表9.8　ガンベルによる確率計算結果

DAILY RAINFALL DATA　　(UNIT: mm)

STATION NAME & STATION NO.	STORM DURATION (DAYS)	RETURN PERIOD (YEAR) 2	5	10	20	50	100	200
RIDDAN	1	101	156	192	227	272	306	340
	2	128	176	209	240	280	310	339
1217011	3	150	198	231	262	302	332	362
n=19	5	184	256	303	348	407	451	495
KANOWIT	1	107	140	162	183	210	231	251
W/WORKS	2	130	160	180	200	225	244	262
2021036	3	150	180	199	218	242	260	279
n=20	5	185	223	248	272	303	326	349
LONG SEMADOH	1	72	94	108	122	139	152	165
	2	100	130	149	168	192	210	229
4255006	3	122	164	192	219	253	279	305
n=22	5	161	211	245	277	319	350	381
LONG BILONG	1	131	160	179	198	221	239	257
	2	170	206	229	252	281	303	324
4349016	3	203	239	262	285	314	336	357
n=11	5	244	286	313	340	374	400	426
KAPIT	1	103	130	147	164	186	202	218
	2	136	180	210	239	275	303	330
2029001	3	164	219	255	290	335	369	402
n=37	5	314	276	317	356	407	445	483
SONG	1	80	110	130	149	173	192	210
	2	104	137	159	181	208	229	249
2025012	3	123	167	179	120	227	248	268
n=23	5	159	200	227	253	287	312	337
NANGA	1	96	139	168	196	232	258	285
BANGKIT	2	129	190	229	268	317	354	391
1726041	3	159	223	265	305	358	397	436
n=15	5	211	296	353	408	478	531	584

Note : n indicates number of years (Calendar Year) of record used in analysis.

表9.9　岩井法による確率計算結果

DAILY RAINFALL DATA　　(UNIT: mm)

STATION NAME & STATION NO.	STORM DURATION (DAYS)	RETURN PERIOD (YEAR) 2	5	10	20	50	100	200
RIDDAN	1	98	146	182	218	267	306	348
	2	127	170	197	222	253	276	299
1217011	3	149	191	215	236	262	280	297
n=19	5	184	246	288	328	381	420	460
KANOWIT	1	109	136	156	177	207	232	258
W/WORKS	2	131	156	169	181	195	205	213
2021036	3	152	177	190	202	216	226	234
n=20	5	187	221	241	258	280	295	310
LONG SEMALOH	1	73	94	108	122	139	152	165
	2	100	130	149	168	192	210	229
4255006	3	124	154	171	187	207	220	234
n=22	5	163	110	223	245	272	292	312
LONG BILONG	1	133	157	174	190	212	228	245
	2	172	203	227	252	288	318	350
4349016	3	205	234	251	266	284	296	308
n=11	5	246	281	303	322	346	364	381
KAPIT	1	104	127	141	153	167	177	186
	2	136	178	206	232	266	292	318
2029001	3	162	212	240	266	296	317	337
n=37	5	215	270	302	330	364	388	410
SONG	1	80	108	130	151	181	206	231
	2	104	133	150	167	187	201	215
2025012	3	124	153	171	188	208	222	236
n=23	5	160	196	216	234	255	270	284
NANGA	1	96	125	142	159	179	195	210
BANGKIT	2	129	171	198	223	255	280	304
1726041	3	159	211	245	278	317	347	376
n=15	5	210	276	316	352	396	428	458

Note : n indicates number of years (Calendar Year) of record used in analysis.

表 9.10　ログ・ピアソン・Type III による確率計算結果

DAILY RAINFALL DATA　　(UNIT: mm)

STATION NAME & STATION NO.	STORM DURATION (DAYS)	RETURN PERIOD (YEAR) 2	5	10	20	50	100	200
RIDDAN	1	97	144	177	210	257	293	332
	2	127	173	204	233	272	301	331
1217011	3	149	196	226	254	291	318	345
n=19	5	184	245	284	321	370	406	443
KANOWIT	1	103	128	149	173	208	239	274
W/WORKS	2	129	156	173	188	210	225	241
2021036	3	152	178	193	207	224	236	247
n=20	5	187	221	241	258	280	295	310
LONG SEMADOH	1	72	91	103	115	130	142	154
	2	98	123	141	159	184	205	227
4255006	3	116	147	173	203	251	293	342
n=22	5	154	193	225	259	312	356	407
LONG BILONG	1	130	153	169	185	205	221	238
	2	166	194	215	236	267	291	318
4349016	3	205	234	251	266	284	296	308
n=11	5	246	279	299	315	335	349	363
KAPIT	1	104	129	145	160	178	191	204
	2	136	176	202	225	257	280	304
2029001	3	162	227	271	312	369	412	456
n=37	5	215	274	311	345	389	421	453
SONG	1	78	104	123	141	167	187	208
	2	104	133	152	170	193	210	227
2025012	3	124	154	188	198	209	224	239
n=23	5	160	197	220	240	266	285	303
NANGA	1	88	117	143	176	231	283	346
BANGKIT	2	122	165	202	242	305	361	425
1726041	3	159	212	247	280	323	355	387
n=15	5	207	278	326	372	436	485	536

表9.11　水力地点の設計降雨量（1／4）

POTENTIAL SITE : KANOWIT
CATCHMENT AREA : 1331(SQ.KM)

(Unit:mm)

RETURN PERIOD (YEARS)	DURATION(HRS) 3	6	9	12	15	18	21	24	TOTAL
2	9	14	15	20	21	7	6	5	97
5	12	19	20	26	28	9	7	6	127
10	14	22	23	30	32	11	9	7	147
20	16	24	26	34	36	12	10	8	167
50	19	28	30	39	42	14	11	9	191
100	20	31	33	43	46	15	12	10	210
200	22	34	36	47	50	16	13	11	228

POTENTIAL SITE : SEKRANG-1
CATCHMENT AREA : 508(SQ.KM)

(Unit:mm)

RETURN PERIOD (YEARS)	DURATION(HRS) 3	6	9	12	15	18	21	24	TOTAL
2	9	14	14	19	20	7	5	4	93
5	14	21	22	29	31	10	8	7	144
10	17	26	28	36	39	13	10	8	177
20	20	31	33	43	46	15	12	10	209
50	24	37	39	51	55	18	15	12	250
100	27	41	44	58	61	20	16	13	282
200	30	46	49	64	68	23	18	15	313

POTENTIAL SITE : SEKRANG-2
CATCHMENT AREA : 360(SQ.KM)

(Unit:mm)

RETURN PERIOD (YEARS)	DURATION(HRS) 3	6	9	12	15	18	21	24	TOTAL
2	9	14	15	19	20	7	5	4	94
5	14	21	23	30	32	10	8	7	145
10	17	26	28	37	39	13	10	8	179
20	20	31	33	43	46	15	12	10	211
50	25	37	39	52	55	18	15	12	253
100	28	42	44	58	62	20	17	13	285
200	31	46	49	65	69	23	18	15	316

表 9.12　水力地点の設計降雨量（2／4）

POTENTIAL SITE : KAPIT-1
CATCHMENT AREA : 101(SQ.KM)

(Unit:mm)

RETURN PERIOD (YEARS)	DURATION(HRS) 3	6	9	12	15	18	21	24	TOTAL
2	10	15	15	20	22	7	6	5	99
5	12	18	19	26	27	9	7	6	125
10	14	21	22	29	31	10	8	7	141
20	15	23	25	32	34	11	9	7	157
50	17	26	28	37	39	13	10	8	179
100	19	29	30	40	42	14	11	9	194
200	20	31	33	43	46	15	12	10	209

POTENTIAL SITE : KAPIT-2
CATCHMENT AREA : 220(SQ.KM)

(Unit:mm)

RETURN PERIOD (YEARS)	DURATION(HRS) 3	6	9	12	15	18	21	24	TOTAL
2	9	13	14	18	20	6	5	4	90
5	13	19	20	27	28	9	8	6	131
10	15	23	25	32	34	11	9	7	158
20	18	27	29	38	40	13	11	9	184
50	21	32	34	45	48	16	13	10	218
100	24	36	38	50	53	17	14	11	243
200	26	39	42	55	58	19	16	13	268

POTENTIAL SITE : IBAU
CATCHMENT AREA : 163(SQ.KM)

(Unit:mm)

RETURN PERIOD (YEARS)	DURATION(HRS) 3	6	9	12	15	18	21	24	TOTAL
2	7	11	12	16	17	5	4	4	76
5	10	15	16	21	23	8	6	5	105
10	12	18	19	25	27	9	7	6	124
20	14	21	22	29	31	10	8	7	142
50	16	24	26	34	36	12	10	8	164
100	18	27	28	37	40	13	11	9	182
200	19	29	31	41	43	14	12	9	200

表 9.13　水力地点の設計降雨量（3／4）

POTENTIAL SITE : BANGKIT
CATCHMENT AREA : 167(SQ.KM)

(Unit:mm)

RETURN PERIOD (YEARS)	DURATION(HRS) 3	6	9	12	15	18	21	24	TOTAL
2	9	13	14	19	20	7	5	4	91
5	13	19	21	27	29	10	8	6	132
10	15	23	25	33	35	11	9	8	160
20	18	27	29	38	41	13	11	9	186
50	21	32	34	45	48	16	13	10	220
100	24	36	38	50	53	18	14	12	245
200	26	40	42	56	59	19	16	13	271

POTENTIAL SITE : AYAT
CATCHMENT AREA : 59(SQ.KM)

(Unit:mm)

RETURN PERIOD (YEARS)	DURATION(HRS) 3	6	9	12	15	18	21	24	TOTAL
2	9	14	15	19	20	7	5	4	93
5	13	20	21	28	29	10	8	6	135
10	16	24	25	33	36	12	9	8	163
20	18	28	30	39	41	14	11	9	190
50	22	33	35	46	49	16	13	11	225
100	24	37	39	51	55	18	15	12	250
200	27	41	43	57	60	20	16	13	276

POTENTIAL SITE : MEDAMIT-2
CATCHMENT AREA : 186(SQ.KM)

(Unit:mm)

RETURN PERIOD (YEARS)	DURATION(HRS) 3	6	9	12	15	18	21	24	TOTAL
2	12	18	19	25	27	9	7	6	123
5	15	22	23	31	33	11	9	7	150
10	16	25	26	34	37	12	10	8	168
20	18	27	29	38	41	13	11	9	186
50	20	31	32	43	45	15	12	10	208
100	22	33	35	46	49	16	13	11	225
200	23	36	38	50	53	17	14	11	242

表9.14　水力地点の設計降雨量（4／4）

POTENTIAL SITE : PASIA
CATCHMENT AREA : 177(SQ.KM)

(Unit:mm)

RETURN PERIOD (YEARS)	DURATION(HRS) 3	6	9	12	15	18	21	24	TOTAL
2	7	10	11	14	15	5	4	3	68
5	9	13	14	18	19	6	5	4	88
10	10	15	16	21	22	7	6	5	102
20	11	17	18	24	25	8	7	5	115
50	13	19	20	27	28	9	8	6	131
100	14	21	22	29	31	10	8	7	143
200	15	23	24	32	34	11	9	7	155

POTENTIAL SITE : MUKOH
CATCHMENT AREA : 292(SQ.KM)

(Unit:mm)

RETURN PERIOD (YEARS)	DURATION(HRS) 3	6	9	12	15	18	21	24	TOTAL
2	9	13	14	18	19	6	5	4	89
5	13	19	20	27	28	9	7	6	129
10	15	23	24	32	34	11	9	7	156
20	18	27	28	37	40	13	11	9	182
50	21	32	34	44	47	16	13	10	216
100	23	35	37	49	52	17	14	11	240
200	26	39	41	54	58	19	15	12	265

表9.15　洪水解析の要約（1／2）

POTENTIAL SITE (LOAD CENTER)	CATCHMENT AREA (sq.km)	RETURN PERIOD (years)	FLOOD VOLUME (MCM)	PEAK DISCHARGE (cms)	SPECIFIC DISCHARGE (cms/sq.km)
PASIA (LIMBANG)	177	2	3.4	101	0.6
		5	6.1	160	0.9
		10	8.1	201	1.1
		20	10.1	239	1.4
		50	12.6	287	1.6
		100	14.6	323	1.8
		200	16.6	358	2.0
MEDAMIT-2 (LIMBANG)	186	2	12.0	277	1.5
		5	16.6	361	1.9
		10	19.8	417	2.2
		20	23.1	473	2.5
		50	27.1	542	2.9
		100	30.2	595	3.2
		200	33.3	648	3.5
KANOWIT (SARIKEI)	1,331	2	49.5	1,040	0.8
		5	80.3	1,554	1.2
		10	102.3	1,899	1.4
		20	124.7	2,243	1.7
		50	152.2	2,656	2.0
		100	173.9	2,984	2.3
		200	194.6	3,294	2.5
SEKRANG-1 (SRI AMAN)	508	2	18.4	413	0.8
		5	40.0	784	1.5
		10	55.1	1,026	2.0
		20	70.0	1,261	2.5
		50	89.1	1,562	3.1
		100	103.9	1,797	3.5
		200	118.4	2,023	4.0
SEKRANG-2 (SRI AMAN)	360	2	13.8	324	0.9
		5	29.6	608	1.7
		10	41.0	798	2.2
		20	52.0	977	2.7
		50	66.3	1,212	3.4
		100	77.3	1,390	3.9
		200	87.9	1,563	4.3

表9.16　洪水解析の要約（2／2）

POTENTIAL SITE (LOAD CENTER)	CATCHMENT AREA (sq.km)	RETURN PERIOD (years)	FLOOD VOLUME (MCM)	PEAK DISCHARGE (cms)	SPECIFIC DISCHARGE (cms/sq.km)
KAPIT-1 (KAPIT)	101	2	4.5	121	1.2
		5	6.8	169	1.7
		10	8.4	199	2.0
		20	9.9	228	2.3
		50	12.2	269	2.7
		100	13.7	297	2.9
		200	15.2	324	3.2
KAPIT-2 (KAPIT)	220	2	8.0	210	1.0
		5	15.9	363	1.7
		10	21.5	464	2.1
		20	27.2	561	2.6
		50	34.6	688	3.1
		100	40.0	781	3.6
		200	45.5	874	4.0
IBAU (KAPIT)	163	2	4.1	113	0.7
		5	7.9	192	1.2
		10	10.6	244	1.5
		20	13.3	293	1.8
		50	16.7	353	2.2
		100	19.6	403	2.5
		200	22.5	451	2.8
BANGKIT (KAPIT)	167	2	6.3	177	1.1
		5	12.4	302	1.8
		10	16.9	388	2.3
		20	21.3	467	2.8
		50	27.0	571	3.4
		100	31.3	647	3.9
		200	35.6	727	4.4
AYAT (KAPIT)	59	2	2.4	71	1.2
		5	4.6	120	2.0
		10	6.3	153	2.6
		20	7.9	185	3.1
		50	10.1	226	3.8
		100	11.6	255	4.3
		200	13.2	285	4.8
MUKOH (KAPIT)	292	2	10.3	273	0.9
		5	20.3	469	1.6
		10	27.7	601	2.1
		20	35.1	705	2.4
		50	44.8	895	3.1
		100	51.7	1,012	3.5
		200	58.9	1,135	3.9

表9.17　可能最大降雨量

(Unit : mm)

Potential Site	Catchment Area (sq. km)	PMP			
		1-day	2-day	3-day	5-day
Pasia	177	384	531	706	885
Medamit-2	186	541	686	761	906
Kapit-1	101	512	768	935	1,128
Kapit-2	220	427	585	657	878
Ibau	163	542	646	700	880
Bangkit	167	431	592	664	888
Ayat	59	440	604	678	907
Mukoh	292	422	579	649	868
Kanowit	1,331	496	524	558	700
Sekrang-1	508	495	501	538	730
Sekrang-2	360	495	501	538	730

表9.18　可能最大降雨量の設計ハイエトグラフ

(Unit : mm)

Potential Site	PMP Hyetograph				
	1st-day	2nd-day	3rd-day	4th-day	5th-day
Pasia	90	175	384	147	90
Medamit-2	73	145	541	75	73
Kapit-1	97	256	512	167	97
Kapit-2	110	158	427	110	72
Ibau	90	104	542	90	54
Bangkit	112	161	431	112	72
Ayat	115	164	440	115	74
Mukoh	110	157	422	110	70
Kanowit	34	71	496	71	28
Sekrang-1	37	96	495	96	6
Sekrang-2	37	96	495	96	6

表11.1　主要構造物の諸元

	SEK-1	SEK-2	K'WIT	MUKOH	KAPIT-2	PASIA	MED-2
1. Development type	RES	RES	RES	RUN	RES	RUN	RUN with pondage
2. Installed capy.(MW)	11.8	21.3	25.1	1.94	4.2	12.4	4.49
3. Max. discharge (cms)	44.8	37.4	102.8	7.4	13.2	5.3	7.8
4. Dam							
Type	Rock-fill	Rock-fill	Rock-fill	concrete weir	Rock-fill	concrete weir	concrete weir
Height (m)	54	93	55	7	56	6	21
Crest length (m)	189	369	433	60	143	40	102
5. Spillway							
Type	Overflow chuteway	Over-flow chuteway	Over-flow chuteway	Overflow weir	Over-flow chuteway	Overflow weir	Overflow weir
Design flood (cms)	2,430	1,880	3,200	1,012	1,050	323	595
6. Waterway							
Type	Pressure tunnel	Pre-ssure tunnel	Pre-ssure tunnel	Non-Pre-ssure tunnel	Pre-ssure tunnel	Non-Pre-ssure tunnel	Non-Pre-ssure tunnel
length (m)	300	400	200	1,660	300	3,800	4,400
Numbers	1	1	1	1	1	1	1
Diameter (m)	4.4	4.0	6.6	2.0	2.4	1.8	2.3
7. Penstock							
Length (m)	20	40	140	40	50	950	130
Numbers	1	1	1	1	1	1	1
Diameter (m)	3.1	2.8	4.7	1.5	1.7	1.1	1.7
8. Nos. of generator	2	2	2	2	2	2	2
9. Transmission line							
Length (km)	30	45	65	25	27	110	60
10. Access road							
Length (km)	16	35	40	6	6	20	1

Note: RES; Reservoir type development

表11.2　水車の使用範囲

Turbine Type	Turbine Output (kW)	Effective Head (m)	Ns (m-kW)
Verical Shaft Francis Turbine	2,000-20,000	30-300	60-300
Horizontal Shaft Francis Turbine	200-5,000	15-200	60-240
Kaplan Turbine	1,000-20,000	10-70	250-800
Tubular Turbine	200-5,000	3-20	400-1,000
Pelton Turbine	200-20,000	more than 100	8-28
Cross-Flow Turbine	50-1,000	5-100	45-160

表11.3　同期発電機と誘導発電機の比較

Item	Synchronous Generator	Induction Generator
Capacity	Suitable for a large-capacity generator.	Suitable for a small-capacity generator.
Speed	Although high-speed large-capcity generators of this type are difficult to manufacture, there are no other problems with regard to speed.	For low-speed generator, the exciting current increases, resulting in a low power factor.
Exciter	An exciter is required for supplying a direct current to field windings.	No exciter is required because an exciting current run through armeture windings from the power system.
Independent Operation	Possible	Impossible. Power cannot be generated unless an an exicting current is supplied from the power system.
Voltage Adjustment	Possible	Impossible. Voltage is always at the same level as the electric system.
Power Factor Control	Possible. The power factors of both leading and lagging can be adjusted. Reactive power also can be adjusted.	Impossible. The generator can only be operated with the leading power factor which is primarily determined by load. When necessary to improve the power factor, a condenser is required.
Parallel connection with Electric Power System	Control is complicated because parallel connection requires adjustment of voltage, frequency and phase.	Control is simple because parallel connection is made by merely approximating generator speed to synchronous speed.
Impact on Electric Power System at Time of Parallel Connection	Almost none	Excess current runs because of forced parallel connection. It is essary to consider fully the effect of a voltage drop in the electric system.

- continued -

Item	Synchronous Generator	Induction Generator
Rotor construction	Complicated because field pole and exciter are necessary.	Simple and sturdy because of squirrel cago rotor.
Maintenance	Need maintenance for field exicting equipment and control system.	Maintenance is easy because the construction is simple and no excitor is required.
Cost	Higher than induction generator.	Low cost, but low speed machines are expensive.

