Aug. 15, 1996	13
		Dec. 03, 1996	174
Perak River	4709611	Apr. 04, 1996	30
		Aug. 15, 1996	13
		Dec. 03, 1996	244

No detailed information on logging activities as well as land development activities in the upper reaches has been transmitted to DOE and other agencies related to river water quality. Moreover, the monitoring points for river flow discharge and river water quality are not unified, causing difficulties in clarifying consistent river flow conditions. As a result, DOE has not been able to make any quantitative analysis on the relationship between the turbidity of river water and the logging/land development activities in the upper reaches. No coordination for the control of logging activities also has been made between the Forest Department and the agencies concerned in the management of river water quality.

In addition to the turbidity of river water, the Department of Environment (DOE) had also identified the organic pollutant sources such as industrial estates, pig farms, and rubber/palm oil factories (refer to Fig. II-11). The State DOE executes control over these pollutant sources, while a series of water samplings, laboratory tests, and data processing is entrusted to a private firm under the responsibility of Federal DOE. Due to such conditions, it takes one to two months until the State DOE could get the results of water quality test after the water sampling. As a result, difficulties arise in taking the appropriate measures for the control of pollutant sources.

(2) Ecotourism

Yayasan Perak which is a subsidiary of the State Development Corporation of Perak organizes navigation by boat for ecotourism on Perak River from the Chenderoh Dam up to the river mouth. Difficulties on river navigation are being experienced due to the sediment on the river channel and the sand mining pipes crossing the river channel. In spite of such difficulties of navigation, no coordination has been taken.

Yayasan Perak was designated by the State Economic Planning Committee (EXCO) as a management body for the tourism zone along the river (refer to Fig. II-12). In the tourism zone, the Yayasan Perak undertakes management to preserve the natural conditions/historical monuments and to develop tourism facilities such as camping sites, lodging and fishing facilities. However, information on the land development plan for the tourism zone is seldom given to or stored by Yayasan Perak, which causes difficulty in managing the tourism zone.

CHAPTER 4 OBJECTIVE INFORMATION FOR THE MASTER PLAN

The major issues on the present river basin management for the Perak river basin have been clarified, as described in Chapter 3. To cope with these issues, the Master Plan to set the basic policy for establishment of the RBIS has been formulated. The Master Plan covers various components for data collection, data transmission, data processing, and data dissemination. Among these components, this Chapter highlights the data collection, and the detailed study on the objective information for the RBIS has been subsequently carried out.

4.1 Objective Information to be Collected by the System

4.1.1 Selection of Objective Information

The proposed objective information to be collected by the system are as listed in Table II-9, in due consideration of the following points: (1) major issues on the present and future river basin management in Perak river basin; and, (2) future potential information technology. The proposed information will contain the following items which are currently not available in Malaysia but will be the leading information in the future in response to the advanced information technology being developed in the country.

(a) Field Visual and Audible Information

This kind of information is presently not available in Malaysia. However, the recent multimedia communication technology is going to enable the monitoring of dynamic visual and audible scenes of the remote field on the real time base. Such information is deemed to be useful for flood and other emergency disaster management.

(b) Radar Rainfall Gauge and Automatic Water Quality Gauge

The recent technology on hydrological gauging and telecommunication devices will enhance the gauging function as well as the data transmission speed. Examples of such improvement are the radar rainfall gauge and the automatic water quality gauge. These gauging devices would cope with the current issues on the river gauging data which are not adequate in terms of gauging density, particularly, the density of point rainfall gauging stations, and less useful due to the delay of their data transmission. In view of these developed technologies, the radar rainfall gauge and the automatic water quality gauge are proposed as part of the objective RBIS.

As shown in Table II-9, all of the proposed information other than the above items have been made available by the various government agencies. A considerable part of the existing available information have been digitized and stored by the computerized database systems. The existing database systems, however, had been developed independently by the government agencies without any network linkage, and the information is hardly exchanged among them. Under these current conditions, the objective information currently available will be collected in line with the following principles:

(a) The proposed RBIS is not to take over the data management work of the existing government agencies. Instead, the system will have a function to collect and link the existing data information sources managed by the various government agencies.

(b) The information collected by the proposed river basin system will be distributed to the related government agencies, and further, some of the information will be open to the public. Such common use of river basin information will facilitate support for the comprehensive river basin management.

The proposed objective will be used as the basic data for the flood management, the water resources management, the river environmental management and the watershed management. The details of the proposed information are as described below:

(1) River Basin Gauging and Monitoring Information

The information includes river basin gauging data (rainfall, river stage/discharge, river suspended load and river water quality data) as well as field visual information. This information is classified into real-time and non-real time information. The real-time information is in principle used for disaster management such as flood forecasting and warning, and pollutant control. On the other hand, the non-real time information is used to clarify the long-term relationship between the hydrological conditions of the river and the impacts of basin land development (the logging activities in the upper reaches, the urban and industrial development in the basin).