表14.1　7水力地点の工事費

(For Optimized Development Scale at Each Site)

(Unit: M$ million)

Item	SRI AMAN SEK-1	SRI AMAN SEK-2	SARIKEI K'WIT	KAPIT MUKOH	KAPIT KAPIT-2	LIMBANG PASIA	LIMBANG MED-2*
Installed Capacity (MW)	11.8	17.0	25.1	1.94	4.2	12.4	4.6
Construction Cost :							
1. Civil Works							
- Preparatory works	9.18	15.02	21.49	1.16	4.65	2.95	2.90
- Main work	61.22	100.10	143.79	7.75	30.98	19.64	19.32
Sub-total	70.40	115.12	165.28	8.91	35.63	22.59	22.22
2. Generating Equipment	12.54	12.58	21.30	3.74	5.88	6.22	5.34
3. Transmission Line	4.80	7.20	10.40	1.80	1.94	26.40	9.60
4. Access Road	5.12	13.83	12.80	2.38	2.38	9.60	0.86
Sub-total of 1 to 4	92.86	148.73	209.78	16.83	45.83	64.81	38.02
5. Land Acquisition	0.08	0.75	4.80	0	0	0	0
6. Engineering and Administration	9.29	14.87	20.98	1.68	4.58	6.48	3.80
7. Contingency	15.33	24.65	35.33	2.78	7.56	10.69	6.28
Total	117.56 = 117.6	189.0	270.89 = 271.9	21.29 = 21.3	57.97 = 58.0	81.98 = 86.0	48.10 = 48.1

Note: (1) Estimate at mid 1986 price, excluding price contingency.
(2) See Appendix VII for breakdowned detail.
(3) * Run-of-river scheme without pondage.

表14.2　リンバン地域ムダミット－2のキャッシュフロー

System : Limbang　　Project : Modamit-2 with Pondage (4.5 MW)　Case: Basic Fuel price MS0.12/kWh

Description	Unit	1986	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005	06	07	08	09	2010	2011-33 Average	2033
1. Demand, peak power (MW)	MW	2.3	2.5	2.7	2.9	3.2	3.6	4.0	4.3	4.6	5.0	5.3	5.7	6.1	6.5	7.0	7.4	7.8	8.3	8.8	9.3	9.9	10.4	11.1	11.7	12.4	29.3	46.2
2. , energy (GWh)	GWh	11.8	12.7	13.8	15.0	16.5	18.2	20.1	21.7	23.3	25.0	26.7	28.6	30.5	32.6	34.9	37.0	39.1	41.4	43.9	46.4	49.2	52.1	55.1	58.4	61.8	145.9	230.0
3. Annual load factor	%	59	58	58	59	59	58	57	58	58	87	58	57	56	56	57	57	57	57	57	57	57	57	57	57	57	57	57
4. Reserve capacity	MW	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.5	5.9	
5. Required total capacity	MW	3.3	3.5	3.7	3.9	4.2	4.6	5.0	5.3	5.6	6.0	6.4	6.8	7.3	7.8	8.4	8.9	9.4	10.0	10.6	11.2	11.9	12.5	13.3	14.0	14.9	35.2	
6. Diesel retirement	MW							-0.675		-1.06		-0.2	-0.6				-1.05			-0.6		-1.0		-1.0				
7. Power addition, hydro	MW									2.25			2.25															
, diesel	MW			0.6		1.0		1.0									1.0		2.0			3.0		2.0		1.0		
8. System capacity	MW	3.6	3.6	4.2	4.2	5.2	5.2	5.5	5.5	6.7	6.7	6.5	8.7	8.7	8.7	8.7	9.7	9.7	11.7	11.1	11.1	13.1	13.1	14.1	14.1	15.1	35.2	
(L.O. units)	"									(4.4)	(4.4)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(5.2)	(5.2)	(7.2)	(6.6)	(6.6)	(8.6)	(8.6)	(9.6)	(9.6)	(10.6)	(30.7)	
9. Installation cost, hydro	M$ x mill						10.20	24.80	12.92		0.80	2.40																-
, diesel	"	0.48	1.44	0.80	2.40	0.80	2.40								0.80	2.40	1.60	4.80		2.40	7.20	1.60	4.80	0.80	2.40			-
10. Power generation, hydro	GWh									17.5	18.1	18.6	26.0	27.1	28.4	29.2	30.0	30.7	31.5	32.3	32.7	33.7	34.1	34.9	35.4	35.7	35.9	
, diesel	GWh	11.8	12.7	13.8	15.0	16.5	18.2	20.1	21.7	5.8	6.9	8.1	2.6	3.4	4.2	5.7	7.0	8.4	9.9	11.6	13.5	15.5	8.0	20.2	23.0	26.1	110.0	
11. Hydro OM cost	M$ x mill									0.37	0.37	0.37	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
12. Diesel OM cost, fixed	M$ x mill	0.35	0.35	0.40	0.40	0.50	0.50	0.53	0.53	0.42	0.42	0.40	0.40	0.40	0.40	0.40	0.50	0.50	0.69	0.63	0.63	0.83	0.83	0.92	0.92	1.02	2.95	
variable	"	0.06	0.07	0.07	0.08	0.09	0.09	0.10	0.11	0.03	0.04	0.04	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.11	0.12	0.14	0.57	
fuel (HSD)	"																											
fuel (LO)	"	1.47	1.58	1.72	0.87	2.06	2.27	2.51	2.71	0.72	0.86	1.01	0.32	0.42	0.52	0.71	0.87	1.05	1.24	1.45	1.68	1.93	2.25	2.52	2.87	3.26	13.72	
13. Total cost (hydro + diesel)	M$ x mill	2.36	3.44	2.99	4.75	3.45	15.46	27.94	16.27	1.54	2.49	4.22	1.13	1.24	2.14	3.94	3.41	6.79	2.38	4.94	9.98	4.84	8.37	4.75	6.71	4.82	17.64	

Present Worth (M$ x mill):　　Rate of Return : 19.8%

Discount rate (%)	10.0
Net present value	+2.30
B/C Ratio	1.04

表14.3　リンバン地域パシアのキャッシュフロー

System : Limbang　　Project : Pasia (12.4 MW)　　Case: Basic = Fuel price M$0.12/kWh

Description	Unit	1986	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005	06	07	08	09	2010	2011-33 Average	2033
1. Demand, peak power (MW)	MW	2.3	2.5	2.7	2.9	3.2	3.6	4.0	4.3	4.6	5.0	5.3	5.7	6.1	6.5	7.0	7.4	7.8	8.3	8.8	9.3	9.9	10.4	11.1	11.7	12.4	29.3	46.2
2. , energy (GWh)	GWh	11.8	12.7	13.8	15.0	16.5	18.2	20.1	21.7	23.3	25.0	26.7	28.6	30.5	32.6	34.9	37.0	39.1	41.4	43.9	46.4	49.2	52.1	55.1	58.4	61.8	145.9	230.0
3. Annual load factor	%	59	58	58	59	59	58	57	58	58	57	58	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57
4. Reserve capacity	MW																										5.9	
5. Required total capacity	MW	3.3	3.5	3.7	3.9	4.2	4.6	5.0	5.3	5.6	6.0	6.4	6.8	7.3	7.8	8.4	8.9	9.4	10.0	10.6	11.2	11.9	12.5	13.3	14.0	14.9	35.2	
6. Diesel retirement	MW							-0.675		-1.06		-0.2	-0.6				-1.05			-0.6		-1.0		-1.0				
7. Power addition, hydro	MW									6.2							2.3											
, diesel	MW			0.6		1.0		1.0													3.0			3.0		1.0		
8. System capacity	MW	3.6	3.6	4.2	4.2	5.2	5.2	5.5	5.5	10.6	10.6	10.4	9.8	9.8	9.8	9.8	11.1	11.1	11.1	10.5	13.5	12.5	12.5	14.5	14.5	15.5	35.2	
9. Installation cost, hydro	M$ x mill						15.64	39.0	23.4						1.0	3.0											-	
,diesel	"	0.48	1.44	0.80	2.40	0.80	2.40												2.40	7.20		2.40	7.20	0.80	2.40		-	
10. Power generation, hydro	GWh									23.3	25.0	26.7	28.6	30.5	32.4	34.4	37.0	39.0	41.3	43.7	46.2	48.9	51.8	54.6	57.86	61.0	98.8	
, diesel	GWh	11.8	12.7	13.8	15.0	16.5	18.2	20.1	21.7	0	0	0	0	0	0.2	0.5	0	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.6	0.8	47.1	
11. Hydro OM cost	M$ x mill									0.62	0.62	0.62	0.62	0.62	0.62	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	
12. Diesel OM cost, fixed	M$ x mill	0.35	0.35	0.40	0.40	0.50	0.50	0.53	0.53	0.42	0.42	0.40	0.35	0.35	0.35	0.35	0.25	0.25	0.25	0.19	0.48	0.38	0.38	0.58	0.58	0.67	2.55	
variable	"	0.06	0.07	0.07	0.08	0.09	0.09	0.10	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.24	
fuel	"	1.47	1.58	1.72	1.87	2.06	2.27	2.51	0	0	0	0	0	0	0.02	0.06	0	0.01	0.01	0.02	0.02	0.04	0.04	0.06	0.07	0.10	5.88	
13. Total cost (hydro + diesel)	M$ x mill	2.36	3.44	2.99	4.75	3.45	20.86	42.14	24.04	1.04	1.04	1.04	0.97	0.97	1.99	4.06	0.90	0.91	3.31	8.06	1.15	3.47	8.27	2.09	3.70	1.42	9.29	

Present Worth (M$ x mill):
Discount rate (%) 10.0
Net present value -1.14
B/C Ratio 0.99

Rate of Return : 9.8%

表14.4　リンバン地域オールディーゼルのキャッシュフロー

System : Limbang　　Project : ALL DIESEL　　Case: Basic = Fuel price M$0.12/kWh

Description	Unit	1986	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005	06	07	08	09	2010	2011-33 Average	2033
1. Demand, peak power (MW)	MW	2.3	2.5	2.7	2.9	3.2	3.6	4.0	4.3	4.6	5.0	5.3	5.7	6.1	6.5	7.0	7.4	7.8	8.3	8.8	9.3	9.9	10.4	11.1	11.7	12.4	29.3	46.2
2. , energy (GWh)	GWh	11.8	12.7	13.8	15.0	16.5	18.2	20.1	21.7	23.3	25.0	26.7	28.6	30.5	32.6	34.9	37.0	39.1	41.4	43.9	46.4	49.2	52.1	55.1	58.4	61.8	145.9	230.0
3. Annual load factor	%	59	58	58	59	59	58	57	58	58	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	0.57	0.57
4. Reserve capacity	MW	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.5	5.9	
5. Required total capacity	MW	3.3	3.5	3.7	3.9	4.2	4.6	5.0	5.3	5.6	6.0	6.4	6.8	7.3	7.8	8.4	8.9	9.4	10.0	10.6	11.2	11.9	12.5	13.3	14.0	14.9	35.2	
6. Diesel retirement	MW							-0.675		-1.06		-0.2	-0.6				-1.05			-0.6		-1.0		-1.0		-2.0		
7. Power addition, hydro	MW																											
, diesel	MW			0.6		1.0		1.0		2.0		2.0			1.0		2.0		2.0		2.0		3.0		3.0			
8. System capacity	MW	3.6	3.6	4.2	4.2	5.2	5.2	5.5	5.5	6.4	6.4	8.2	7.6	7.6	8.6	8.6	9.5	9.5	11.5	10.9	12.9	11.9	14.9	13.9	16.9	14.9	35.2	
9. Installation cost, hydro	M$ x mill																											
,diesel	"	0.48	1.44	0.80	2.40	0.80	2.40	1.60	4.80	1.60	4.80		0.80	2.40	1.60	4.80	1.60	4.80	1.60	4.80	2.40	7.20	2.40	7.20		-		
10. Power generation, hydro	GWh																											
, diesel	GWh	11.8	12.7	13.8	15.0	16.5	18.2	20.1	21.7	23.3	25.0	26.7	28.6	30.5	32.6	34.9	37.0	39.1	41.4	43.9	46.4	49.2	52.1	55.1	58.4	61.8	145.9	
11. Hydro OM cost	M$ x mill																											
12. Diesel OM cost, fixed	M$ x mill	0.35	0.35	0.40	0.40	0.50	0.50	0.53	0.53	0.61	0.61	0.79	0.73	0.73	0.83	0.83	0.91	0.91	1.10	1.05	1.24	1.14	1.43	1.33	1.62	1.43	3.38	
variable	"	0.06	0.07	0.07	0.08	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.22	0.23	0.24	0.26	0.27	0.29	0.30	0.32	0.76	
fuel	"	1.47	1.58	1.72	1.87	2.06	2.27	2.51	2.71	2.91	3.12	3.33	3.57	3.81	4.07	4.36	4.62	4.88	5.17	5.48	5.79	6.14	6.50	6.88	7.29	7.71	18.21	
13. Total cost (all diesel)	M$ x mill	2.36	3.44	2.99	4.75	3.45	5.26	4.74	8.15	5.24	8.66	4.26	5.25	7.10	6.67	10.17	7.32	10.79	8.09	11.56	9.67	14.74	10.60	15.70	9.21	9.46	22.35	

表14.5　カピット地域ムコのキャッシュフロー

System : Kapit　　Project : Mukoh (1.9 MW)　　Case: Fuel price M$0.12/kWh

Description	Unit	1986	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005	06	07	08	09	2010	2011-33 Average	2033
1. Demand, peak power (MW)	MW	1.27	1.34	1.40	1.47	1.55	1.63	1.71	1.80	1.89	1.98	2.08	2.18	2.29	2.40	2.52	2.65	2.78	2.92	3.06	3.21	3.38	3.55	3.73	3.91	4.11	8.39	12.66
2. , energy (GWh)	GWh	5.6	5.9	6.1	6.4	6.8	7.1	7.5	7.9	8.3	8.7	9.1	9.6	10.0	10.5	11.0	11.6	12.1	12.8	13.4	14.1	14.8	15.5	16.3	17.1	18.0	37.0	55.9
3. Annual load factor	%	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
4. Reserve capacity	MW	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.64	0.68	0.71	0.75	0.78	0.82	1.68	
5. Required total capacity	MW	1.87	1.94	2.0	2.07	2.15	2.23	2.31	2.40	2.49	2.58	2.68	2.78	2.89	3.00	3.12	3.25	3.38	3.52	3.66	3.85	4.06	4.26	4.48	4.69	4.93	10.07	
6. Diesel retirement	MW		-0.075	-0.288							-0.2	-0.2	-0.2	-0.2			-1.2		-0.3		-0.4							
7. Power addition, hydro	MW									1.0					1.0													
, diesel	MW		+0.3	+0.4													+1.0		+1.0			+1.0						
8. System capacity	MW	2.36	2.59	2.3	2.7	2.7	2.7	2.7	2.7	3.7	3.5	3.3	3.1	2.9	3.9	3.9	3.7	3.7	4.4	4.4	4.0	5.0	5.0	5.0	5.0	5.0	10.1	
9. Installation cost, hydro	M$ x mill																											
, diesel	"	0.96	0.32	0.96			3.78	9.45	5.67				0.60	1.80														
															0.80	2.40	0.80	2.40		0.80	2.4							
10. Power generation, hydro	GWh									7.0	7.1	7.4	7.6	7.7	10.2	10.6	11.0	11.3	11.8	12.1	12.5	12.9	12.9	13.3	14.1	14.5	16.9	
, diesel	GWh	5.6	5.9	6.1	6.4	6.8	7.1	7.5	7.9	1.3	1.6	1.7	2.0	2.3	0.3	0.4	0.6	0.8	1.0	1.3	1.6	1.9	12.2	2.0	3.0	3.5	20.1	
11. Hydro OM cost	M$ x mill									0.15	0.15	0.15	0.15	0.15	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	
12. Diesel OM cost, fixed	M$ x mill	0.23	0.25	0.22	0.26	0.36	0.36	0.36	0.36	0.26	0.24	0.22	0.20	0.18	0.18	0.18	0.16	0.16	0.23	0.23	0.19	0.29	0.29	0.29	0.29	0.29	0.78	
variable	"	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.01	0.01	0.01	0.01	0.01	0	0	0	0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.10	
fuel (HSD)	"	1.11	1.04	1.07	0.94	1.13	1.04	1.10	1.17	0.19	0.23	0.24	0.27	0.29	0.04	0.05	0	0	0	0	0	0	0	0	0	0	0	
(LO)	"	0	0.09	0.09	0.22	0.23	0.24	0.26	0.27	0.04	0.06	0.07	0.09	0.11	0.01	0.02	0.08	0.11	0.13	0.17	0.21	0.25	0.29	0.34	0.40	0.46	2.66	
13. Total cost (hydro + diesel)	M$ x mill	2.33	1.73	2.37	1.45	1.76	5.46	11.21	7.51	0.65	0.69	0.69	1.32	2.54	1.20	2.82	1.21	2.84	0.54	1.38	2.98	0.72	0.76	0.81	0.88	0.94	3.71	

Present Worth (M$ x mill):
Discount rate (%) 10.0
Net present value +0.99
B/C Ratio 1.04

Rate of Return : 10.8%

表14.6　カピット地域オールディーゼルのキャッシュフロー

System : Kapit　　Project : ALL DIESEL　　Case: Basic = Fuel price M$0.12/kWh

Description	Unit	1986	87	88	89	1990	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	2005	06	07	08	09	2010	2011-33 Average	2033
1. Demand, peak power (MW)	MW	1.27	1.34	1.40	1.47	1.55	1.63	1.71	1.80	1.89	1.98	2.08	2.18	2.29	2.40	2.52	2.65	2.78	2.92	3.06	3.21	3.38	3.55	3.73	3.91	4.11	8.39	12.66
2. , energy (GWh)	GWh	5.6	5.9	6.1	6.4	6.8	7.1	7.5	7.9	8.3	8.7	9.1	9.6	10.0	10.5	11.0	11.6	12.1	12.8	13.4	14.1	14.8	15.5	16.3	17.1	18.0	37.0	55.9
3. Annual load factor	%	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
4. Reserve capacity	MW	0.6	0.6	0.6	0.6	0.	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.64	0.68	0.71	0.75	0.78	0.82	1.68	
5. Required total capacity	MW	1.87	1.94	2.0	2.07	2.15	2.23	2.31	2.4	2.49	2.58	2.68	2.78	2.89	3.0	3.12	3.25	3.38	3.52	3.66	3.85	4.06	4.26	4.48	4.69	4.93	10.07	
6. Diesel retirement	MW		-0.075	-0.288							-0.2	-0.2	-0.2	-0.2			-1.2		-0.3		-0.4					-1.0	-	
7. Power addition, hydro	MW																										-	
, diesel	MW		+0.3		+0.4						+1.0				+1.0		+1.0		+1.0			1.0				+1.0	-	
8. System capacity	MW	2.36	2.59	2.3	2.7	2.7	2.7	2.7	2.7	2.7	3.5	3.3	3.1	2.9	3.9	3.9	3.7	3.7	4.4	4.4	4.0	5.0	5.0	5.0	5.0	5.0	10.1	
(H.S.D units)		2.36	2.3	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.8	1.6	1.4	1.2	1.2	1.2	0	0	0	0	0	0	0	0	0	0	0	
(L.O units)			0.3	0.3	0.7	0.7	0.7	0.7	0.7	0.7	1.7	1.7	1.7	1.7	2.7	2.7	3.7	3.7	4.4	4.4	4.0	5.0	5.0	5.0	5.0	5.0	10.1	
9. Installation cost, hydro	M$ x mill																											
,diesel	"	0.96	0.32	0.96					0.80	2.40			0.60	2.40	0.80	2.40	0.80	2.40		0.80	2.4			0.80	2.40		-	
10. Power generation, hydro	GWh																											
, diesel	GWh	5.6	5.9	6.1	6.4	6.8	7.1	7.5	7.9	8.3	8.7	9.1	9.6	10.0	10.5	11.0	11.6	12.1	12.8	13.4	14.1	14.8	15.5	16.3	17.1	18.0	37.0	
11. Hydro OM cost	M$ x mill																											
12. Diesel OM cost, fixed	M$ x mill	0.23	0.25	0.22	0.26	0.36	0.36	0.36	0.36	0.36	0.34	0.32	0.30	0.28	0.37	0.37	0.36	0.36	0.42	0.42	0.38	0.48	0.48	0.48	0.48	0.48	0.97	
variable	"	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.19	
fuel (HSD)	"	1.11	1.04	1.07	0.94	1.13	1.04	1.10	1.17	1.22	0.89	0.88	0.86	0.83	0.65	0.67	0	0	0	0	0	0	0	0	0	0	0	
(LO)	"	0	0.09	0.09	0.22	0.23	0.24	0.26	0.27	0.28	0.56	0.62	0.70	0.78	0.96	1.01	1.53	1.60	1.69	1.77	1.86	1.95	2.05	2.16	2.26	2.38	4.90	
13. Total cost (all diesel)	M$ x mill	2.33	1.73	2.37	1.45	1.76	1.68	1.76	2.64	4.30	1.84	1.87	2.71	4.34	2.83	4.51	2.75	4.42	2.18	3.06	4.71	2.51	2.61	3.52	5.23	2.95	6.06	

表14.7　感度分析の要約

Case	Fuel Price: 1986 Basic Price	Fuel Price: Escalation	Diesel Cost	Hydro Cost	Mukoh NPV (M$'000)	Mukoh B/C	Mukoh IRR (%)	Pasia 5/ NPV (M$'000)	Pasia 5/ B/C	Pasia 5/ IRR (%)	Medamit-2 NPV (M$'000)	Medamit-2 B/C	Medamit-2 IRR (%)
Basic Sensitivity Test													
	As estimated 1/	0	As estimated	As estimated	+0.99	1.04	10.8	-1.1	0.99	9.8	+2.3	1.03	10.8
A1	As estimated (M¢ 40/lit)	0	-20% (M$2,560/kW)	As estimated	+0.05	1.00	10.0	-4.67	0.94	9.3	-0.51	0.99	9.9
A2	As estimated 2/	0	As estimated (M$3,200/kW)	+20%	-1.83	0.94	8.8	-12.81	0.87	8.3	-4.80	0.95	8.7
A3	As estimated	0	As estimated	-10%	+2.43	1.09	12.0	+4.68	1.06	10.8	+5.84	1.08	12.1
A4	As estimated	2% p.a. 3/	As estimated	As estimated	+6.36	1.20	13.8	+22.70	1.24	12.7	+13.97	1.14	13.7
B1	Price as at Mar. 86 (M¢ 34.3/lit)	0	As estimated	As estimated	-0.45	0.98	9.7	-6.56	0.92	9.0	-0.96	0.99	9.7
B2	Price as at Mar. 86	3.86% 4/ p.a.	As estimated	As estimated	+11.21	1.31	15.5	+46.94	1.46	14.5	+24.30	1.19	15.3

Note: NPV : Net present value representing saving in thermal costs
1/ : Average of 1985-86 price
2/ : SESCO record
3/ : A tentative rate assumed for increase of oil price
4/ : SESCO's pricing schdule
5/ : With regulating pondage

表14.8　ムコの2代替案の特徴

(2. ALTERNATIVE PLANS)

Demand Scenario: Kapit + Timber Industries

Description		Case-1	Case-2
Type of development		ROR	ROR with pondage
Firm discharge	(m 3/s)	7.4	7.4
Plant discharge	(m 3/s)	7.4	14.8
Effective head	(m)	31.5	36.1
Full supply level	(m)	80.0	87.2
Min. operating level	(m)	-	80.7
Average operating level	(m)	80.0	85.0
Tailwater level	(m)	45.0	45.0
Dam/weir height		5	15.2
Headrace, length	(m)	1,660	1,660
diameter	(m)	2.0	2.7
Penstock, length	(m)	40	40
diameter	(m)	1.5	2.2
Installed capacity	(MW)	1.94	4.45
Dependable output	(MW)	1.94	4.45
Annual energy	(GWh)		
- Primary		16.7	19.1
- Secondary		0	17.5
Total		16.7	36.6
Transmission line			
- Length	(km)	25	25
- Voltage (kV) x circuit		33 x 1	33 x 1
Construction cost	(M$ mill)	21.3	37.1

表14.9　候補地点の技術的特徴

Item	MUKOH	PASIA	MEDAMIT-2
Type of development	Run-of-river	Run-of-river	Run-of-river
Topography	Banks at proposed dam (weir) site are steep and high allowing construction of a high dam. River width is 15 m, with exposed rocks. River deposit seems nil. No difficulty, except for relatively large excavation at powerhouse site due to steep topography thereat.	Damsite shows a steep V-shape topography. River width is 20 m and the gradient some 1/20. River-bed deposit is thin (1-2 m). Powerhouse area is also steep.	River at damsite shows meanders. The width is some 15 m, with exposed rocks on both banks. River deposit is presumably thin (2 m). Powerhouse topography is gentle. No topographical difficulty is foreseeen.
Geology	Damsite is in the zone of hard graywacke and powerhouse in hard slate. Overburden on both banks is very thin. No geological problem effecting the scheme is foreseen.	Whole area fall in graywacke zone. Generally hard and massive. Overburden is almost nil. Depth of weathering of rocks appears to be thin. No specific problem foreseen.	Damsite consists of graywacke (left bank) and shale, generally hard. Powerhouse is in limestone area. Overburden depth is 1 to 2 m left bank, but 5 m on right bank. A 5 m thick fractures zone is observed along limstone-shale boundary which crosses the penstock line, but seems not to constitute a critical constraint to the scheme.
Source of Aggregates	Sand/gravel deposit is scare in the vicinity of project area. To be transported from distant sources, 15-20 km away, or otherwise produced from excavated rocks.	Sand/gravel is scare in the river reaches along the site, but some found along the Batang Trusan. Presumably some to be transported from far deposits.	Sufficient quantity is available in river deposits along Sungai Medamit and Limbang.
Access	Existing logging road passes at 1.5 km from the site could be reached by providing a new road of 4 km in length. In general, accessibility is fair.	A new logging road is under construction to put into operation in end 1987. Upon its completion, access to Lawas is to be made possible. Construction of a new access road of 20 km in steep area would be necessary to reach the site.	Existing logging roads pass nearby the site. A new access road than 1 km. The existing road is under active operation and in a fair to good condition. Access condition is good.
Transmission Line	Transmission line length is 25 km to Kapit. The line passes through hilly areas. The vegetation is relatively thick. In general, the line route will be accessible from the existing logging roads.	Total line length will be some 110 km. Of which, 20 km passes in primary rain forest, crossing mountains of over 1,000 m in altitude, until it reaches the upper reach of the Medamit where the existing logging road exists. Difficulty is fore-seen in this section, both in line construction and future maintenance.	Line length is about 60 km to Limbang, passing mostly in undulating flat areas. Vegatation is relatively thick. Access to the line route is possible from the existing public and public and logging roads.
Land Acquisition and Resettlement	Impounding by pondage limited only in the existing river course. No resettlement of housings is required.	Impounding only in the present river course. No resettlement of housings.	Impounding only in the present river course. No resettlement of housing.
Downstream Water Use	No adverse effect.	No adverse effect.	No adverse effect.

Note : See Appendix III - Summary of Field Reconnaissance for further detailed descriptions.

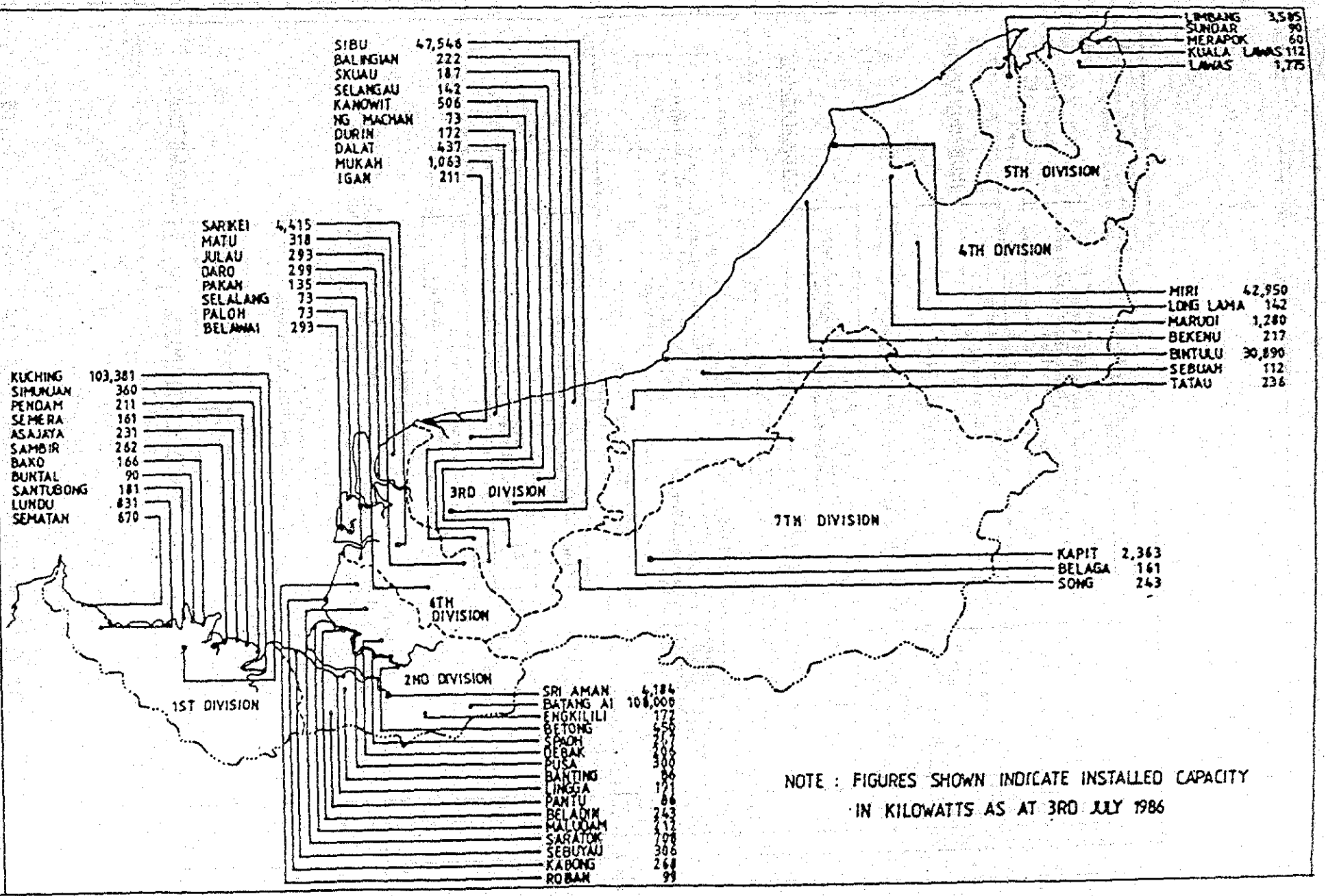
表14.10 低落差案の概要

for Low Head Plan

Description	Lupar	Kanowit	Katibas	Belah	Limbang
Load centre	Sri Aman	Sarikei	Kapit	Kapit	Limbang
Catchment area (km)	2,220	2,530	3,150	12,150	2,820
Average runoff (m^3/s)	220	250	290	1,300	190
Estimated firm discharge (m^3/s)	115	65	100	490	60
Plant discharge(m^3/s)	230	130	200	980	120
Power head (m)	3	3	3	3	3
Installed capacity (MW)	5.7	3.2	5.0	24.5	3.0
Dependable output (MW)	2.9	1.6	2.5	12.2	1.5
Annual energy (GWh)					
- Primary	24.7	13.9	21.5	105.1	12.9
- Secondary	19.8	11.1	17.2	84.1	10.3
Total	44.5	25.0	38.7	189.2	23.2
Weir					
- Height (m)	7	7	7	9	7
- Length (m)	70	50	50	150	100
- Pile foundation depth (m)	15	10	5	10	15
Access road (km)	1	5	60	20	4
Transmissioin line					
- Voltage (kV)	33	33	33	66	33
- Length (km)	35	47	50	18	33
Construction cost (million M$)	67.0	49.5	72.0	330.0	56.0

付　　図

図 1.1 SESCOの管轄区と発電所



GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

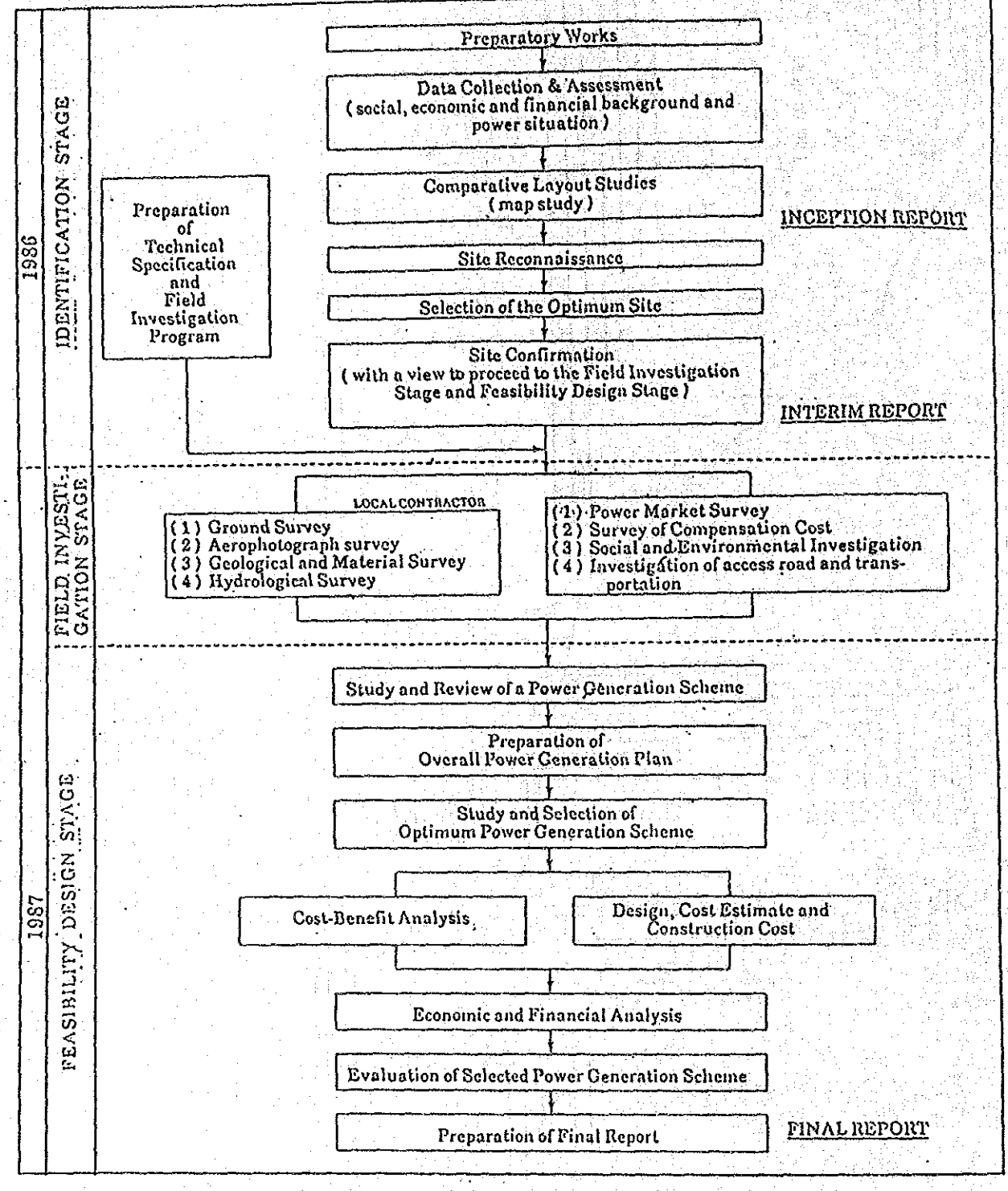


図 2. 1　　フィージビリティー調査の流れ図

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

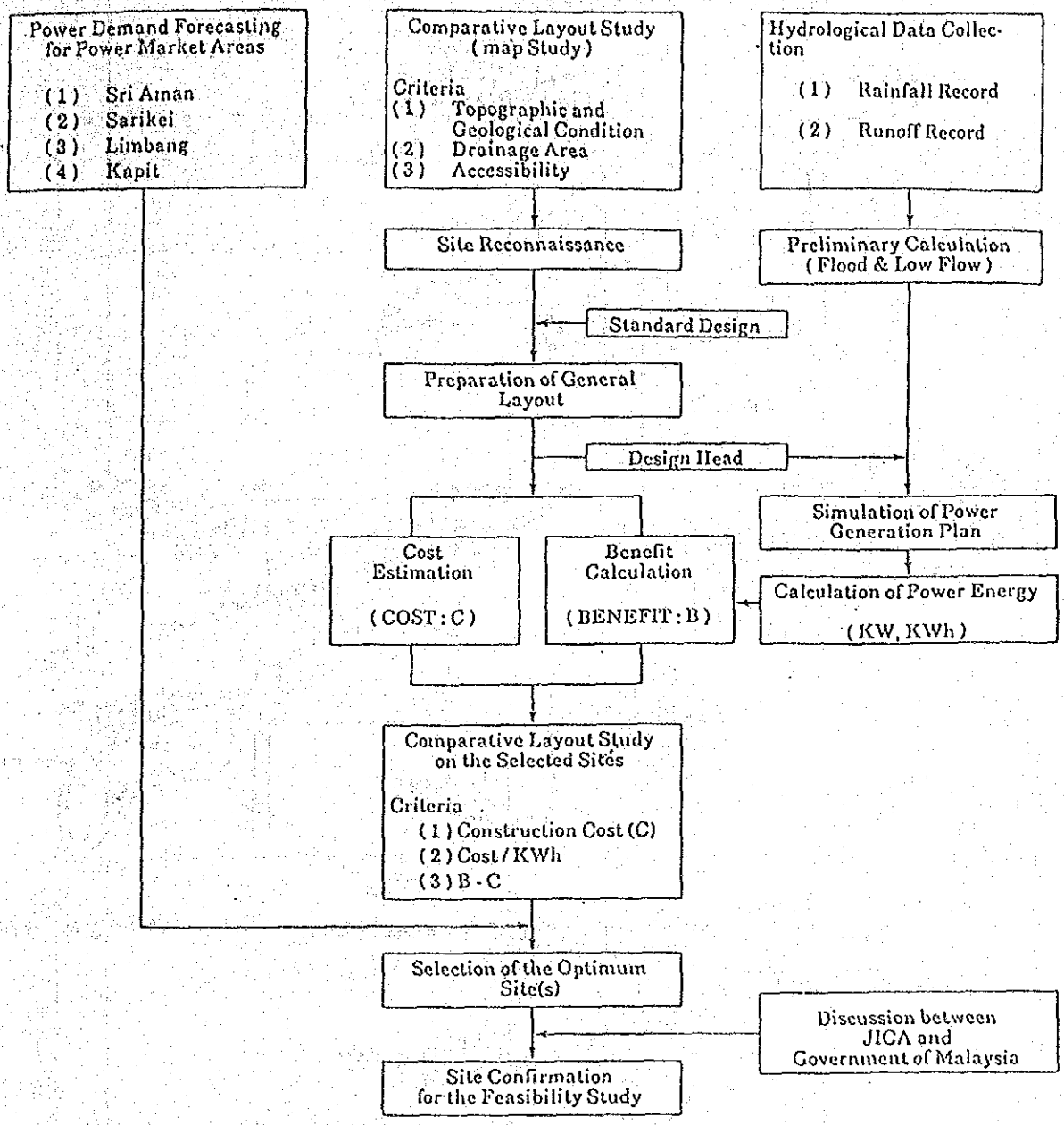
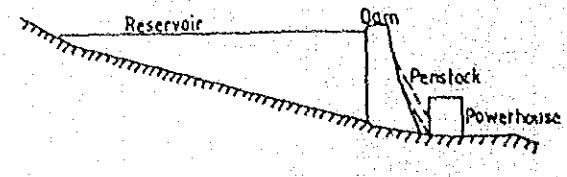
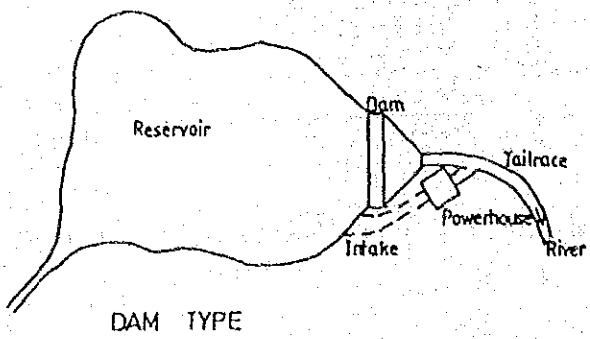


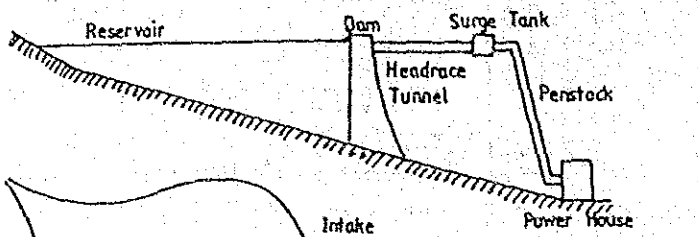
図2.2　フィージビリティー設計用水力地点選定の流れ図

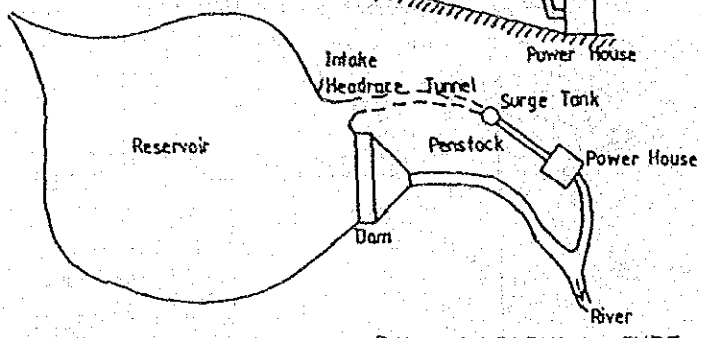
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