(2) Information on River Works

The information includes all ongoing and proposed flood control works, the water supply works, the river environmental improvement works and other river works such as sand mining works and bridge construction. The integrated information on all of such river works will be stored in the database and updated with an interval of one year. The information could be useful as the basic data to facilitate the future river planning.

(3) Information on Field Survey

The information covers the results of major field surveys such as the river channel survey, the flood damage survey and survey on the fauna and flora in the river. The results of the river channel survey are the essential information source to clarify the river channel flow capacity and, at the same time, to monitor the progress of unfavorable channel conditions such as channel sedimentation, erosion and meandering.

The results of flood damage survey are useful information to clarify the flood hazard area and to estimate the flood damage potential of the river basin. The results are, however, not well pigeonholed as described before. A large volume of survey data has accumulated and it is virtually difficult to correlate the objective reports. In this connection, a further study has to be made for an appropriate measure to store the results.

(4) Basin Land Information

The basin land information is given as map information such as the land use map, the forest conservation map, the topographic map, the geographic map, the soil map, and the structural plans for urban development and industrial development. Among the map information, the topographic map, the geographic map and the soil map will be useful to clarify the basin natural conditions. On the other hand, the land use map, the cadastral map and the structural plans will be useful to evaluate the land development conditions in the river basin and will be used as essential information for the watershed management.

(5) Basin Census Information

The basin census information will cover the population in the river basin and the designated probable flood inundation area. The information will facilitate the evaluation of flood damage potential or the basin water demand potential and will support the management of land development in the probable flood inundation area and the management of water supply in the basin.

4.1.2 Map Projection and Scale

The objective RBIS will present the above information in the form of maps, tables and graphics. Among the forms of information, special attention is given to the map information. Different government agencies have digitized various map information using two types of projection: (1) RSO (Rectified Skew Orthomorphic) and (2) Cassini (refer to Table II-10). Between the two projections, the RBIS applies the RSO as an unified projection due to the following reasons:

(a) Most of the objective geographic information is based on the RSO.

(b) It is extremely difficult to convert Cassini to RSO, while conversion from RSO to Cassini could be made through the Arc/Info software.

The scale of map information is given as another major issue. The map information is classified into the basin-wide map and the river-corridor map (cadastral map in river reserve area and the flood inundation map along the river). The basin-wide map covers the entire river basin of 14,700km^2 to present its land conditions such as the topography, the land use, the geology, the soil and the extent of forest conservation and logging area. In contrast to such basin-wide map, the cadastral map and flood inundation map cover the river corridor which is far smaller in extent than the basin-wide map, requiring more detailed map scales.

The detailed clarification was made on the appropriate scales for these map information in due consideration of: (1) minimum requirement of map accuracy; (2) necessary digitizing work volume for the printed maps; and (3) available scales of the existing digitized maps. Based on the clarification, the RBIS applies a scale of 1 is to 500,000 for the basin-wide maps and 1 is to less than 50,000 for the cadastral map and flood inundation area map.

4.1.3 Software and Format for Processing of Objective Information

RBIS will process the mapping data as well as the alphabetic and numeric data and the most eligible software for the processing such information is the Geographic Information System (GIS). The GIS has both graphic and database functions so as to simultaneously process the mapping information and its attribute information.

Since the GIS could manage various mapping information as separate independent layers, it will be easy to present various river basin characteristics by overlaying the layers such as land use, topography, flood inundation area and watershed boundary. Through the presentation of various characteristics of the river basin, the GIS can clarify the important interrelations between the river gauging data (river discharge, water quality, etc.) and land development/conservation conditions (urban/industrial development, deforestation, etc.). At the same time, the GIS could display the digitized map information with a desired scale and/or focus on a specific area. The GIS also will enable easy access to the desired map information and to easily update and/or retrieve the information. Thus, the GIS can provide the essential information for the river basin management.

There are various kinds of application software for GIS, and among them, the Arc/Info database software is widely used as the solutions for GIS database management in Malaysia, as well as over the world. In due consideration of exchangeability of database between the existing information systems, and further familiarity on operation and maintenance of the software, the Arc/Info is applied as the database.

The existing database in Malaysia is in various formats such as the DXF (the standard format for CAD system), the Oracle database file format, the Spreadsheet file format (ASCII Text), and the Arc/Info data format. Since such formats of existing information could be converted and/or transformed into the Arc/Info data format as described below, the objective river basin information system applies the Arc/Info format for data processing.

(a) Spreadsheet file utilizes application software such as Microsoft Excel and Lotus 1-2-3. Since the data in the spreadsheet file is in ASCII format, Arc/Info could access the data without any data conversion.

(b) Oracle database file format is one of the standard formats of database. Since Arc/Info has an access tool to Oracle database, no data conversion is required.

(c) DXF (drawing interchange file) is the standard format for the CAD system which supports graphic processing. In the RBIS, DXF could be imported into the Arc/Info Vector data format by the Arc/Info data import tool.