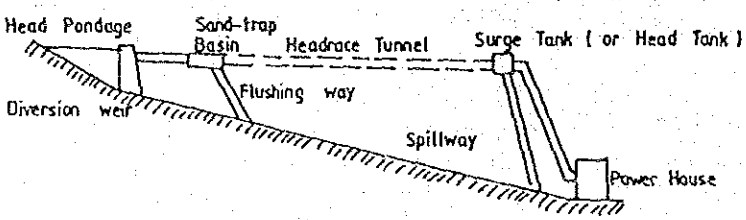


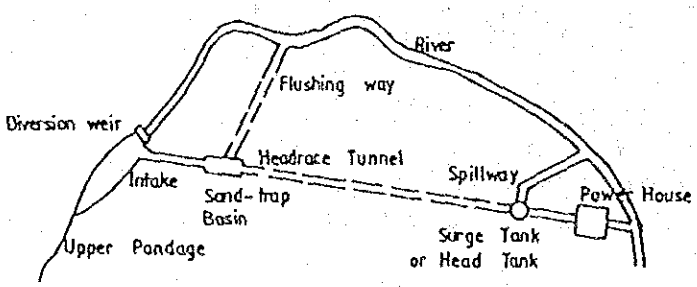
DAM TYPE





DAM + WATERWAY TYPE

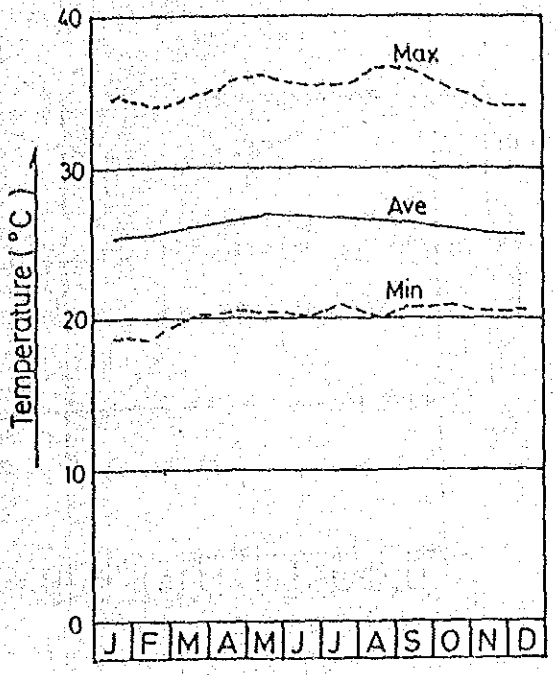




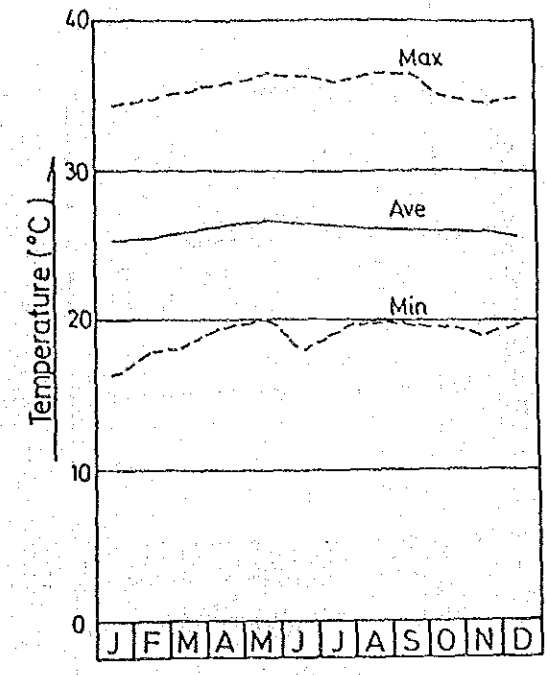
RUN - OF - RIVER TYPE

図4.1　水力開発方式図

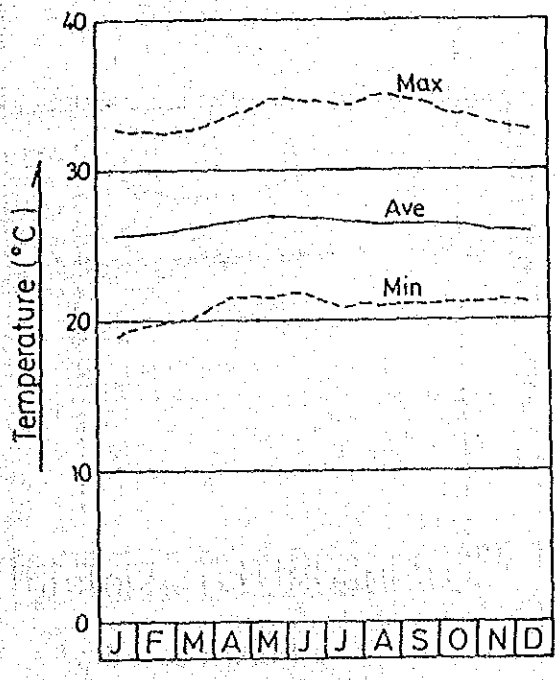
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



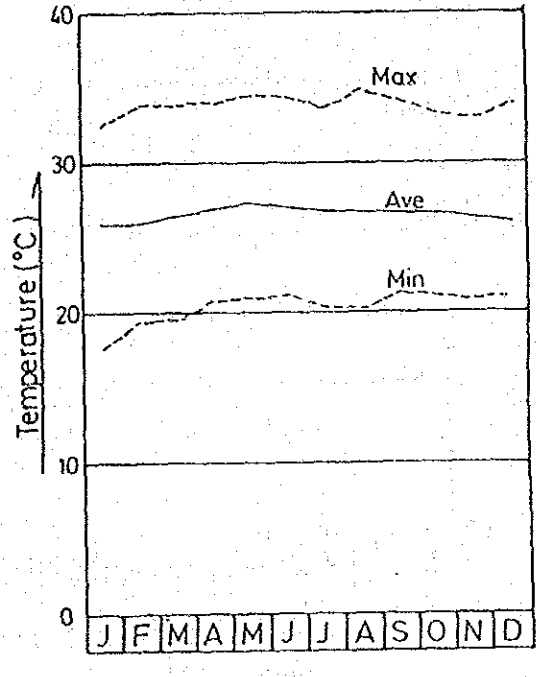
KUCHING
(1968 - 1981)



SIBU
(1968 - 1981)



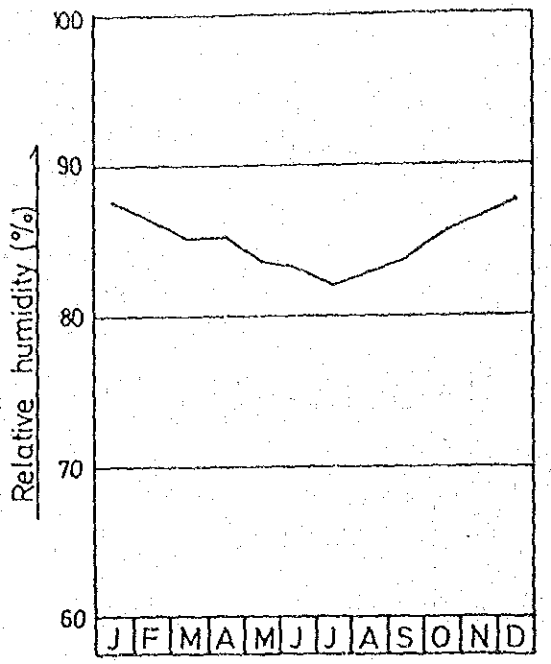
BINTULU
(1968 - 1981)



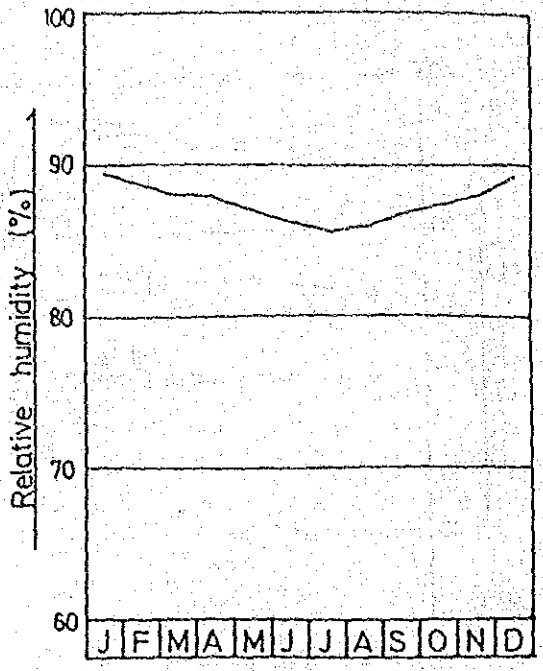
MIRI
(1968 - 1981)

図 5. 1　　平均・最大・最小気温

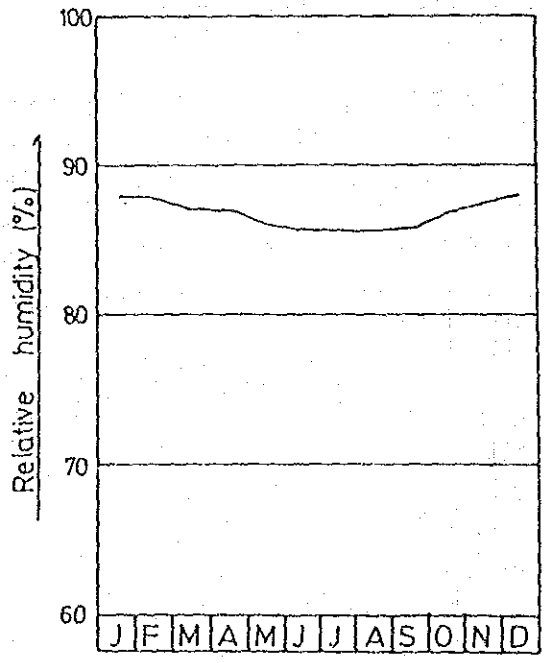
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



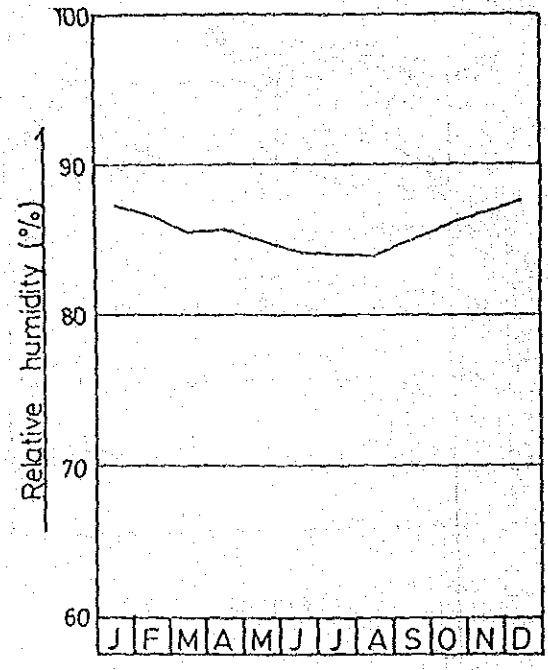
KUCHING (EL 25.6m)
(1968 - 1980)



SIBU (EL 7.5m)
(1968 - 1980)



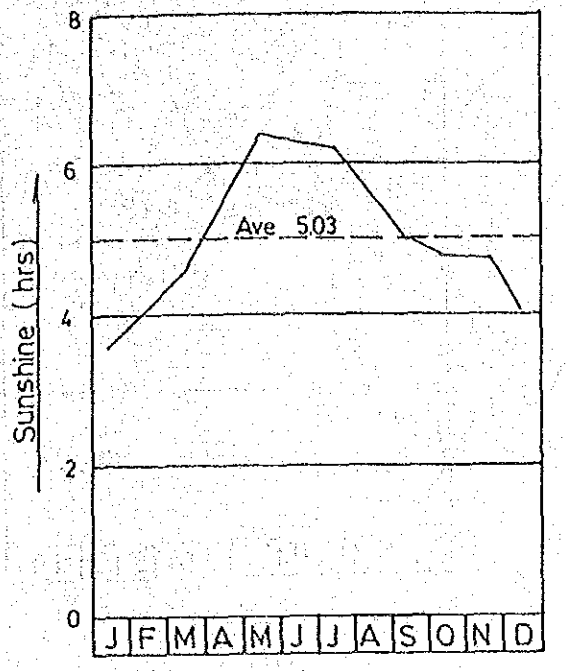
BINTULU (EL 3.1m)
(1968 - 1980)



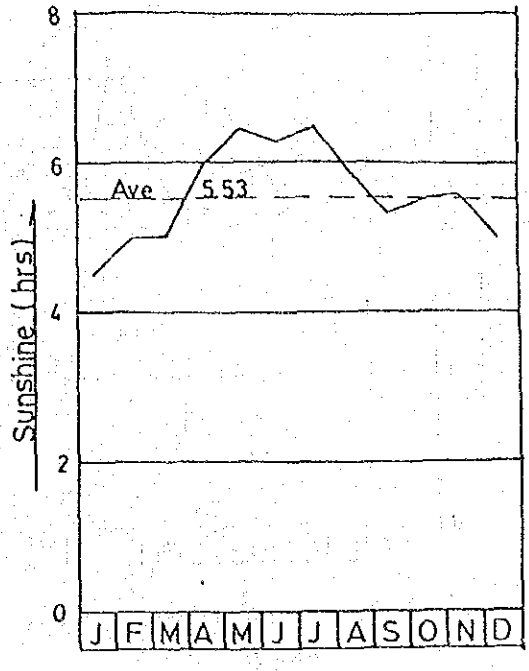
MIRI (EL 16.8m)
(1968 - 1980)

図 5. 2　　平　均　湿　度

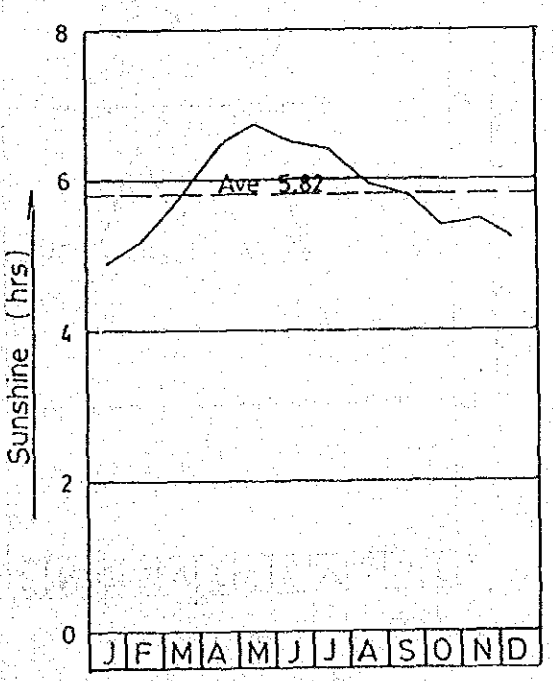
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



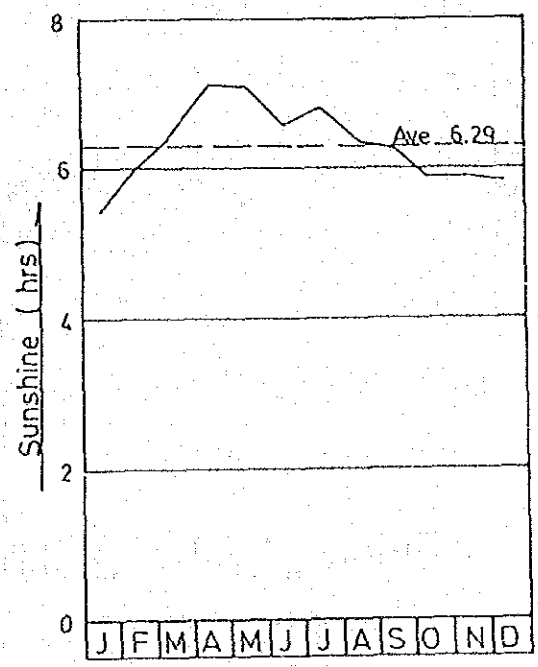
KUCHING



SIBU



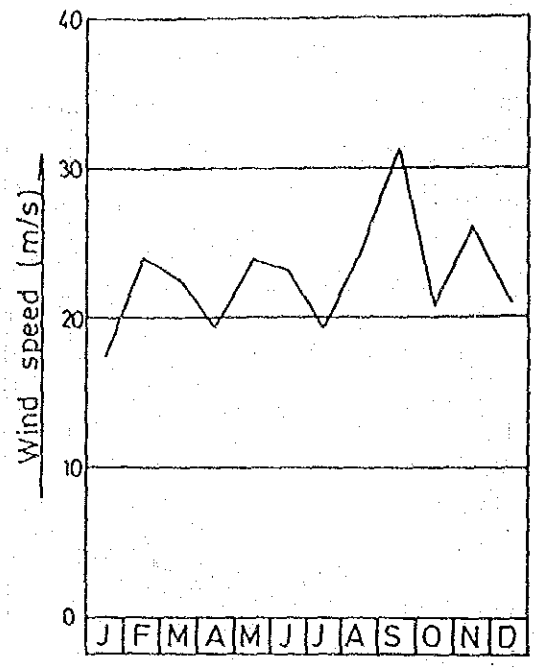
BINTULU



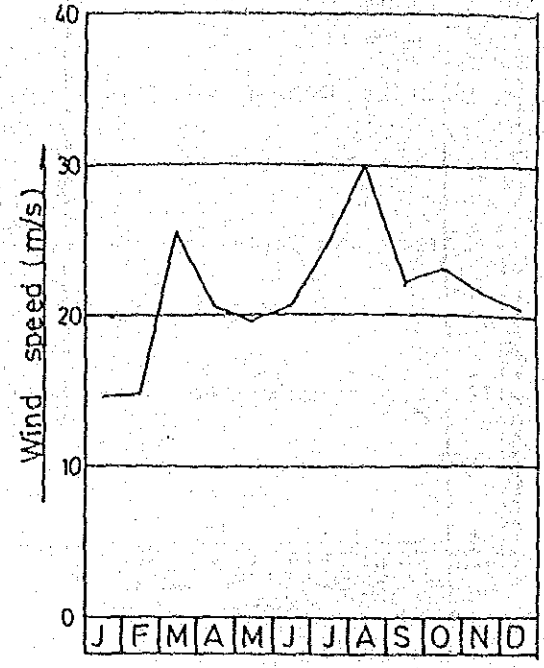
MIRI

図 5.3　　日照時間の月平均パターン

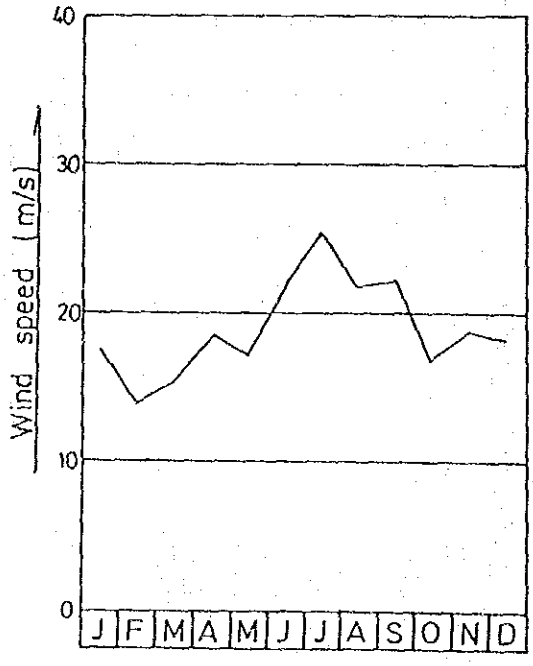
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



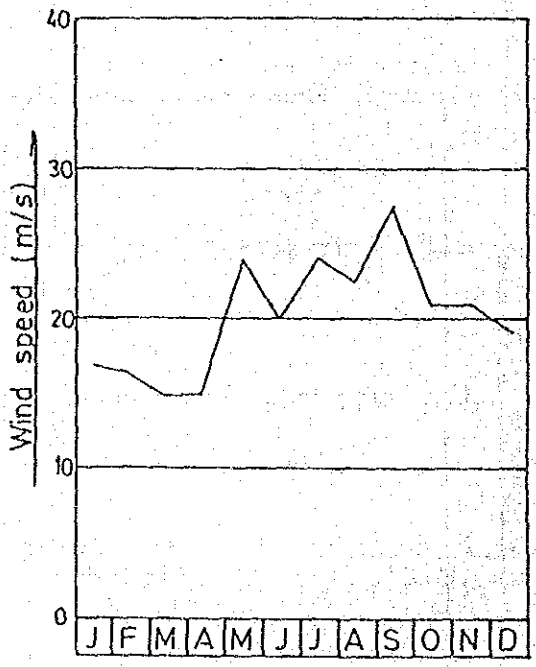
KUCHING
(1964 - 1981)



SIBU
(1964 - 1981)



BINTULU
(1964 - 1981)



MIRI
(1964 - 1981)

図 5. 4　　最　大　風　速

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

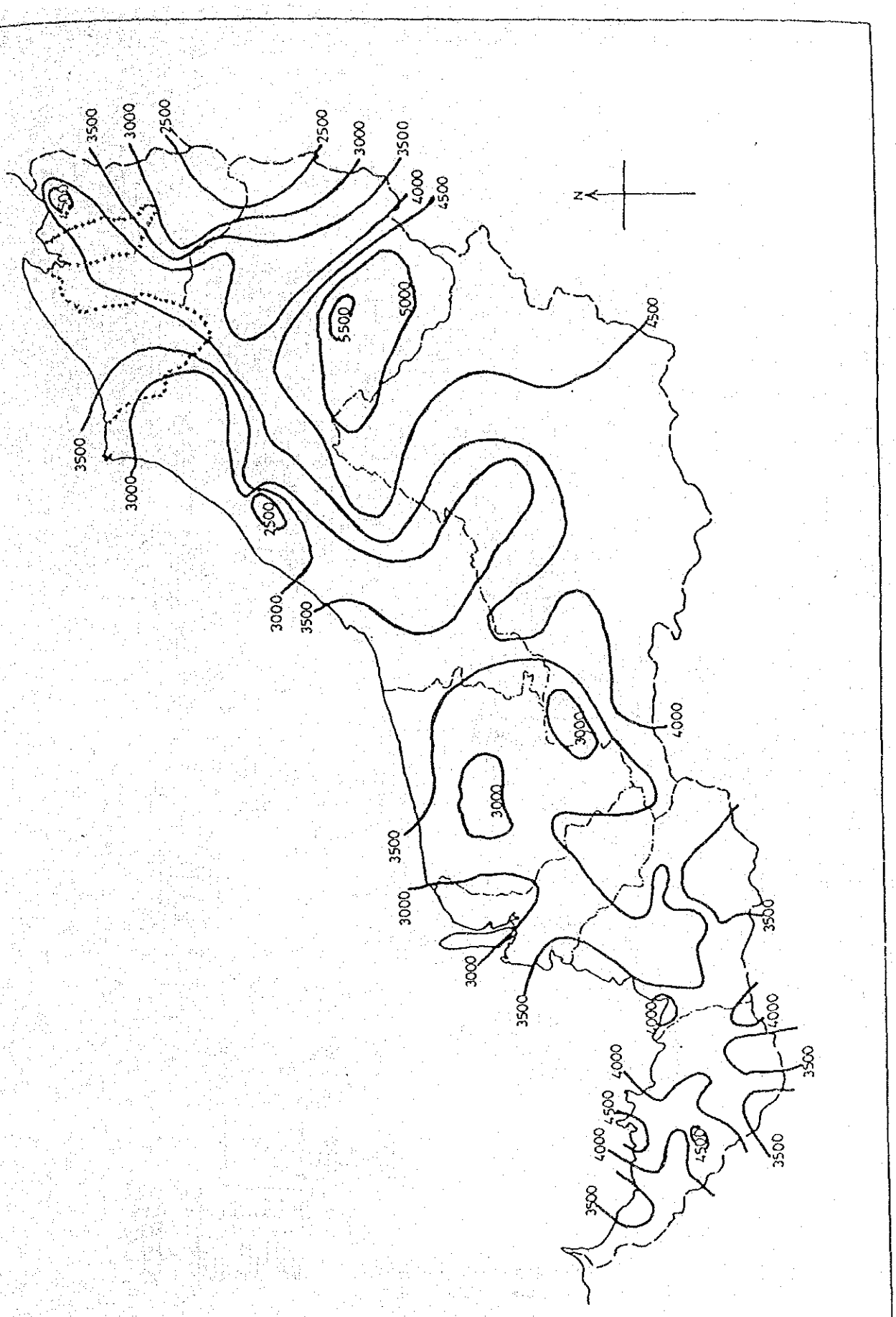


図5.5　年平均等雨量線図

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

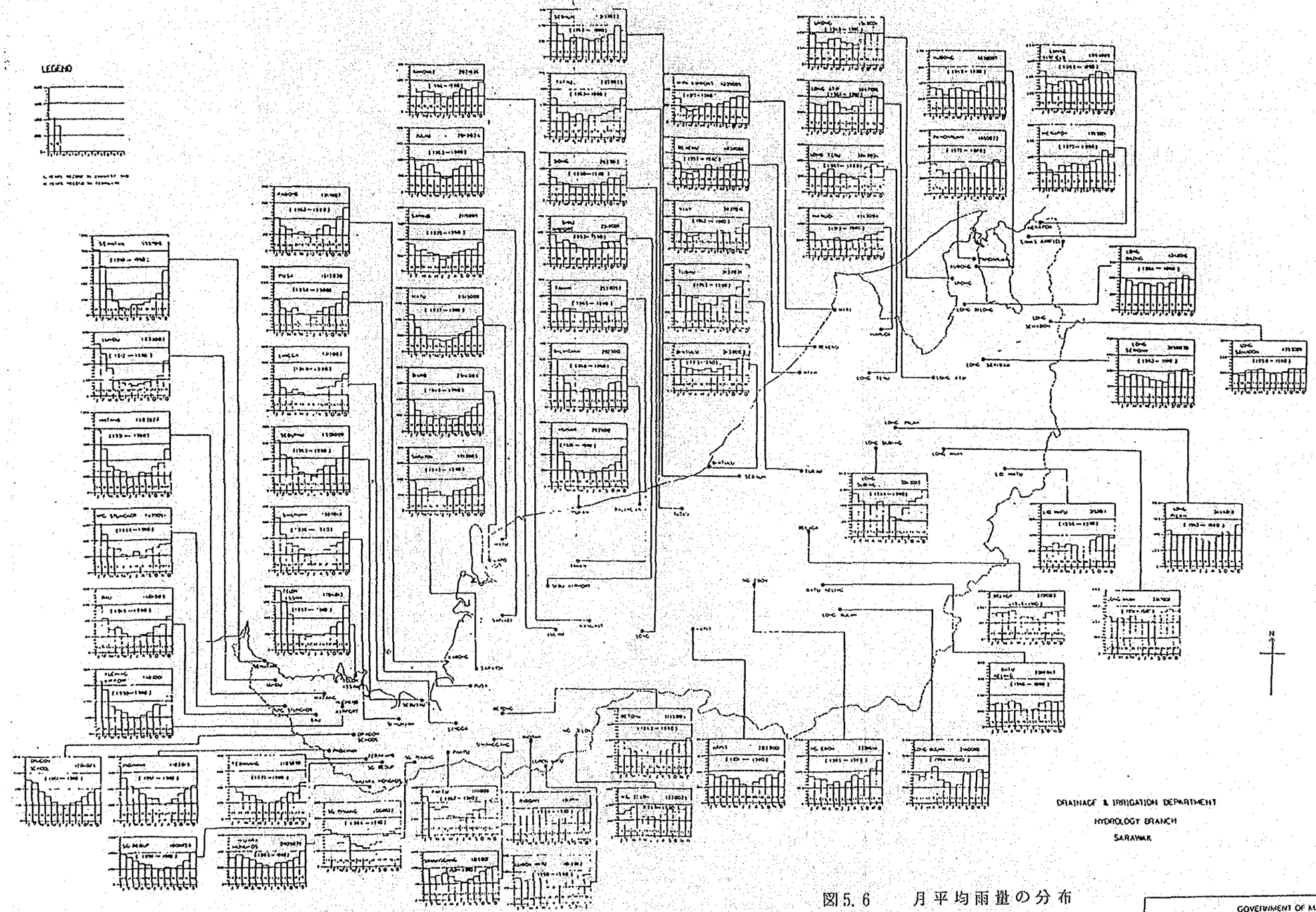
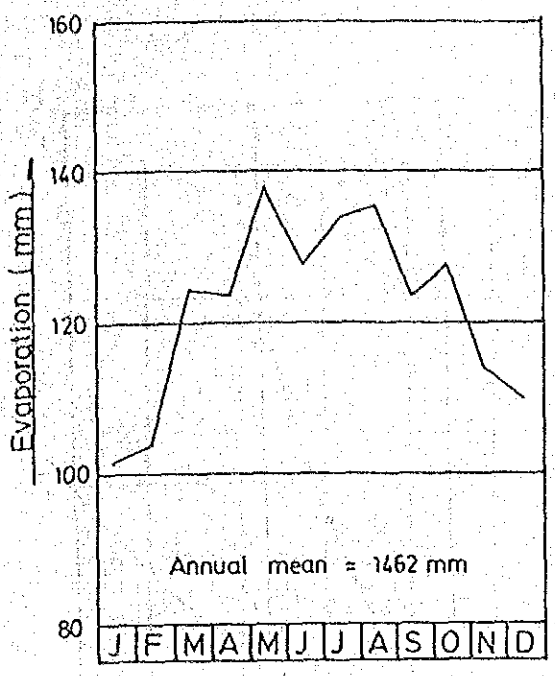
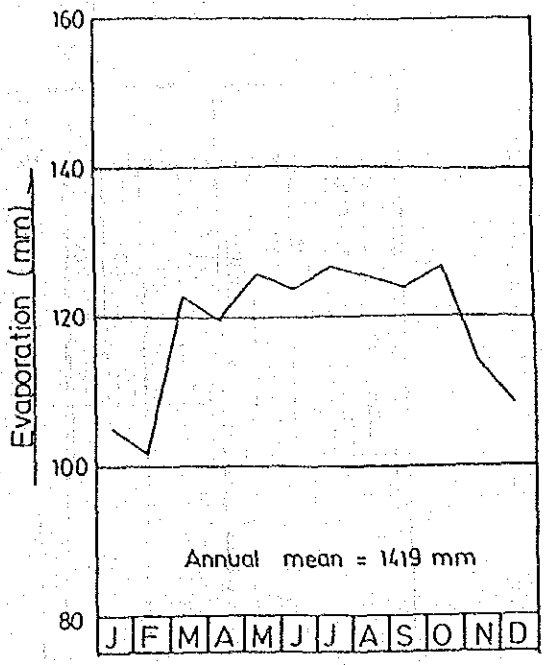


図5.6　月平均雨量の分布

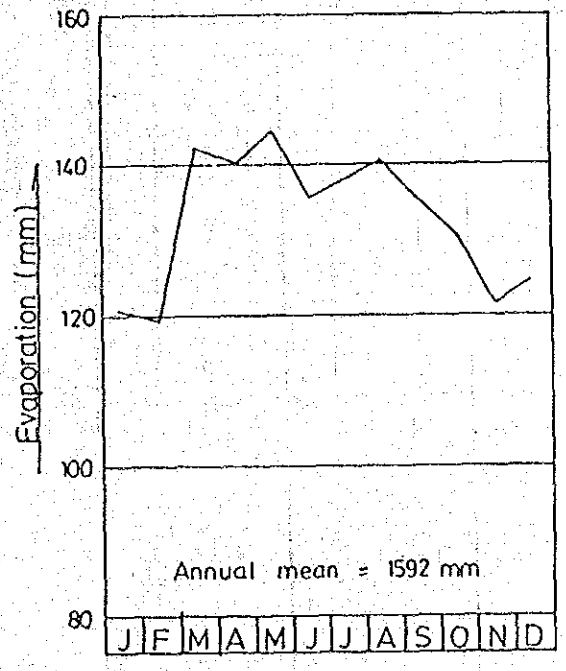
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



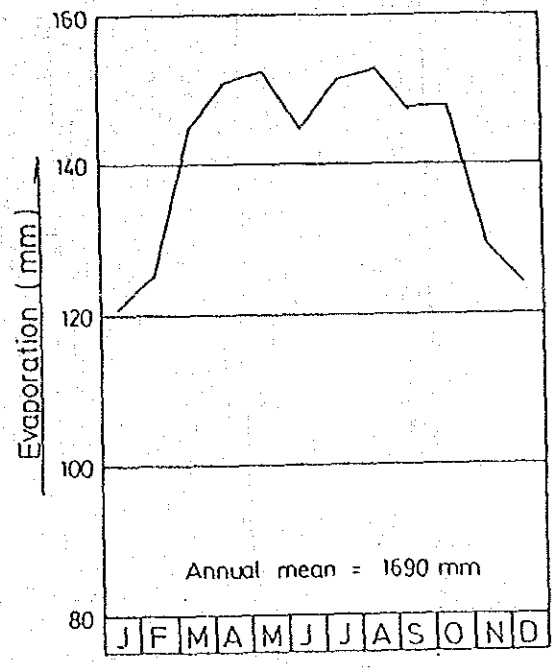
KUCHING
(1968 - 1981)



SIBU
(1968 - 1981)



BINTULU
(1968 - 1981)



MIRI
(1968 - 1981)