The objective information for RBIS may include the non-digital maps or census records owned by the various government agencies. These non-digital data need to be input by typing and digitizing. The alphabetic and numeric value of information are typed into the spreadsheet type file (ASCII text file) and the non-digital map information are digitized into Arc/Info digital map data. Then, some of the spreadsheet data are linked to the digital map as its attribute.

4.2 Objective Information to be Disseminated by the System

4.2.1 Items of Information to be Disseminated

The information will be processed and disseminated to the various users. The information to be disseminated and their users have been proposed through a series of discussions with the Government of Malaysia, as shown in Table II-11. The proposed information will be used as the general information for the public and/or to support the various river basin management works such as flood management, water supply management, river environmental management and watershed management.

4.2.2 Classification of Information According to Users

As shown in Table II-11, the aforesaid objective information are classified into two (2) dissemination levels according to the assumed users: Level 1 for the exclusive use of the government agencies; and, Level 2 for information open to the public. The classification of the information has been made based on the following criteria:

(1) Information to be Disseminated to Government Users (Level 1 Information)

RBIS will disseminate all non-real time information to the government users through the Internet and/or CD-ROM. Moreover, real-time information is to be distributed to the government users through the Internet.

The information to be disseminated will include all raw data (point, line, polygon and attribute data) of map information for GIS. However, before furnishing such raw data of map information, the administrator of the river information system needs to coordinate with the data source agencies having the following consent and/or agreement related to the copyright on the raw data of the map information.

(a) Consent to release copyrighted information;

(b) Cost of data to be charged by the data source agencies from the system administrator; and

(c) Qualification of public users of information, and procedures to qualify the public users.

The river basin information system will start to furnish the information only after the above agreement is made. Moreover, the government users will be qualified in accordance with the agreed procedures, and the information could be released only to the qualified users upon their request.

(2) Information to be Disseminated to Public Users (Level 2 Information)

The RBIS would be useful as the dissemination medium of information to public users, and would facilitate understanding and cooperation of public users with the ongoing and projected river basin management works. Moreover, the Internet will be used to disseminate real-time disaster information (flood forecasting information and drought information) so as to facilitate evacuation and prevention activities of public users against floods and to make then aware of drought conditions and initiate their cooperation in drought management.

However, difficulties may arise in releasing some information to public users. The objective information to be open to public users are thus to be selected in due consideration of the following viewpoints:

(a) It is virtually difficult to release raw data of map information due to copyright and data transmission capacity.

(b) The logging activities controlled by the Forest Department as well as the information on the point pollutant sources monitored by DOE are restricted by the Departments to be open to the public users;

(c) Release of information relative to urban and industrial development plans may lead to unfavorable land speculation by the public users.

4.3 Stage-wise Development of Objective Information

The stage-wise development schedule for the objective information is proposed, as shown in Fig. II-13. As shown in the schedule, all currently available information in Malaysia will be collected, processed and disseminated by the next 8th Malaysia Plan, and the full operational condition of RBIS will be pledged. Following the 8th Five-year Malaysia Plan, the futuristic information will be availed of by RBIS from the 9th to 11th Five-year Malaysia Plan, as scheduled below.

(1) Automatic Water Quality Gauging Information in 9th Malaysia Plan (2006 to 2010)

The existing automatic water quality gauging system has technical difficulties in maintenance works and its available monitoring items are limited to temperature, conductivity, pH value, turbidity and dissolved oxygen. Intensive development works are, however, being carried out, and it is anticipated that the present defects of the system will be improved within the 9th Malaysia Plan. Hence, the automatic water quality sensor as well as its related telecommunication and computer systems for the analysis of water quality is scheduled in the 9th Malaysia Plan.

(2) Radar Rainfall Gauging Information in 10th Malaysia Plan (2011 to 2015)

The proposed radar rainfall gauge has a wide gauging range, so that the thirteen (13) radar rainfall gauges could cover the whole country of Malaysia. However, the radar rainfall gauge also requires a high investment cost of about RM 12 million (RM 4.2 million for radar site cost, RM 6.8 million for computer for radar analysis, and RM 1.32 for multiplex radio wave). In view of the nationwide gauging coverage as well as the high investment cost, it is deemed necessary that the radar rainfall gauge be developed in line with the nationwide development plan instead of the basin-wide development plan. Since the implementation of such nationwide development plan will require a rather long period, the radar rainfall gauge system is proposed in the 10th Malaysia Plan.

(3) Dynamic Visual Field Information in11th Malaysia Plan

The optical fiber network is likely to cover the Perak river basin during the 11th Malaysia Plan in due consideration of the Telecommunication Vision 2020 formulated by Telekom Malaysia. Such optical fiber network is indispensable for Industrial Television (ITV) to transmit the dynamic visual field information.

Therefore, the ITV together with its data transmission system of optical fiber line is assumed to be established in the 11th Malaysia Plan. In addition to the ITV, the satellite communication system is scheduled as the backup of the optical fiber data transmission system.