図5.7　年平均蒸発量

FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK

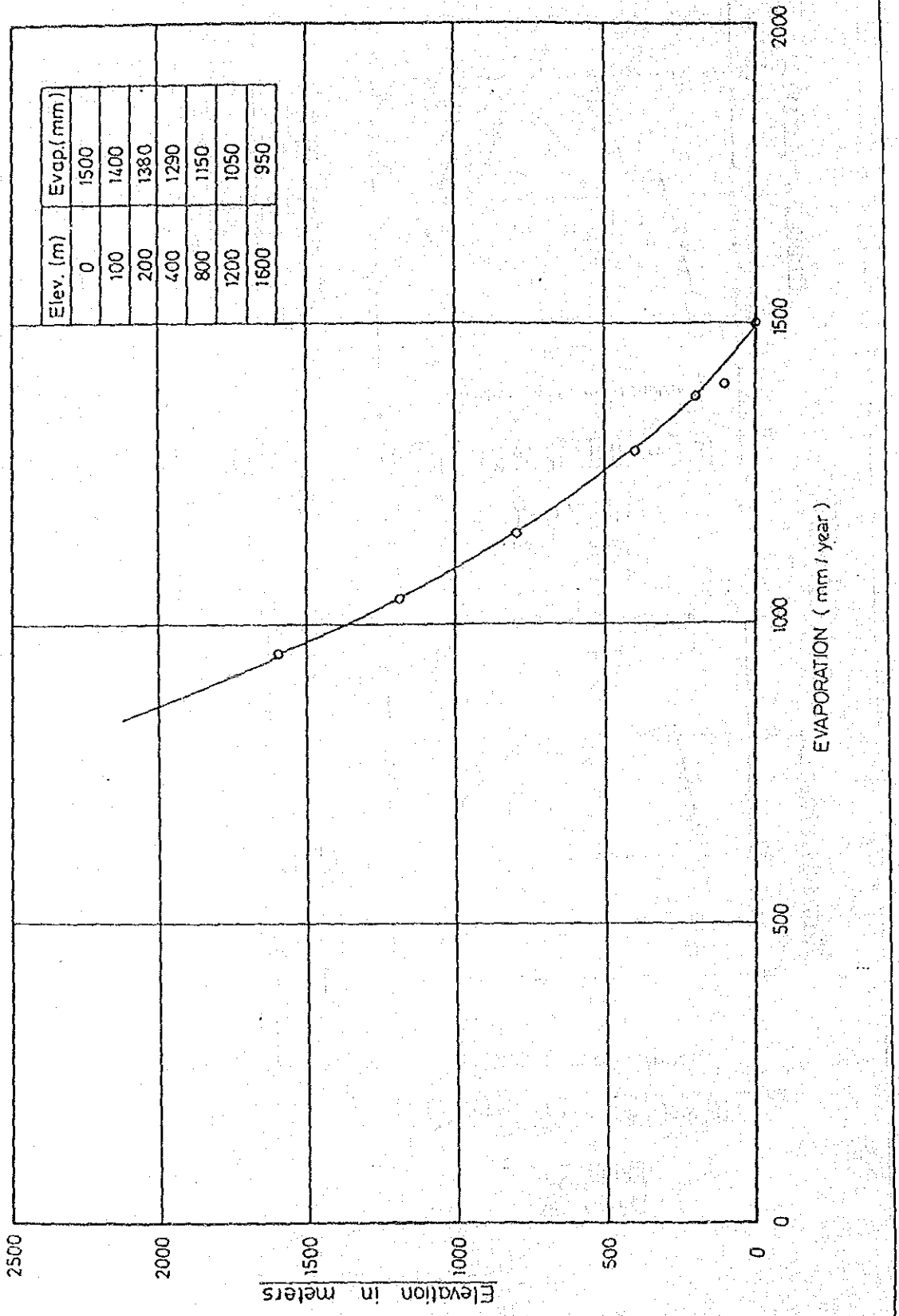


図5.8　蒸発散量と標高の関係

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

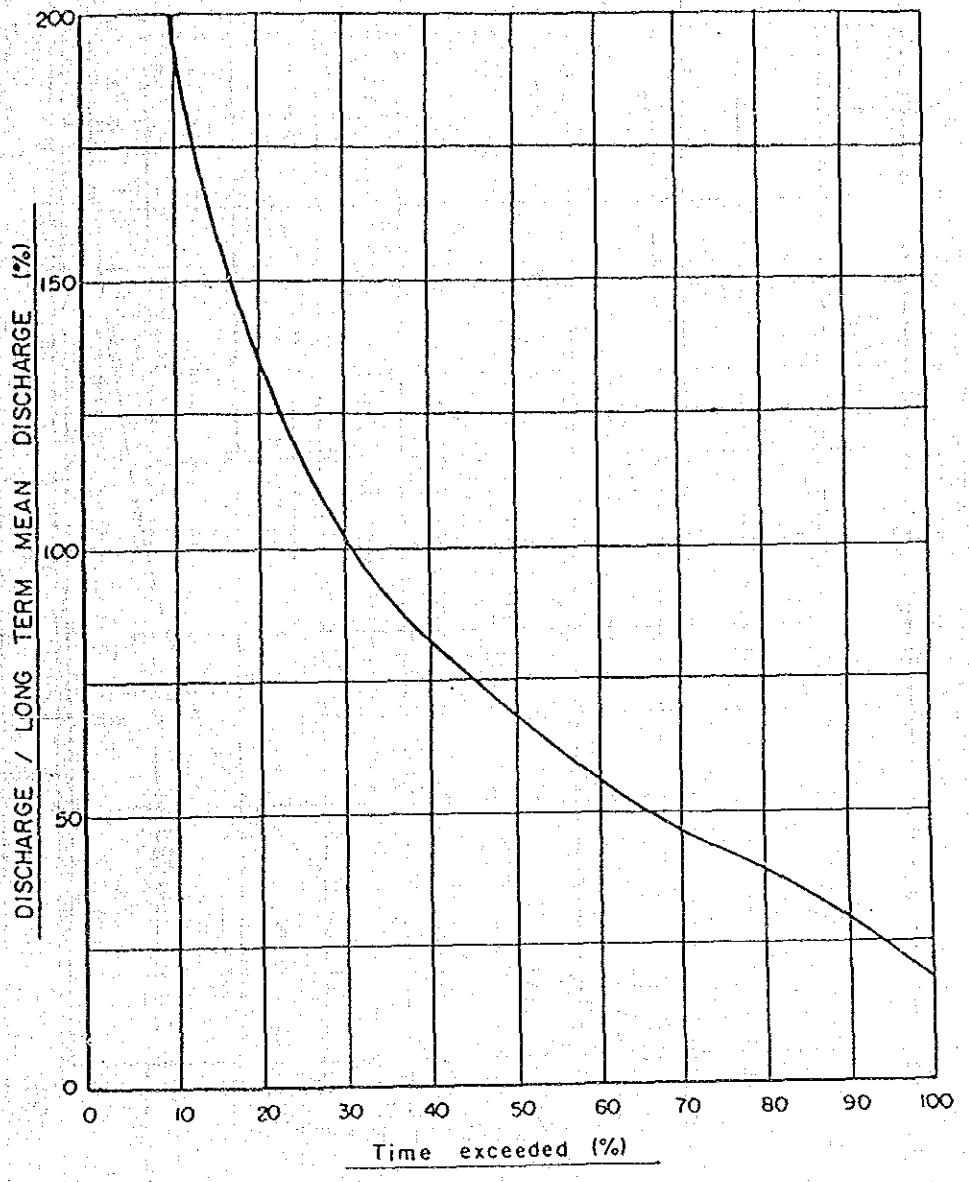


図5.9　無次元流況曲線

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

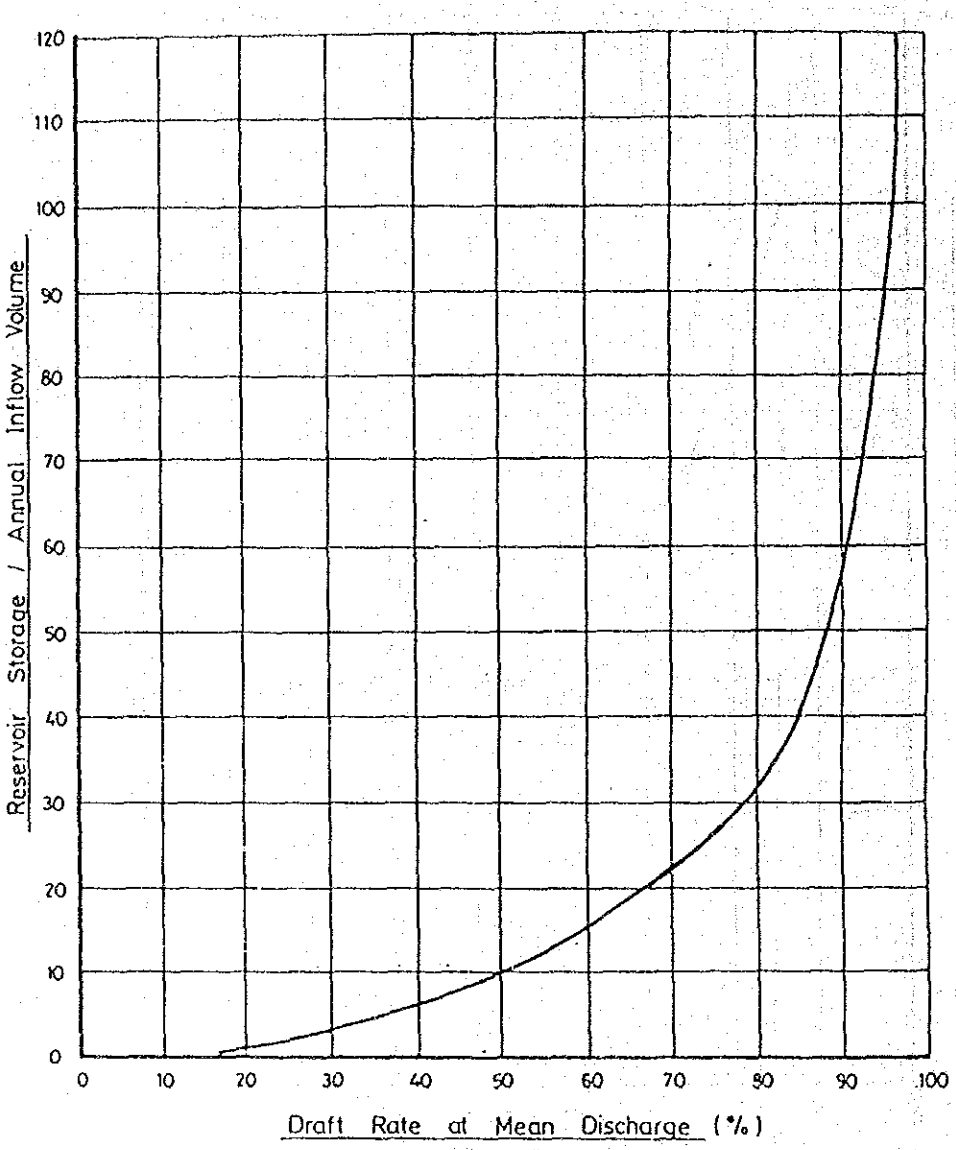


図 5.10　無次元貯水量使用水量曲線

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

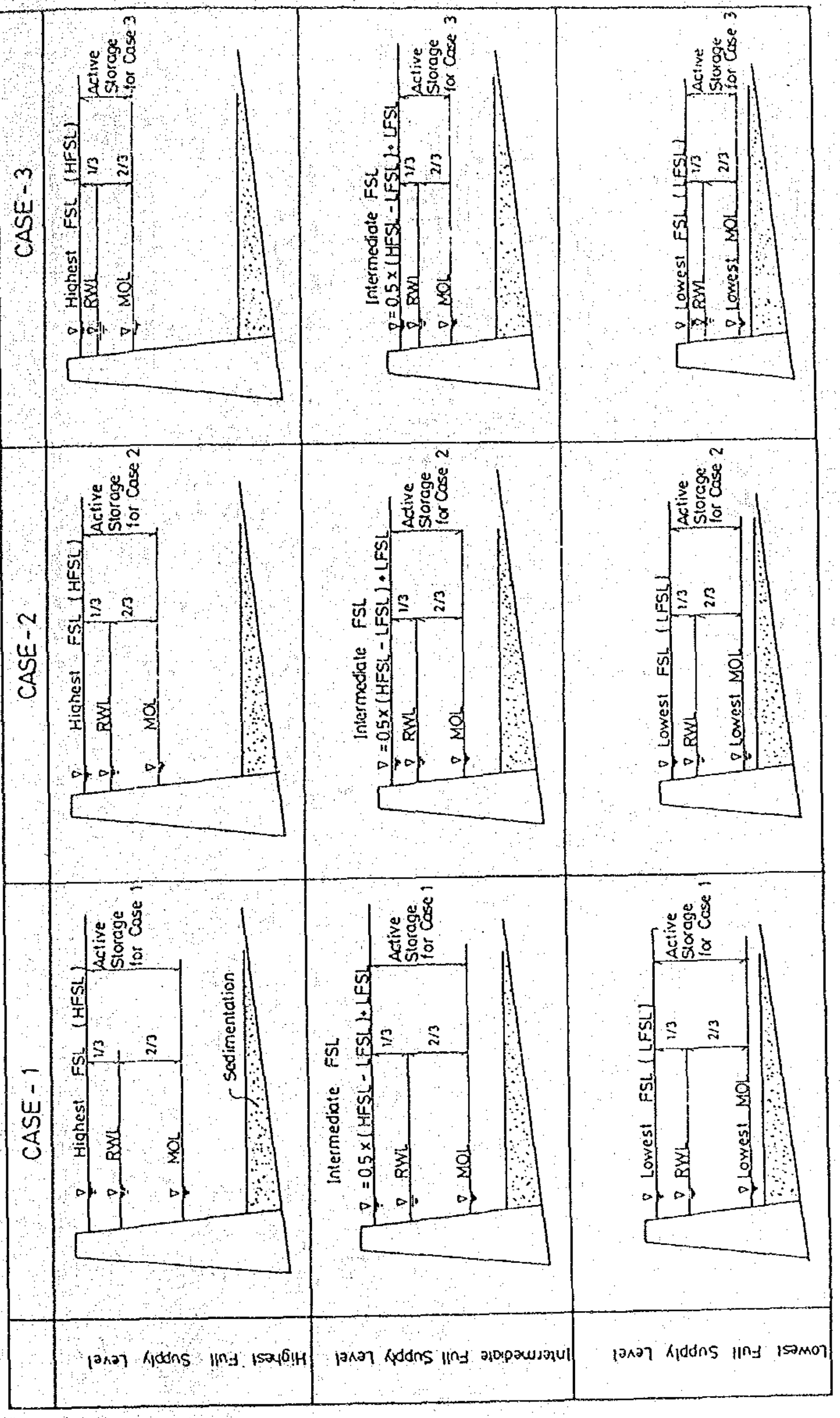
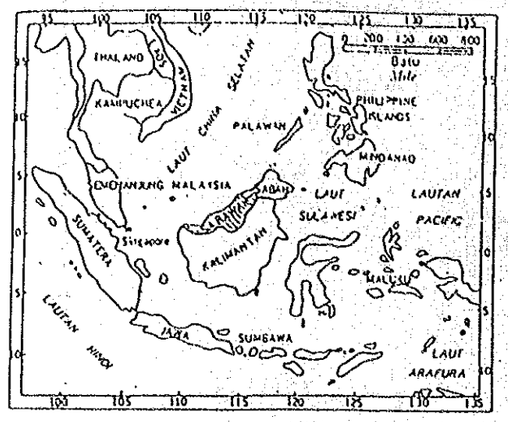


図6.1　貯水池開発方式の概略出力計算図

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



1985
PETUNJUK
REFERENCE

- Sempadan Antarabangsa / *International Boundary*
- Sempadan Negeri / *State Boundary*
- Sempadan Bahagian / *Divisional Boundary*
- Jalan Raya Utama / *Trunk Road*
- Jalan Raya Kedua / *Secondary Road*
- Jalan Raya Sedang dibina / *Road Under Construction*
- Ibu Bahagian / *Divisional Headquarters*
- Ibu Daerah / *District Headquarters*
- Pekan / *Bazar*
- Kampung / *Village*
- Padang Terbang, Lapangan Terbang / *Airport, Airfield*
- Rumahapi / *Lighthouse*

Legend: ; Potential Site Proceeded to Second Screening

; Selected Rainfall Stations

Skel (*Scale*) 1 : 2,000,000

Batu *Mile* 0 10 20 30 40 50 60 70 80 90 100

Kilometer *Kilometre* 0 30 120 150

LAWAS
TENGOA
TRUSAN
LONG BILONG
MEDAMIT - 2
MEDAMIT - 1
LONG SEMADOH
LIMBANG
PASIA
SABAH
BRUNEI
SELATAN
CHINA
LAUT
KAPIT - 1
KAPIT - 2
MUKOH
IBAU
KANOWIT W/W
TEKALIT
KANOWIT
SARI-2
SARI-1
SRIA - 2
SEKRANG - 1
SRIA - 1
RIDDAN
LEMANAK
SEKRANG - 2
SONG
BANGKIT
AYAT
NANGA BANGKIT
KAPIT P.W.D
K A L I M A N T A N
(INDONESIA)

図9.1　雨量観測所位置図

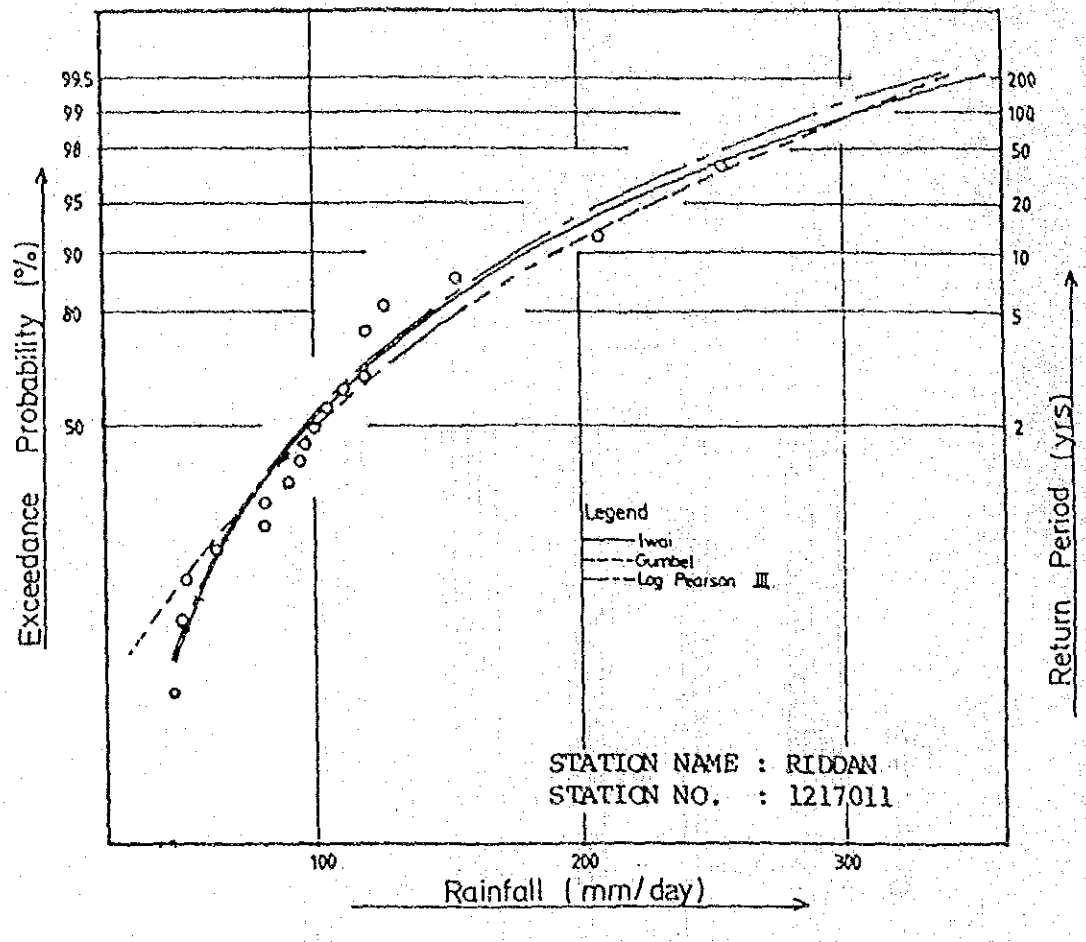
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

RAINFALL STATION AND PERIOD OF RECORDS

STATION NO.	STATION NAME	TYPE	LOCATION Lat	LOCATION Long	PERIOD OF RECORDS 1931 - 1960, 61 – 84
SEKRANG-1, SEKRANG-2 POTENTIAL SITES					
1217011	RIDOAN	S	1° 13' N	111° 42' E	
KANOWIT POTENTIAL SITE					
2021036	KANOWIT W/W	R.S	2° 06' N	112° 09' E	
MEDAMIT-2, PASIA POTENTIAL SITES					
4255006	LONG SEMADOH	S	4° 13' N	115°35' E	
4349016	LONG BILONG	S	4° 22' N	114°56' E	
KAPIT-1, KAPIT-2, IBAU, BANGKIT, AYAT, MUKOH POTENTIAL SITES					
2029001	KAPIT P.W.D	R.S	2° 01' N	112° 56' E	
2025012	SONG	R.S	2° 01' N	112° 33' E	
1726041	NANGA BANGKIT	S	1° 46' N	112° 38' E	

図9.2　降雨量記録期間

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



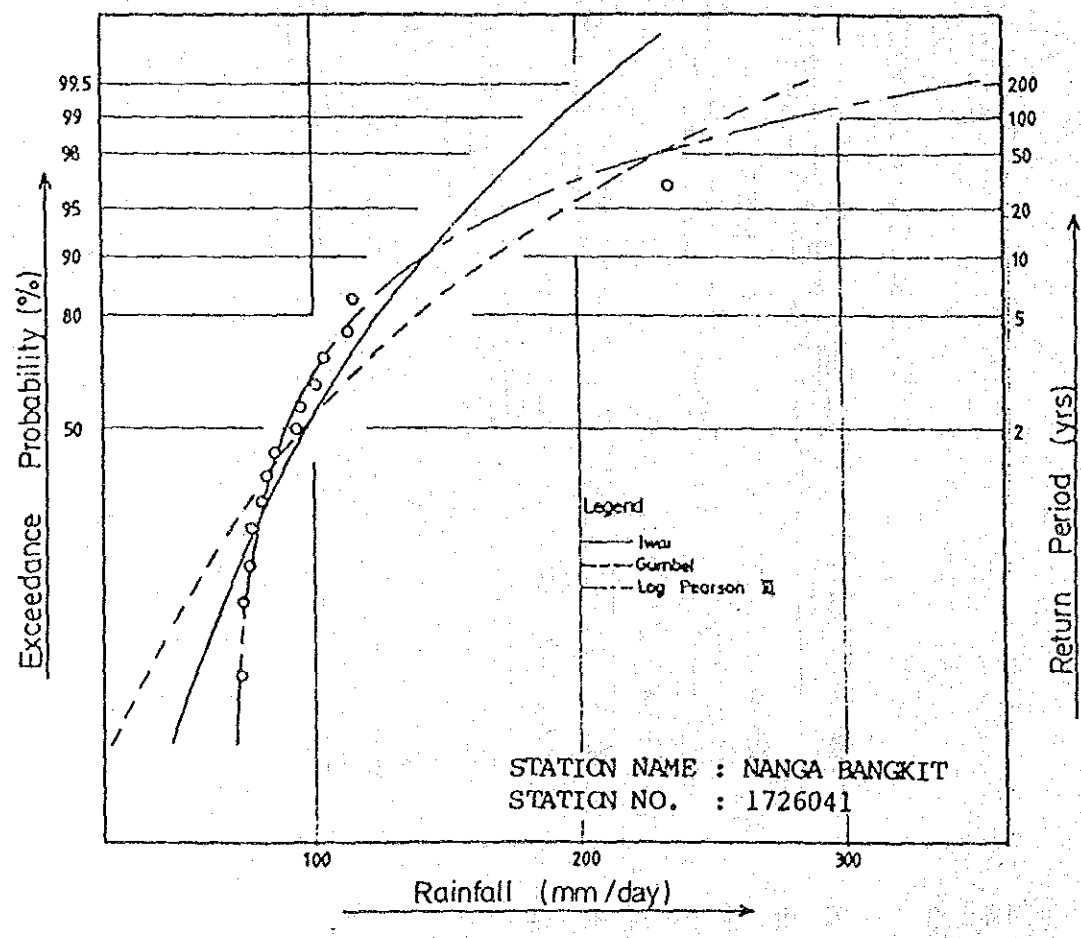
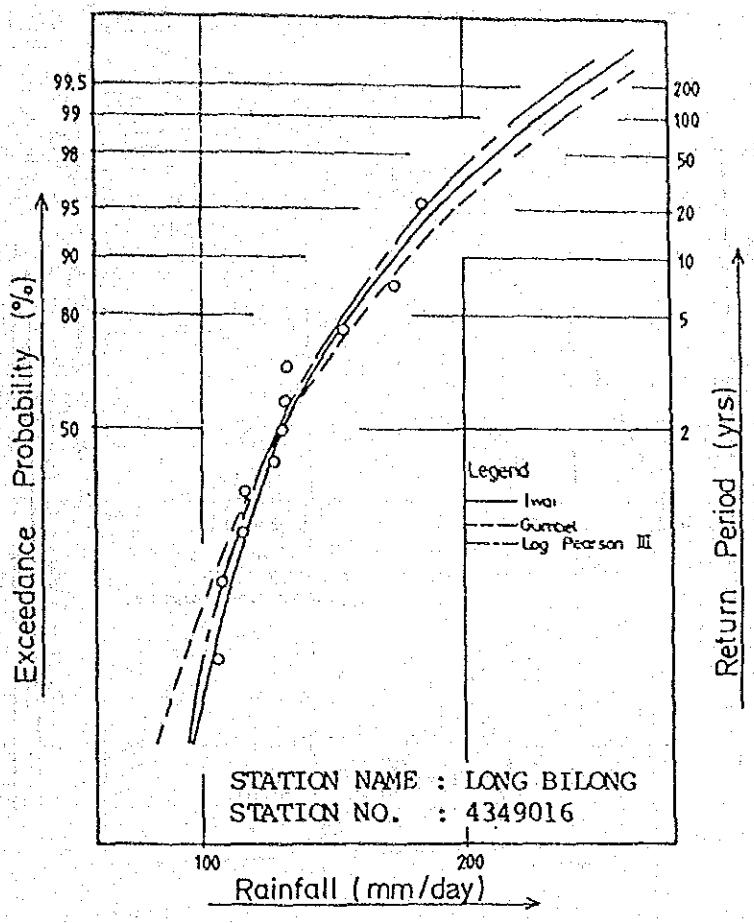


図9.3　確率計算（1／4）

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



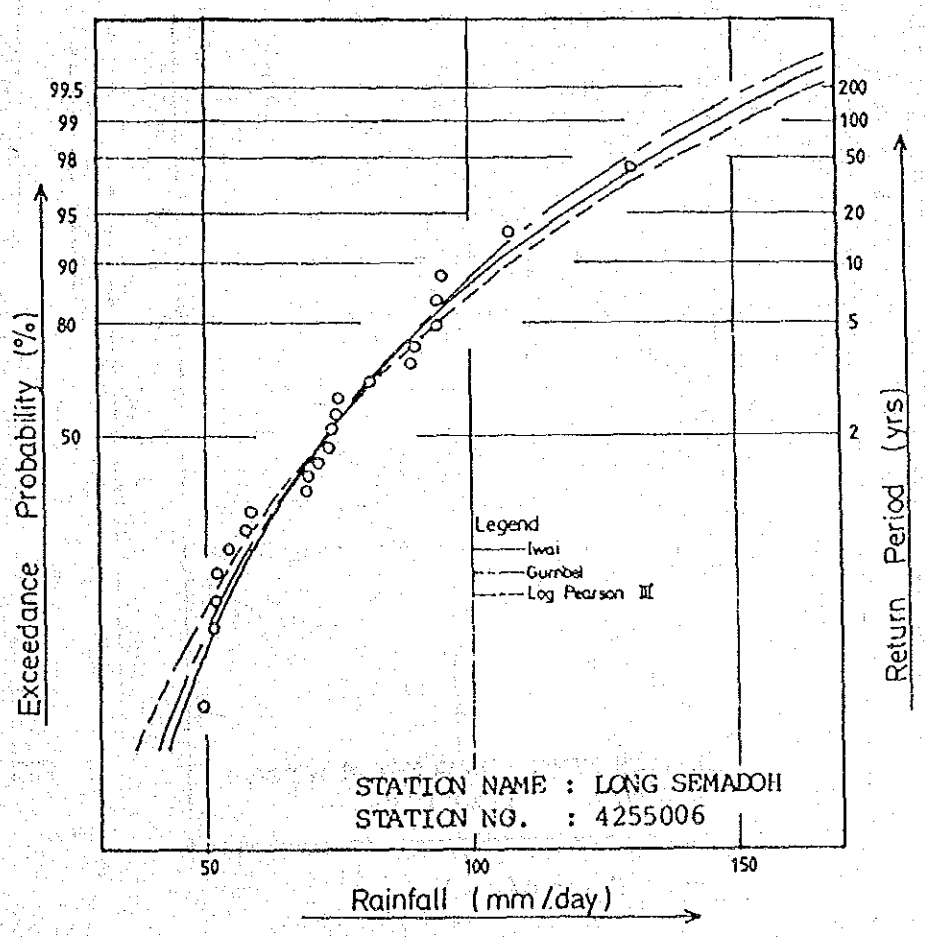
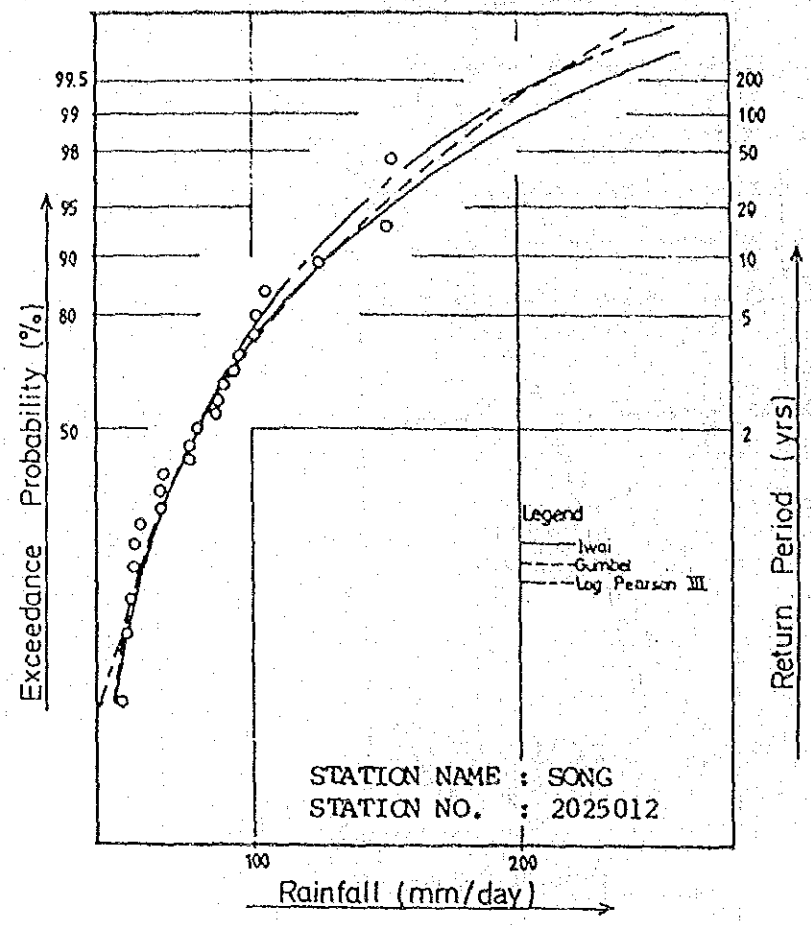


図9.4 確率計算（2／4）

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



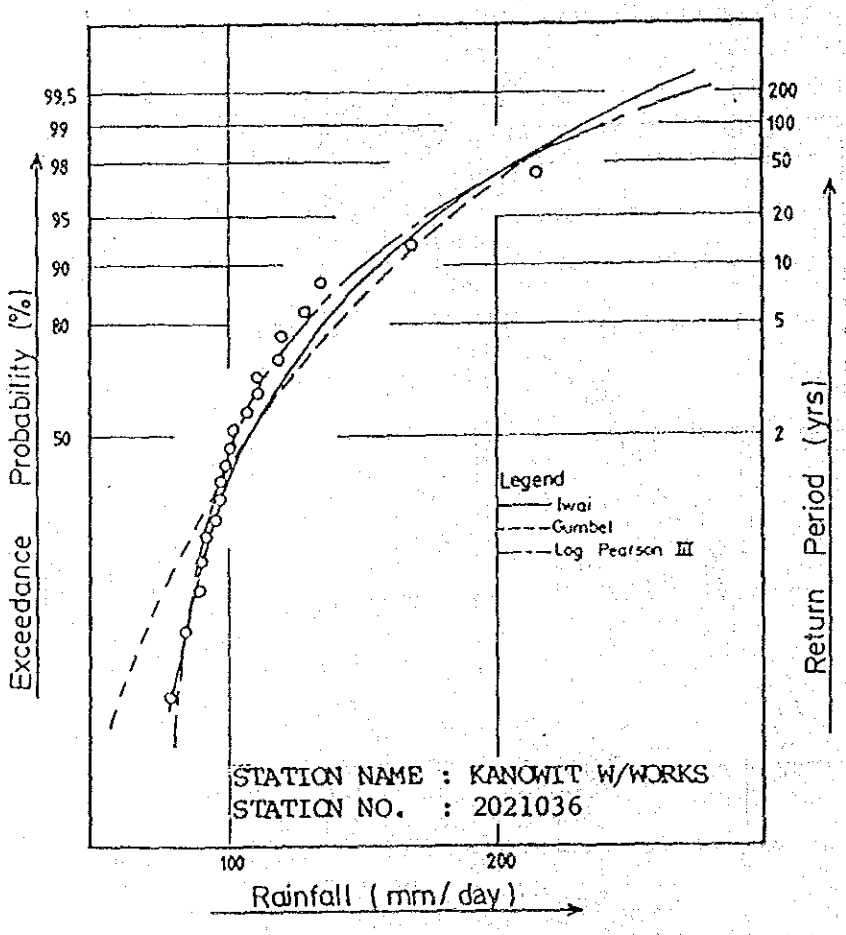


図9.5　確率計算（3／4）

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

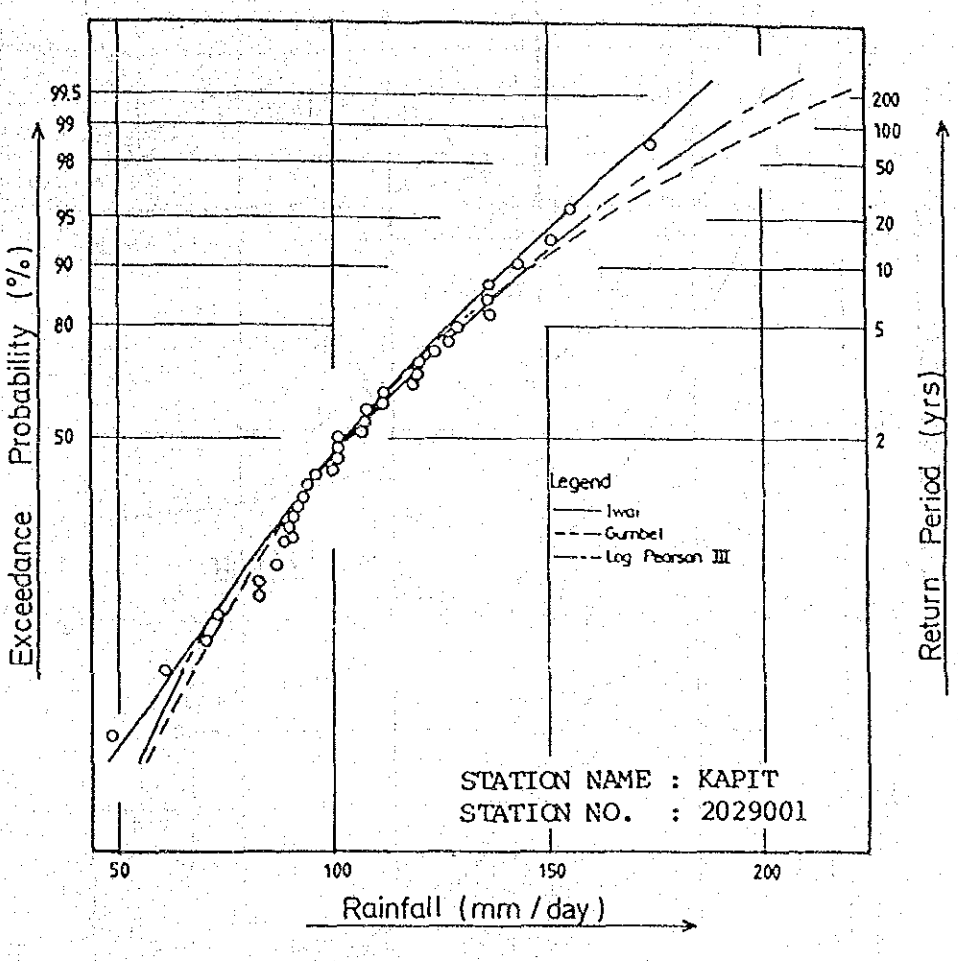


図9.6　確率計算（4／4）

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

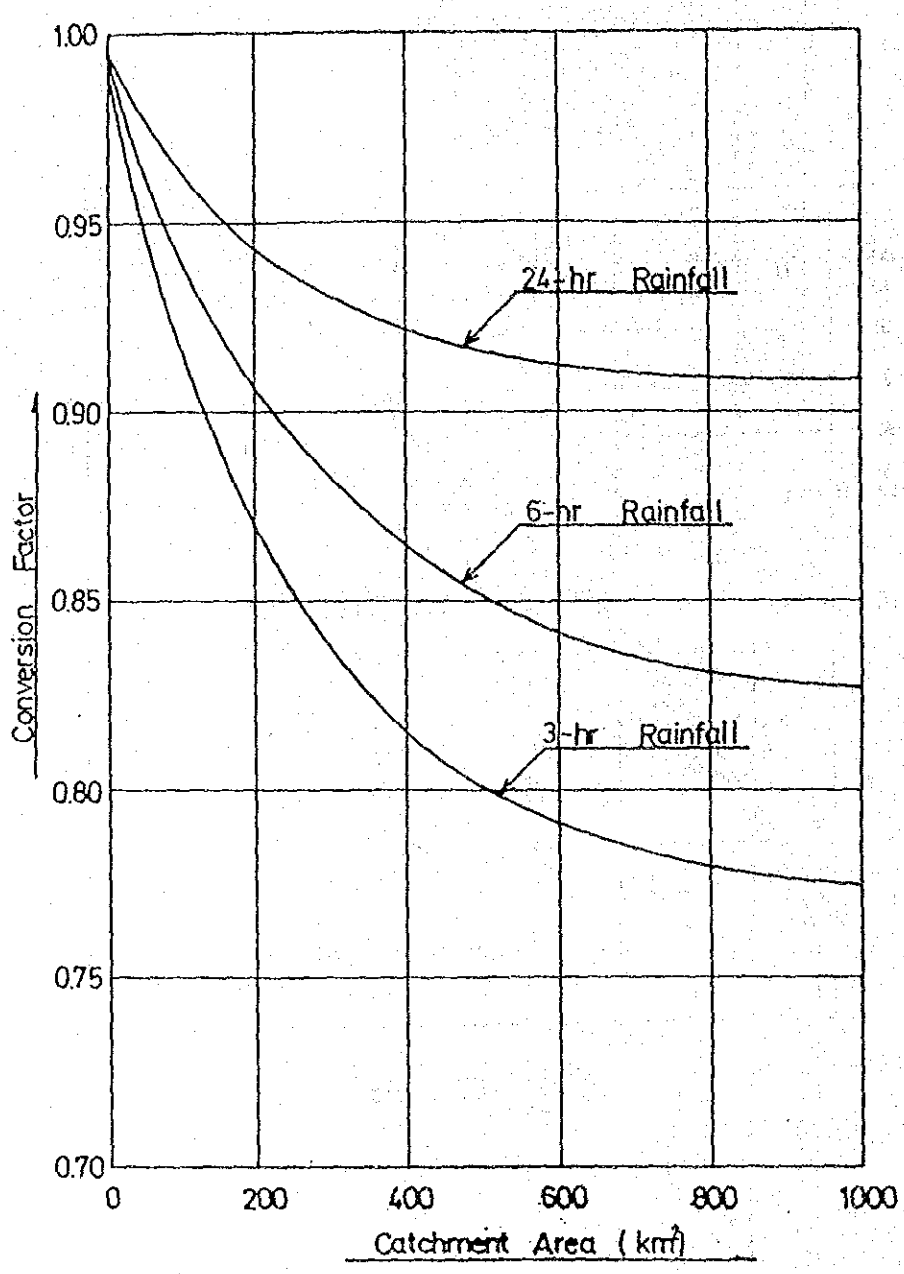
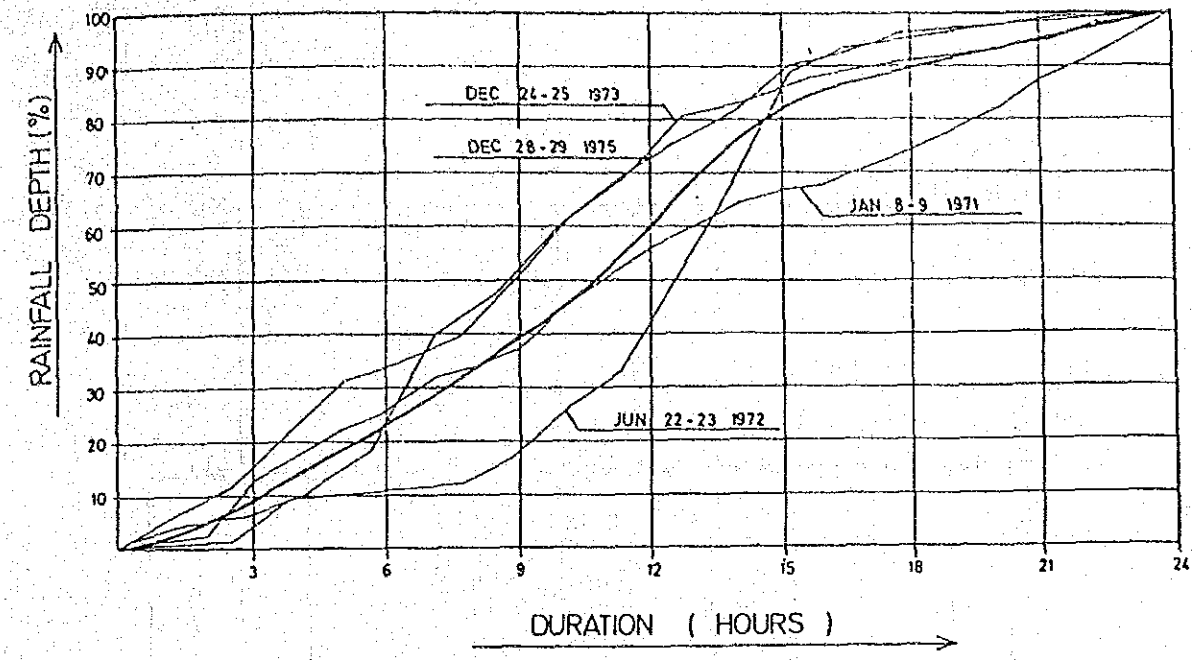


図 9. 7　　変　換　係　数

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



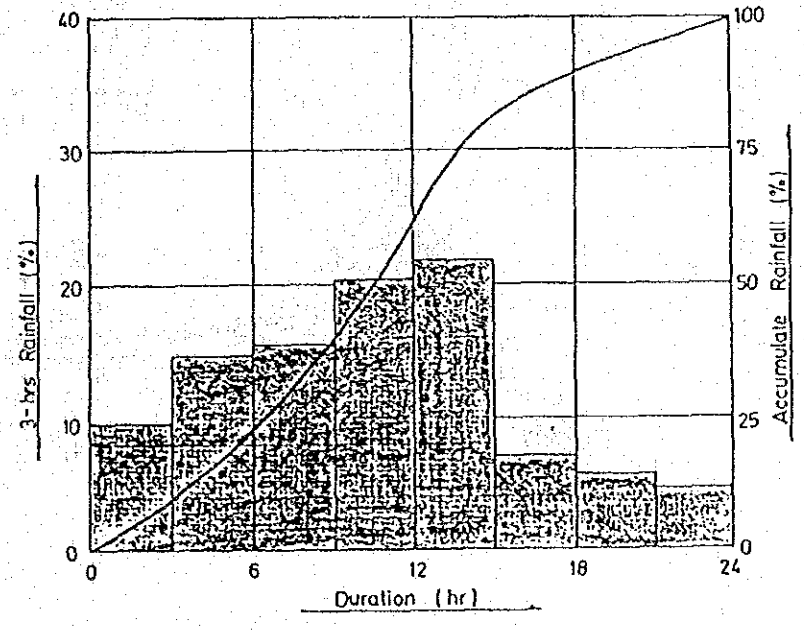
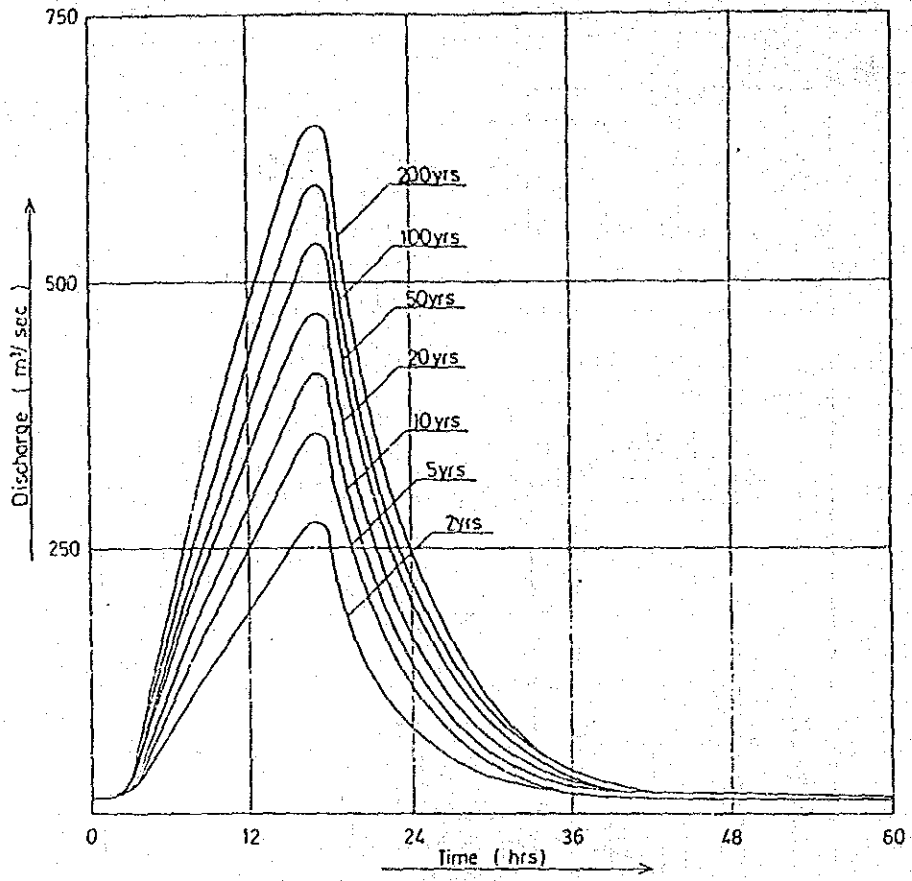


図9.8　深度・期間解析

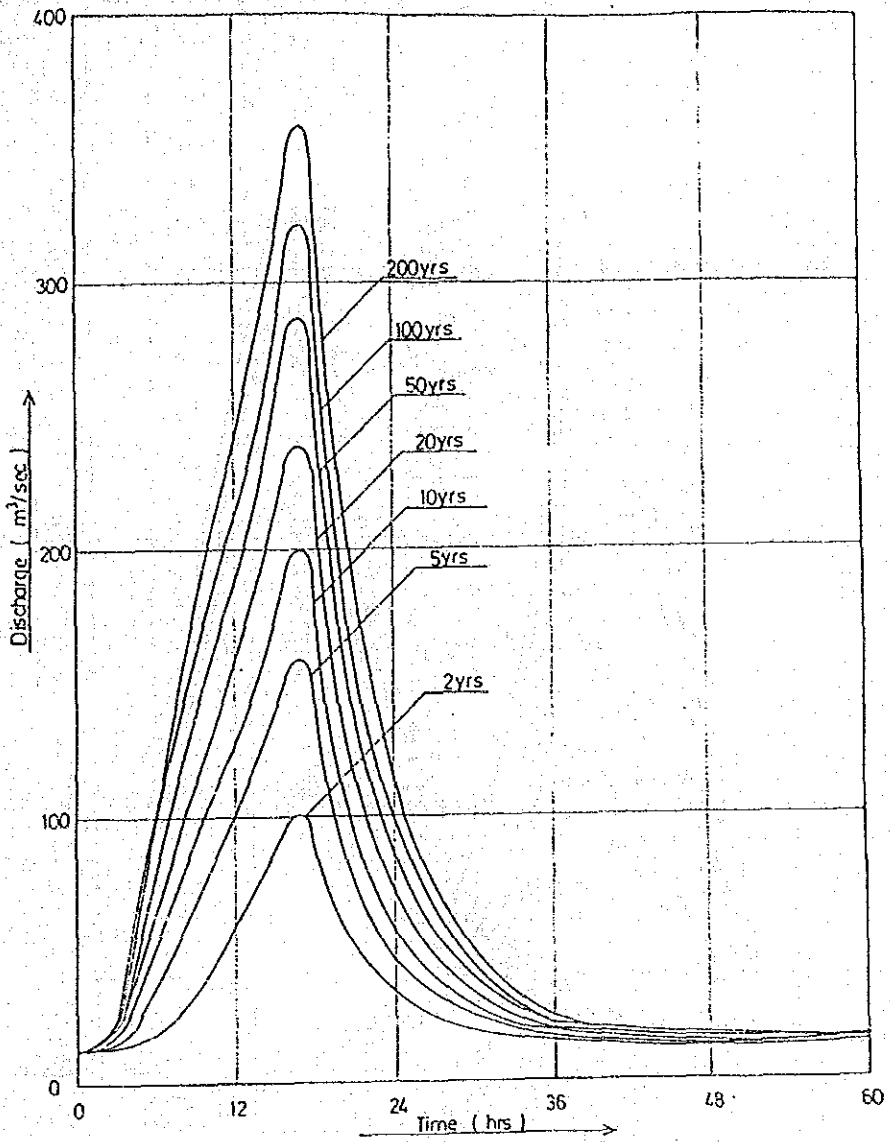
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



FLOOD HYDROGRAPH FOR MEDAMIT - 2

図 9. 9　　ムダミット－２の洪水波形

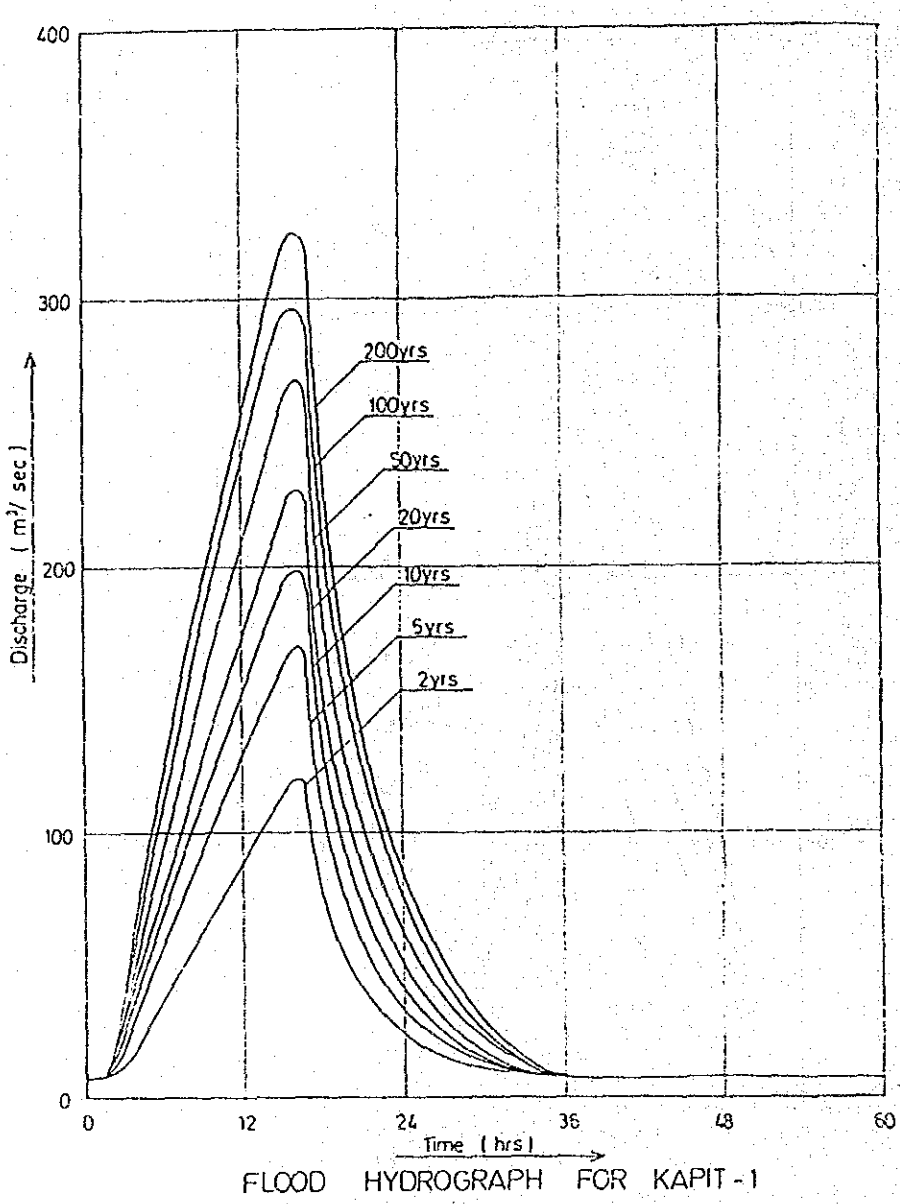
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



FLOOD HYDROGRAPH FOR PASIA

図 9.10　パ シ ア の 洪 水 波 形

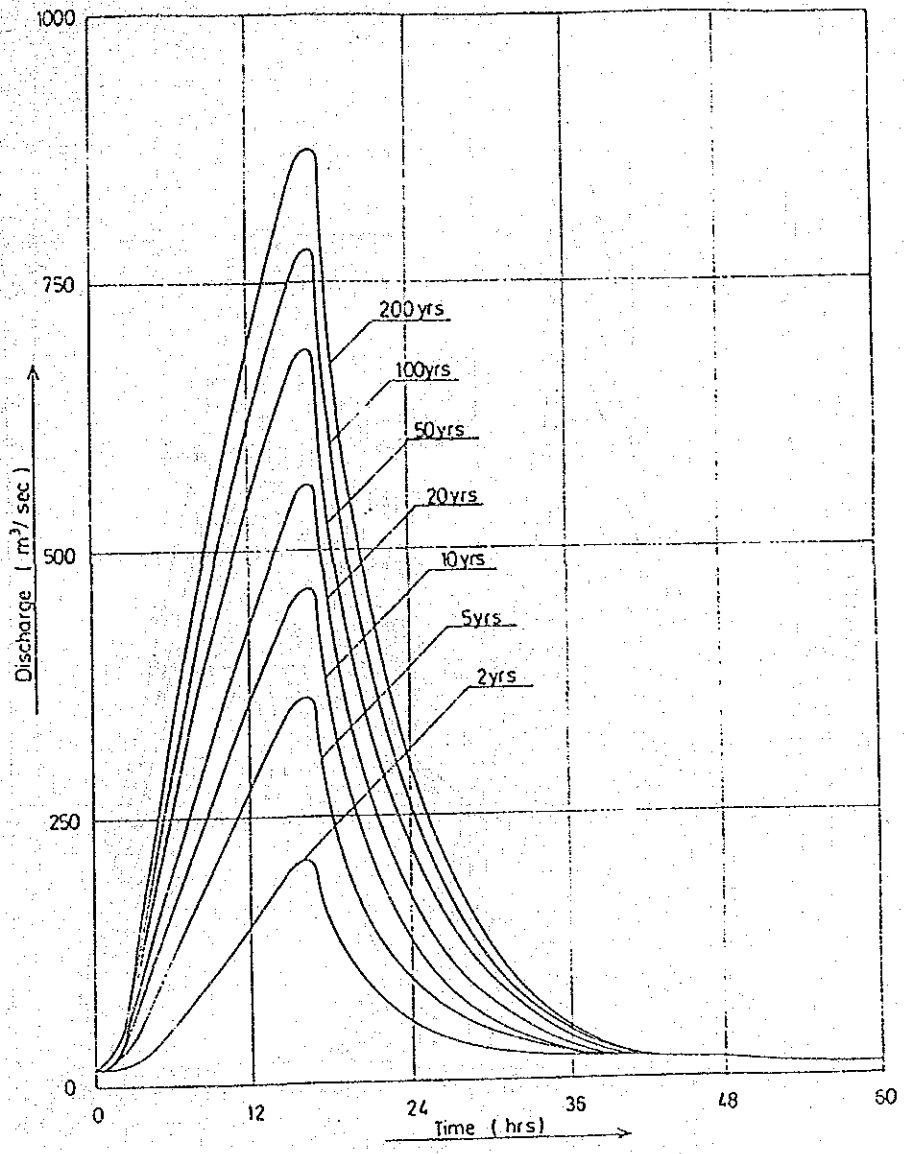
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



FLOOD HYDROGRAPH FOR KAPIT - 1

図 9.11　カピット－1の洪水波形

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



FLOOD HYDROGRAPH FOR KAPIT-2

図 9.12　カピット－２の洪水波形

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

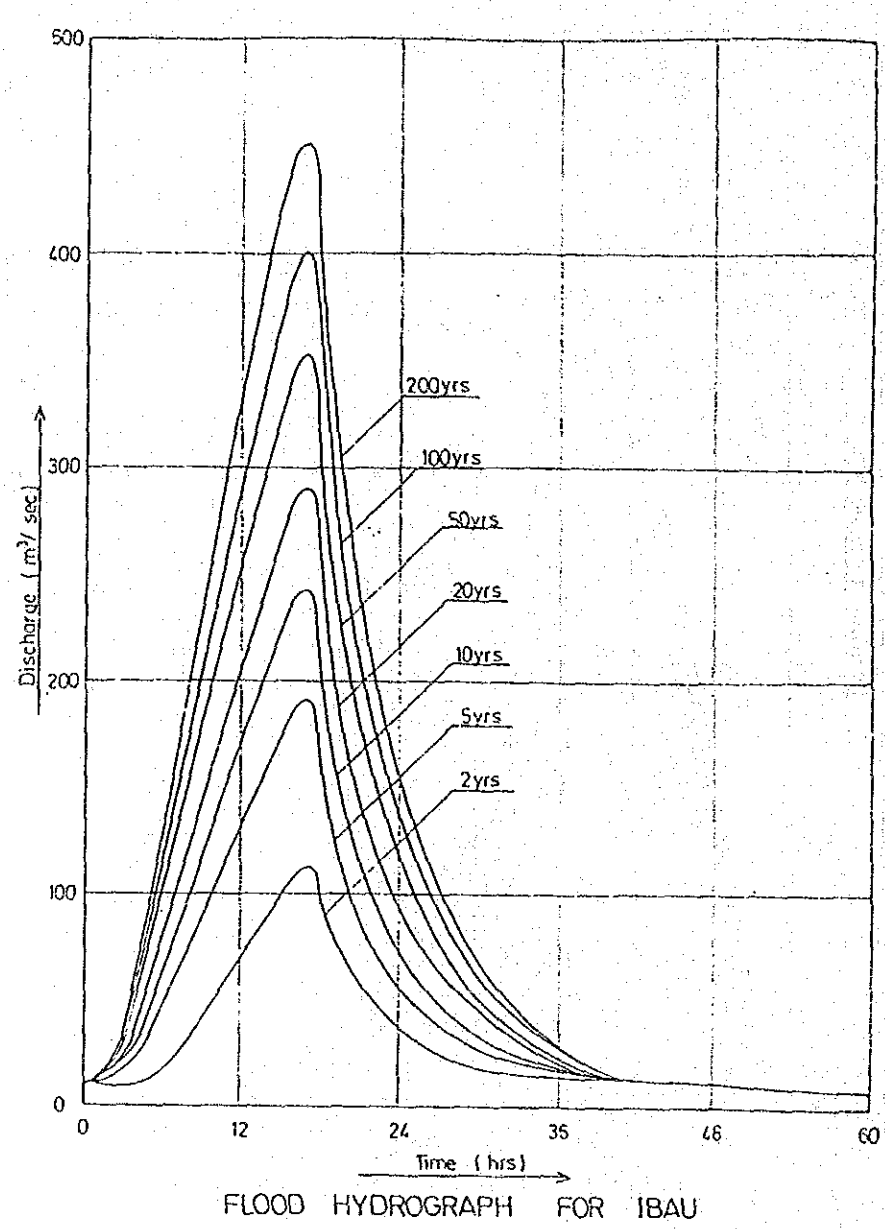
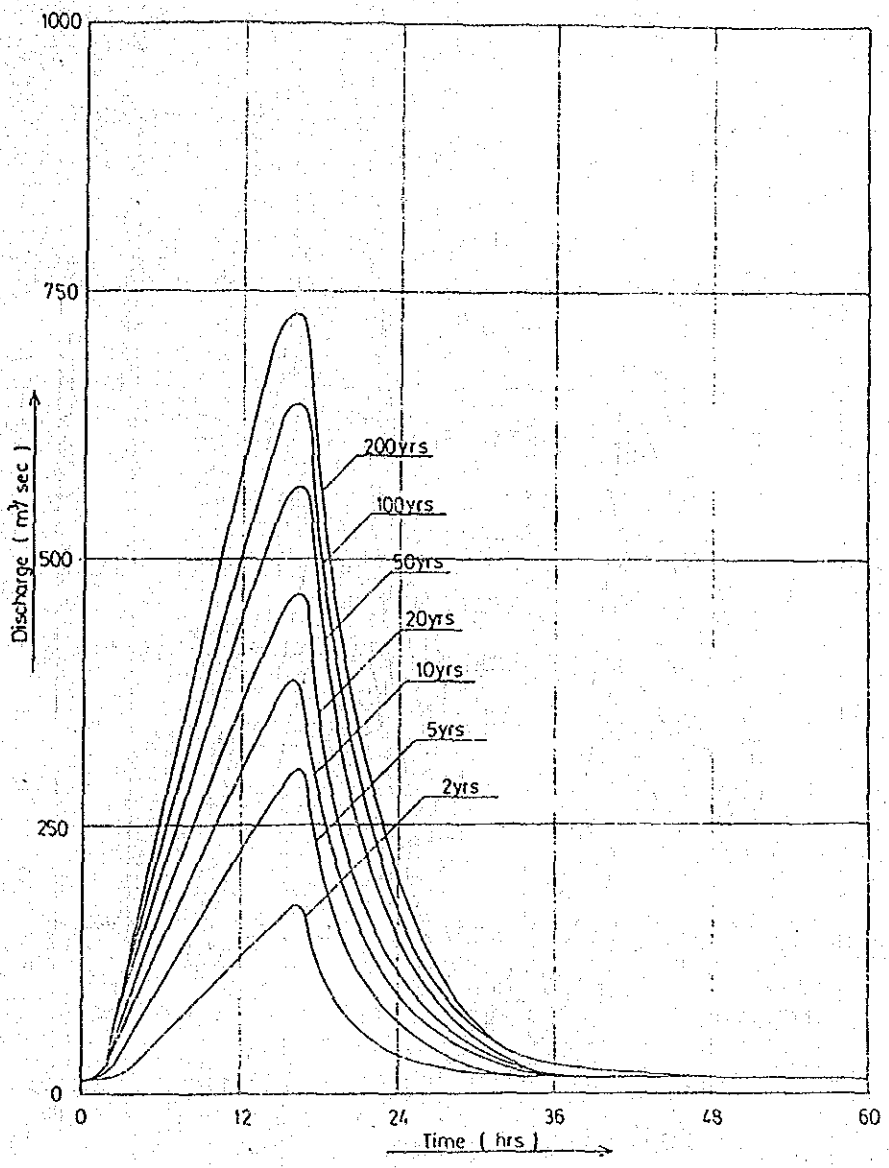


図 9.13　イバウの洪水波形

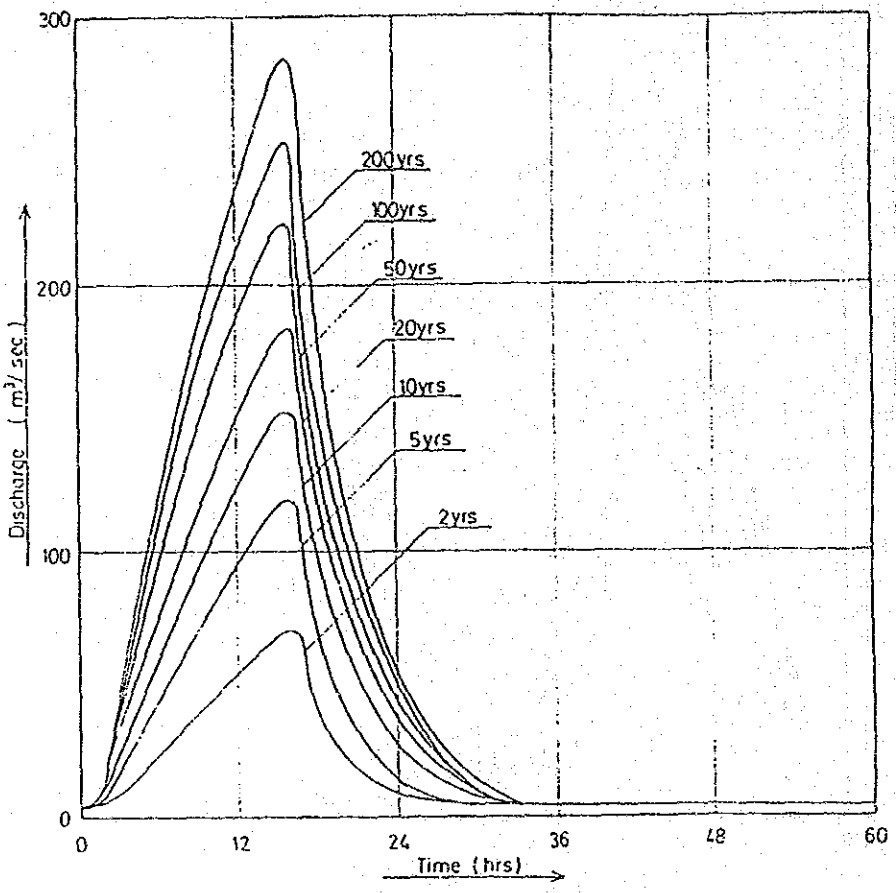
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



FLOOD HYDROGRAPH FOR BANGKIT

図 9.14　バンキットの洪水波形

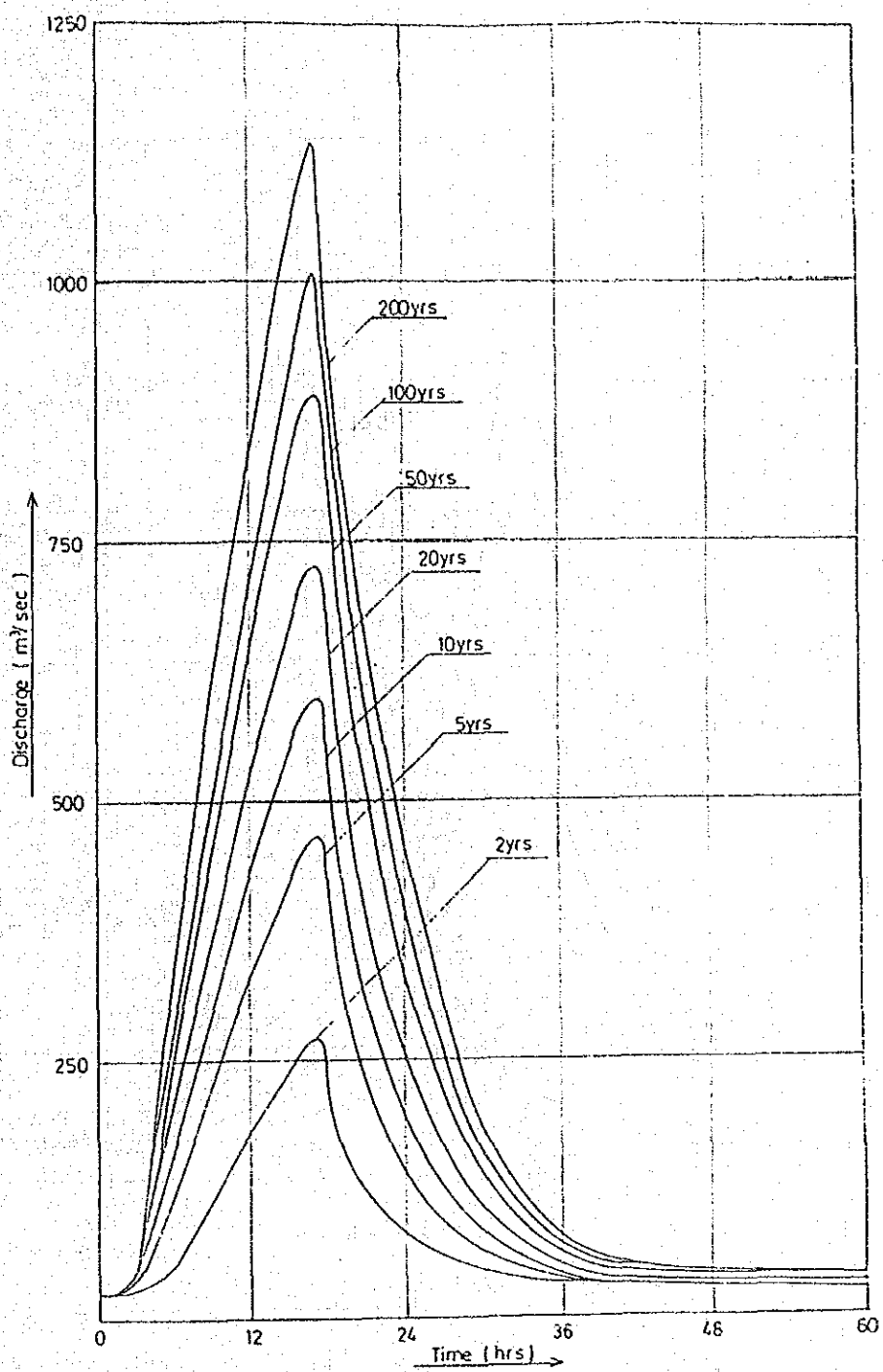
GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



FLOOD HYDROGRAPH FOR AYAT

図 9.15　アヤットの洪水波形

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



FLOOD HYDROGRAPH FOR MUKOH

図 9.16　ム コ の 洪 水 波 形

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY