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WATER MASTER PLANS FOR IRINGA, RUVUMA AND MBEYA REGIONS

HYDROLOGIC DATA
VOLUME 8

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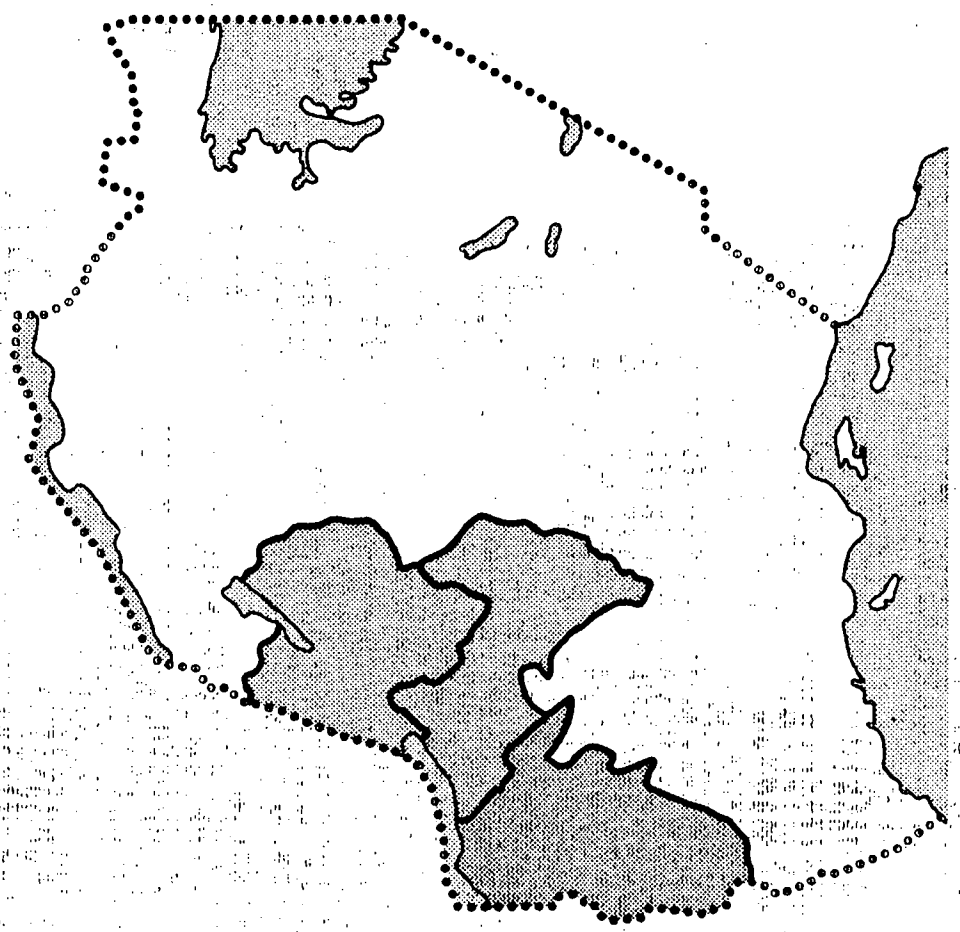

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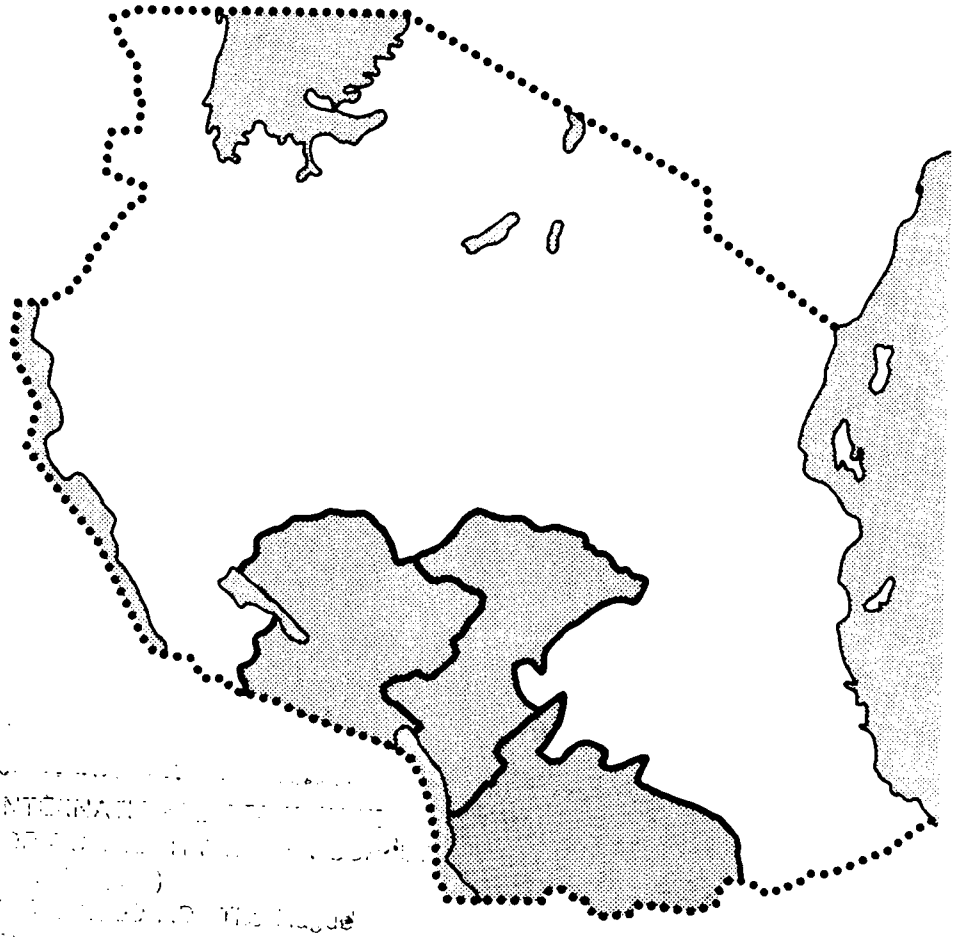

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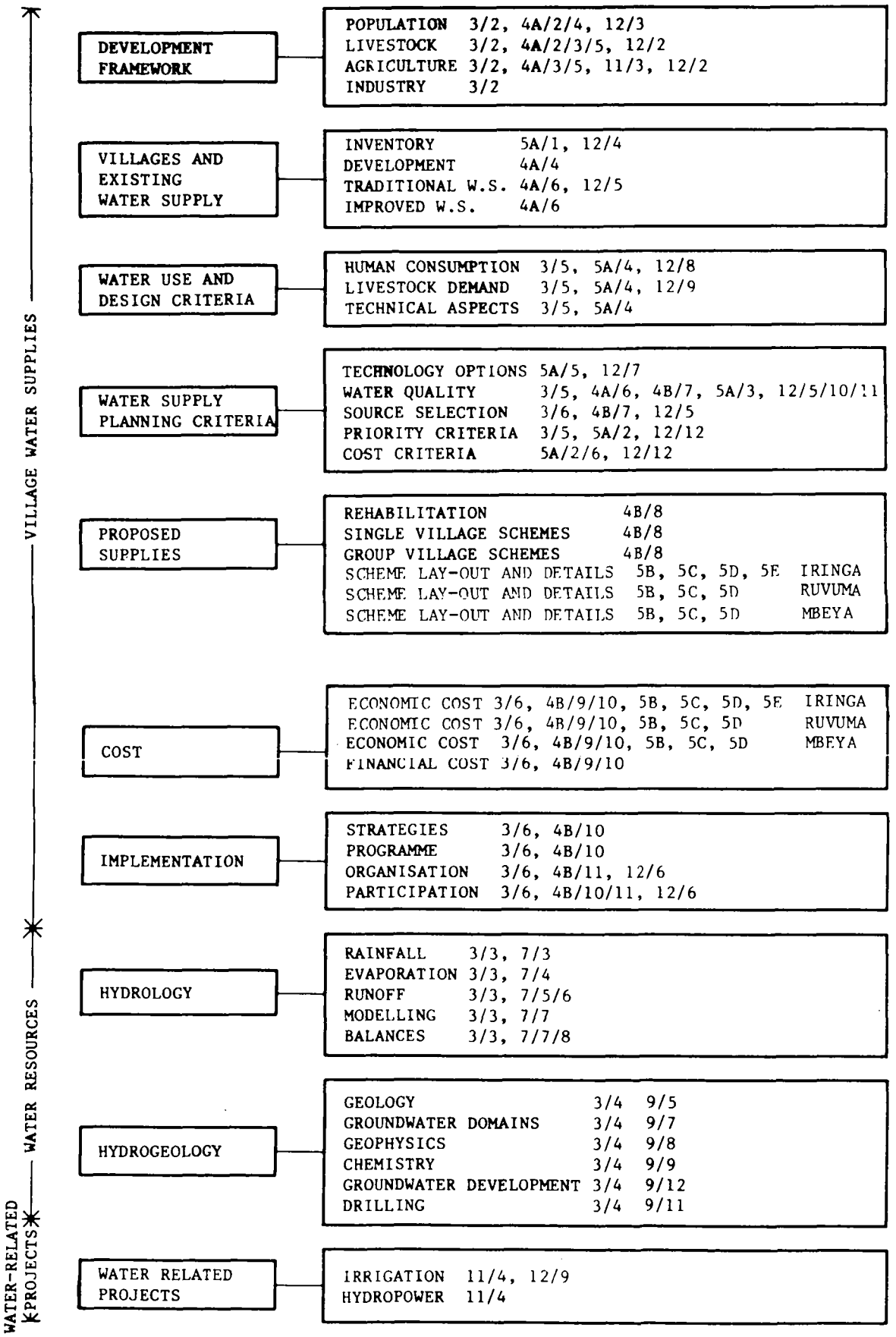
GUIDE TO WATER MASTER PLANS FOR IRINGA, RUVUMA AND MBEYA



NOTES

THE CHAPTERS REFERRED TO ARE THOSE WHERE THE MAIN DESCRIPTIONS APPEAR.

THE REFERENCE CODE 5A/6 MEANS, VOLUME 5A, CHAPTER 6.

CONTENT - HYDROLOGIC DATA

Appendix 1
Refers to Volume 7, Chapter 3.

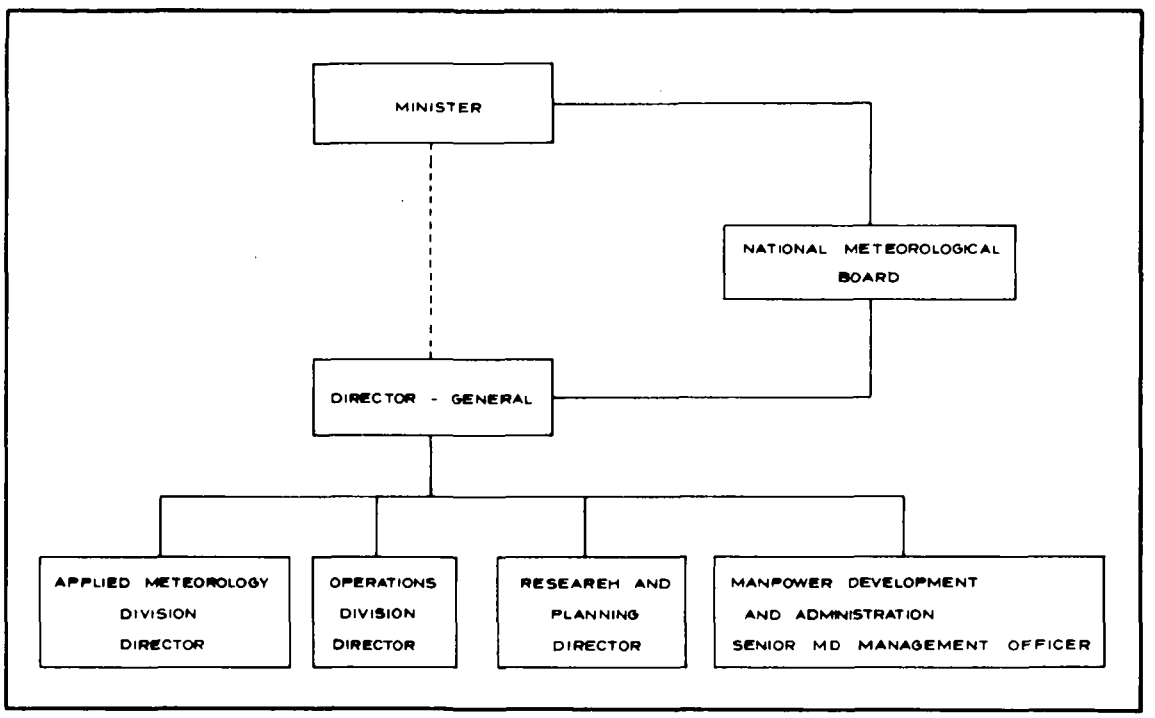


Figure 3.2[8] - Directorate of meteorology - DOM - organisation.

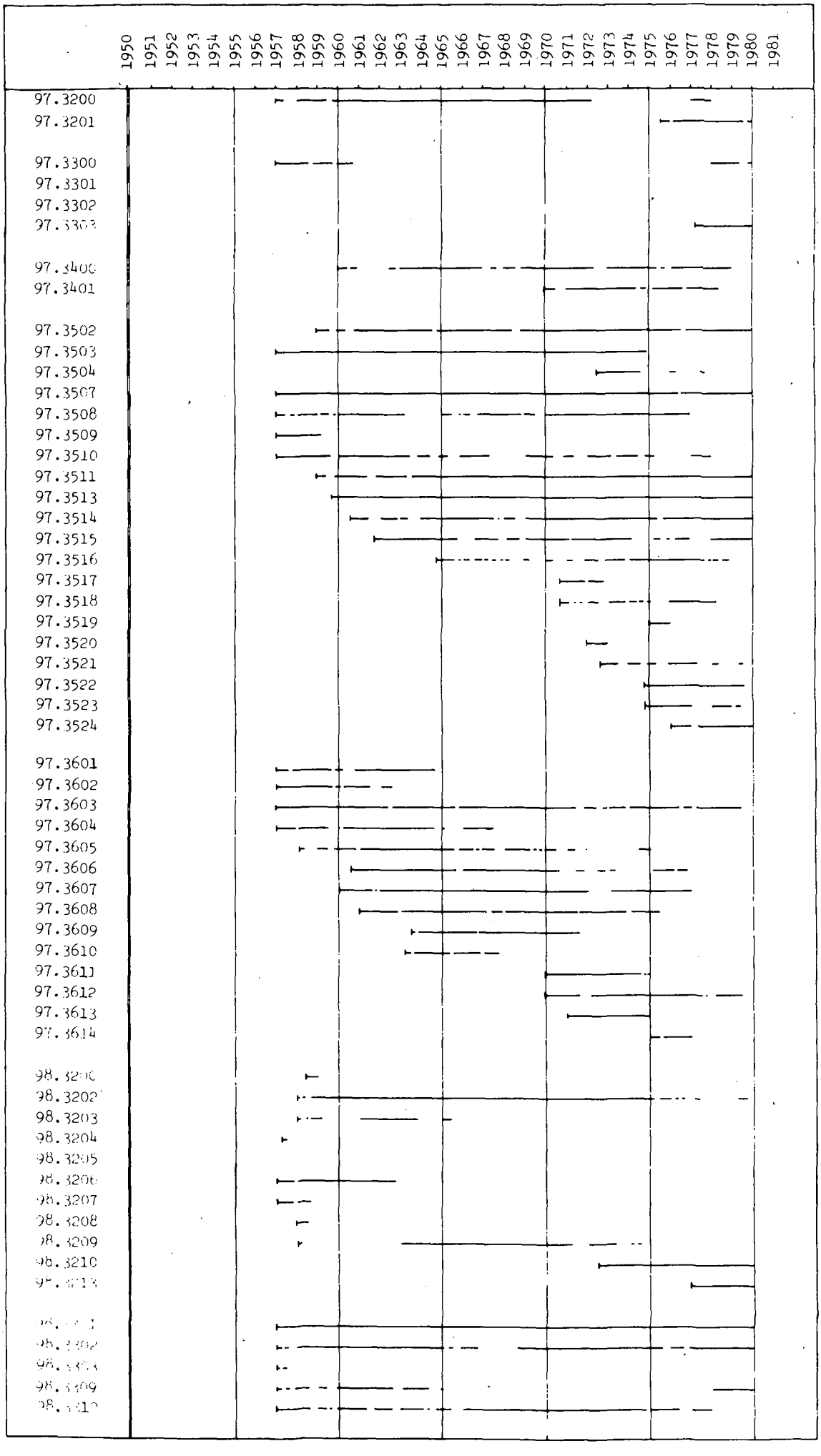


Figure 3.10[8] - Rainfall station barchart.

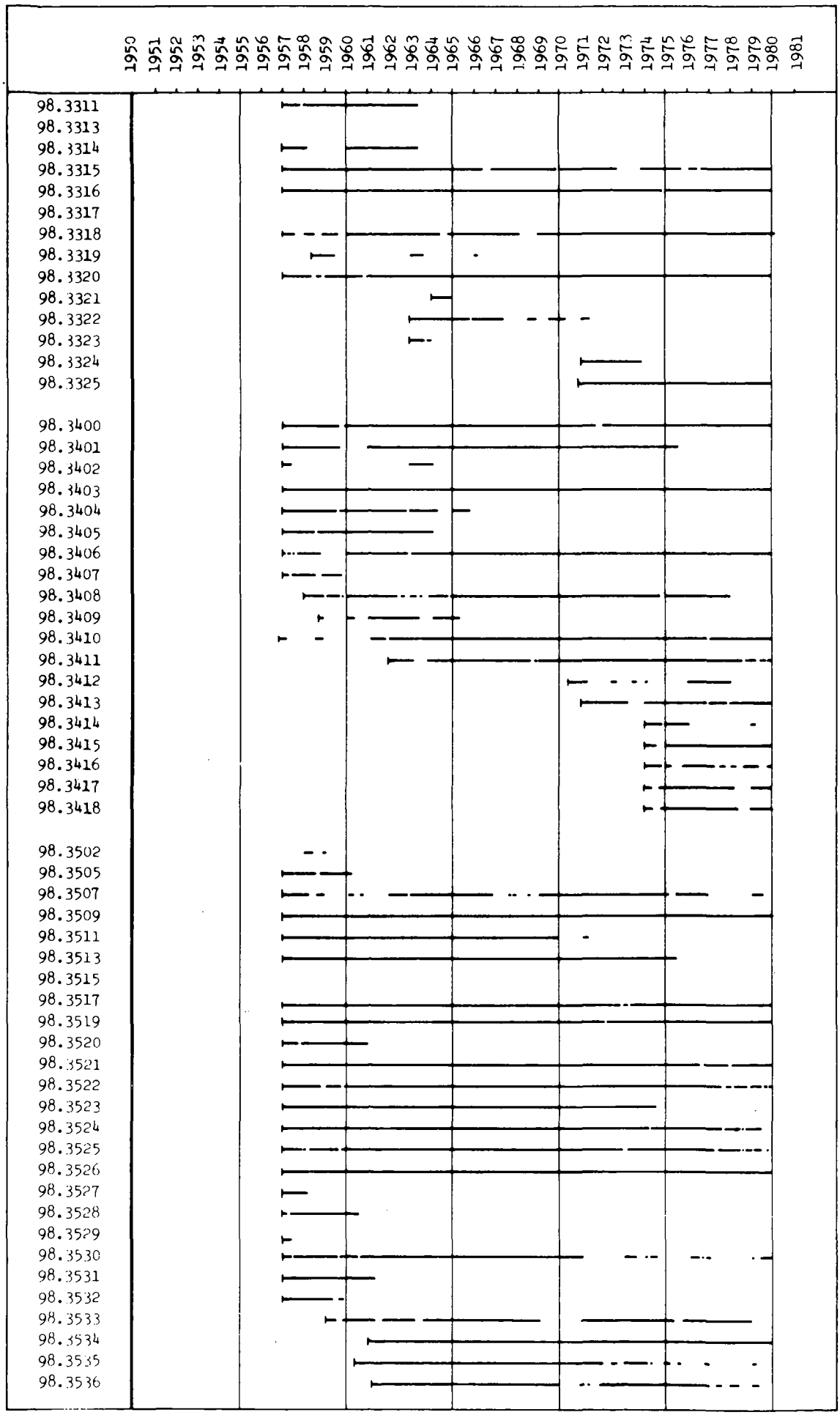


Figure 3.10[8] - Rainfall station barchart, cont'd.

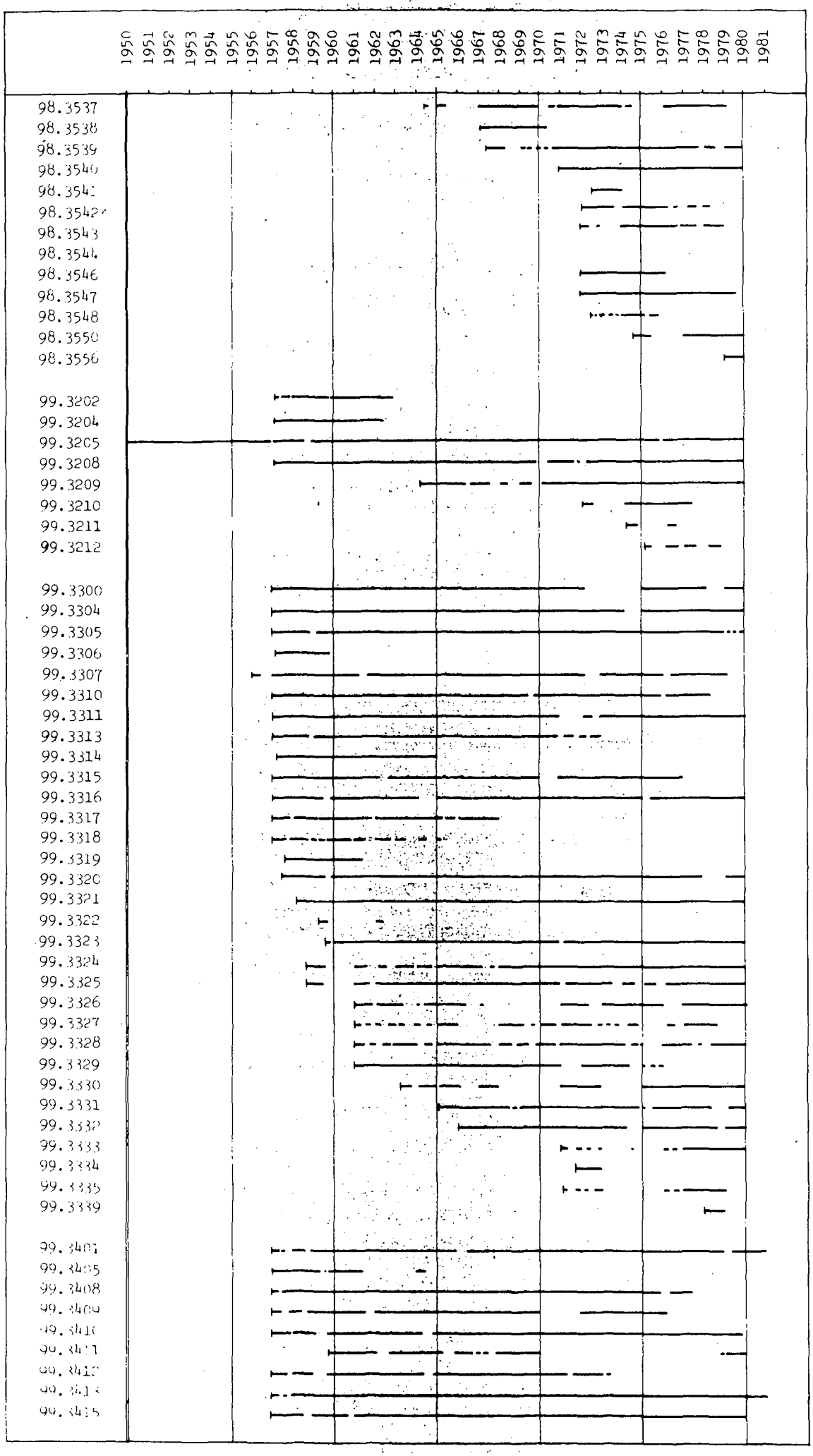


Figure 3.10[8] - Rainfall station barchart, cont'd.

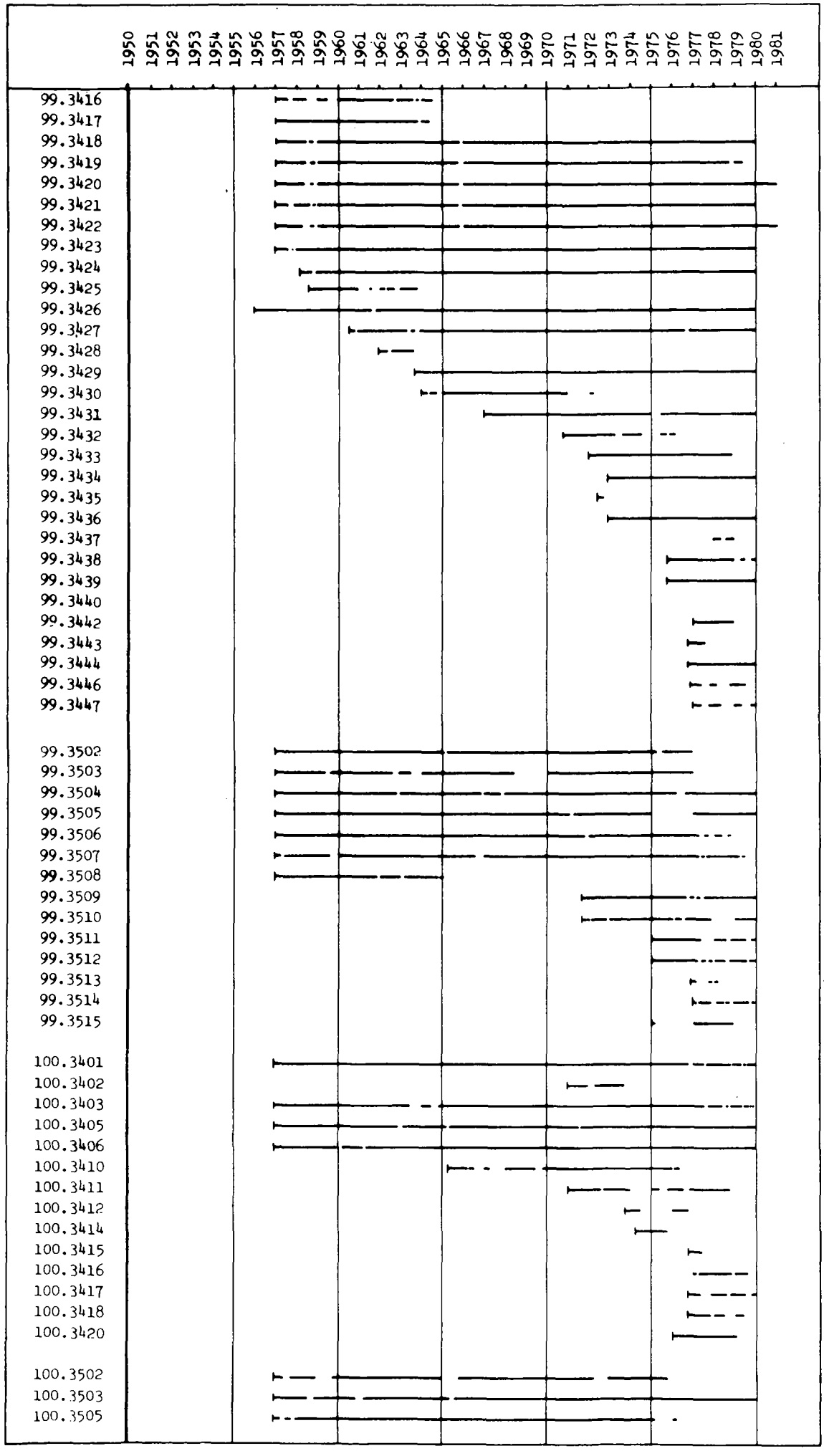


Figure 3.10[8] - Rainfall station barchart, cont'd.

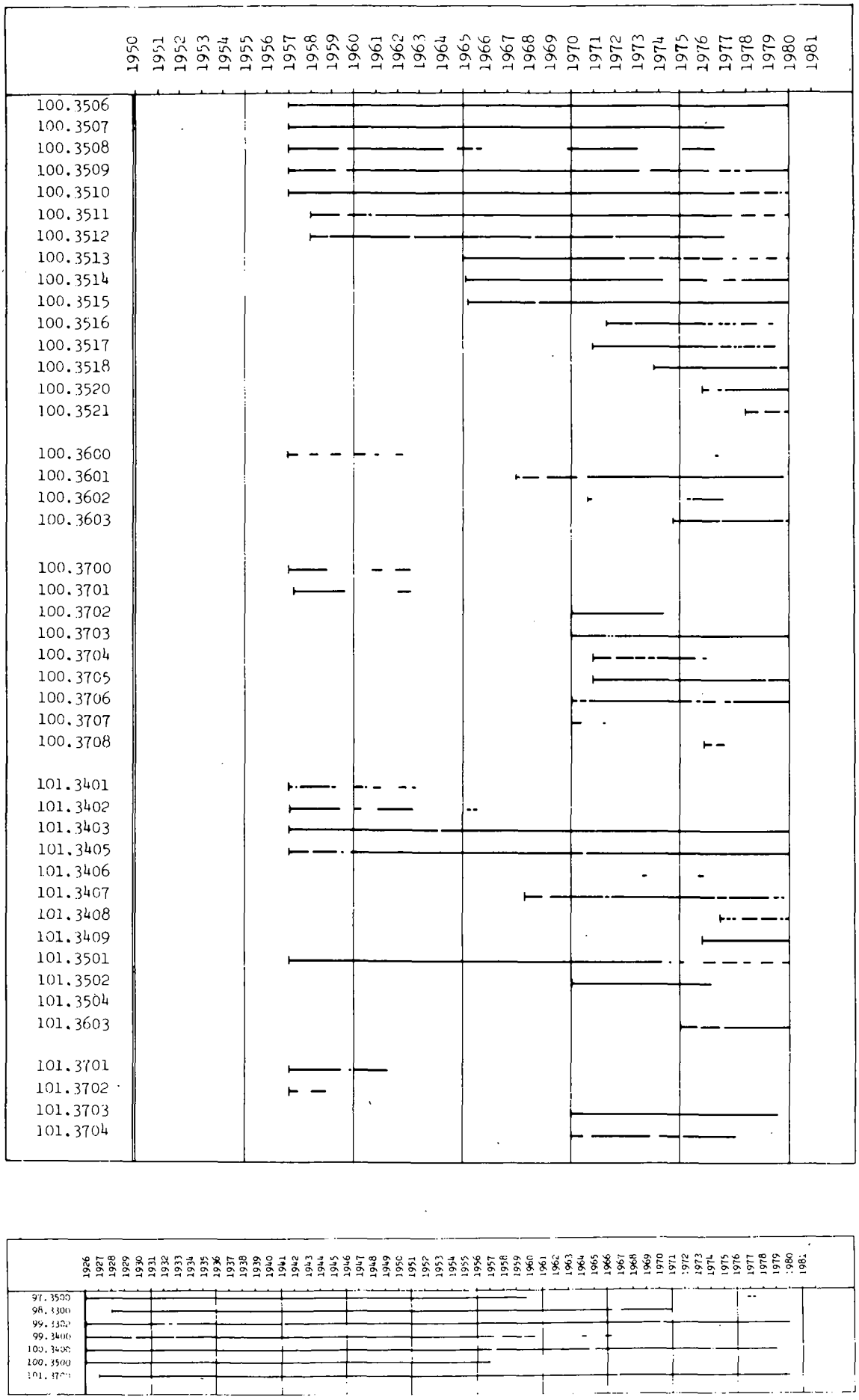
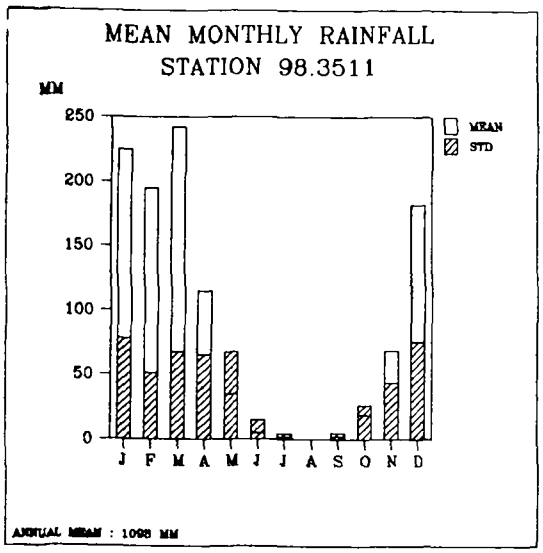
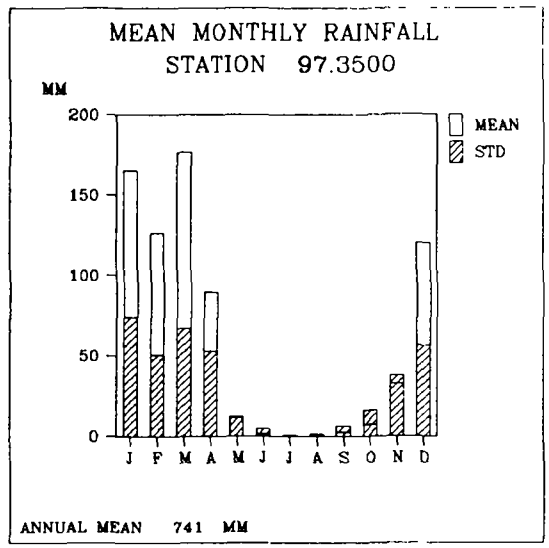
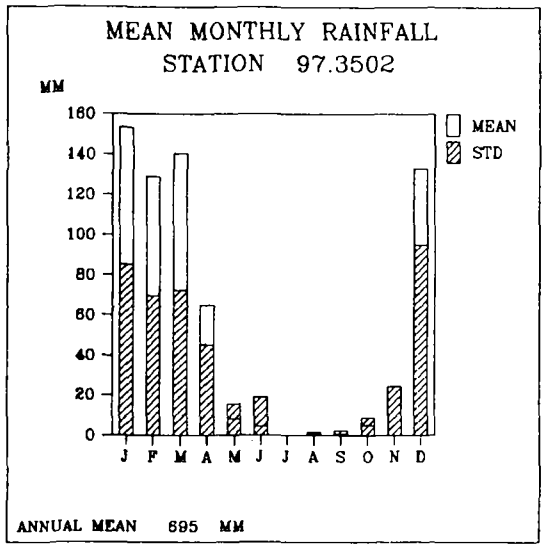
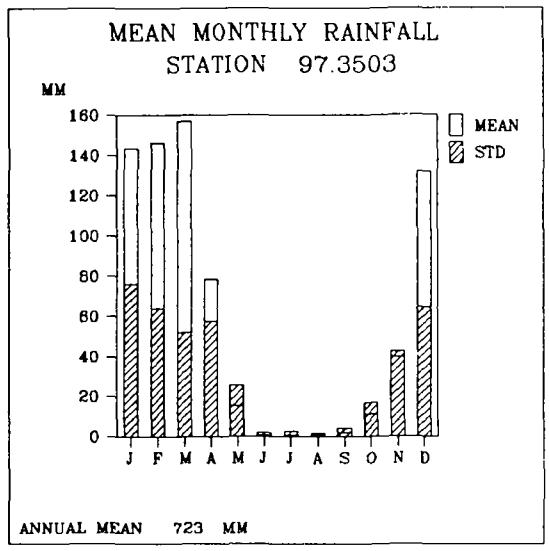


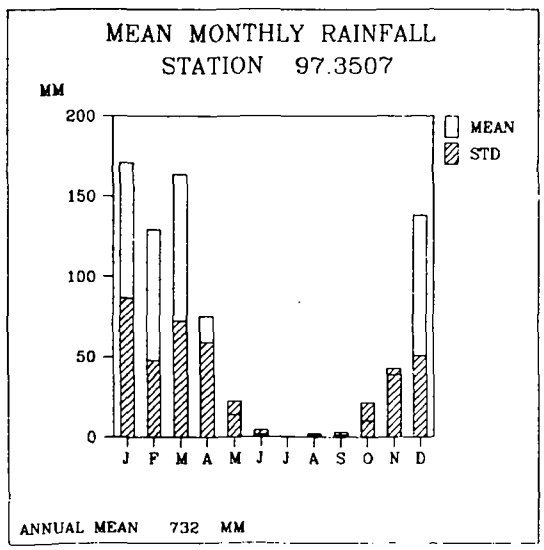
Figure 3.10[8] - Rainfall station barchart, cont'd.











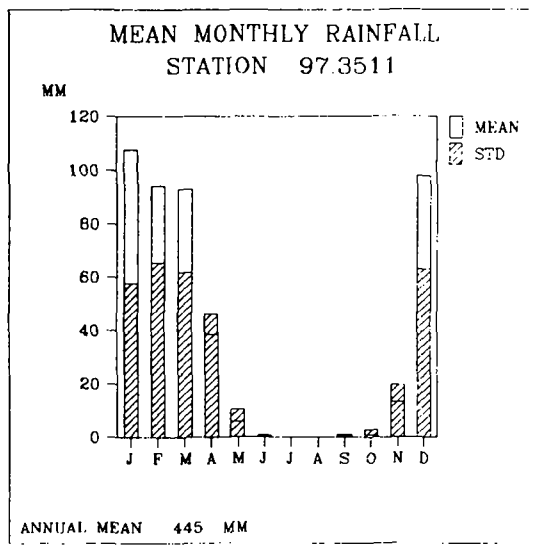
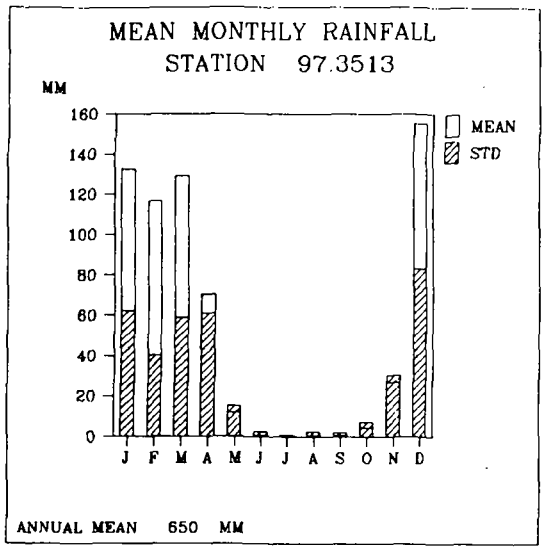
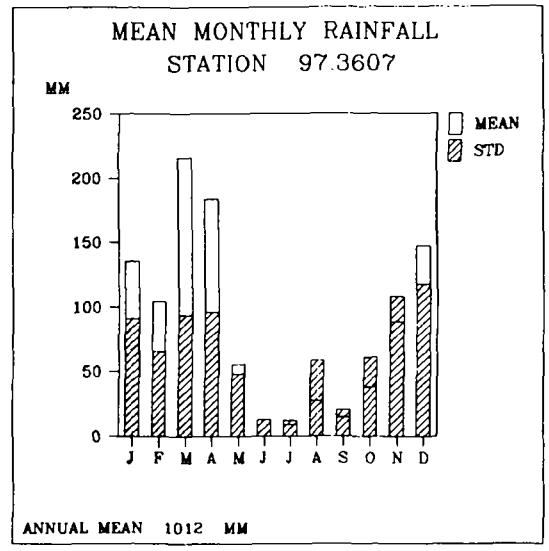
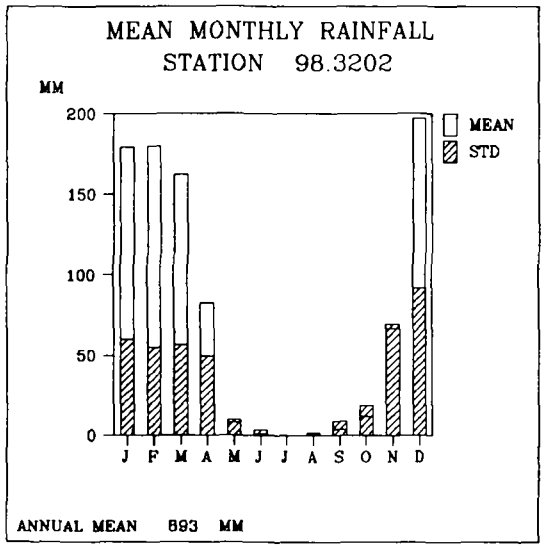
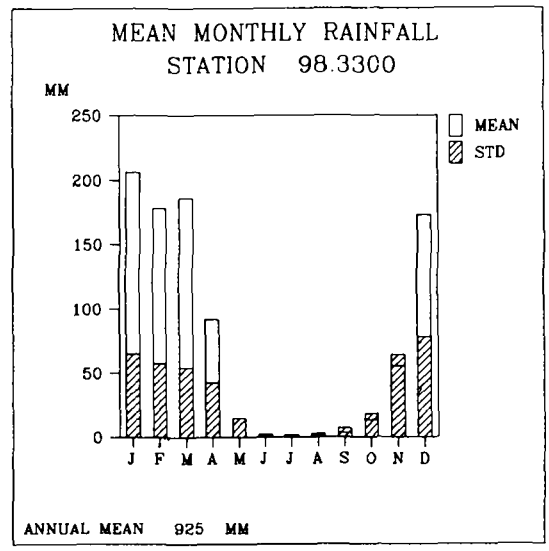


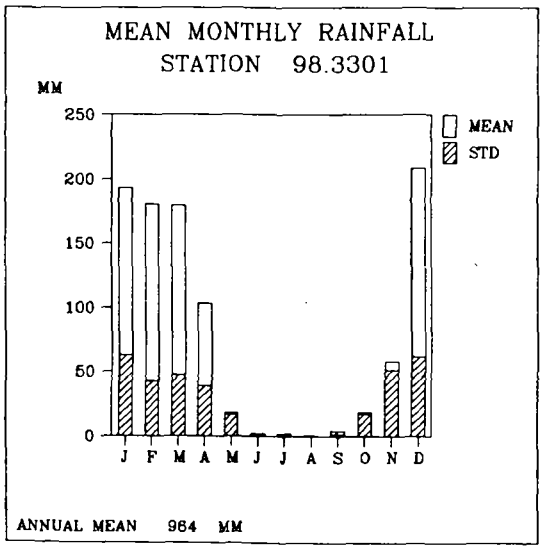
Figure 3.19[8] - Mean monthly rainfall and standard deviation for stations with record length greater than 15 years.











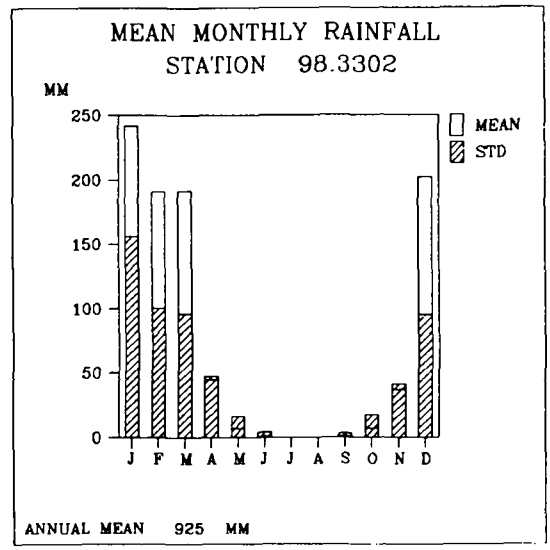
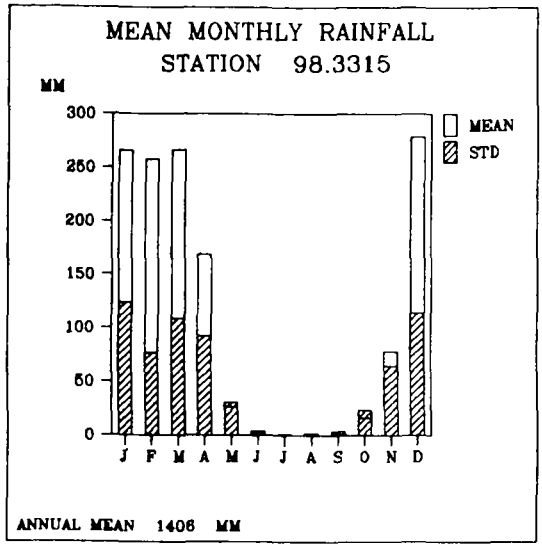
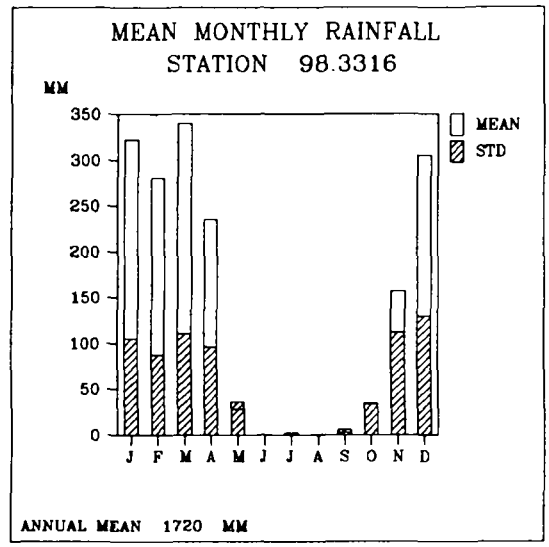
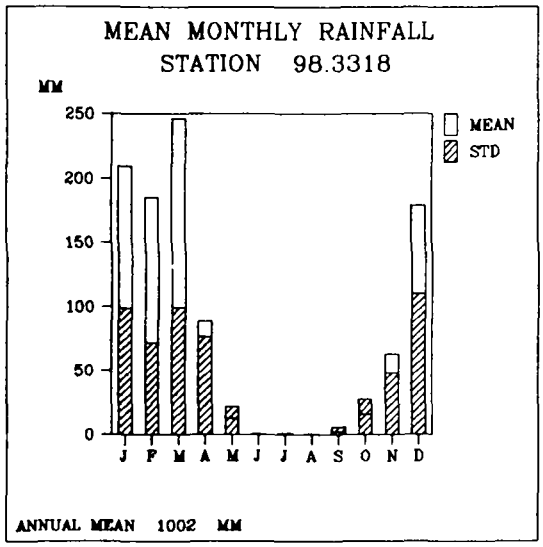
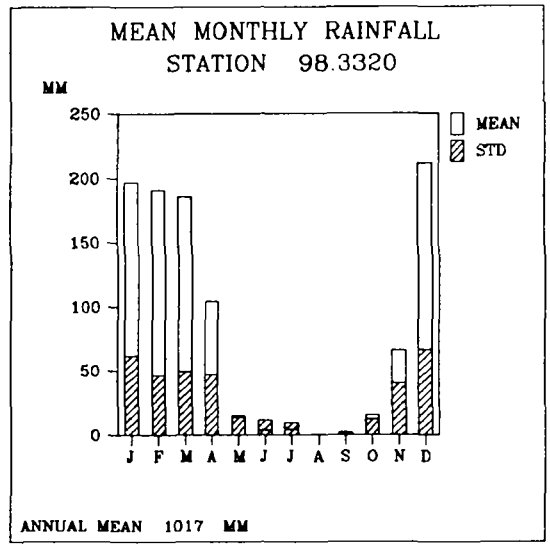


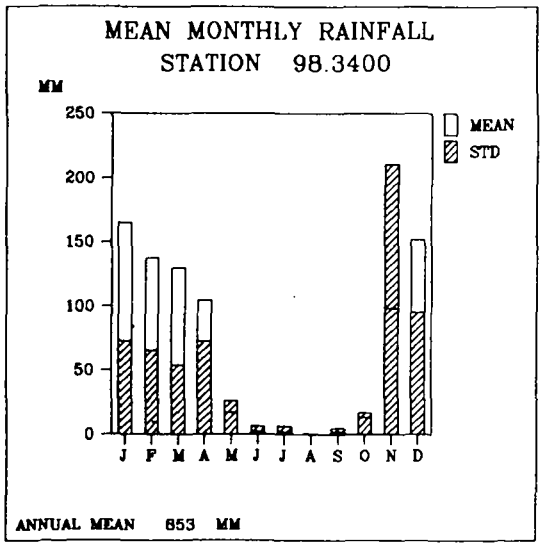
Figure 3.19[8] - Cont'd.

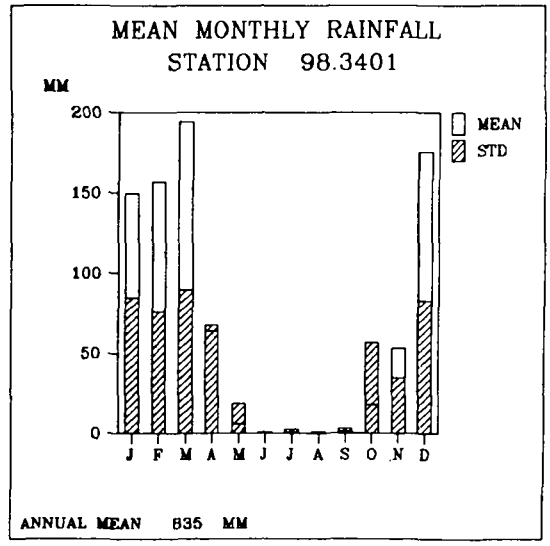












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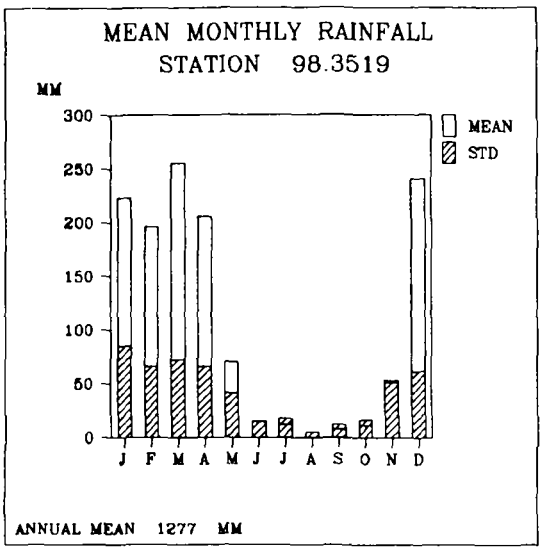

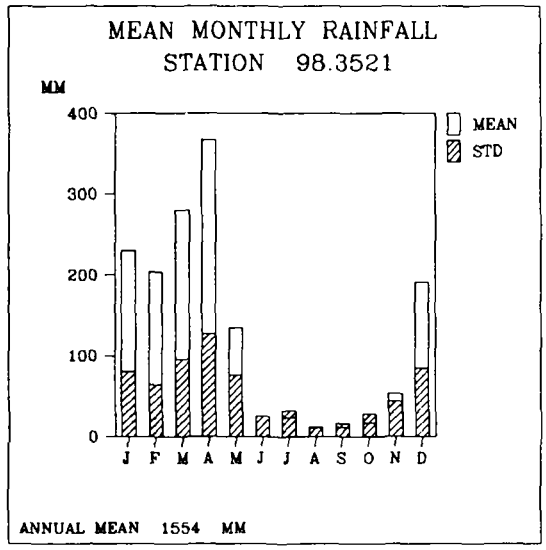

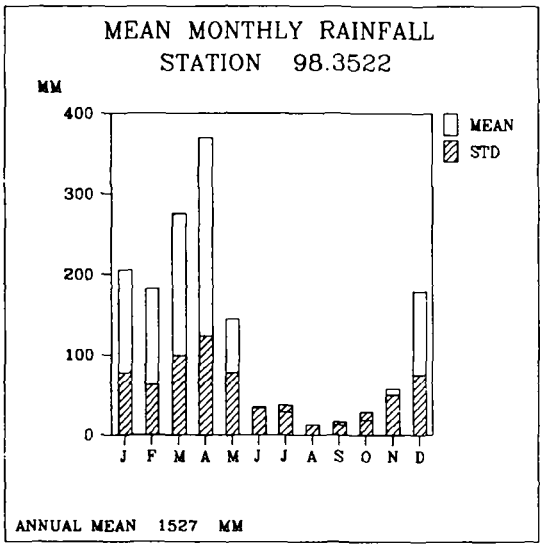

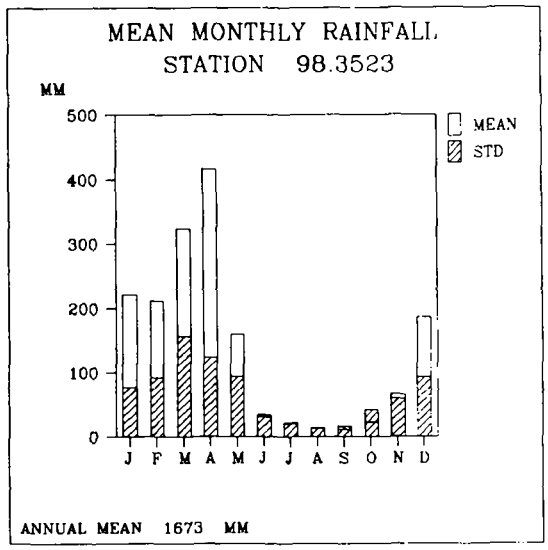

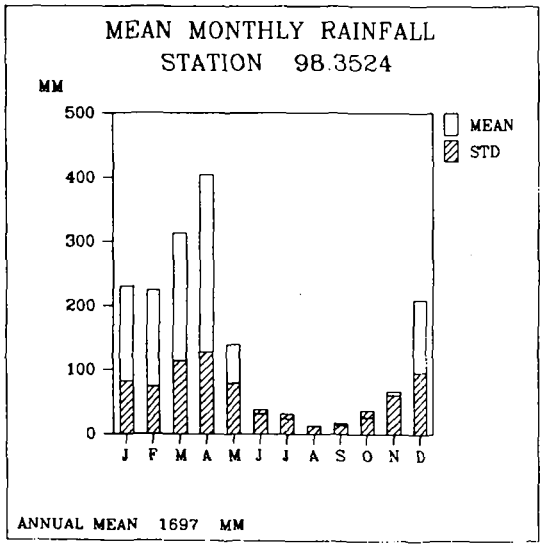

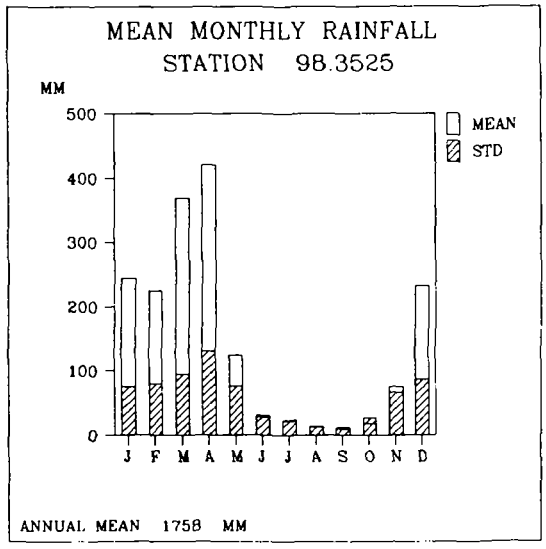

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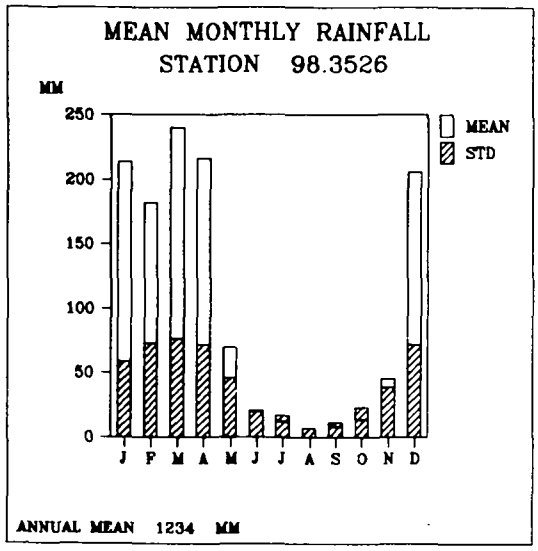

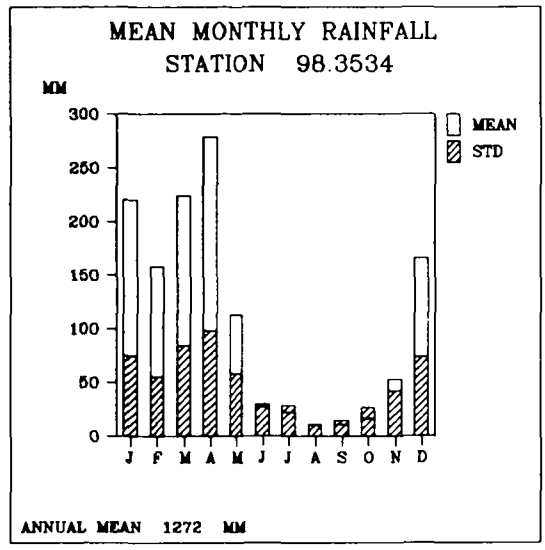

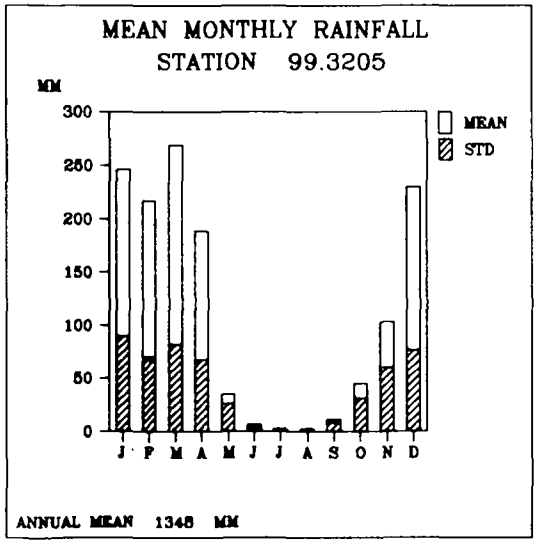

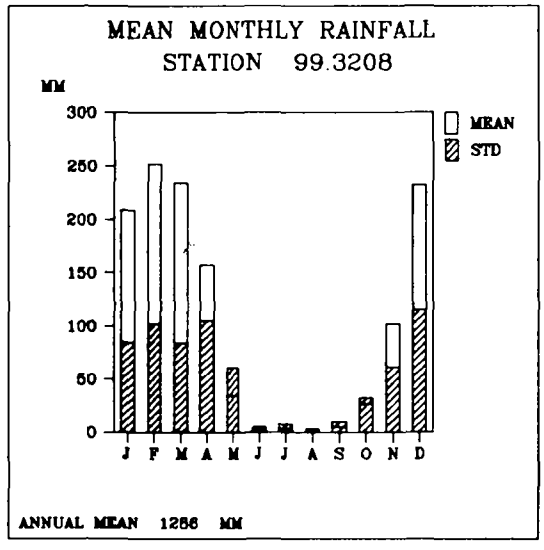

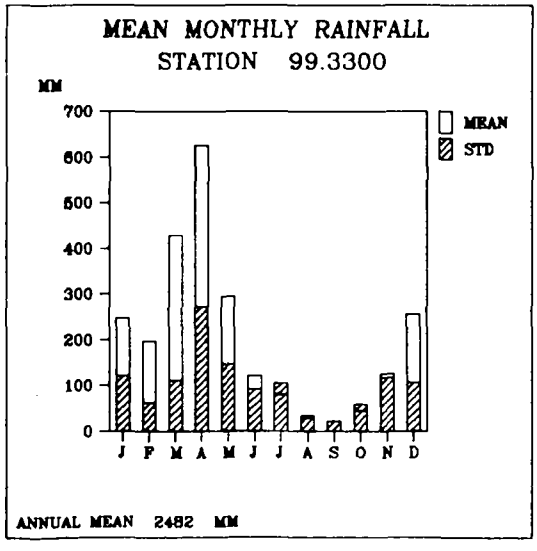

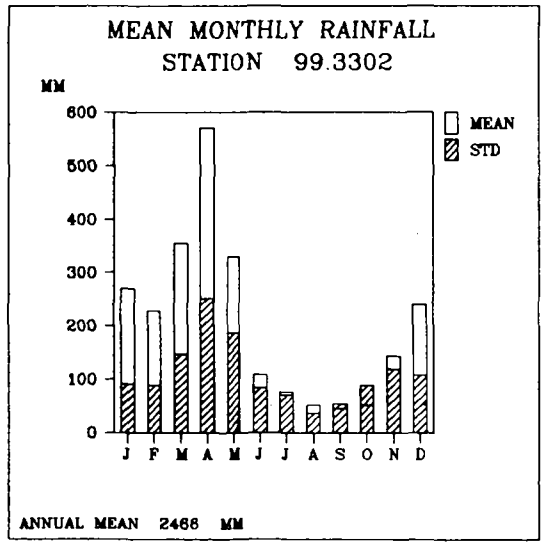

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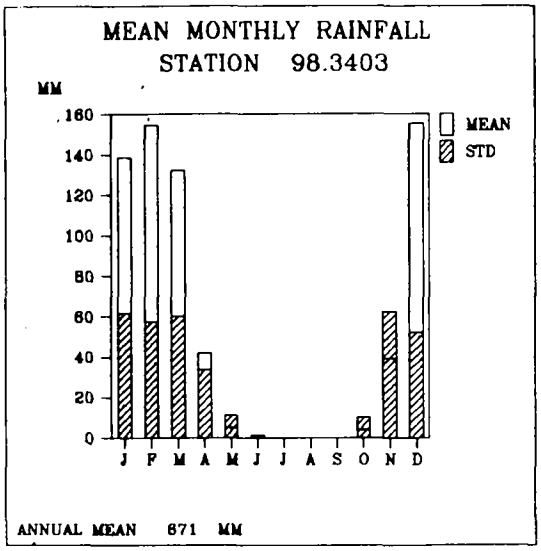

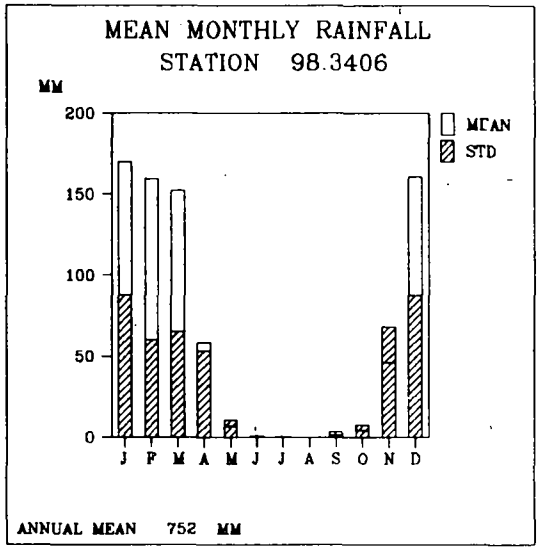

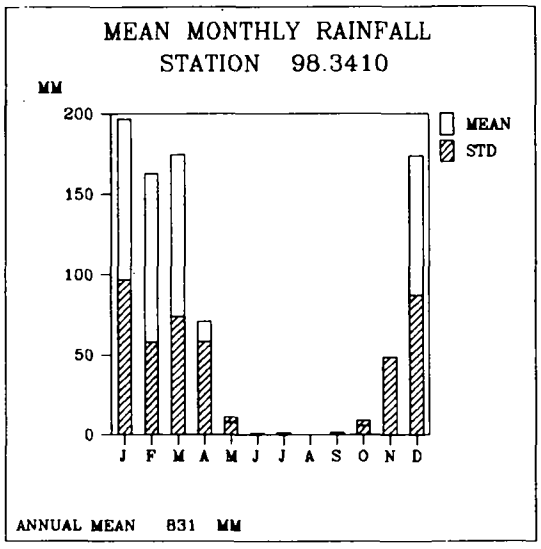

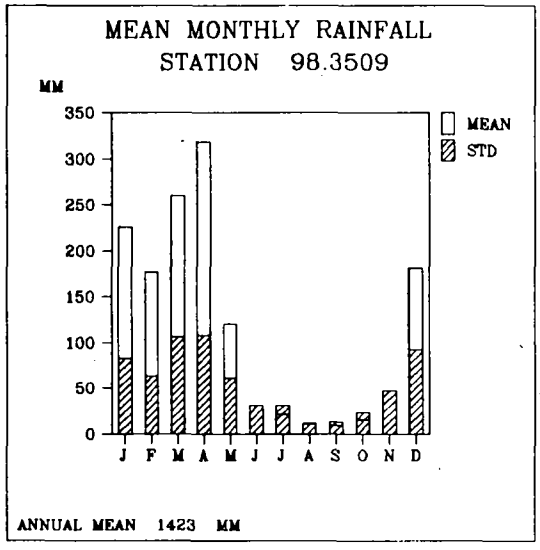

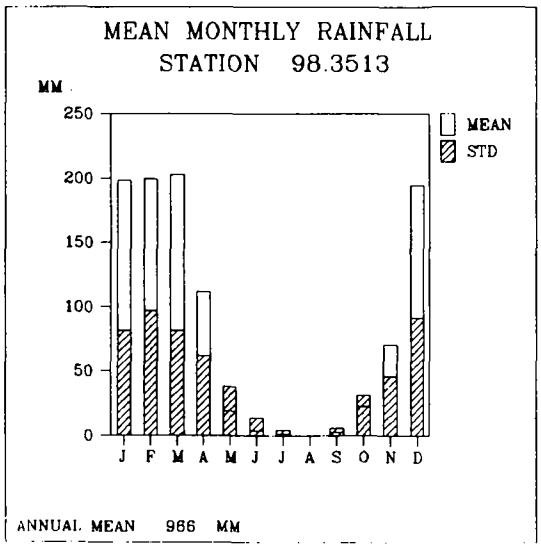

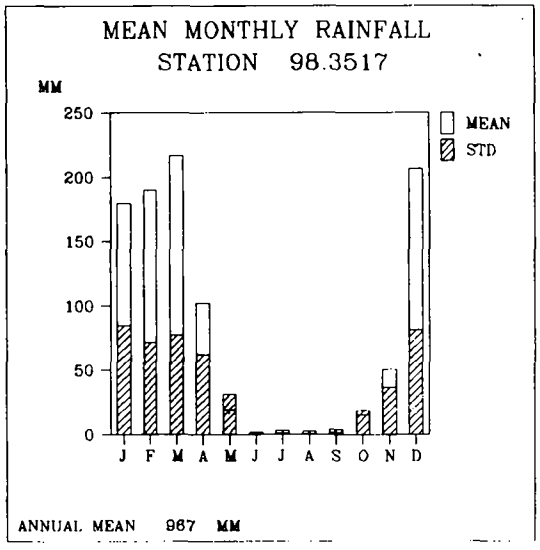

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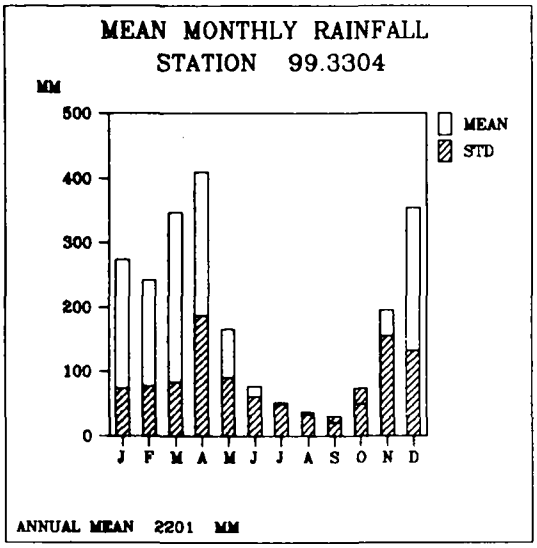
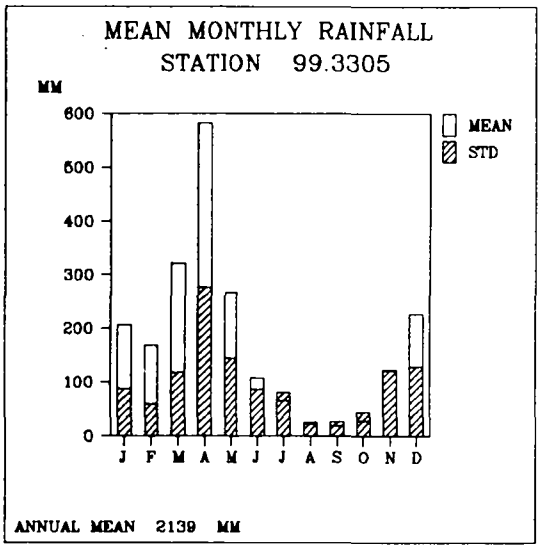
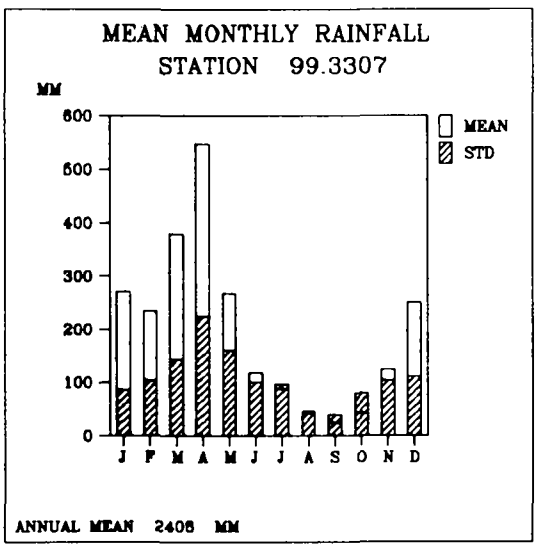
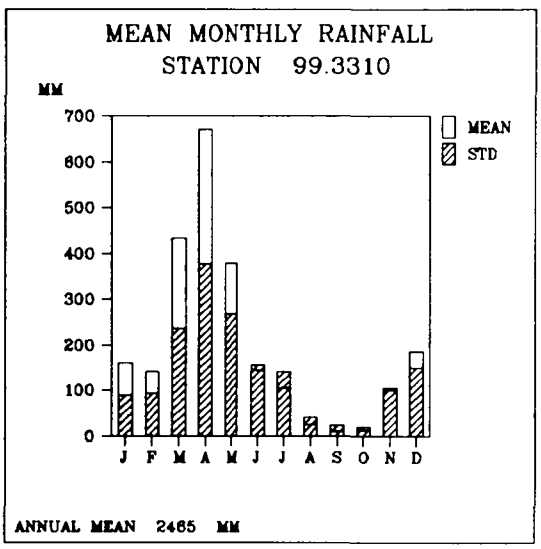
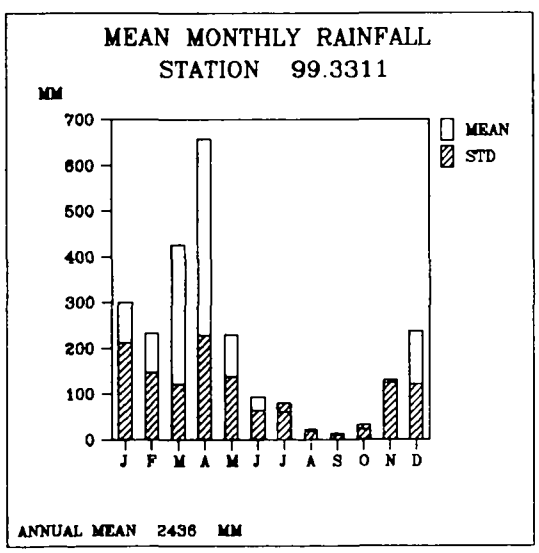










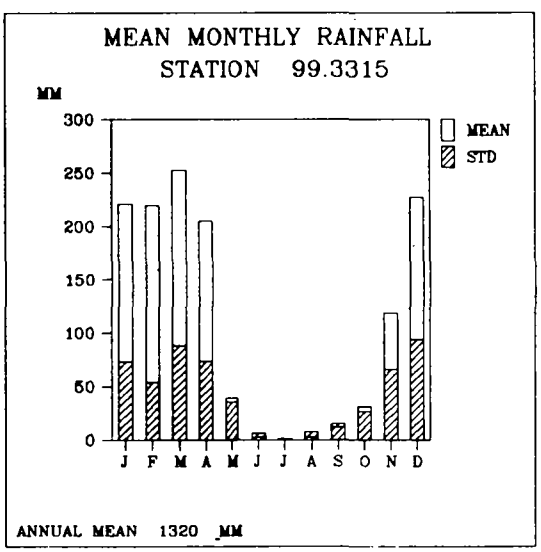


Figure 3.19[8] - Cont'd.

Grid	Area km^2	Number of rainfall stations	GAUGE DENSITY		
			Km^2 represented by 1 station	Number of stations per 1000 km^2	Meets the reasonable minimum objective (1 gauge/ 1000 km^2)
97.32	12100	1	12100	0.1	No
97.33	12100	5	2400	0.4	No
97.34	12100	2	6100	0.2	No
97.35	12100	21	600	1.7	Yes
97.36	12100	14	900	1.2	Yes
98.32	12100	13	900	1.1	Yes
98.33	12100	20	600	1.6	Yes
98.34	12100	19	600	1.6	Yes
98.35	12100	39	300	3.2	Yes
99.32	2200	8	300	3.6	Yes
99.33	6700	32	200	4.8	Yes
99.34	12100	40	300	3.3	Yes
99.35	12100	14	900	1.2	Yes
100.34	7600	15	500	2.0	Yes
100.35	12100	20	600	1.7	Yes
100.36	12100	4	3000	0.3	No
100.37	12100	9	1300	0.7	No
101.34	3300	8	400	2.7	Yes
101.35	6500	3	2200	0.5	No
101.36	7800	1	7800	0.1	No
101.37	7100	4	1800	0.6	No
Average	10000	14	700	1.4	Yes

Table 3.2[8] Rainfall station density for different grid squares for Iringa, Mbeya and Ruvuma regions.

Station Number	Station Name	Region	Operation Responsibility	Period of Observation	Visited	Reliability	Exposure	No. of Gaps	Average gap length (weeks)
97.3200	Gua Kijijini	Mbeya	Kilimo	1957-79	Yes	Good	Good	4	97.9
97.3201	Mafyeko	Mbeya	Private	1975-79	Yes	Fair	Good	5	14.9
97.3300	Kipembawe	Mbeya	Maji	1957-79	Yes	No recs.		6	163.8
97.3302	Mtanila	Mbeya	Mission	1976-79	Yes	Fair	Fair	1	200.1
97.3303	Mafyeko	Mbeya		1977-79	Yes	Fair	Good	1	4.3
97.3400	Mkupule	Iringa	Maji	1960-79	Yes	Good	Good	10	24.3
97.3401	Msembe	Iringa	Maji	1967-79	Yes	Fair	Good	5	8.6
97.3500	Iringa Rec.Off.	Iringa	Kilimo	1926-79				3	345.6
97.3502	Irole Mission	Iringa	Mission	1959-79	Yes	Good	Good	6	16.7
97.3503	Tosamaganga	Iringa	Private	1957-74	Yes	Fair	Good	1	4.4
97.3504	Kimande	Iringa	Private	1957-79	Yes	Good	Good	10	73.3
97.3507	Ihimbu Farm	Iringa	Private	1957-79	Yes	Good	Fair	2	6.6
97.3508	Idodi	Iringa	Kilimo	1957-79				11	35.0
97.3509	Igumbiro	Iringa		1957-59				1	47.7
97.3510	Ismani	Iringa	Kilimo	1957-79				14	38.1
97.3511	Mtera	Iringa	Maji	1959-79	Yes	Good	Good	4	14.1
97.3513	Nduli Airfield	Iringa	DOM	1959-79	Yes	Good	Good	1	2.3
97.3514	Iringa-Maji	Iringa	Maji	1960-79	Yes	Good	Good	7	14.4
97.3515	Seatondale Exp.	Iringa	Kilimo	1961-79	Yes	Good	Good	7	24.8
97.3516	Mkwawa Sec.Sch.	Iringa	Private	1964-79	Yes	Fair	Good	14	22.3
97.3517	Nzihi	Iringa	Kilimo	1970-72				2	13.1
97.3518	Kitayawa	Iringa	Kilimo	1970-74				8	8.2
97.3519	Luganga Kilolo	Iringa	Kilimo	1974-79	Yes	Fair	Fair	2	115.9
97.3520	Pawaga	Iringa	Kilimo	1972-72				0	0.0
97.3521	Nzihi Lutega	Iringa	Kilimo	1972-79				5	23.2
97.3522	Izazi	Iringa	Private	1974-79				1	17.1
97.3523	Nyangolo	Iringa	Private	1974-79				4	21.5
97.3524	Izazi Maji	Iringa	Maji	1976-79	Yes	Bad	Good	1	17.1
97.3601	Madizini Estate	Morogoro		1957-64				3	10.2
97.3602	Kisawasawa Miss.	Morogoro	Mission	1957-62				4	16.4
97.3603	Ilula Mission	Iringa	Mission	1957-79	Yes	Good	Fair	13	18.8
97.3604	Sanje Estate	Morogoro		1957-67				4	36.0
97.3605	Mazombe	Iringa	Kilimo	1958-79				14	46.7
97.3606	Malolo			1960-76				9	23.2
97.3607	Ulaya	Morogoro		1960-76				3	20.3
97.3608	Kisanga Msolwa	Morogoro		1961-75				6	10.9
97.3609	Sanjo	Iringa		1963-71				4	12.0
97.3610	Ichonde	Iringa		1963-67				4	13.1
97.3611	Mikumi	Morogoro		1970-74				2	4.4
97.3612	Lyassa (Image)	Iringa	Private	1970-79	Yes	Good	Good	5	11.2
97.3613	Mahenge (Mtandika)	Iringa	Kilimo	1971-76	Yes	No recs.	No rain Gauge	3	106.0
97.3614	Ipera	Iringa		1975-76				1	4.3
98.3200	Saza Mine	Mbeya		1958-58				0	0.0
98.3202	Mkulwe Mission	Mbeya	Mission	1957-75				9	21.5
98.3203	Rukwa Hotel	Mbeya		1957-64				5	43.5
98.3204	Makachese	Mbeya		1957-57				1	30.6
98.3205	Kampunda	Rukwa		1957-57				1	30.6
98.3206	Itumbi	Mbeya		1957-62				2	8.7
98.3207	Laela	Rukwa		1957-58				2	19.7
98.3208	Laela Mission	Rukwa	Mission	1958-58				1	30.6
98.3209	Kamsamba	Mbeya	Mission	1958-74				6	77.7
98.3210	Mwambani	Mbeya	Private	1972-79	Yes	Good	Fair	1	4.4
98.3213	Miyunga	Mbeya	Private	1977-79				2	8.6
98.3300	Mbeya Bomani	Mbeya	Kilimo	1928-73				3	53.7
98.3301	Mbeya Airport	Mbeya	DOM	1957-79	Yes	Good	Good	1	4.4
98.3302	Chunya	Mbeya	Kilimo	1957-79				8	16.3
98.3303	Ailsa Farm	Mbeya		1957-57				2	19.5
98.3309	Galula H/Met	Mbeya	Maji	1957-79	Yes	Bad	Good	8	98.7
98.3310	Irambo Mission	Mbeya	Mission	1957-79				15	18.5
98.3311	Ntumbi	Mbeya		1957-63				2	21.9
98.3313	Gungutas Reefs	Mbeya		1958-72				2	380.4
98.3314	Mbeya School	Mbeya	Private	1957-63				3	45.1
98.3315	Kawetere	Mbeya	Forestry	1957-79				5	8.8
98.3316	Lusibilo Farm	Mbeya	Private	1957-79				2	2.6
98.3317	Nzovwe	Mbeya	Mission	1957-79				12	51.7
98.3318	Lupatingatinga	Mbeya	Private	1957-79	Yes	Bad	Good	6	18.1
98.3319	Magoya Mission	Mbeya	Mission	1958-66				4	83.8
98.3320	Mbeya Maji	Mbeya	Maji	1961-79	Yes	Good	Fair	5	12.2
98.3321	Utengule P.V. School	Mbeya		1964-64				0	0.0
98.3322	Mbeya Range	Mbeya	Forestry	1963-71				6	31.2
98.3323	Lupa N. Forest	Mbeya		1963-63				1	17.4
98.3324	Mwambani	Mbeya	Mission	1965-79	Yes	Fair	Fair	6	49.7
98.3325	Uyole Marti	Mbeya	DOM	1970-79				1	8.7
98.3400	Madibira	Mbeya	Maji	1957-79		Good	Good	4	5.5
98.3401	Malangali Sch.	Iringa	Private	1957-79				3	102.0
98.3402	Chimala River Farm	Mbeya		1957-73				3	271.0
98.3403	Rujewa Mission	Mbeya	Mission	1957-79				1	4.4
98.3404	Ilembula Mis.	Iringa	Mission	1957-65				5	13.1
98.3405	Luhanyana Farm	Iringa		1957-63				2	26.1
98.3406	Igawa	Mbeya	Maji	1957-79	Yes	Good	Good	5	15.7
98.3407	Wangingombe	Iringa		1958-60				3	11.7

Table 3.3[8] - Rainfall station description.

Station Number	Station Name	Region	Operation Responsibility	Period of Observation	Visited	Reliability	Exposure	No. of Gaps	Average gap length (weeks)
98.3408	Mbarali irr.farm	Mbeya	Kilimo	1957-1979				12	15.8
98.3409	Chimala N.D.	Mbeya		1958-1965				5	34.9
98.3410	Kimani	Mbeya	Maji	1956-1979				6	28.3
98.3411	Saja	Iringa	Kilimo	1962-1979	yes	good	good	9	13.6
98.3412	Chimala	Mbeya	Private	1970-1979				6	48.3
98.3413	Matamba	Mbeya	Private	1971-1979				5	12.2
98.3414	Mayale Village	Iringa	Private	1974-1979				4	48.4
98.3415	Wangingombe	Iringa	Private	1974-1979	yes	good	good	1	4.4
98.3416	Uhenga Uj. Vill.	Iringa	private	1974-1979	yes	good	good	6	13.7
98.3417	Kijombe village	Iringa	Private	1974-1979				2	23.6
98.3418	Lyadebwe village	Iringa	Private	1974-1979				2	21.4
98.3502	Iheme	Iringa		1958-1958				1	21.9
98.3505	Dunsandle estate	Iringa		1957-1960				2	26.3
98.3507	Mufindi Forest	Iringa	Forestry	1957-1979				14	31.1
98.3509	Kilima	Iringa	Private	1957-1979	yes	good	good	5	4.4
98.3511	Mkewe estate	Iringa	Private	1957-1971				2	47.9
98.3513	Wasa Mission	Iringa	Mission	1957-1979	yes	good	good	2	111.6
98.3515	Ifuenga Farm	Iringa		1972-1972				2	8.8
98.3517	Ulete Mission	Iringa	Mission	1957-1979	yes	good	good	4	6.5
98.3519	Ifupira Mufindi	Iringa	Private	1957-1979	yes	good	good	2	2.3
98.3520	Kinoga Mufindi	Iringa	Private	1957-1960				1	4.3
98.3521	Kidope Mufindi	Iringa	Private	1957-1979	yes	fair	fair	4	7.6
98.3522	Luiga Mufindi	Iringa	Private	1957-1979	yes	fair	fair	7	4.4
98.3523	Luisenga Mufindi	Iringa	Private	1957-1975				2	34.8
98.3524	Kivere Mufindi	Iringa	Private	1957-1979		good	good	5	7.1
98.3525	Idebe Tea Co.	Iringa	Private	1957-1979		good	good	10	5.3
98.3526	Echidna Tea Co.	Iringa	Private	1957-1979		good	good	0	0.0
98.3527	Matitu estate	Iringa		1957-1972				2	382.6
98.3528	Tuferu	Iringa		1957-1960				2	12.9
98.3529	Irundi Farm	Iringa		1957-1957				1	35.0
98.3530	Kalinga Forest	Iringa	Forestry	1957-1979				14	25.3
98.3531	Itanga Estate	Iringa		1957-1961				1	30.6
98.3532	Mninga	Iringa		1957-1959				2	6.6
98.3533	Johns Corner	Iringa	Kilimo	1959-1979	yes	fair	fair	7	34.8
98.3534	Matugutu	Iringa	Private	1961-1979	yes	good	good	3	10.1
98.3535	Irundi Hill	Iringa	Forestry	1960-1979				8	39.3
98.3536	Irundi Hill N.	Iringa	Forestry	1963-1979				7	40.6
98.3537	Irundi Office A.	Iringa	Forestry	1964-1979				8	33.1
98.3538	Ngwazi	Iringa	Maji	1967-1970	yes	good	fair	2	19.6
98.3539	Mafinga	Iringa	Private	1967-1979	yes	fair	good	12	15.7
98.3540	Sao Hill livest.	Iringa	Private	1970-1979	yes	good	good	4	13.1
98.3541	Luganga Kilolo	Iringa	Kilimo	1972-1973	yes	fair	good	2	13.1
98.3542	Sadani	Iringa	Private	1972-1979				5	24.1
98.3543	Kibengu	Iringa	Kilimo	1972-1979				4	38.9
98.3544	Usokami	Iringa	Private	1972-1979				3	92.7
98.3546	Kasanga	Iringa	Kilimo	1972-1979				1	198.0
98.3547	Mabanda	Iringa	Private	1972-1979				2	8.6
98.3548	Mufindi Bomani	Iringa	Kilimo	1972-1979				7	36.3
98.3550	Boma la Ngombe	Iringa	Private	1974-1979				2	45.4
98.3556	Dabaga Seed Farm	Iringa	Private	1979-1979	yes	good	good	0	0.0
99.3202	Komera Coffe Est.	Mbeya		1957-1962				6	5.8
99.3204	Erik Est., Mbozi	Mbeya		1957-1964				3	18.9
99.3205	Mbimba Research	Mbeya	Kilimo	1950-1979				4	16.3
99.3208	Mlowo Mission	Mbeya	Mission	1957-1979				4	17.5
99.3209	Chivanda	Mbeya	Private	1964-1979	yes	good	fair	6	25.4
99.3210	Igamba	Mbeya	Kilimo	1971-1979				4	55.0
99.3211	Kapele	Mbeya	Kilimo	1974-1979				3	89.2
99.3212	Mwenge	Mbeya	Private	1974-1979				6	28.0
99.3300	Musekera Estate	Mbeya	Private	1957-1979				2	93.1
99.3302	Tukuyu Bomani	Mbeya	Kilimo	1926-1979	yes	fair	fair	7	4.3
99.3304	Rungwe Tea Est.	Mbeya	Private	1957-1979	yes	fair	bad	2	26.1
99.3305	Mwitika Estate	Mbeya	Private	1957-1979				4	8.6
99.3306	Manow Mission	Mbeya		1957-1959				2	6.5
99.3307	Tukuyu Hospital	Mbeya	Private	1957-1979	yes	good	good	5	22.5
99.3310	Kyela Hospital	Mbeya	Private	1957-1979	yes	fair	bad	4	29.0
99.3311	Makete Leprosy	Mbeya	Private	1957-1979				1	8.7
99.3313	Rungwe Sec.Sch	Mbeya	Private	1957-1972	yes	no recs.		6	10.9
99.3314	Mlowo Farm	Mbeya		1957-1964				0	0.0
99.3315	Nyara Estate	Mbeya	Private	1957-1979				4	53.7
99.3316	Chivanjee Tea E.	Mbeya	Private	1957-1979	yes	good	good	8	11.0
99.3317	Itumba	Mbeya		1957-1967				5	6.1
99.3318	Ipinde Middle S	Mbeya	Private	1957-1965				13	16.5
99.3319	Panda Hill	Mbeya		1957-1961				2	17.4
99.3320	Njugilo	Mbeya	Kilimo	1957-1979				3	21.5
99.3321	Mitalula Exp.	Mbeya	Kilimo	1959-1979				1	4.3
99.3322	Mwakeleli Middle School	Iringa	Private	1959-1967				2	80.6
99.3323	Kiganga Coffee	Mbeya	Private	1959-1979				4	4.4
99.3324	Kiwira	Mbeya	Private	1956-1979	yes	fair	good	11	20.6
99.3325	Isangati	Mbeya	Private	1958-1979				9	20.8
99.3326	Mwalupindi	Mbeya	Private	1961-1979	yes	bad	good	18	23.6
99.3327	Rungwe Pr. Sch.	Mbeya	Private	1961-1979	yes	bad	good	22	21.3
99.3328	Igembe	Mbeya	Private	1961-1979				10	17.4

Table 3.3[8] - Rainfall station description, cont'd.

Station Number	Station Name	Region	Operation Responsibility	Period of Observation	Visited	Reliability	Exposure	No. of Gaps	Average gap length (weeks)
99.3329	Ndara Agric.	Mbeya	Kilimo	1961-79				6	49.5
99.3330	Kimombo Pyr/watt	Mbeya	Forestry	1962-79				10	33.9
99.3331	Santilya	Mbeya	Private	1965-79				5	25.0
99.3332	Ywama ext.Pr.Sch	Mbeya	Private	1965-74				2	187.0
99.3333	Kiwira	Mbeya	Forestry	1966-79	Yes	fair	Bad	5	14.8
99.3334	Ihindi State	Mbeya	Forestry	1971-72				0	0.0
99.3335	Itope-Tenende	Mbeya	Maji	1971-79	Yes	Good	Fair	9	20.8
99.3339	Manow It.Scheme	Mbeya	Kilimo	1974-79				3	10.0
99.3400	Milo Mission	Iringa	Mission	1926-66				8	49.2
99.3401	Njombe Bomani	Iringa	Kilimo	1957-80	Yes	Bad	Bad	6	9.1
99.3405	Uwemba Mission	Iringa	Mission	1957-64				4	44.6
99.3408	Kipengere	Iringa	Mission	1957-79				4	36.4
99.3409	Madunda	Iringa	Mission	1957-79				5	66.6
99.3410	Lugalawa	Iringa	Mission	1957-79				3	13.0
99.3411	Makete H/Met (Bulongwa)	Iringa	Maji	1978-79				1	4.3
99.3412	Sofulka Est.Ltd.	Iringa	Private	1957-74				6	18.1
99.3413	Luponde Farm	Iringa	Kilimo	1957-79				2	8.8
99.3415	Njombe Wattle Research	Iringa	Private	1957-80	Yes	Good	Good	2	8.8
99.3416	Lupalilo N.A.Sch	Iringa	Private	1957-64				7	18.8
99.3417	Mdopi Farm	Iringa	Private	1957-63				3	11.7
99.3418	Tanganyika Wattle I	Iringa	Private	1957-79	Yes	Good	Good	3	10.2
99.3419	Tanganyika Wattle II	Iringa	Private	1957-79	Yes	Good	Good	5	19.5
99.3420	Tanganyika Wattle III	Iringa	Private	1957-80	Yes	Good	Good	5	7.9
99.3421	Tanganyika Wattle IV	Iringa	Private	1957-79	Yes	Good	Good	4	8.7
99.3422	Tanganyika Wattle V	Iringa	Private	1957-80	Yes	Good	Good	4	7.7
99.3423	Dansland Farm	Iringa	Private	1957-79				2	8.8
99.3424	Ichenga	Iringa	Kilimo	1958-79				1	4.3
99.3425	Tandala	Iringa		1958-63				5	15.7
99.3426	Lusitu	Iringa	Private	1956-79				1	4.4
99.3427	Helvetina Farm	Iringa	Private	1960-79				4	8.8
99.3428	Linstock Farm	Iringa	Private	1962-63				2	8.7
99.3429	Igeri (Pyrethr) Agromet	Iringa	DOM	1963-79				0	0.0
99.3430	Itope	Iringa		1964-72				4	32.7
99.3431	Uwemba Tea Est.	Iringa	Private	1967-79				1	4.3
99.3432	Igosi Village	Iringa	Kilimo	1970-79				5	48.9
99.3433	Nyumbanitu Wattle Co.	Iringa	Private	1972-79	Yes	Good	Good	1	60.0
99.3434	Wangama Wattle Co. Ltd.	Iringa	Private	1972-79	Yes	Good	Good	0	0.0
99.3435	Wangama Village	Iringa	Kilimo	1972-72				1	8.7
99.3436	Igwachanya	Iringa	Mission	1972-79				0	0.0
99.3437	Matema	Mbeya	Kilimo	1976-79				3	37.1
99.3438	Mahalule Farm	Iringa	Private	1975-79				3	5.7
99.3439	Kilolelo Farm	Iringa	Private	1975-79				0	0.0
99.3440	Maboga	Ruvuma	Maji	1976-76				0	0.0
99.3442	Mahologwa	Iringa	Private	1977-79				1	51.4
99.3443	Kilondo	Iringa	Private	1976-79				3	41.4
99.3444	Ligumbilo	Iringa	Private	1976-79				0	0.0
99.3446	Kiyombo	Iringa	Private	1976-79				4	22.5
99.3447	Mlangali	Iringa	Private	1977-79				3	22.9
99.3502	Ifinga Mission	Morogoro	Mission	1957-79				4	61.3
99.3503	Kifanya Mission	Iringa	Mission	1957-79				5	59.6
99.3504	Lupembe Estate	Iringa	Private	1957-79				3	4.4
99.3505	Matembwe	Iringa	Mission	1957-79				3	71.3
99.3506	Mahanje	Ruvuma	Mission	1957-79	Yes	Good	Fair	6	10.2
99.3507	Taveta	Morogora	Mission	1957-79				8	13.0
99.3508	Mfrika Estate	Iringa		1957-64				3	4.4
99.3509	Ukalawa Tea	Iringa	Private	1971-79				3	4.3
99.3510	Lupembe Tea Project	Iringa	Private	1971-79				5	13.8
99.3511	Matetereka	Ruvuma	Private	1975-79				3	20.4
99.3512	Masigira	Ruvuma	Maji	1974-79	Yes	Good	Good	8	9.2
99.3513	Mavanga	Iringa	Private	1976-79				3	25.7
99.3514	Madaba	Ruvuma	Maji	1977-79	Yes	Good	Good	7	6.8
99.3515	Ndoleleji Wattle Co.	Ruvuma	Private	1975-79	Yes	Good	Good	2	77.6
100.3400	Lituhi Mission	Iringa	Mission	1926-79				4	29.1
100.3401	Litembo Mission	Ruvuma	Mission	1957-79	Yes	fair	Fair	7	7.5
100.3402	Manda	Iringa	Fisheries	1971-73				2	17.4
100.3403	Ruanda	Ruvuma	Mission	1957-79	Yes	Good	Fair	10	12.7
100.3405	Lupingu	Iringa	Mission	1957-79				3	3.0
100.3406	Luilo	Ruvuma	Mission	1957-79				3	8.8
100.3410	Ndengo-Mbinga	Ruvuma	Kilimo	1965-79	Yes	Good	Good	8	39.0
100.3411	Rudewa Village	Iringa	Kilimo	1971-79				5	30.3
100.3412	Matiri	Ruvuma	Mission	1973-79				3	81.1
100.3414	Miyao Exp.	Ruvuma	Kilimo	1975-76				1	8.7
100.3415	Mkumbi	Ruvuma	Mission	1976-79				1	132.9

Table 3.3[8] - Rainfall station description, cont'd.

Station Number	Station Name	Region	Operation Responsibility	Period of Observation	Visited	Reliability	Exposure	No. of Gaps	Average gap length (weeks)
100.3416	Makonde	Iringa	Private	1976-79				3	10.0
100.3417	Mbwila	Iringa	Private	1976-79				4	13.9
100.3418	Lifua	Iringa	Private	1976-79				3	24.3
100.3420	Mhumbi	Ruvuma	Maji	1976-79				1	47.1
100.3500	Songea 2nd Order	Ruvuma		1926-56				0	0.0
100.3502	Kigonsera	Ruvuma	Private	1957-79	Yes	No Recs.	No. Recs.	7	52.8
100.3503	Matimira	Ruvuma	Mission	1957-79				7	1.9
100.3505	Mgazini	Ruvuma	Mission	1957-79				4	47.4
100.3506	Peramiho	Ruvuma	Mission	1957-79	Yes	Good	Good	2	4.1
100.3507	Magagula	Ruvuma	Mission	1957-77				1	152.0
100.3508	Mbinga	Ruvuma	Mission	1957-76	Yes	No Recs.	No Recs.	7	82.6
100.3509	Ligera	Ruvuma	Mission	1957-79	Yes	Bad	Bad	5	11.3
100.3510	Songea Air Field	Ruvuma	DOM	1957-79	Yes	Good	Good	5	11.4
100.3511	Hanga Estate	Ruvuma	Mission	1958-79	Yes	Fair	Fair	6	20.4
100.3512	Ngoni Matengo Seed Farm	Ruvuma	Private	1958-76	Yes			6	34.1
100.3513	Likonde Seminary	Ruvuma	Mission	1965-79	Yes	Fair	Good	10	14.4
100.3514	Songea Bomani	Ruvuma	Kilimo	1965-79	Yes	Fair	Good	4	28.3
100.3515	Matogoro	Ruvuma	Forestry	1965-79				1	4.4
100.3516	Gumbiro	Ruvuma	Private	1971-79	Yes	Fair	Good	8	14.7
100.3517	Mputa Settlement	Ruvuma	Private	1971-79	Yes	Fair	Fair	6	11.7
100.3518	Mlale	Ruvuma	Private	1973-79				2	4.3
100.3520	Litumba Ndyosi	Ruvuma	Maji	1976-79				2	10.7
100.3521	Mbinga Bomani	Ruvuma	Kilimo	1977-79	Yes	Fair	Fair	3	16.0
100.3600	Nyamtumbo School	Ruvuma	Private	1957-76				8	118.0
100.3601	Hulia	Ruvuma	Private	1967-79				6	21.0
100.3602	Namanima	Ruvuma	Kilimo	1970-76	Yes	No Recs.	No Recs.	4	96.1
100.3603	Suluti Exp.	Ruvuma	Kilimo	1974-79	Yes	Good	Good	2	4.3
100.3700	Mindu Mission	Ruvuma	Mission	1957-62				3	50.8
100.3701	Puchapucha	Ruvuma		1957-62				2	78.4
100.3702	Nakapanya	Ruvuma	Kilimo	1970-74				1	47.7
100.3703	Muhuwesi River	Ruvuma	Maji	1970-79				4	20.7
100.3704	Nampungu	Ruvuma	Private	1971-75				6	38.1
100.3705	Nandembo	Ruvuma	Private	1971-79				1	4.3
100.3706	Matemanga	Ruvuma	Kilimo	1970-79				5	18.3
100.3707	Lumesule	Mtwara		1970-71				3	23.3
100.3708	Ngongowele Pr.S.	Mtwara	Private	1976-76				1	21.9
101.3401	Liuli Mission	Ruvuma	Mission	1957-62				8	19.0
101.3402	Mango Mission	Ruvuma	Mission	1957-65				5	48.9
101.3403	Mbamba Bay	Ruvuma	Cust. Author.					2	30.5
101.3405	Mpapa Matengo	Ruvuma	Forestry	1957-79	Yes	Fair	Bad	7	5.6
101.3406	Chiwanda	Ruvuma	Kilimo	1973-75				1	139.1
101.3407	Lundo	Ruvuma	Kilimo	1967-79				8	10.3
101.3408	Ndengu Exp.	Ruvuma	Kilimo	1976-79	Yes	Fair	Good	6	6.5
101.3409	Mbamba Bay	Ruvuma	Maji	1977-79	Yes	Good	Good	8	6.0
101.3501	Liparamba	Ruvuma	Mission	1957-79				6	31.0
101.3502	Mhukuru Settlmt.	Ruvuma	Kilimo	1969-79				2	118.2
101.3504	Mhinga Village	Ruvuma	Maji	1977-79	Yes	Fair	Good	0	0.0
101.3603	Maundi	Ruvuma	Maji	1974-79				6	5.8
101.3700	Tunduru Bomani	Ruvuma	Kilimo	1926-79				5	4.3
101.3701	Namasakata	Ruvuma		1957-61				3	19.0
101.3702	Visikani	Ruvuma		1957-58				2	24.1
101.3703	Misechela-Namasakata	Ruvuma	Private	1970-79				1	25.7
101.3704	Nalasi	Ruvuma	Private	1971-75					

Table 3.3[8] - Rainfall station description, cont'd.

Station	Station No.	Value of events (mm) for return periods (years)					
		2	5	10	15	20	30
Nduli Airport	97.3513	650	790	860	900	920	950
Mbeya Airport	98.3301	970	1080	1130	1160	1180	1200
Madibira	98.3400	850	1060	1180	1230	1270	1310
Igawa	98.3406	750	880	960	990	1010	1040
Chivanjee Tea Estate	99.3316	2520	2910	3090	3180	3240	3260
Njombe Wattle Research	99.3415	1200	1350	1430	1470	1490	1510
Igeri Agromet Station	99.3429	1370	1540	1620	1670	1690	1720
Songea Airport	100.3510	1140	1320	1410	1460	1490	1530

Table 3.7[8] Frequency analysis of annual maximum precipitation.

Station	Station No.	Value of events (mm) for return periods (years)					
		2	5	10	15	20	30
Nduli Airport	97.3513	650	510	440	400	380	350
Mbeya Airport	98.3301	970	850	790	760	740	720
Madibira	98.3400	850	640	520	470	430	390
Igawa	98.3406	750	620	540	510	490	460
Chiwanjee Tea Estate	99.3316	2520	2150	1960	1870	1810	1790
Njombe Wattle Research	99.3415	1200	1050	970	930	910	890
Igeri Agromet Station	99.3429	1370	1200	1120	1070	1050	1030
Songea Airport	100.3510	1140	960	870	820	790	750

Table 3.8[8] Frequency analysis of annual minimum precipitation.

$$T = \frac{\sigma_x \sqrt{2\pi}}{\int_x^{\infty} e^{-\frac{\left(\frac{x - \bar{x}}{\sigma_x}\right)^2}{2}}}$$

T = recurrence interval

x = total annual rainfall

$\bar{x}$ = mean annual rainfall

σ_x= standard deviation

Station No.	Mean Annual Rainfall mm	Standard deviation mm
97.3513	650	163
98.3301	965	137
98.3400	854	256
98.3406	752	162
99.3316	2526	438
99.3415	1192	173
99.3429	1373	198
100.3510	1141	213

Table 3.11[8] Distribution function and parameters for calculation of recurrence intervals.

Reorganisation and storage of data

The database has been constructed using rainfall observations for 279 stations in total. The data was obtained from East African Meteorological Department on three magnetic tapes each containing observations corresponding to a specific timespan (tape 1: 1926-70, tape 2: 1971-74, tape 3: 1975-76). The data was blocked month by month, but unfortunately by means of three different block-structures and representations. The preliminary analysis of the tapes showed, however, that no consistent system had been used in the creation of these: observations from the same station were spread unchronologically throughout the tape, and identical blocks were encountered quite frequently. There were no indications of missing observations, when the "shut-down"-period exceeded one month. These difficulties implied that a thorough sorting-job was required. For each tape the observations had to be gathered chronologically station by station, and subsequently stored with station code number in ascending order. Eventually the records from all three tapes were merged and transferred to a more suitable block structure, each block containing one year of observations. The reorganisation also included automatic indication of missing months. The information thus transferred was adapted to the serviceprograms, developed for the hydro-data database. Minor changes to this software were necessary in order to provide print and plot representation of the observations. Examples are given in Annex A of this note.

Preliminary statistical analysis

In order to assess the quality and range of data recorded for the individual stations, it was decided to carry out a first order statistical analysis of all stations on the tape. This analysis was arranged to provide information on the following properties:

- monthly values, and - if possible - annual totals for each year.
- no. of rainy days - monthly and annually - for each year.
- statistics for the entire record-period, including mean value, mean standard deviation, and coefficient of variation, for monthly as well as for annual values of precipitation and number of rainy days.

Introduction

This note describes the work involved in the setting up of a rainfall database containing data observed in Iringa, Ruvuma and Mbeya regions in Tanzania. The work has been performed by DHI (Danish Hydraulic Institute) in cooperation with CCKK, and it is based on rainfall data received from East African Meteorological Department, Nairobi, Kenya.

The final storage of data has been done in exactly the same way as discharge data is stored by Maji on the ICL-computer in Dar es Salaam. This allows for a direct transfer of the base to Tanzania, where it may be operated by slightly modified Maji-soft-ware.

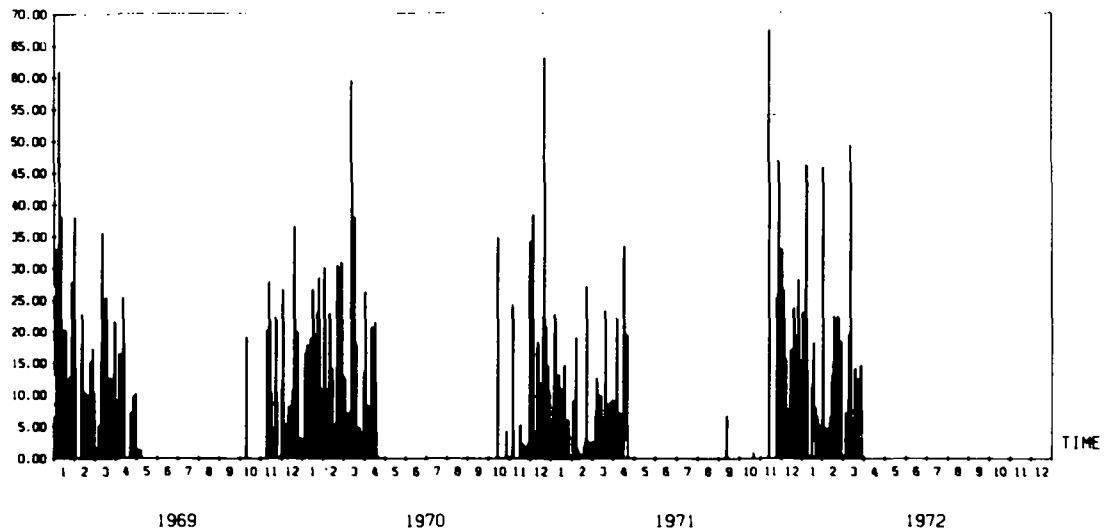
A computerprintout of the results for station 97.3200 is included in Annex A. Note that the printing of asteriks indicates, that one or more values within the record are punched as missing values. In such cases months or years containing missing values are omitted from the statistics.

Precipitation
example of data lay-outs
and statistics for station 97.3200.

RAINFALL
MM/DAY

STATION CODE NO. 973200

PERIOD: 1969 - 1972



STATION CODE NO. 9233000

PRECIPITATION (MM)

YEAR 1969

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1	6.3	14.0	10.2	0.0	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.9	
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.7	
4	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5	13.0	0.0	1.3	7.6	1.3	0.0	0.0	0.0	0.0	0.0	0.0	5.1	
6	31.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	
7	15.2	0.0	1.3	16.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9	61.0	0.0	5.1	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	20.3	5.1	
11	0.0	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.1	0.0	0.0	
12	38.1	22.9	18.3	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.1	
13	0.0	6.3	35.6	25.4	0.0	0.0	0.0	0.0	0.0	0.0	27.9	3.8	
14	0.0	0.0	5.1	17.8	0.0	0.0	0.0	0.0	0.0	0.0	21.6	0.0	
15	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	0.0	
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.2	0.0	
17	0.0	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.9	
18	20.3	2.5	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.7	
19	5.1	7.6	25.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
20	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.6	
21	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	11.7	
22	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.8	
23	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.3	1.8	
24	0.9	15.2	10.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	8.9	19.8	
25	12.7	0.0	12.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	
26	10.2	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	17.3	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
28	27.9	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	
31	38.1		21.6	0.0		0.0	0.0	0.0	0.0	0.0		0.0	
SUM	293.3	136.6	159.5	103.1	13.6	0.0	0.0	0.0	0.0	19.1	124.4	158.6	YEAR 1008.2
DAYS	13	14	12	10	4	0	0	0	0	1	9	16	79

PRECIPITATION STATISTICS - TANZANIA

STATION CODE NO = 9233000

DHI NO = 1

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1957	MONTHLY SUM (MM)	317.2	412.7	174.3	******	******	******	******	******	******	******	******	******	******
	NO OF RAINY DAYS	28	21	21	***	***	***	***	***	***	***	***	***	***
1958	MONTHLY SUM (MM)	137.9	99.9	318.1	130.7	9.2	0.0	0.0	0.0	0.0	0.0	192.4	343.5	1993.3
	NO OF RAINY DAYS	14	12	14	14	2	0	0	0	0	0	8	13	77
1959	MONTHLY SUM (MM)	61.7	87.4	82.3	72.4	0.0	******	0.0	0.0	4.3	51.0	80.1	128.5	******
	NO OF RAINY DAYS	7	6	8	5	0	***	0	0	1	7	10	15	***
1960	MONTHLY SUM (MM)	149.3	89.5	140.8	44.0	10.3	0.0	0.0	0.0	0.0	3.8	0.0	213.7	650.4
	NO OF RAINY DAYS	12	9	13	9	4	0	0	0	0	1	0	11	59
1961	MONTHLY SUM (MM)	142.9	317.4	266.9	177.3	46.5	0.0	0.0	0.0	0.0	0.0	288.8	286.8	1527.6
	NO OF RAINY DAYS	19	22	26	23	3	0	0	0	0	0	19	16	130
1962	MONTHLY SUM (MM)	288.5	160.8	208.2	157.2	6.9	0.0	0.0	0.0	0.0	146.0	117.9	136.5	1182.0
	NO OF RAINY DAYS	17	20	17	13	1	0	0	0	0	8	9	12	97
1963	MONTHLY SUM (MM)	136.7	115.1	194.1	188.9	29.9	0.0	0.0	0.0	0.0	0.0	246.8	281.8	1133.3
	NO OF RAINY DAYS	9	6	14	18	1	0	0	0	0	0	21	22	89
1964	MONTHLY SUM (MM)	289.7	193.1	266.0	34.7	0.0	0.0	0.0	0.0	0.0	0.0	67.1	136.8	987.1
	NO OF RAINY DAYS	28	19	21	7	0	0	0	0	0	0	4	14	94
1965	MONTHLY SUM (MM)	80.8	93.4	185.2	87.9	0.0	0.0	0.0	0.0	0.0	19.1	50.5	261.3	788.2
	NO OF RAINY DAYS	7	10	12	8	0	0	0	0	0	1	6	17	63
1966	MONTHLY SUM (MM)	127.9	153.9	377.0	107.9	0.0	0.0	0.0	0.0	0.0	6.4	99.3	193.1	1066.5
	NO OF RAINY DAYS	18	12	25	12	0	0	0	0	0	1	5	8	79
1967	MONTHLY SUM (MM)	36.3	161.4	129.6	154.9	102.9	0.0	0.0	0.0	0.0	0.0	92.0	207.4	934.6
	NO OF RAINY DAYS	7	8	8	8	5	0	0	0	0	0	4	14	54
1968	MONTHLY SUM (MM)	177.3	128.4	290.4	198.8	7.1	0.0	0.0	0.0	0.0	0.3	63.5	156.5	1022.3
	NO OF RAINY DAYS	12	8	16	17	1	0	0	0	0	1	4	16	75
1969	MONTHLY SUM (MM)	293.3	136.6	159.5	103.1	13.6	0.0	0.0	0.0	0.0	19.1	124.4	158.6	1008.2
	NO OF RAINY DAYS	13	14	12	10	4	0	0	0	0	1	9	16	79
1970	MONTHLY SUM (MM)	201.8	135.6	192.8	161.5	0.0	0.0	0.0	0.0	0.0	30.3	42.9	316.8	1141.7
	NO OF RAINY DAYS	14	14	13	13	0	0	0	0	0	2	6	20	84
1971	MONTHLY SUM (MM)	118.9	71.7	112.9	123.9	0.0	0.0	0.0	0.0	8.0	1.0	140.0	238.1	814.5
	NO OF RAINY DAYS	13	16	18	14	0	0	0	0	2	1	3	20	87
1972	MONTHLY SUM (MM)	171.7	182.7	133.2	******	******	******	******	******	******	******	******	******	******
	NO OF RAINY DAYS	15	11	12	***	***	***	***	***	***	***	***	***	***
STATISTICS FOR THE ENTIRE PERIODE OF 16 YEARS														
OBS NO		16	16	16	14	14	13	14	14	14	14	14	14	13
AMOUNT OF PRECIPITATION (MM)														
MEAN		166.7	164.9	201.0	118.7	16.7	0.0	0.0	0.0	0.9	20.4	113.5	209.2	1018.7
STD		72.8	100.1	80.6	48.4	28.3	0.0	0.0	0.0	2.3	39.6	79.1	89.4	219.4
STD/MEAN		0.44	0.61	0.40	0.41	1.69	0.0	0.0	0.0	2.67	1.94	0.70	0.28	0.22
NO OF RAINY DAYS														
MEAN		14.2	13.1	15.3	11.8	1.5	0.0	0.0	0.0	0.2	1.6	8.1	15.4	81.4
STD		5.6	5.3	4.9	4.6	1.8	0.0	0.0	0.0	0.6	3.6	3.7	3.8	19.0
STD/MEAN		0.40	0.40	0.32	0.39	1.19	0.0	0.0	0.0	2.70	1.96	0.71	0.25	0.23

Appendix 2
Refers to Volume 7, Chapter 4.

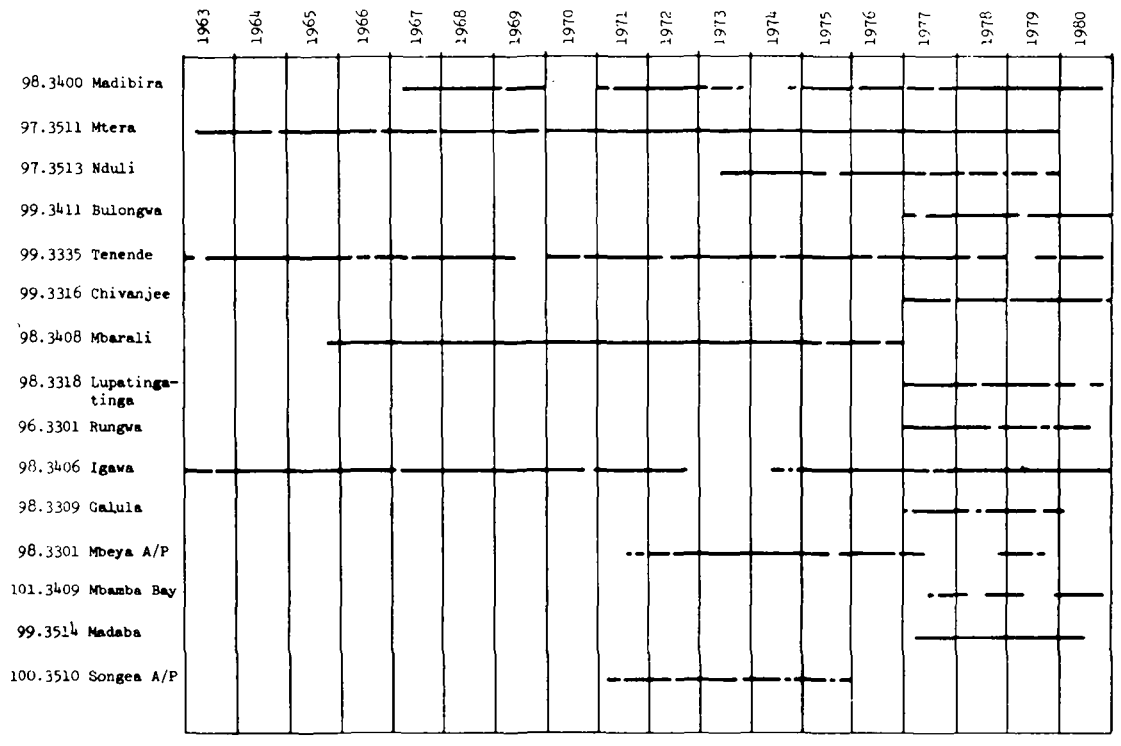


Figure 4.4[8] - Pan evaporation data availability.

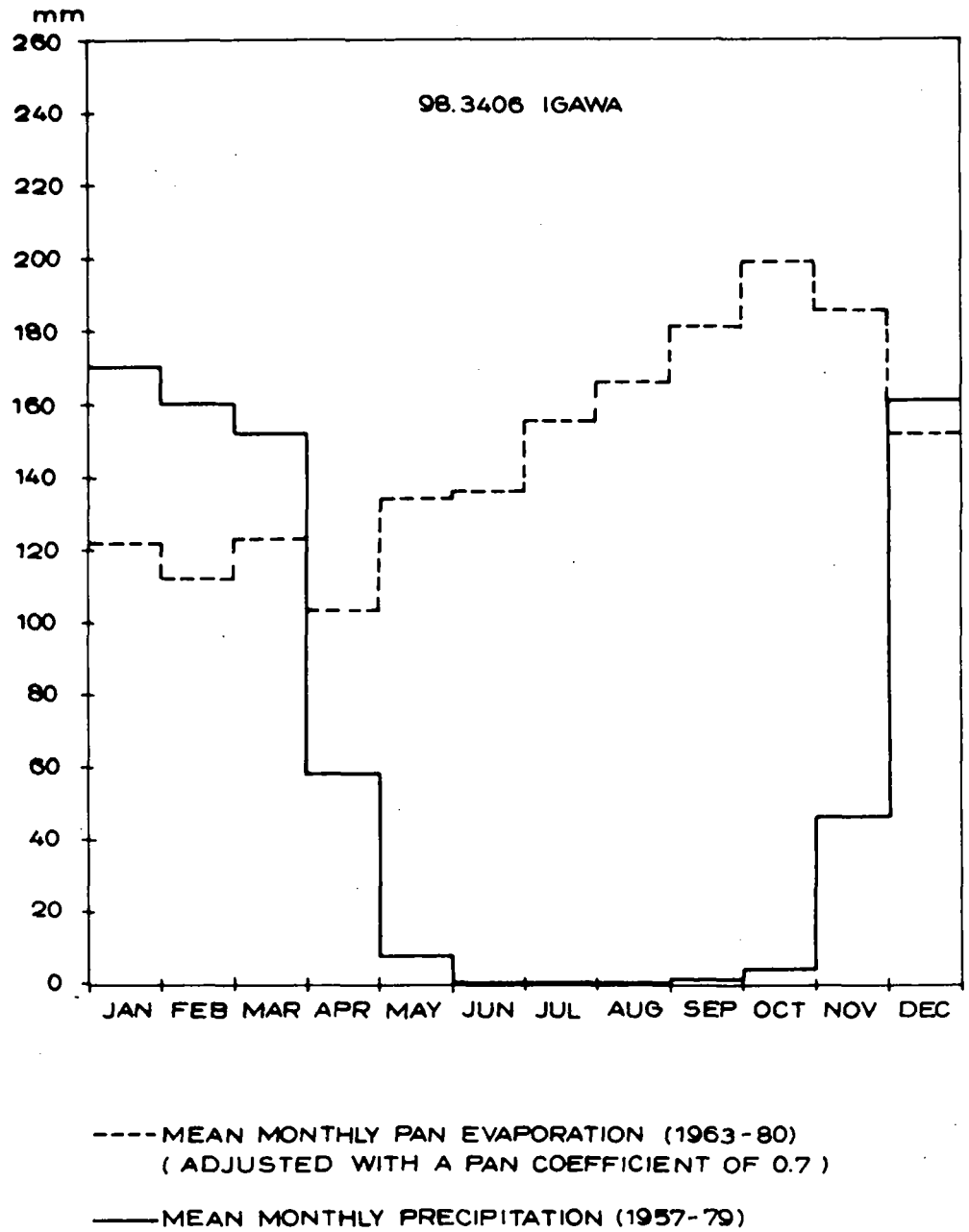


Figure 4.6[8] - Seasonal variation of mean monthly rainfall and mean monthly pan evaporation.

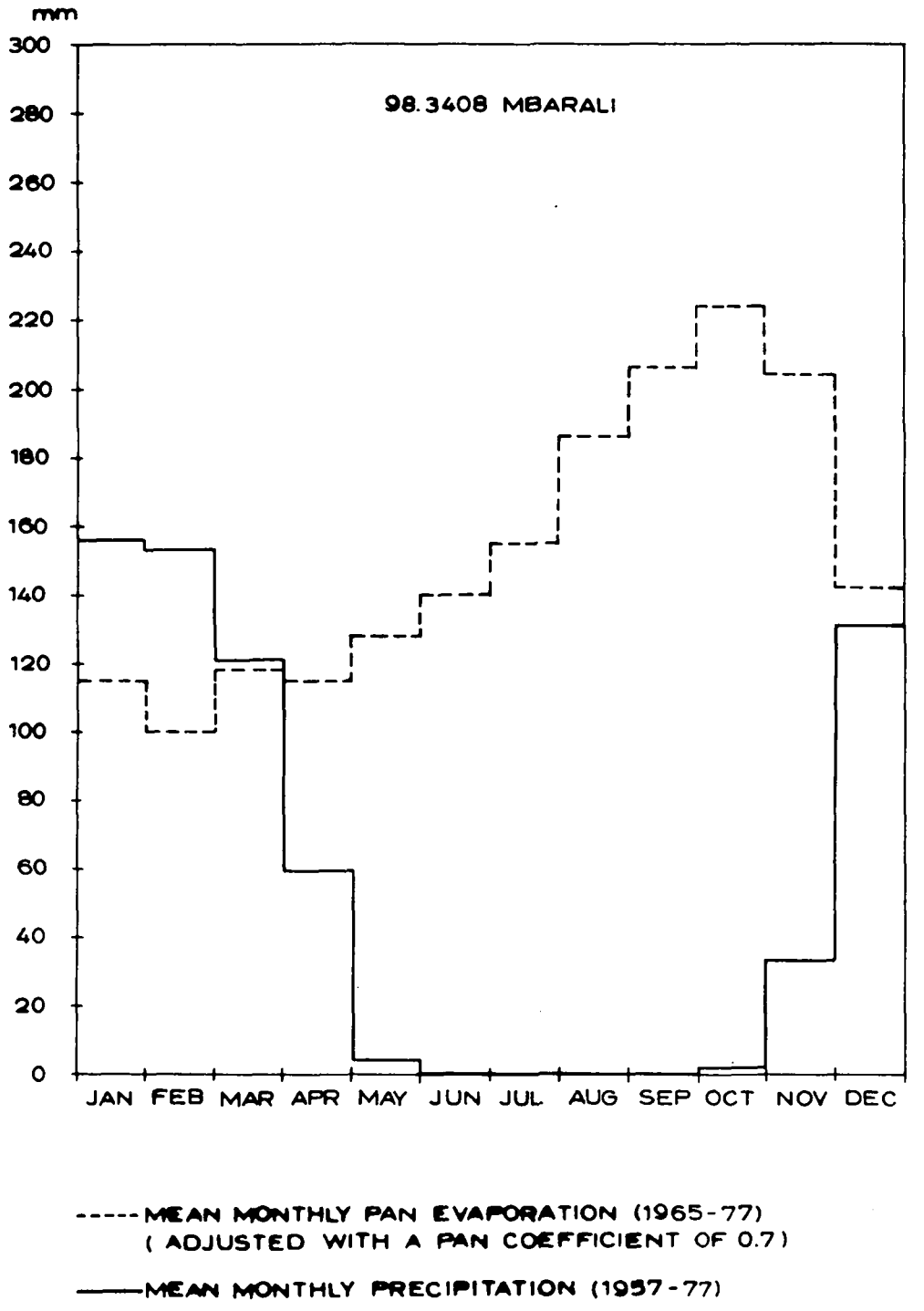


Figure 4.7[8] - Seasonal variation of mean monthly rainfall and mean monthly pan evaporation.

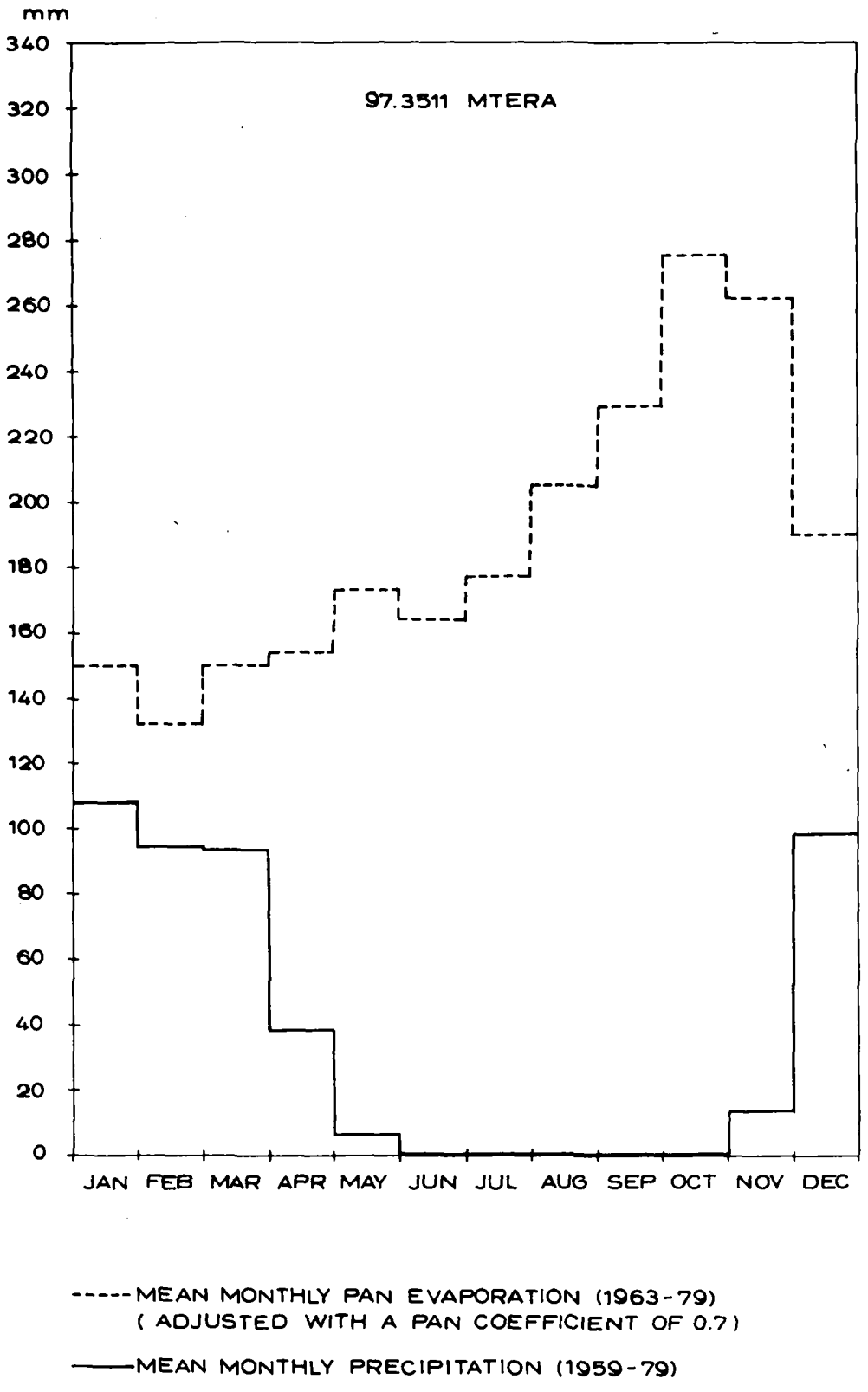


Figure 4.8[8] - Seasonal variation of mean monthly rainfall and mean monthly pan evaporation.

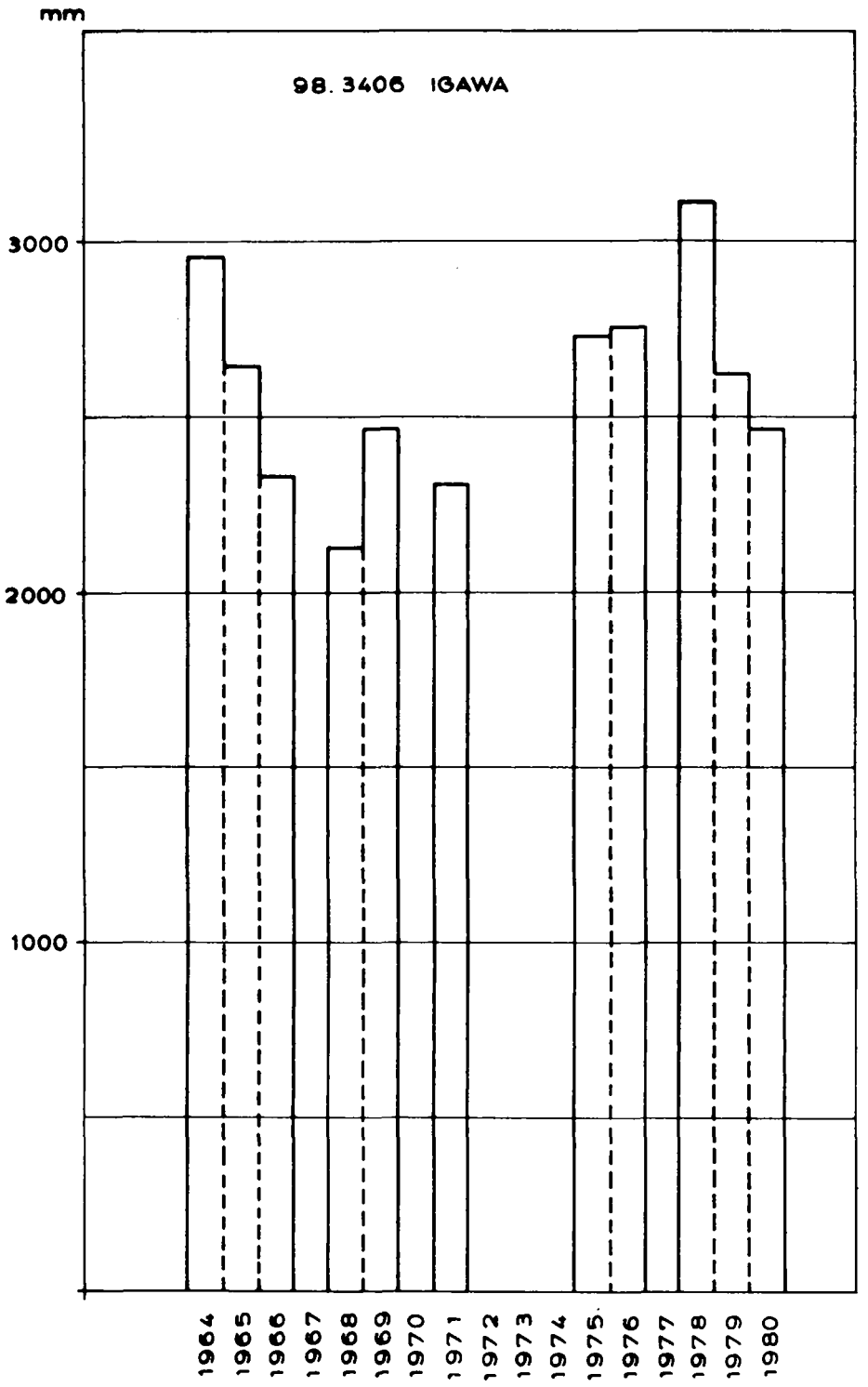


Figure 4.10[8] - Annual pan evaporation (adjusted with a pan coefficient of 0.7).

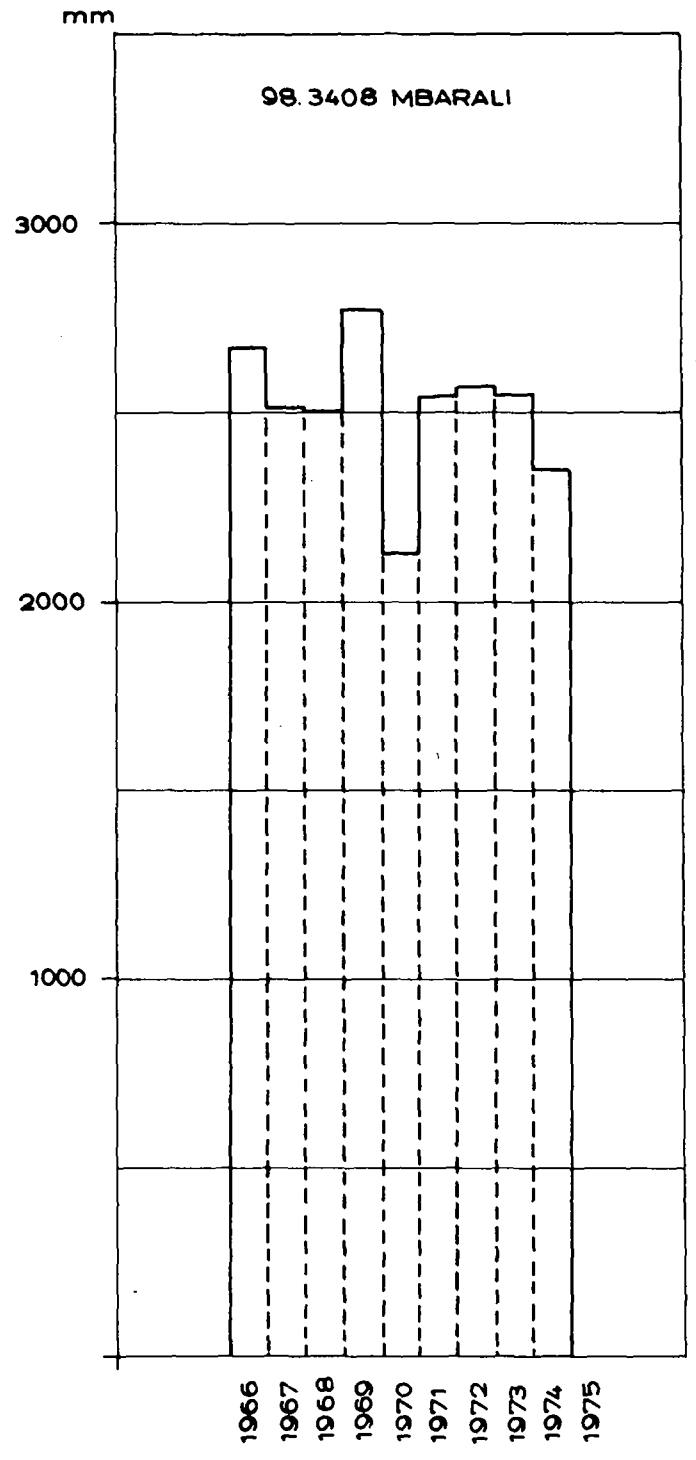


Figure 4.11[8] - Annual pan evaporation (adjusted with a pan coefficient of 0.7)

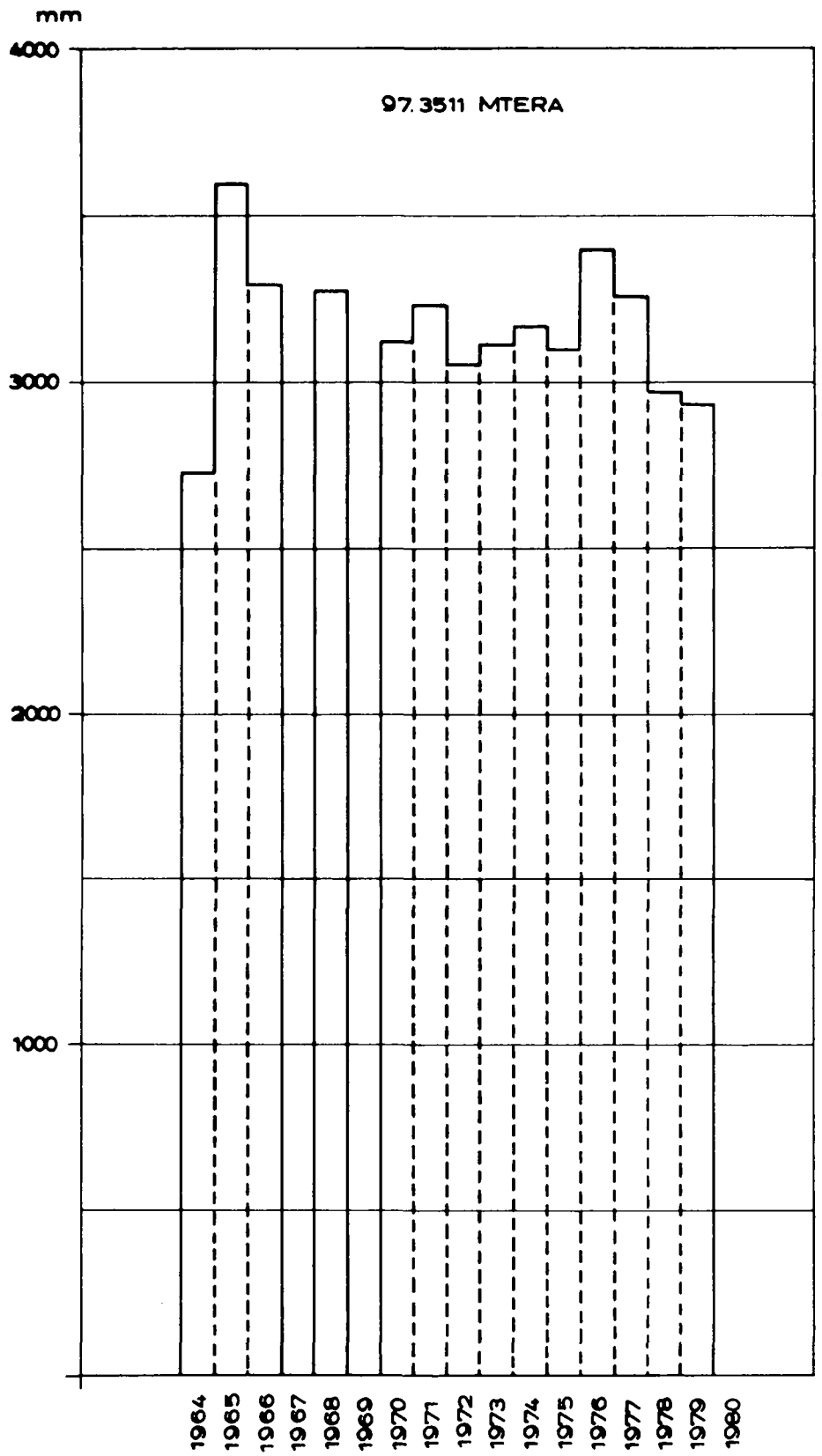


Figure 4.12[8] - Annual pan evaporation (adjusted with a pan coefficient of 0.7).

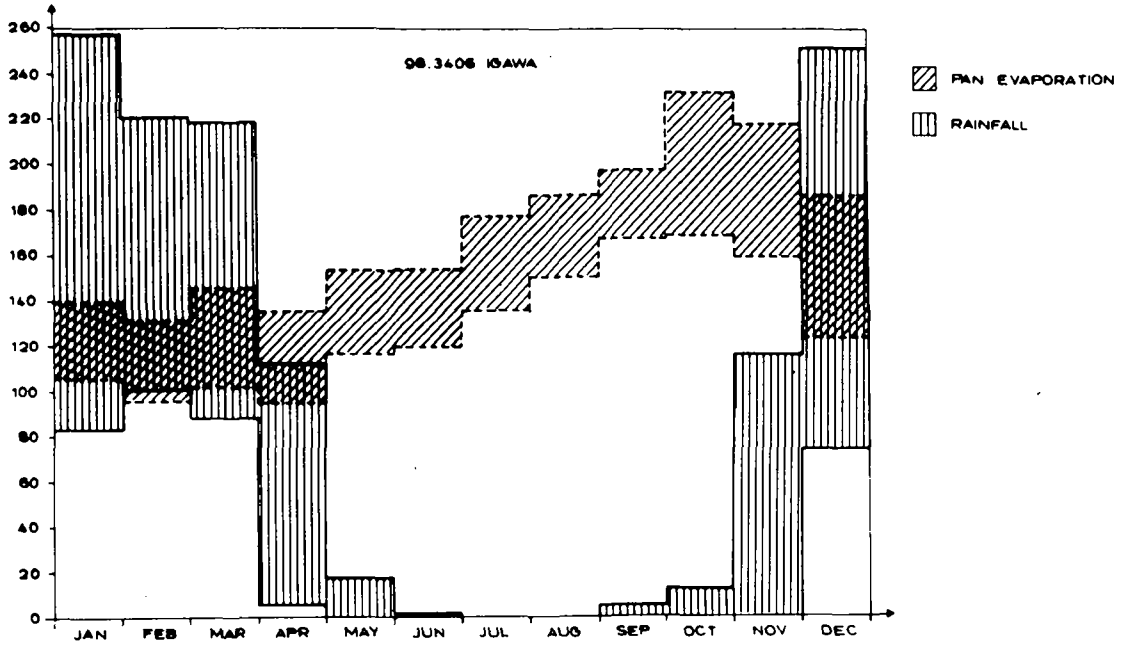


Figure 4.14[8] - Variability of monthly pan evaporation and monthly rainfall.

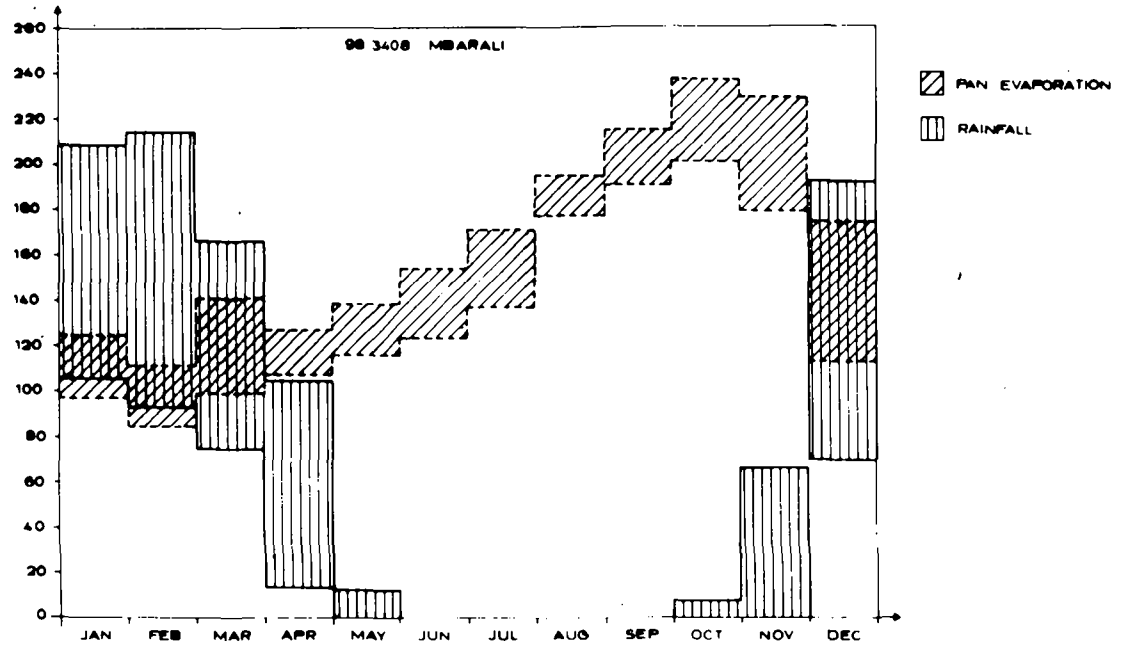


Figure 4.15[8] - Variability of monthly pan evaporation and montly rainfall.

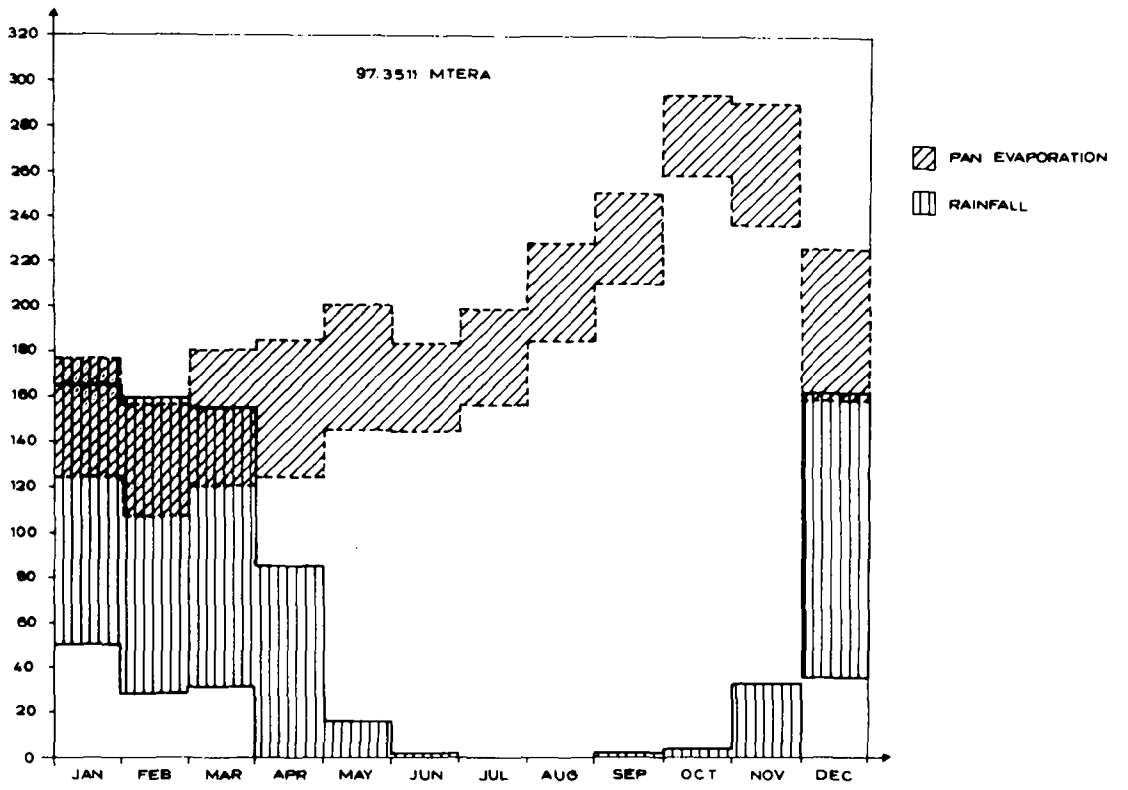
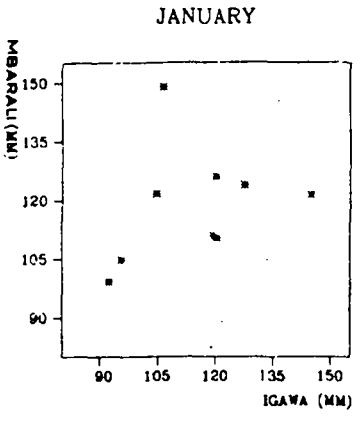
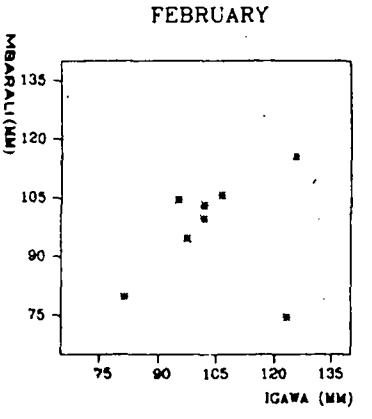


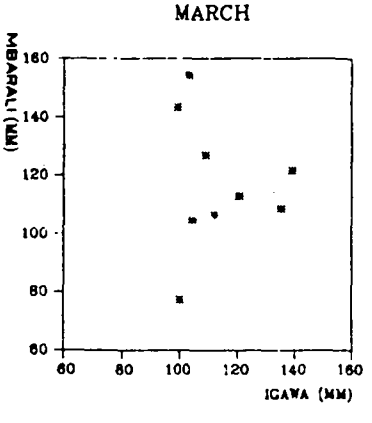
Figure 4.16[8] - Variability of monthly pan evaporation and monthly rainfall.



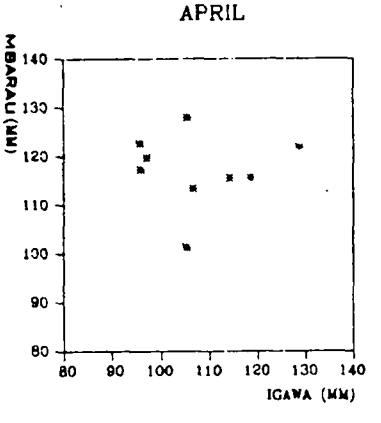
CORRELATION IGAWA-MBARALI



CORRELATION IGAWA-MBARALI



CORRELATION IGAWA-MBARALI



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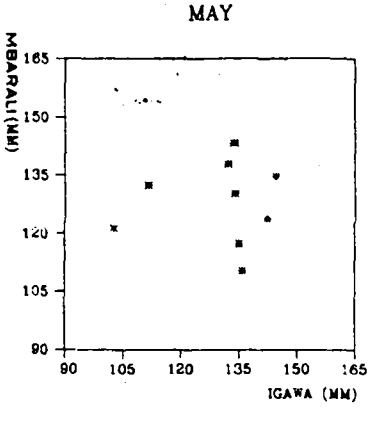
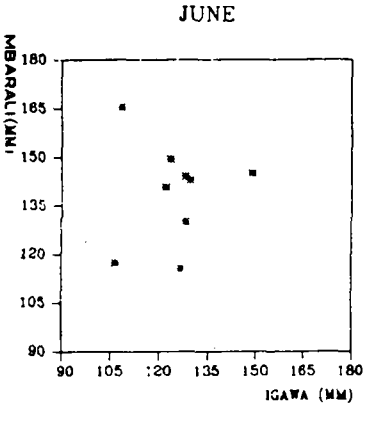
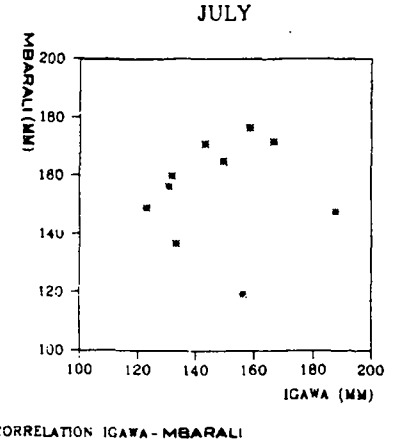


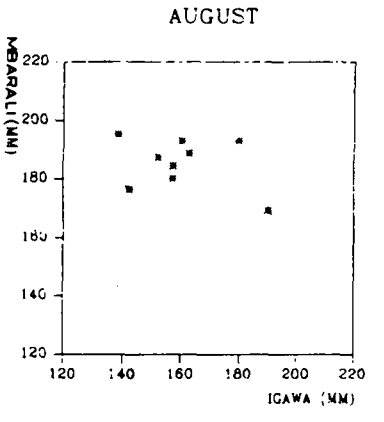
CORRELATION IGAWA-MBARALI



CORRELATION IGAWA-MBARALI



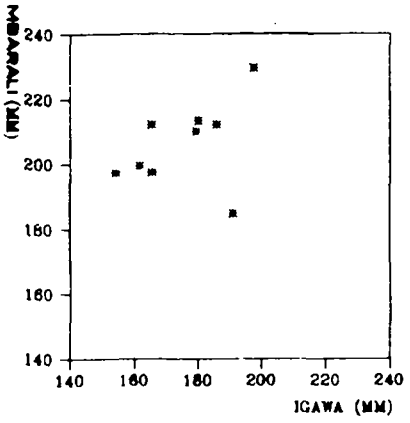
CORRELATION IGAWA-MBARALI



CORRELATION IGAWA-MBARALI

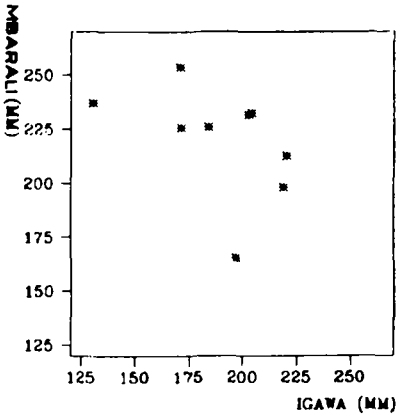
Figure 4.18[8] - Correlation Igawa - Mbarali.

SEPTEMBER



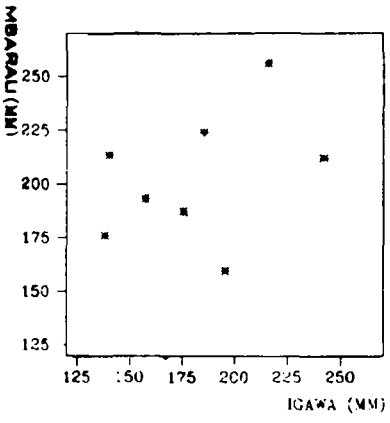
CORRELATION IGAWA-MBARALI

OCTOBER



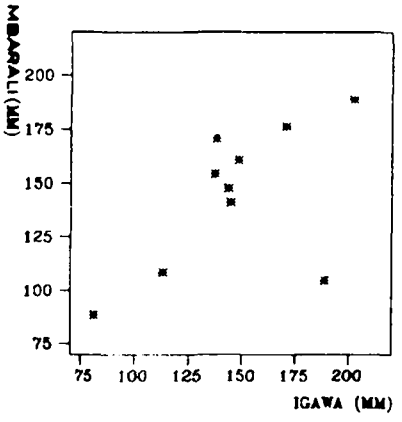
CORRELATION IGAWA-MBARALI

NOVEMBER



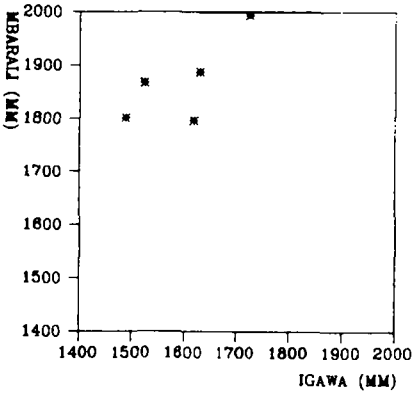
CORRELATION IGAWA-MBARALI

DECEMBER



CORRELATION IGAWA-MBARALI

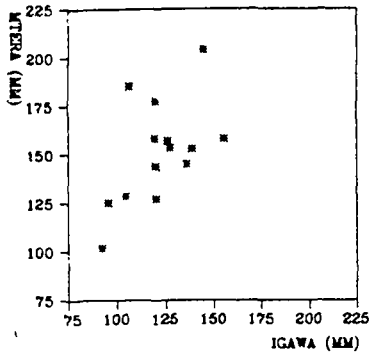
YEARLY



CORRELATION IGAWA-MBARALI

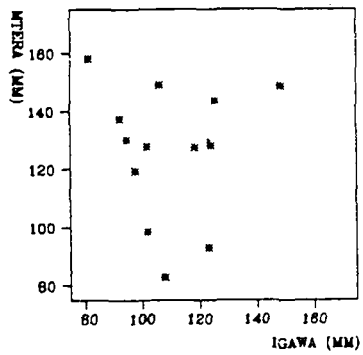
Figure 4.19[8] - Correlation Igawa - Mbarali.

JANUARY



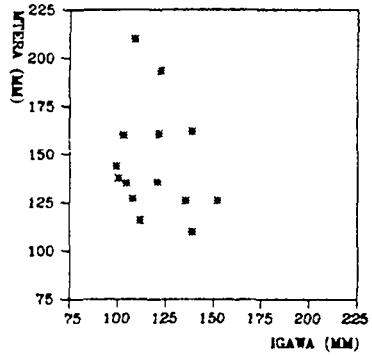
CORRELATION IGAWA-MTERA

FEBRUARY



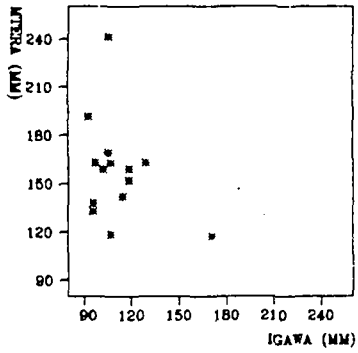
CORRELATION IGAWA-MTERA

MARCH



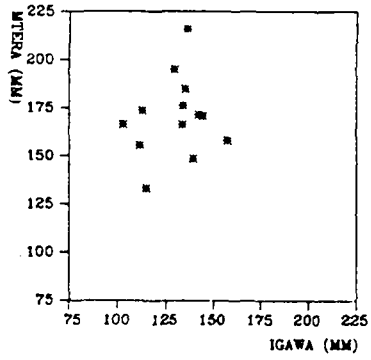
CORRELATION IGAWA-MTERA

APRIL



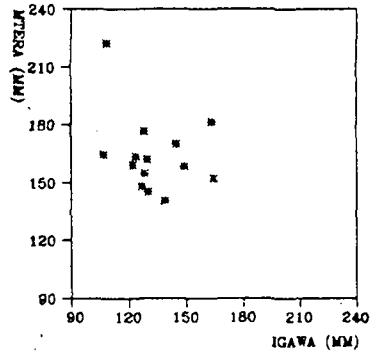
CORRELATION IGAWA-MTERA

MAY



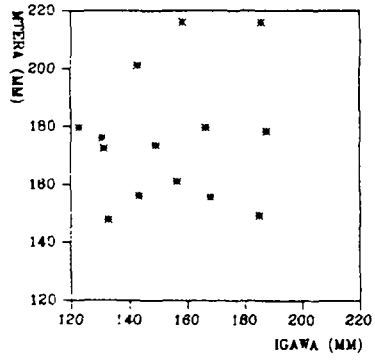
CORRELATION IGAWA-MTERA

JUNE



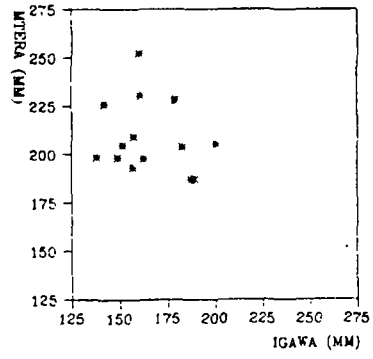
CORRELATION IGAWA-MTERA

JULY



CORRELATION IGAWA-MTERA

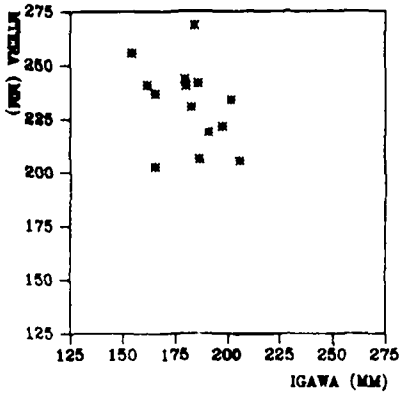
AUGUST



CORRELATION IGAWA-MTERA

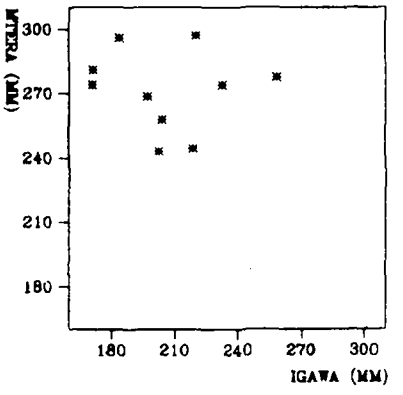
Figure 4.20[8] - Correlation Igawa - Mtera.

SEPTEMBER



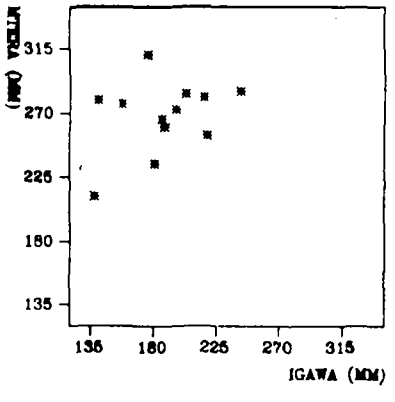
CORRELATION IGAWA-MTERA

OCTOBER



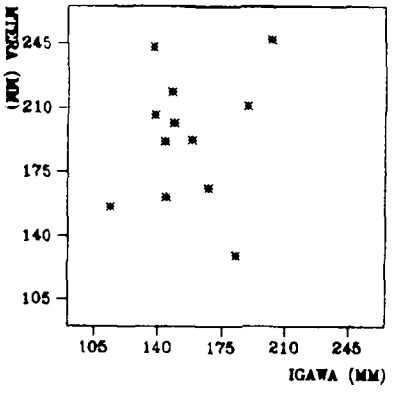
CORRELATION IGAWA-MTERA

NOVEMBER



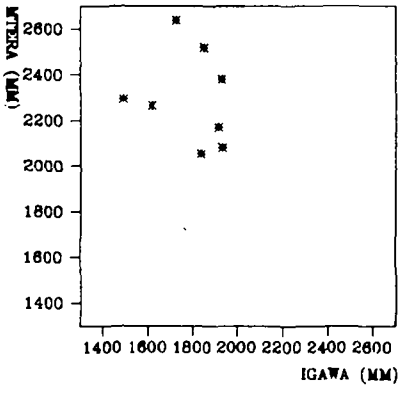
CORRELATION IGAWA-MTERA

DECEMBER



CORRELATION IGAWA-MTERA

YEARLY



CORRELATION IGAWA-MTERA

Figure 4.21[8] - Correlation Igawa - Mtera.

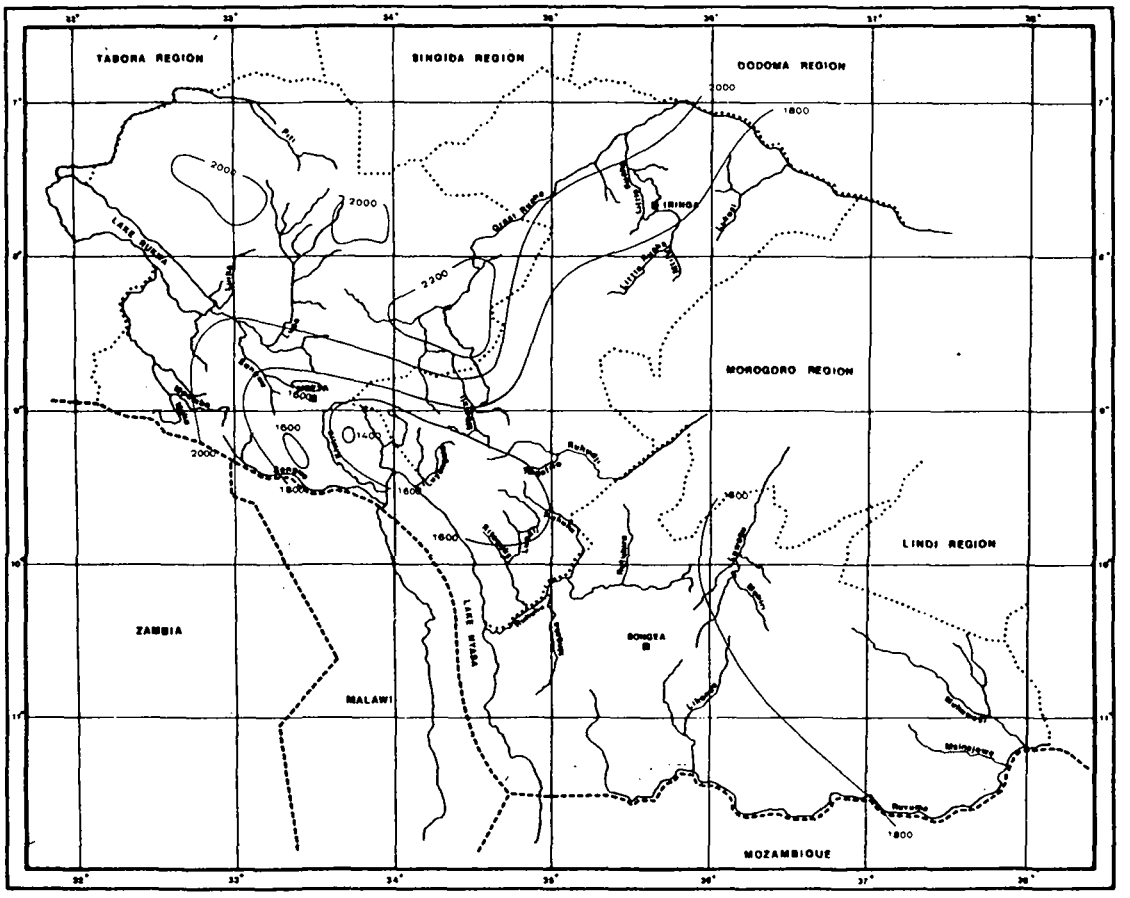


Figure 4.23[8] - Isoline map of potential evaporation (Woodhead).

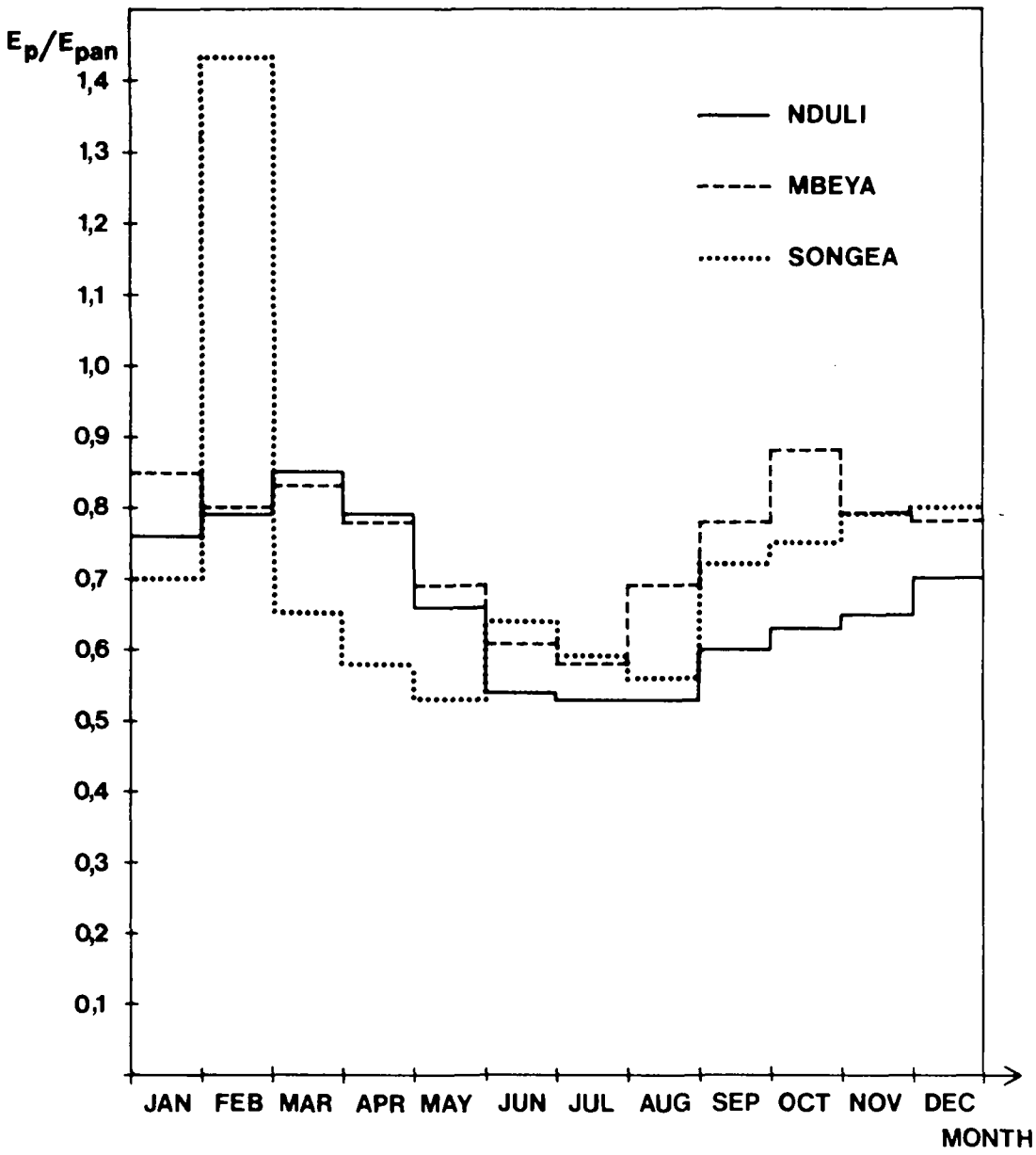


Figure 4.24[8]. Seasonal variation of pan coefficient.

Station Number	Station Name	Region	Operation Responsibility	Period of Record	Visited	Reliability	Exposure	Altitude (m above sea lev.)	Mean ann. pan evap. in mm(x0.7)
96.3301	Rungwa	Mbeya	Maji	1977-80	Yes	Good	Good	1220	1427
97.3401	Msembe	Iringa	Maji	-	Yes	Bad	Good	792	Unreliable records
97.3511	Mtera	Iringa	Maji	1962-79	Yes	Good	Good	683	2261
97.3513	Nduli	Iringa	DOM	1973-79	Yes	Good	Good	1428	1412
97.3525	Izazi Maji	Iringa	Maji		Yes	Bad	Good		Unreliable records
98.3301	Mbeya Airfield	Mbeya	DOM	1971-79	Yes	Good	Good	1750	1332
98.3309	Galula	Mbeya	Maji	1977-80	Yes	Bad	Good	850	1930
98.3318	Lupatingatinga	Mbeya	Maji	1977-80	Yes	Bad	Good	1372	1187
98.3400	Madibira	Iringa	Maji	1967-80		Good	Good	1150	1394
98.3406	Igawa	Mbeya	Maji	1963-80	Yes	Good	Good	1067	1779
98.3408	Mbarali	Mbeya	Maji	1965-76				1055	1835
98.3538	Ngwazi	Iringa	Consultants (Maji)		Yes		Fair	1830	
98.3540	Sao Hill Livest	Iringa	Consultants (Maji)		Yes		Good	2073	
99.3316	Chivanju	Mbeya	Maji	1977-80	Yes	Good	Good	1067	1016
99.3324	Kiwira Pr. Sch.	Mbeya	Consultants (Maji)		Yes		Good	1360	
99.3326	Mwalupindi Pr. Sch.	Mbeya	Consultants (Maji)		Yes		Good	2135	
99.3335	Itope-Tenende	Mbeya	Maji	1963-80	Yes	Good	Fair	549	1516
99.3411	Bulongwa	Iringa	Maji	1977-80				2135	840
99.3514	Madaba	Ruvuma	Maji	1977-80	Yes	Good	Good	1670	1277
100.3510	Songea Airport	Ruvuma	DOM	1971-75	Yes	Good	Good	1100	1279
101.3409	Mbamba Bay	Ruvuma	Maji	1977-80	Yes	Good	Good	490	1417
	Mngaka Maji	Ruvuma	Consultants (Maji)		Yes		Good	1340	
	Mbinga Maji	Ruvuma	Consultants (Maji)		Yes		Good	1340	

Table 4.1[8] - List of evaporation pans.

Station: 96.3301 Rungwa

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1977	91	88	117	128	104	113	124	145	176	217	130	98	1533
1978	91	120	100	99	98	99	113	150			80	87	
1979	113	86	115	103	91	99	52		124	206		93	
1980	85	120	93	101	111	109	111						
Means	95	104	106	108	101	105	100	148	150	212	105	93	

Sum of monthly means: 1427

Table 4.2[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station: 97.3511 Mtera

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1963				137	146	171	179	184	191	303	236	172	
1964	158	148	125	117	158	152	149	186	206		283	218	
1965	145	137	193	191	195	181	216	230	268	268	272	210	2519
1966	177	158	143	169	216	222	216	228	221		311	242	
1967	185	161	160	137	155	163	172	204	202	248	211		
1968	125	127	135	132	166	164	179	225	255	295	279	205	2293
1969	204	130	209	241	247	176	201	252	240	273	265		
1970	101	119	137	142	166	162	178	198	243	288	290	155	2183
1971	128	92	161	162	184	159	176	209	240	280	276	191	2264
1972	153	98	126	163	176	154	173	197	236	259	216	178	2132
1973	118	126	168	155	185	158	171	160	236	282	235	179	2177
1974	165	172	195	114	144	148	147	193	221	257	252	201	2214
1975	144	143	115	162	171	160	161	187	218	244	285	160	2169
1976	158	149	135	155	170	158	179	203	241	296	281	246	2380
1977	127	127	160	158	173	169	194	227	205	267	260	165	2280
1978	153	128	127	151	148	140	155	205	233	273	234	129	2081
1979	157	82	109	118	133	145	156	198	230	277	254	192	2055
Means	150	132	150	154	173	164	177	205	229	275	262	190	2229

Sum of monthly means: 2261

Table 4.3[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station: 97.3513 Nduli

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1973						124	133	140	153	185	142	126	
1974	101	116	75	73	92	88	105	141	133	101	148	120	1293
1975	102	100	82	104	109	95				151	171	106	
1976	109	92	95	84	104	121	131	137	148	160	156	157	1496
1977	103	94	105	73	94		123	127	151	174	138	124	
1978	90	94		104	106	98	113	136	155	178		97	
1979		74	85	72	90	111	117			171	151	128	
Means	101	95	88	85	99	106	120	136	148	160	151	123	1395

Sum of monthly means: 1412

Table 4.4[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station: 98.3301 Mbeya Airfield

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1971								121		173	160		
1972	77	130	95	132	97		116	145	160	164	119	124	
1973	89	77	76	77	103	97	108	125	154	177	150	113	1346
1974	79	77	93	84	90	94	94	125	155	163	142	111	1307
1975	89	96	95	94	86	103	117			150	162	91	
1976	87	76	89	74	85	86	96	111	141	145		137	
1977	78	82	89	77	78								
1978											140	76	
1979	97	73	91	73	82	87		126	153				
Means	85	87	90	87	89	93	106	126	153	162	145	109	1327

Sum of monthly means: 1332

Table 4.5[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station: 98.3309 Galula

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1977	129		167	165	171	143	166	192	210	236	124	123	
1978	118	99	110			160		192	208	237	255	120	
1979	118	149	111	116	122	116	119			149	172	165	
1980	156												
Means	130	124	129	141	146	189	143	192	209	207	184	136	

Sum of monthly means: 1930

Table 4.6[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station: 99.3316 Chivanjee

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1977	99	84	121	68	61	51	52	59	75	113	112		
1978	69	68	84	175	46	38	43	74	100	157	129	74	1057
1979		111	108	167	44	57	62	68	89	113	97	32	
1980	63	75	113	78	60	48	41	65	90	101		94	
Means	77	85	107	122	53	49	50	67	89	121	113	83	

Sum of monthly means: 1016

Table 4.7[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station: 98.3318 Lupatingatinga

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1977	76	92	83	78	83	63	122	182	134	83	82	78	1155
1978	67	65	59	103	96		74	102	132	139	90	59	
1979	76	75	96	82	96	92	111	124	130	139		67	
1980	119	108	117	105				161	164	135			
Means	90	85	89	92	91	78	102	142	140	124	86	68	

Sum of monthly means: 1187

Table 4.8[8] - Adjusted monthly pan eveporation in mm (pan coefficient = 0.7).

Station: 98.3400 Madibira

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1967				80	115	117	137	154	144	159	133	110	
1968	93	123	82	149	99	106	126	99	144	198	149	110	1483
1969	182	78			182	189	162	182	174	191	151	125	
1970													
1971	84	88	102		143	138	149	151	138	125	121	112	
1972	91	75	97	86	89	102	115	119	140	147	115	102	1282
1973	82	96		73	134	109	106	121		158			
1974										162	142		
1975	106	80	78	84	97	100	108	125	130	136	123	62	1235
1976	95		86	73	104	102	108	115	134	141	142	130	
1977		76	80	75	97	115	108		161	149	138	108	
1978	136	76	76	67	97	90	104	136	170	115	123	115	1309
1979	97	66	91	79	91	90	119	134	153	167	132	112	1336
1980	84	89	84	81	93	113	121	128	153	167			
Means	106	85	87	85	112	115	122	134	150	155	134	109	1329

Sum of monthly means: 1394

Table 4.9[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station: 98.3406 Igawa

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1963	116	113	176	137	176	156		161	167	180	169	184	
1964	155	148	152	170	157	164	184	187	186	211	202	147	2069
1965	136	92	122	92	129	163	185	160	184	197	195	188	1849
1966	120	81	99	105	136	108	158	179	197	130	175	137	1629
1967	106		103	95	111	123	131	152	165	202	138	81	
1968	95	101	104	96	102	106	122	142	154	184	140	138	1488
1969	144	94	108	105	132	128	142	160	180	171	185	170	1725
1970	92	97	100	114	133	129	187	138	179			123	
1971	104	123	139	106	135	122	130	157	161	171	157	143	1617
1972	127	101	135	97	134	128	149	162					
1973													
1974						126	132	157		204		148	
1975	120	125	111	128	142.2	143	156	189	191	219	242	144	1914
1976	119	106	120	118	144.6	149	166	183	185	220	215	202	1931
1977	120	118	121	101	112.6	144		178	206		187	167	
1978	138	124	107	118	139.4	138	168	200	201	232	180	182	1932
1979	125	107	138	107	115.0	130	143	149	182	258	218	158	1834
1980	119	136	121	117	134.5	138	158	167	178	197	197	128	1794
Means	122	112	123	113	134	136	155	166	181	199	186	152	1799

Sum of monthly means: 1779

Table 4.10[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station: 98.3408 Mbarali

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1965										165	160	104	
1966	110	79	143	101	110	165	176	192	229	237	187	154	1887
1967	148	119	154	122	132	149	159	187	197	231	176	88	1867
1968	104	103	104	117	121	117	148	176	197	226	213	170	1801
1969	121	104	126	128	137	144	170	192	213	253	224	176	1993
1970	99	94	77	115	143	142	147	195	210	240	224	108	1799
1971	121	74	121	113	117	140	156	184	199	225	193	147	1795
1972	123	99	108	119	130	130	164	188	212	238	199	128	1843
1973	110	103	110	117	138	149	149	193	203	230	191	132	1830
1974	106	103	128	96	112	115	136	180	214	232	210	160	1796
1975	125	115	106	121	123		119	169	184	198	212	141	
1976	110	105	112	115	134	144	171		212	212	256	188	
Means	117	100	118	115	128	140	154	186	207	224	204	142	1846

Sum of monthly means: 1835

Table 4.11[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station: 99.3335 Tenende

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1963	115	101				81	85	110	136	167	125	120	
1964	91	93	155	229	182	77	86	97	86	175	204	146	1627
1965	131	150	274	363	110	100	87	104	125	131	142	111	1822
1966	79	103	173		215	154	70		54	140	128	112	
1967	125	87	99	103		88	81	86	149	131	98	191	
1968	92	109	259	235	272	81	78	114	107	132	135	99	1719
1969	103	108	105	198	227								
1970	97	147	220	168	90	92	62		106	130	127	98	
1971	92	85	171	322	77	78	95	96	107	135	111	106	1479
1972	105	84	97	163		66	58	91	116	137	172	125	
1973	93	90	117	82	76	113	73	93	146	146	131	120	1284
1974	102	93	128	332	105	68		90	100	131	132	120	
1975	123	124	141	175	136	226	75	77	75	78	99	100	1435
1976	92	112	193	143	253		80	75	65	64	75	152	
1977	139	65	192	215	229	74	155	91	88	109	119	136	1619
1978	121	156	252			122	57	90	108	122	118	73	
1979							78	90	114	133	126	137	
1980	95	96	132	82	291	72	83	80	101	105			
Means	106	106	170	201	175	100	82	93	105	128	128	122	1576

Sum of monthly means: 1516

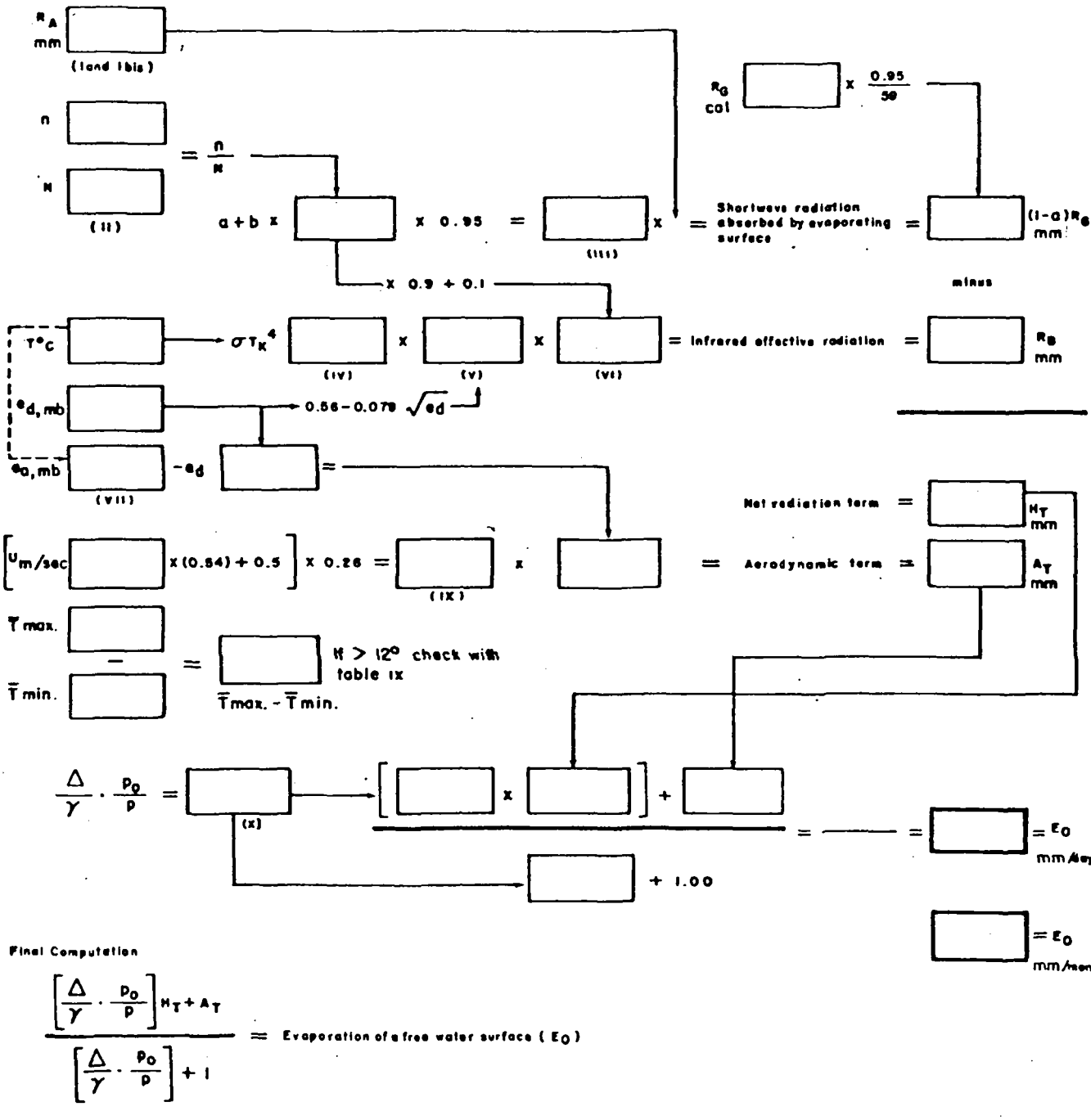
Table 4.12[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

FAO/UNESCO/WMO AGROCLIMATOLOGY SURVEYS

EVAPORATION OF A FREE WATER SURFACE after PENMAN

Country ..... Station ..... Period .....

Latitude ..... Longitude ..... Altitude .....



Final Computation

$$\frac{\left[\frac{\Delta}{\gamma} \cdot \frac{p_o}{p}\right] H_T + A_T}{\left[\frac{\Delta}{\gamma} \cdot \frac{p_o}{p}\right] + 1} = \text{Evaporation of a free water surface } (E_O)$$

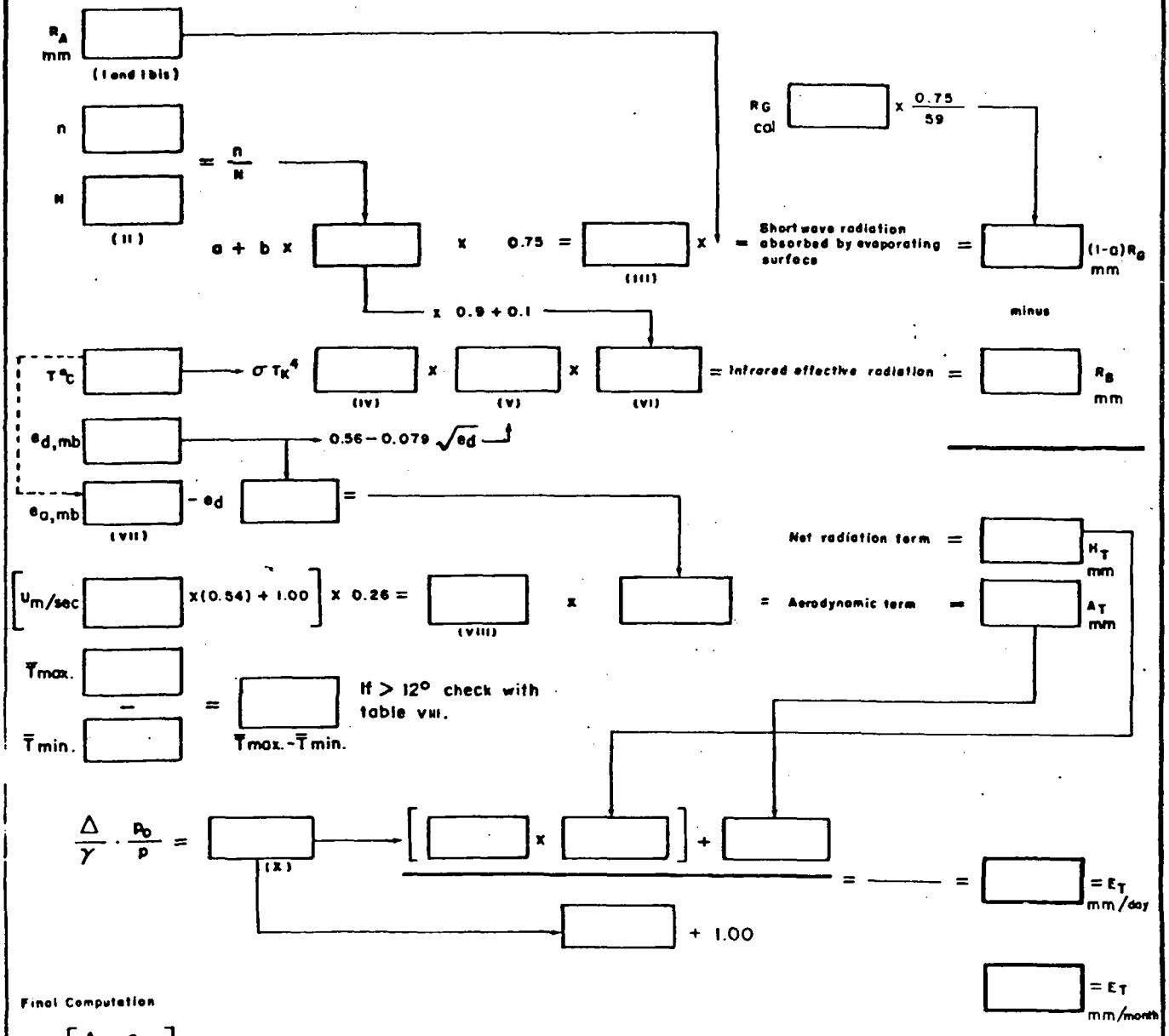
* Roman numeral indicates No. of appropriate table

FAO/UNESCO/WMO AGROCLIMATOLOGY SURVEYS

POTENTIAL EVAPOTRANSPIRATION after PENMAN

Country ..... Station ..... Period .....

Latitude ..... Longitude ..... Altitude .....



Final Computation

$$\frac{\left[\frac{\Delta}{\gamma}\cdot\frac{p_o}{p}\right]H_t + A_t}{\left[\frac{\Delta}{\gamma}\cdot\frac{p_o}{p}\right]+1} = \text{Potential Evapotranspiration } (E_T)$$

* Roman numeral indicates No of appropriate table

TABLE X

Table giving $\frac{\Delta_x po}{\gamma \; p}$ in function of T°C
and standard elevation in metres above or below sea level

	Elevation in metres										
T°C	2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000
0	0.86	0.88	0.90	0.93	0.95	0.97	1.00	1.03	1.05	1.08	1.11
1	0.92	0.94	0.96	0.99	1.01	1.04	1.07	1.09	1.12	1.15	1.18
2	0.97	1.00	1.03	1.05	1.07	1.10	1.13	1.16	1.20	1.23	1.26
3	1.04	1.07	1.09	1.12	1.15	1.18	1.21	1.24	1.27	1.31	1.34
4	1.11	1.13	1.16	1.19	1.22	1.25	1.29	1.32	1.36	1.39	1.43
5	1.17	1.21	1.24	1.27	1.30	1.33	1.37	1.40	1.44	1.48	1.51
6	1.25	1.28	1.31	1.35	1.38	1.41	1.45	1.49	1.53	1.57	1.61
7	1.33	1.36	1.40	1.43	1.47	1.51	1.55	1.59	1.63	1.67	1.71
8	1.41	1.45	1.48	1.52	1.56	1.60	1.64	1.69	1.73	1.77	1.82
9	1.50	1.54	1.58	1.62	1.66	1.70	1.74	1.79	1,84	1.88	1.93
10	1.59	1.63	1.67	1.72	1.76	1.80	1.85	1.90	1.95	2.00	2.05
11	1.68	1.73	1.77	1.82	1.86	1.91	1.96	2.01	2.07	2.12	2.17
12	1.78	1.83	1.87	1.92	1.97	2.02	2.07	2.13	2.18	2.24	2.30
13	1.89	1.94	1.99	2.04	2.09	2.14	2.20	2.26	2.32	2.37	2.43
14	2.00	2.05	2.10	2.16	2.21	2.26	2.32	2.39	2.45	2.51	2.58
15	2.11	2.17	2.22	2.28	2.34	2.40	2.46	2.53	2.59	2.66	2.72
16	2.24	2.30	2.36	2.42	2.48	2.54	2.61	2.68	2.75	2.82	2.89
17	2.37	2.43	2.50	2.56	2.62	2.69	2.76	2.84	2.91	2.98	3.06
18	2.51	2.57	2.64	2.71	2.77	2.84	2.92	3.00	3.08	3.15	3.23
19	2.65	2.72	2.79	2.86	2.93	3.00	3.08	3.17	3.25	3.33	3.42
20	2.80	2.87	2.94	3.02	3.09	3.17	3.26	3.34	3.43	-	-
21	2.95	3.03	3.11	3.19	3.26	3.35	3.44	3.53	-	-	-
22	3.11	3.19	3.28	3.36	3.44	3.53	3.62	-	-	-	-
23	3.29	3.37	3.46	3.55	3.63	3.72	-	-	-	-	-
24	3.46	3.55	3.64	3.74	3.83	-	-	-	-	-	-
25	3.64	3.74	3.84	3.94	-	-	-	-	-	-	-
26	3.84	3.94	4.04	-							
27	4.04	4.15	-								
28	4.25	-									
29	-										

TABLE X

Table giving $\frac{\Delta_x po}{\gamma \ p}$ in function of T°C
and standard elevation in metres above or below sea level

	Elevation in metres											
T°C	-400	-200	0	200	400	600	800	1000	1200	1400	1600	1800
0	0.63	0.65	0.67	0.69	0.71	0.72	0.74	0.76	0.78	0.80	0.82	0.84
1	0.68	0.70	0.72	0.74	0.75	0.77	0.79	0.81	0.83	0.85	0.87	0.89
2	0.72	0.74	0.76	0.78	0.80	0.82	0.84	0.86	0.88	0.91	0.93	0.95
3	0.77	0.79	0.81	0.83	0.86	0.88	0.90	0.92	0.94	0.97	0.99	1.01
4	0.83	0.85	0.87	0.89	0.91	0.93	0.96	0.98	1.00	1.03	1.05	1.08
5	0.88	0.90	0.92	0.94	0.97	0.99	1.01	1.04	1.07	1.09	1.12	1.15
6	0.94	0.96	0.98	1.00	1.03	1.05	1.08	1.10	1.13	1.16	1.19	1.22
7	1.00	1.02	1.04	1.07	1.09	1.12	1.15	1.17	1.21	1.24	1.27	1.30
8	1.07	1.09	1.11	1.13	1.16	1.19	1.22	1.25	1.28	1.31	1.35	1.38
9	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.32	1.36	1.39	1.43	1.46
10	1.19	1.22	1.25	1.28	1.31	1.34	1.37	1.41	1.44	1.48	1.52	1.55
11	1.26	1.29	1.32	1.35	1.39	1.42	1.45	1.49	1.53	1.57	1.61	1.65
12	1.34	1.37	1.40	1.43	1.47	1.50	1.54	1.57	1.62	1.66	1.70	1.74
13	1.42	1.45	1.48	1.52	1.55	1.59	1.63	1.67	1.71	1.76	1.80	1.84
14	1.51	1.54	1.57	1.61	1.64	1.68	1.72	1.77	1.81	1.86	1.91	1.95
15	1.58	1.62	1.66	1.70	1.74	1.78	1.82	1.87	1.92	1.97	2.02	2.06
16	1.68	1.72	1.76	1.80	1.85	1.89	1.94	1.98	2.04	2.09	2.14	2.19
17	1.76	1.81	1.86	1.91	1.95	2.00	2.05	2.10	2.15	2.21	2.26	2.32
18	1.87	1.92	1.97	2.02	2.06	2.11	2.17	2.22	2.28	2.33	2.39	2.45
19	1.98	2.03	2.08	2.13	2.18	2.23	2.29	2.34	2.40	2.47	2.53	2.59
20	2.07	2.13	2.19	2.25	2.30	2.36	2.42	2.47	2.54	2.60	2.67	2.73
21	2.22	2.27	2.32	2.37	2.43	2.49	2.55	2.61	2.68	2.75	2.82	2.88
22	2.32	2.38	2.44	2.50	2.56	2.63	2.69	2.75	2.83	2.90	2.97	3.04
23	2.46	2.52	2.58	2.64	2.71	2.77	2.84	2.90	2.98	3.06	3.13	3.21
24	2.60	2.66	2.72	2.78	2.85	2.92	2.99	3.06	3.14	3.22	3.30	3.38
25	2.72	2.79	2.86	2.93	3.00	3.08	3.15	3.22	3.31	3.40	3.48	3.56
26	2.85	2.93	3.01	3.09	3.16	3.24	3.32	3.40	3.49	3.58	3.66	3.75
27	3.01	3.09	3.17	3.25	3.33	3.41	3.49	3.57	3.67	3.76	3.86	3.95
28	3.18	3.26	3.34	3.42	3.50	3.59	3.67	3.76	3.86	3.96	4.06	4.15
29	3.35	3.43	3.51	3.60	3.68	3.77	3.86	3.95	4.06	4.17	4.27	4.37
30	3.51	3.60	3.69	3.78	3.87	3.97	4.06	4.16	4.27	4.38	4.49	-
31	3.68	3.78	3.88	3.98	4.07	4.17	4.27	4.37	4.49	4.60	-	
32	3.87	3.97	4.07	4.18	4.28	4.38	4.49	4.59	4.71	-		
33	4.07	4.17	4.27	4.38	4.48	4.59	4.70	4.81	-			
34	4.26	4.37	4.48	4.59	4.70	4.82	4.93	-				
35	4.47	4.59	4.71	4.83	4.95	5.06	-					

TABLE IX - U

Evaporation of a free water surface

Expression 0.26 (0.5 + 0.75.U) where wind speed (U) is expressed in m/sec for $14°C < T_M - T_m \leq 15°C$

U	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0 130	0.150	0.169	0.189	0.208	0.228	0.247	0.267	0.286	0.306
1	0.325	0.345	0.364	0.384	0.403	0.423	0.442	0.462	0.481	0.501
2	0.520	0.540	0.559	0.579	0.598	0.618	0.637	0.657	0.676	0.696
3	0.715	0.735	0.754	0.774	0.793	0.813	0.832	0.852	0.871	0.891
4	0.910	0.930	0.949	0.969	0.988	1.008	1.027	1.047	1.066	1.086
5	1.105	1.125	1.144	1.164	1.183	1.203	1.222	1.242	1.261	1.281
6	1.300	1.320	1.339	1.359	1.378	1.398	1.417	1.437	1.456	1.476
7	1.495	1.515	1.534	1.554	1.573	1.593	1.612	1.632	1.651	1.671
8	1.690	1.710	1.729	1.749	1.768	1.788	1.807	1.827	1.846	1.866
9	1.885	1.905	1.924	1.944	1.963	1.983	2.002	2.022	2.041	2.061
10	2.080	2.100	2.119	2.139	2.158	2.178	2.197	2.217	2.236	2.256
11	2.275									

Expression 0.26 (0.5 + 0.82.U) where wind speed (U) is expressed in m/sec for $15°C < T_M - T_m \leq 16°C$

U	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.130	0.151	0.173	0.194	0.215	0.237	0.258	0.279	0.301	0.322
1	0.343	0.365	0.386	0.407	0.428	0.450	0.471	0.492	0.514	0.535
2	0.556	0.578	0.599	0.620	0.642	0.663	0.684	0.706	0.727	0.748
3	0.770	0.791	0.812	0.834	0.855	0.876	0.898	0.919	0.940	0.961
4	0.983	1.004	1.025	1.047	1.068	1.089	1.111	1.132	1.153	1.175
5	1.196	1.217	1.239	1.260	1.281	1.303	1.324	1.345	1.367	1.388
6	1.409	1.431	1.452	1.473	1.494	1.516	1.537	1.558	1.580	1.601
7	1.622	1.644	1.665	1.686	1.708	1.729	1.750	1.772	1.793	1.814
8	1.836	1.857	1.878	1.900	1.921	1.942	1.964	1.985	2.006	2.027
9	2.049	2.070	2.091	2.113	2.134	2.155	2.177	2.198	2.219	2.241
10	2.262	2.283	2.305	2.326	2.347	2.369	2.390	2.411	2.433	2.454
11	2.475									

Expression 0.26 (0.5 + 0.89.U) where wind speed (U) is expressed in m/sec for $16°C < T_M - T_m$

U	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.130	0.153	0.176	0.199	0.223	0.246	0.269	0.292	0.315	0.338
1	0.361	0.385	0.408	0.431	0.454	0.477	0.500	0.523	0.547	0.570
2	0.593	0.616	0.639	0.662	0.685	0.709	0.732	0.755	0.778	0.801
3	0.824	0.847	0.870	0.894	0.917	0.940	0.963	0.986	1.009	1.032
4	1.056	1.079	1.102	1.125	1.148	1.171	1.194	1.218	1.241	1.264
5	1.287	1.310	1.333	1.356	1.380	1.403	1.426	1.449	1.472	1.495
6	1.518	1.542	1.565	1.588	1.611	1.634	1.657	1.680	1.704	1.727
7	1.750	1.773	1.796	1.819	1.842	1.866	1.889	1.912	1.935	1.958
8	1.981	2.004	2.027	2.051	2.074	2.097	2.120	2.143	2.166	2.189
9	2.213	2.236	2.259	2.282	2.305	2.328	2.351	2.375	2.398	2.421
10	2.444	2.467	2.490	2.513	2.537	2.560	2.583	2.606	2.629	2.652
11	2.675									

TABLE IX - U

Evaporation of a free water surface

Expression 0.26 (0.5 + 0.54.U) where wind speed (U) is expressed in m/sec for $T_M - T_m \leq 12°C$

U	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.130	0.144	0.158	0.172	0.186	0.200	0.214	0.228	0.242	0.256
1	0.270	0.284	0.298	0.313	0.327	0.341	0.355	0.369	0.383	0.397
2	0.411	0.425	0.439	0.453	0.467	0.481	0.495	0.509	0.523	0.537
3	0.551	0.565	0.579	0.593	0.607	0.621	0.635	0.649	0.664	0.678
4	0.692	0.706	0.720	0.734	0.748	0.762	0.776	0.790	0.804	0.818
5	0.832	0.846	0.860	0.874	0.888	0.902	0.916	0.930	0.944	0.958
6	0.972	0.986	1.000	1.015	1.029	1.043	1.057	1.071	1.085	1.099
7	1.113	1.127	1.141	1.155	1.169	1.183	1.197	1.211	1.225	1.239
8	1.253	1.267	1.281	1.295	1.309	1.323	1.337	1.351	1.366	1.380
9	1.394	1.408	1.422	1.436	1.450	1.464	1.478	1.492	1.506	1.520
10	1.534	1.548	1.562	1.576	1.590	1.604	1 618	1.632	1.646	1.660
11	1.674									

Expression 0.26 (0.5 + 0.61.U) where wind speed (U) is expressed in m/sec for $12°C < T_M - T_m \leq 13°C$

U	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.130	0.146	0.162	0.178	0.193	0.209	0.225	0.241	0.257	0.273
1	0.289	0.304	0.320	0.336	0.352	0.368	0.384	0.400	0.415	0.431
2	0.447	0.463	0.479	0.495	0.511	0.527	0.542	0.558	0.574	0.590
3	0.606	0.622	0.638	0.653	0.669	0.685	0.701	0.717	0.733	0.749
4	0.764	0.780	0.796	0.812	0.828	0.844	0.860	0.875	0.891	0.907
5	0.923	0.939	0.955	0.971	0.986	1.002	1.018	1.034	1.050	1.066
6	1.082	1.097	1.113	1.129	1.145	1.161	1.177	1.193	1.208	1.224
7	1.240	1.256	1.272	1.288	1.304	1.320	1.335	1.351	1.367	1.383
8	1.399	1.415	1.431	1.446	1.462	1.478	1.494	1.510	1.526	1.542
9	1.557	1.573	1.589	1.605	1.621	1.637	1.653	1.668	1.684	1.700
10	1.716	1.732	1.748	1.764	1.779	1.795	1.811	1.827	1.843	1.859
11	1.875									

Expression 0.26 (0.5 + 0.68.U) where wind speed (U) is expressed in m/sec for $13°C < T_M - T_m \leq 14°C$

U	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.130	0.148	0.165	0.183	0.201	0.218	0.236	0.254	0.271	0.289
1	0.307	0.324	0.342	0.360	0.378	0.395	0.413	0.431	0.448	0.466
2	0.484	0.501	0.519	0.537	0.554	0.572	0.590	0.607	0.625	0.643
3	0.660	0.678	0.696	0.713	0.731	0.749	0.766	0.784	0.802	0.820
4	0.837	0.855	0.873	0.890	0.908	0.926	0.943	0.961	0.979	0.996
5	1.014	1.032	1.049	1.067	1.085	1.102	1.120	1.138	1.155	1.173
6	1.191	1.208	1.226	1.244	1.262	1.279	1.297	1.315	1.332	1.350
7	1.368	1.385	1.403	1.421	1.438	1.456	1.474	1.491	1.509	1.527
8	1.544	1.562	1.580	1.597	1.615	1.633	1.650	1.668	1.686	1.704
9	1.721	1.739	1.757	1.774	1.792	1.810	1.827	1.845	1.863	1.880
10	1.898	1.916	1.933	1.951	1.969	1.986	2.004	2.022	2.039	2.057
11	2.075									

TABLE VIII - U

Potential evapotranspiration

Expression 0.26 (1 + 0.75U) where wind speed (U) is expressed in m/sec
for $14°C < T_M - T_m \leq 15°C$

U	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.260	0.280	0.299	0.319	0.338	0.358	0.377	0.397	0.416	0.436
1	0.455	0.475	0.494	0.514	0.533	0.553	0.572	0.592	0.611	0.631
2	0.650	0.670	0.689	0.709	0.728	0.748	0.767	0.787	0.806	0.826
3	0.845	0.865	0.884	0.904	0.923	0.943	0.962	0.982	1.001	1.021
4	1.040	1.060	1.079	1.099	1.118	1.138	1.157	1.177	1.196	1.216
5	1.235	1.255	1.274	1.294	1.313	1.333	1.352	1.372	1.391	1.411
6	1.430	1.450	1.469	1.489	1.508	1.528	1.547	1.567	1.586	1.606
7	1.625	1.645	1.664	1.684	1.703	1.723	1.742	1.762	1.781	1.801
8	1.820	1.840	1.859	1.879	1.898	1.918	1.937	1.957	1.976	1.996
9	2.015	2.035	2.054	2.074	2.093	2.113	2.132	2.152	2.171	2.191
10	2.210	2.230	2.249	2.269	2.288	2.308	2.327	2.347	2.366	2.386

Expression 0.26 (1 + 0.82U) where wind speed (U) is expressed in m/sec
for $15°C < T_M - T_m \leq 16°C$

U	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.260	0.281	0.303	0.324	0.345	0.367	0.388	0.409	0.431	0.452
1	0.473	0.495	0.516	0.537	0.558	0.580	0.601	0.622	0.644	0.665
2	0.686	0.708	0.729	0.750	0.772	0.793	0.814	0.836	0.857	0.878
3	0.900	0.921	0.942	0.964	0.985	1.006	1.028	1.049	1.070	1.091
4	1.113	1.134	1.155	1.177	1.198	1.219	1.241	1.262	1.283	1.305
5	1.326	1.347	1.369	1.390	1.411	1.433	1.454	1.475	1.497	1.518
6	1.539	1.561	1.582	1.603	1.624	1.646	1.667	1.688	1.710	1.731
7	1.752	1.774	1.735	1.816	1.838	1.859	1.880	1.902	1.923	1.944
8	1.966	1.987	2.008	2.030	2.051	2.072	2.094	2.115	2.136	2.157
9	2.179	2.200	2.221	2.243	2.264	2.285	2.307	2.328	2.349	2.371
10	2.392	2.413	2.435	2.456	2.477	2.499	2.520	2.541	2.563	2.584

Expression 0.26 (1 + 0.89U) where wind speed (U) is expressed in m/sec
for $16°C < T_M - T_m$

U	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.260	0.283	0.306	0.329	0.353	0.376	0.399	0.422	0.445	0.468
1	0.491	0.515	0.538	0.561	0.584	0.607	0.630	0.653	0.677	0.700
2	0.723	0.746	0.769	0.792	0.815	0.839	0.862	0.885	0.908	0.931
3	0.954	0.977	1.000	1.024	1.047	1.070	1.093	1.116	1.139	1.162
4	1.186	1.209	1.232	1.255	1.278	1.301	1.324	1.348	1.371	1.394
5	1.417	1.440	1.463	1.486	1.510	1.533	1.556	1.579	1.602	1.625
6	1.648	1.672	1.695	1.718	1.741	1.764	1.787	1.810	1.834	1.857
7	1.880	1.903	1.926	1.949	1.972	1.996	2.019	2.042	2.065	2.088
8	2.111	2.134	2.157	2.181	2.204	2.227	2.250	2.273	2.296	2.319
9	2.343	2.366	2.389	2.412	2.435	2.458	2.481	2.505	2.528	2.551
10	2.574	2.597	2.620	2.643	2.667	2.690	2.713	2.736	2.759	2.782

TABLE VIII - U

Potential evapotranspiration

Expression 0.26 (1 + 0.54U) where wind speed (U) is expressed in m/sec for $T_M - T_m \leq 12°C$

U	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.260	0.274	0.288	0.302	0.316	0.330	0.344	0.358	0.372	0.386
1	0.400	0.414	0.428	0.443	0.457	0.471	0.485	0.499	0.513	0.527
2	0.541	0.555	0.569	0.583	0.597	0.611	0.625	0.639	0.653	0.667
3	0.681	0.695	0.709	0.723	0.737	0.751	0.765	0.779	0.794	0.808
4	0.822	0.836	0.850	0.864	0.878	0.892	0.906	0.920	0.934	0.948
5	0.962	0.976	0.990	1.004	1.018	1.032	1.046	1.060	1.074	1.088
6	1.102	1.116	1.130	1.145	1.159	1.173	1.187	1.201	1.215	1.229
7	1.243	1.257	1.271	1.285	1.299	1.313	1.327	1.341	1.355	1.369
8	1.383	1.397	1.411	1.425	1.439	1.453	1.467	1.481	1.496	1.510
9	1.524	1.538	1.552	1.566	1.580	1.594	1.608	1.622	1.636	1.650
10	1.664	1.678	1.692	1.706	1.720	1.734	1.748	1.762	1.776	1.790

Expression 0.26 (1 + 0.61U) where wind speed (U) is expressed in m/sec for $12°C < T_M - T_m \leq 13°C$

U	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.260	0.276	0.292	0.308	0.323	0.339	0.355	0.371	0.387	0.403
1	0.419	0.434	0.450	0.466	0.482	0.498	0.514	0.530	0.545	0.561
2	0.577	0.593	0.609	0.625	0.641	0.657	0.672	0.688	0.704	0.720
3	0.736	0.752	0.768	0.783	0.799	0.815	0.831	0.847	0.863	0.879
4	0.894	0.910	0.926	0.942	0.958	0.974	0.990	1.005	1.021	1.037
5	1.053	1.069	1.085	1.101	1.116	1.132	1.148	1.164	1.180	1.196
6	1.212	1.227	1.243	1.259	1.275	1.291	1.307	1.323	1.338	1.354
7	1.370	1.386	1.402	1.418	1.434	1.450	1.465	1.481	1.497	1.513
8	1.529	1.545	1.561	1.576	1.592	1.608	1.624	1.640	1.656	1.672
9	1.687	1.703	1.719	1.735	1.751	1.767	1.783	1.798	1.814	1.830
10	1.846	1.862	1.878	1.894	1.909	1.925	1.941	1.957	1.973	1.989

Expression 0.26 (1 + 0.68U) where wind speed (U) is expressed in m/sec for $13°C < T_M - T_m \leq 14°C$

U	0 0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.260	0.278	0.295	0.313	0.331	0.348	0.366	0.384	0.401	0.419
1	0.437	0.454	0.472	0.490	0.508	0.525	0.543	0.561	0.578	0.596
2	0.614	0.631	0.649	0.667	0.684	0.702	0.720	0.737	0.755	0.773
3	0.790	0.808	0.826	0.843	0.861	0.879	0.896	0.914	0.932	0.950
4	0.967	0.985	1.003	1.020	1.038	1.056	1.073	1.091	1.109	1.126
5	1.144	1.162	1.179	1.197	1.215	1.232	1.250	1.268	1.285	1.303
6	1.321	1.338	1.356	1.374	1.392	1.409	1.427	1.445	1.462	1.480
7	1.498	1.515	1.533	1.551	1.568	1.586	1.604	1.621	1.639	1.657
8	1.674	1.692	1.710	1.727	1.745	1.763	1.780	1.798	1.816	1.834
9	1.851	1.869	1.887	1.904	1.922	1.940	1.957	1.975	1.993	2.010
10	2.028	2.046	2.063	2.081	2.099	2.116	2.134	2.152	2.169	2.187

TABLE VII

Saturation vapour pressure over water e_a in millibars as function of T°C

(Smithsonian Table 1951)

T.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
-5	4.21	4.18	4.15	4.12	4.09	4.06	4.03	4.00	3.97	3.94
-4	4.55	4.51	4.48	4.44	4.41	4.38	4.34	4.31	4.28	4.25
-3	4.90	4.86	4.83	4.79	4.75	4.72	4.68	4.65	4.61	4.58
-2	5.28	5.24	5.20	5.16	5.12	5.08	5.05	5.01	4.97	4.93
-1	5.68	5.64	5.60	5.55	5.51	5.47	5.43	5.39	5.35	5.31
-0	6.11	6.06	6.02	5.98	5.93	5.89	5.85	5.80	5.76	5.72
0	6.11	6.15	6.20	6.24	6.29	6.33	6.38	6.43	6.47	6.52
1	6.57	6.61	6.66	6.71	6.76	6.81	6.86	6.90	6.95	7.00
2	7.05	7.11	7.16	7.21	7.26	7.31	7.36	7.42	7.47	7.52
3	7.58	7.63	7.68	7.74	7.79	7.85	7.90	7.96	8.02	8.07
4	8.13	8.19	8.24	8.30	8.36	8.42	8.48	8.54	8.60	8.66
5	8.72	8.78	8.84	8.90	8.97	9.03	9.09	9.15	9.22	9.28
6	9.35	9.41	9.48	9.54	9.61	9.67	9.74	9.81	9.88	9.94
7	10.01	10.08	10.15	10.22	10.29	10.36	10.43	10.51	10.58	10.65
8	10.72	10.80	10.87	10.94	11.02	11.09	11.17	11.24	11.32	11.40
9	11.47	11.55	11.63	11.71	11.79	11.87	11.95	12.03	12.11	12.19
10	12.27	12.36	12.44	12.52	12.61	12.69	12.78	12.86	12.95	13.03
11	13.12	13.21	13.30	13.38	13.47	13.56	13.65	13.74	13.83	13.93
12	14.02	14.11	14.20	14.30	14.39	14.49	14.58	14.68	14.77	14.87
13	14.97	15.07	15.17	15.27	15.37	15.47	15.57	15.67	15.77	15.87
14	15.98	16.08	16.19	16.29	16.40	16.50	16.61	16.72	16.83	16.94
15	17.04	17.15	17.26	17.38	17.49	17.60	17.71	17.83	17.94	18.06
16	18.17	18.29	18.41	18.53	18.64	18.76	18.88	19.00	19.12	19.25
17	19.37	19.49	19.61	19.74	19.86	19.99	20.12	20.24	20.37	20.50
18	20.63	20.76	20.89	21.02	21.16	21.29	21.42	21.56	21.69	21.83
19	21.96	22.10	22.24	22.38	22.52	22.66	22.80	22.94	23.09	23.23
20	23.37	23.52	23.66	23.81	23.96	24.11	24.26	24.41	24.56	24.71
21	24.86	25.01	25.17	25.32	25.48	25.64	25.79	25.95	26.11	26.27
22	26.43	26.59	26.75	26.92	27.08	27.25	27.41	27.58	27.75	27.92
23	28.09	28.26	28.42	28.60	28.77	28.95	29.12	29.30	29.48	29.65
24	29.83	30.01	30.19	30.37	30.56	30.74	30.92	31.11	31.30	31.48
25	31.67	31.86	32.05	32.24	32.43	32.63	32.82	33.02	33.21	33.41
26	33.61	33.81	34 01	34.21	34.41	34.62	34.82	35.03	35.23	35.44
27	35.65	35.86	36.07	36.28	36.50	36.71	36.92	37.14	37.36	37.58
28	37.80	38.02	38.24	38.46	38.69	38.91	39.14	39.37	39.59	39.82
29	40.06	40.29	40.52	40.76	40.99	41.23	41.47	41.71	41.95	42.19
30	42.43	42.67	42.92	43.17	43.41	43.66	43.91	44.17	44.42	44.67
31	44.93	45.18	45.44	45.70	45.96	46.22	46.49	46.75	47.02	47.28
32	47.55	47.82	48.09	48.36	48.64	48.91	49.19	49.47	49.75	50.03
33	50.31	50.59	50.87	51.16	51.45	51.74	52.03	52.32	52.61	52.90
34	53.20	53.50	53.80	54.10	54.40	54.70	55.00	55.31	55.62	55.93
35	56.24	56.55	56.86	57.18	57.49	57.81	58.13	58.45	58.77	59.10
36	59.42	59.75	60.08	60.41	60.74	61.07	61.41	61.74	62.08	62.42
37	62.76	63.11	63.45	63.80	64.14	64.49	64.84	65.20	65.55	65.91
38	66.26	66.62	66.99	67.35	67.71	68.08	68.45	68.82	69.19	69.56
39	69.93	70.31	70.69	71.07	71.45	71.83	72.22	72.61	73.00	73.39

TABLE VI

Expression $0.9 \frac{n}{N} + 0.1$

n/N	0.	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	n/N
0.00	0.10	0.11	0.12	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.00
0.10	0.19	0.20	0.21	0.22	0.23	0.24	0.24	0.25	0.26	0.27	0.10
0.20	0.28	0.29	0.30	0.31	0.32	0.33	0.33	0.34	0.35	0.36	0.20
0.30	0.37	0.38	0.39	0.40	0.41	0.42	0.42	0.43	0.44	0.45	0.30
0.40	0.46	0.47	0.48	0.49	0.50	0.51	0.51	0.52	0.53	0.54	0.40
0.50	0.55	0.56	0.57	0.58	0.59	0.60	0.60	0.61	0.62	0.63	0.50
0.60	0.64	0.65	0.66	0.67	0.68	0.69	0.69	0.70	0.71	0.72	0.60
0.70	0.73	0.74	0.75	0.76	0.77	0.78	0.78	0.79	0.80	0.81	0.70
0.80	0.82	0.83	0.84	0.85	0.86	0.87	0.87	0.88	0.89	0.90	0.80
0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.96	0.97	0.98	0.99	0.90
1.00	1.00										1.00

TABLE V

Expression of $0.56 - 0.079\sqrt{e_d}$ where e_d is vapour pressure expressed in millibars

e_d	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
5	0.38	0.38	0.38	0.38	0.38	0.37	0.37	0.37	0.37	0.37
6	0.37	0.37	0.36	0.36	0.36	0.36	0.36	0.36	0.35	0.35
7	0.35	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.34
8	0.34	0.34	0.33	0.33	0.33	0.33	0.33	0.33	0.32	0.32
9	0.32	0.32	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31
10	0.31	0.31	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.30
11	0.30	0.30	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.29
12	0.29	0.29	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
13	0.28	0.28	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
14	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
15	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
16	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
17	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
18	0.23	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
19	0.22	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
20	0.21	0.21	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
21	0.20	0.20	0.20	0.20	0.19	0.19	0.19	0.19	0.19	0.19
22	0.19	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.18
23	0.18	0.18	0.18	0.18	0.18	0.18	0.17	0.17	0.17	0.17
24	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
25	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
26	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15
27	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.14	0.14	0.14
28	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
29	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
30	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.12
31	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11
32	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
33	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
34	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.09
35	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
36	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08
37	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07
38	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
39	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06
40	0.06									

TABLE IV

Blackbody radiation (σT_K^4) expressed in mm of water in function of T°C

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	11.02	11.04	11.06	11.08	11.09	11.10	11.12	11.14	11.15	11.17
1	11.18	11.20	11.22	11.24	11.25	11.26	11.28	11.30	11.31	11.33
2	11.35	11.37	11.39	11.41	11.42	11.43	11.45	11.47	11.48	11.50
3	11.51	11.53	11.55	11.57	11.58	11.59	11.61	11.63	11.64	11.66
4	11.68	11.70	11.72	11.74	11.75	11.76	11.78	11.80	11.81	11.83
5	11.85	11.87	11.89	11.90	11.92	11.94	11.96	11.97	11.98	12.00
6	12.02	12.04	12.06	12.08	12.09	12.10	12.12	12.14	12.16	12.18
7	12.20	12.22	12.24	12.26	12.27	12.29	12.31	12.32	12.34	12.36
8	12.37	12.39	12.41	12.43	12.44	12.46	12.48	12.50	12.51	12.53
9	12.55	12.57	12.59	12.60	12.62	12.64	12.66	12.67	12.69	12.71
10	12.73	12.75	12.77	12.79	12.80	12.81	12.83	12.85	12.87	12.89
11	12.91	12.93	12.95	12.97	12.99	13.01	13.02	13.04	13.06	13.08
12	13.09	13.11	13.13	13.14	13.16	13.18	13.20	13.23	13.25	13.27
13	13.28	13.30	13.32	13.34	13.35	13.37	13.39	13.41	13.43	13.45
14	13.46	13.48	13.50	13.52	13.54	13.55	13.57	13.59	13.61	13.63
15	13.65	13.67	13.69	13.71	13.73	13.74	13.76	13.78	13.80	13.82
16	13.84	13.86	13.88	13.90	13.92	13.94	13.95	13.97	13.99	14.01
17	14.03	14.05	14.07	14.09	14.11	14.13	14.15	14.17	14.19	14.21
18	14.23	14.25	14.27	14.29	14.31	14.33	14.35	14.37	14.39	14.41
19	14.43	14.45	14.47	14.49	14.51	14.53	14.54	14.56	14.58	14.60
20	14.62	14.64	14.66	14.68	14.70	14.73	14.75	14.77	14.79	14.81
21	14.83	14.85	14.87	14.89	14.91	14.93	14.95	14.97	14.99	15.01
22	15.03	15.05	15.07	15.09	15.11	15.13	15.15	15.17	15.19	15.21
23	15.23	15.25	15.27	15.29	15.31	15.34	15.36	15.38	15.40	15.42
24	15.44	15.46	15.48	15.50	15.52	15.55	15.57	15.59	15.61	15.63
25	15.65	15.67	15.69	15.71	15.73	15.76	15.78	15.80	15.82	15.84
26	15.86	15.88	15.90	15.92	15.94	15.97	15.99	16.01	16.03	16.05
27	16.07	16.09	16.11	16.14	16.16	16.18	16.20	16.22	16.25	16.27
28	16.29	16.31	16.33	16.35	16.37	16.40	16.42	16.44	16.46	16.48
29	16.50	16.52	16.54	16.57	16.59	16.61	16.63	16.65	16.68	16.70
30	16.72	16.74	16.77	16.79	16.81	16.84	16.86	16.88	16.90	16.93
31	16.95	16.97	16.99	17.02	17.04	17.06	17.08	17.10	17.13	17.15
32	17.17	17.19	17.22	17.24	17.26	17.29	17.31	17.33	17.35	17.38
33	17.40	17.42	17.45	17.47	17.49	17.52	17.54	17.56	17.58	17.61
34	17.65	17.68	17.70	17.72	17.75	17.77	17.79	17.81	17.84	17.86
35	17.88	17.90	17.93	17.95	17.97	18.00	18.02	18.04	18.07	18.09

TABLE III - $\frac{n}{N}$

$$\left[a + b\,\frac{n}{N}\right] \begin{cases} \times 0.75 & \text{for potential evapotranspiration of vegetal cover} \\ \times 0.95 & \text{for evaporation from free water} \end{cases}$$

C. Humid tropical zones - a = 0.29 b = 0.42

n/N	0.29 + 0.42 n/N	x0.75	x0.95	n/N	0.29 + 0.42 n/N	x0.75	x0.95	n/N	0.29 + 0.42 n/N	x0.75	x0.95
0.01	0.29	0.22	0.28	0.34	0.43	0.32	0.41	0.67	0.57	0.43	0.54
0.02	0.30	0.22	0.28	0.35	0.44	0.33	0.42	0.68	0.58	0.43	0.55
0.03	0.30	0.23	0.29	0.36	0.44	0.33	0.42	0.69	0.58	0.43	0.55
0.04	0.31	0.23	0.29	0.37	0.45	0.33	0.42	0.70	0.58	0.44	0.55
0.05	0.31	0.23	0.30	0.38	0.45	0.34	0.43	0.71	0.59	0.44	0.56
0.06	0.32	0.24	0.30	0.39	0.45	0.34	0.43	0.72	0.59	0.44	0.56
0.07	0.32	0.24	0.30	0.40	0.46	0.34	0.44	0.73	0.60	0.45	0.57
0.08	0.32	0.24	0.31	0.41	0.46	0.35	0.44	0.74	0.60	0.45	0.57
0.09	0.33	0.25	0.31	0.42	0.47	0.35	0.44	0.75	0.61	0.45	0.57
0.10	0.33	0.25	0.32	0.43	0.47	0.35	0.45	0.76	0.61	0.46	0.58
0.11	0.34	0.25	0.32	0.44	0.47	0.36	0.45	0.77	0.61	0.46	0.58
0.12	0.34	0.26	0.32	0.45	0.48	0.36	0.46	0.78	0.62	0.46	0.59
0.13	0.34	0.26	0.33	0.46	0.48	0.36	0.46	0.79	0.62	0.47	0.59
0.14	0.35	0.26	0.33	0.47	0.49	0.37	0.46	0.80	0.63	0.47	0.59
0.15	0.35	0.26	0.34	0.48	0.49	0.37	0.47	0.81	0.63	0.47	0.60
0.16	0.36	0.27	0.34	0.49	0.50	0.37	0.47	0.82	0.63	0.48	0.60
0.17	0.36	0.27	0.34	0.50	0.50	0.38	0.48	0.83	0.64	0.48	0.61
0.18	0.37	0.27	0.35	0.51	0.50	0.38	0.48	0.84	0.64	0.48	0.61
0.19	0.37	0.28	0.35	0.52	0.51	0.38	0.48	0.85	0.65	0.49	0.61
0.20	0.37	0.28	0.36	0.53	0.51	0.38	0.49	0.86	0.65	0.49	0.62
0.21	0.38	0.28	0.36	0.54	0.52	0.39	0.49	0.87	0.66	0.49	0.62
0.22	0.38	0.29	0.36	0.55	0.52	0.39	0.49	0.88	0.66	0.49	0.63
0.23	0.39	0.29	0.37	0.56	0.53	0.39	0.50	0.89	0.66	0.50	0.63
0.24	0.39	0.29	0.37	0.57	0.53	0.40	0.50	0.90	0.67	0.50	0.63
0.25	0.40	0.30	0.38	0.58	0.53	0.40	0.51	0.91	0.67	0.50	0.64
0.26	0.40	0.30	0.38	0.59	0.54	0.40	0.51	0.92	0.68	0.51	0.64
0.27	0.40	0.30	0.38	0.60	0.54	0.41	0.51	0.93	0.68	0.51	0.65
0.28	0.41	0.31	0.39	0.61	0.55	0.41	0.52	0.94	0.68	0.51	0.65
0.29	0.41	0.31	0.39	0.62	0.55	0.41	0.52	0.95	0.69	0.52	0.65
0.30	0.42	0.31	0.40	0.63	0.55	0.42	0.53	0.96	0.69	0.52	0.66
0.31	0.42	0.32	0.40	0.64	0.56	0.42	0.53	0.97	0.70	0.52	0.66
0.32	0.42	0.32	0.40	0.65	0.56	0.42	0.53	0.98	0.70	0.53	0.67
0.33	0.43	0.32	0.41	0.66	0.57	0.43	0.54	0.99	0.71	0.53	0.67
								1.00	0.71	0.53	0.67

TABLE III - $\frac{n}{N}$

$$[a + b\,\frac{n}{N}] \begin{cases} \times 0.75 \text{ for potential evapotranspiration of vegetal cover} \\ \times 0.95 \text{ for evaporation from free water} \end{cases}$$

B.. Dry tropical zones - a = 0.25 b = 0.45

n/N	0.25 + 0.45 n/N	x0.75	x0.95	n/N	0.25 + 0.45 n/N	x0.75	x0.95	n/N	0.25 + 0.45 n/N	x0.75	x0.95
0.01	0.25	0.19	0.24	0.34	0.40	0.30	0.38	0.67	0.55	0.41	0.52
0.02	0.26	0.19	0.25	0.35	0.41	0.31	0.39	0.68	0.56	0.42	0.53
0.03	0.26	0.20	0.25	0.36	0.41	0.31	0.39	0.69	0.56	0.42	0.53
0.04	0.27	0.20	0.25	0.37	0.42	0.31	0.40	0.70	0.57	0.42	0.54
0.05	0.27	0.20	0.26	0.38	0.42	0.32	0.40	0.71	0.57	0.43	0.54
0.06	0.28	0.21	0.26	0.39	0.43	0.32	0.40	0.72	0.57	0.43	0.55
0.07	0.28	0.21	0.27	0.40	0.43	0.32	0.41	0.73	0.58	0.43	0.55
0.08	0.29	0.21	0.27	0.41	0.43	0.33	0.41	0.74	0.58	0.44	0.55
0.09	0.29	0.22	0.28	0.42	0.44	0.33	0.42	0.75	0.59	0.44	0.56
0.10	0.30	0.22	0.28	0.43	0.44	0.33	0.42	0.76	0.59	0.44	0.56
0.11	0.30	0.22	0.28	0.44	0.45	0.34	0.43	0.77	0.60	0.45	0.57
0.12	0.30	0.23	0.29	0.45	0.45	0.34	0.43	0.78	0.60	0.45	0.57
0.13	0.31	0.23	0.29	0.46	0.46	0.34	0.43	0.79	0.61	0.45	0.58
0.14	0.31	0.23	0.30	0.47	0.46	0.35	0.44	0.80	0.61	0.46	0.58
0.15	0.32	0.24	0.30	0.48	0.47	0.35	0.44	0.81	0.61	0.46	0.58
0.16	0.32	0.24	0.31	0.49	0.47	0.35	0.45	0.82	0.62	0.46	0.59
0.17	0.33	0.24	0.31	0.50	0.48	0.36	0.45	0.83	0.62	0.47	0.59
0.18	0.33	0.25	0.31	0.51	0.48	0.36	0.46	0.84	0.63	0.47	0.60
0.19	0.34	0.25	0.32	0.52	0.48	0.36	0.46	0.85	0.63	0.47	0.60
0.20	0.34	0.26	0.32	0.53	0.49	0.37	0.46	0.86	0.64	0.48	0.61
0.21	0.34	0.26	0.33	0.54	0.49	0.37	0.47	0.87	0.64	0.48	0.61
0.22	0.35	0.26	0.33	0.55	0.50	0.37	0.47	0.88	0.65	0.48	0.61
0.23	0.35	0.27	0.34	0.56	0.50	0.38	0.48	0.89	0.65	0.49	0.62
0.24	0.36	0.27	0.34	0.57	0.51	0.38	0.48	0.90	0.66	0.49	0.62
0.25	0.36	0.27	0.34	0.58	0.51	0.38	0.49	0.91	0.66	0.49	0.63
0.26	0.37	0.28	0.35	0.59	0.52	0.39	0.49	0.92	0.66	0.50	0.63
0.27	0.37	0.28	0.35	0.60	0.52	0.39	0.49	0.93	0.67	0.50	0.64
0.28	0.38	0.28	0.36	0.61	0.52	0.39	0.50	0.94	0.67	0.50	0.64
0.29	0.38	0.29	0.36	0.62	0.53	0.40	0.50	0.95	0.68	0.51	0.64
0.30	0.39	0.29	0.37	0.63	0.53	0.40	0.51	0.96	0.68	0.51	0.65
0.31	0.39	0.29	0.37	0.64	0.54	0.40	0.51	0.97	0.69	0.51	0.65
0.32	0.39	0.30	0.37	0.65	0.54	0.41	0.52	0.98	0.69	0.52	0.66
0.33	0.40	0.30	0.38	0.66	0.55	0.41	0.52	0.99	0.70	0.52	0.66
								1.00	0.70	0.53	0.67

TABLE III - $\frac{n}{N}$

$$\left[a + b\,\frac{n}{N}\right] \begin{cases} \times 0.75 \text{ for potential evapotranspiration of vegetal cover} \\ \times 0.95 \text{ for evaporation from free water} \end{cases}$$

A. Temperate regions - a = 0.18 b = 0.55

n/N	0.18 + 0.55 n/N	x0.75	x0.95	n/N	0.18 + 0.55 n/N	x0.75	x0.95	n/N	0.18 + 0.55 n/N	x0.75	x0.95
0.01	0.19	0.14	0.18	0.34	0.37	0.28	0.35	0.67	0.55	0.41	0.52
0.02	0.19	0.14	0.18	0.35	0.37	0.28	0.35	0.68	0.55	0.42	0.53
0.03	0.20	0.15	0.19	0.36	0.38	0.28	0.36	0.69	0.56	0.42	0.53
0.04	0.20	0.15	0.19	0.37	0.38	0.29	0.36	0.70	0.57	0.42	0.54
0.05	0.21	0.16	0.20	0.38	0.39	0.29	0.37	0.71	0.57	0.43	0.54
0.06	0.21	0.16	0.20	0.39	0.39	0.30	0.37	0.72	0.58	0.43	0.55
0.07	0.22	0.16	0.21	0.40	0.40	0.30	0.38	0.73	0.58	0.44	0.55
0.08	0.22	0.17	0.21	0.41	0.41	0.30	0.39	0.74	0.59	0.44	0.56
0.09	0.23	0.17	0.22	0.42	0.41	0.31	0.39	0.75	0.59	0.44	0.56
0.10	0.24	0.18	0.22	0.43	0.42	0.31	0.40	0.76	0.60	0.45	0.57
0.11	0.24	0.18	0.23	0.44	0.42	0.32	0.40	0.77	0.60	0.45	0.57
0.12	0.25	0.18	0.23	0.45	0.43	0.32	0.41	0.78	0.61	0.46	0.58
0.13	0.25	0.19	0.24	0.46	0.43	0.32	0.41	0.79	0.61	0.46	0.58
0.14	0.26	0.19	0.24	0.47	0.44	0.33	0.42	0.80	0.62	0.47	0.59
0.15	0.26	0.20	0.25	0.48	0.44	0.33	0.42	0.81	0.63	0.47	0.59
0.16	0.27	0.20	0.25	0.49	0.45	0.34	0.43	0.82	0.63	0.47	0.60
0.17	0.27	0.21	0.26	0.50	0.46	0.34	0.43	0.83	0.64	0.48	0.60
0.18	0.28	0.21	0.27	0.51	0.46	0.35	0.44	0.84	0.64	0.48	0.61
0.19	0.28	0.21	0.27	0.52	0.47	0.35	0.44	0.85	0.65	0.49	0.62
0.20	0.29	0.22	0.28	0.53	0.47	0.35	0.45	0.86	0.65	0.49	0.62
0.21	0.30	0.22	0.28	0.54	0.48	0.36	0.45	0.87	0.66	0.50	0.63
0.22	0.30	0.23	0.29	0.55	0.48	0.36	0.46	0.88	0.66	0.50	0.63
0.23	0.31	0.23	0.29	0.56	0.49	0.37	0.46	0.89	0.67	0.50	0.64
0.24	0.31	0.23	0.30	0.57	0.49	0.37	0.47	0.90	0.68	0.51	0.64
0.25	0.32	0.24	0.30	0.58	0.50	0.37	0.47	0.91	0.68	0.51	0.65
0.26	0.32	0.24	0.31	0.59	0.50	0.38	0.48	0.92	0.69	0.51	0.65
0.27	0.33	0.25	0.31	0.60	0.51	0.38	0.48	0.93	0.69	0.52	0.66
0.28	0.33	0.25	0.32	0.61	0.52	0.39	0.49	0.94	0.70	0.52	0.66
0.29	0.34	0.25	0.32	0.62	0.52	0.39	0.49	0.95	0.70	0.53	0.67
0.30	0.35	0.26	0.33	0.63	0.53	0.39	0.50	0.96	0.71	0.53	0.67
0.31	0.35	0.26	0.33	0.64	0.53	0.40	0.51	0.97	0.71	0.54	0.68
0.32	0.36	0.27	0.34	0.65	0.54	0.40	0.51	0.98	0.72	0.54	0.68
0.33	0.36	0.27	0.34	0.66	0.54	0.41	0.52	0.99	0.72	0.54	0.69
								1.00	0.73	0.55	0.69

TABLE II - N

Daily average month by month of the astronomically possible sunshine duration in hours and tenths

Northern Lats.	J	F	M	A	M	J	J	A	S	O	N	D
Southern Lats.	J	A	S	O	N	D	J	F	M	A	M	J
50°	8.5	10.1	11.8	13.8	15.4	16.3	15.9	14.5	12.7	10.8	9.1	8.1
48°	8.8	10.2	11.8	13.6	15.2	16.0	15.6	14.3	12.6	10.9	9.3	8.3
46°	9.1	10.4	11.9	13.5	14.9	15.7	15.4	14.2	12.6	10.9	9.5	8.7
44°	9.3	10.5	11.9	13.4	14.7	15.4	15.2	14.0	12.6	11.0	9.7	8.9
42°	9.4	10.6	11.9	13.4	14.6	15.2	14.9	13.9	12.9	11.1	9.8	9.1
40°	9.6	10.7	11.9	13.3	14.4	15.0	14.7	13.7	12.5	11.2	10.0	9.3
35°	10.1	11.0	11.9	13.1	14.0	14.5	14.3	13.5	12.4	11.3	10.3	9.8
30°	10.4	11.1	12.0	12.9	13.6	14.0	13.9	13.2	12.4	11.5	10.6	10.2
25°	10.7	11.3	12.0	12.7	13.3	13.7	13.5	13.0	12.3	11.6	10.9	10.6
20°	11.0	11.5	12.0	12.6	13.1	13.3	13.2	12.8	12.3	11.7	11.2	10.9
15°	11.3	11.6	12.0	12.5	12.8	13.0	12.9	12.6	12.2	11.8	11.4	11.2
10°	11.6	11.8	12.0	12.3	12.6	12.7	12.6	12.4	12.1	11.8	11.6	11.5
5°	11.8	11.9	12.0	12.2	12.3	12.4	12.3	12.3	12.1	12.0	11.9	11.8
0°	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1

TABLE I bis - R_A

Solar radiation on a horizontal surface at the limit of the atmosphere expressed as mm of evaporable water and for a solar constant = 2.00 cal.cm^{-2}.min^{-1}

Southern Hemisphere

Lat S	J	F	M	A	M	J	J	A	S	O	N	D
50°	17.54	14.66	10.85	7.03	4.24	3.05	3.47	5.51	8.90	12.88	16.53	18.22
48°	17.61	14.86	11.19	7.47	4.73	3.51	3.95	5.99	9.32	13.15	16.60	18.24
46°	17.68	15.06	11.53	7.91	5.22	3.97	4.43	6.47	9.74	13.43	16.67	18.26
44°	17.75	15.27	11.87	8.35	5.71	4.43	4.90	6.94	10.16	13.70	16.73	18.28
42°	17.82	15.47	12.21	8.80	6.12	4.89	5.38	7.42	10.59	13.97	16.80	18.29
40°	17.88	15.68	12.54	9.24	6.61	5.34	5.85	7.88	11.02	14.24	16.87	18.31
38°	17.86	15.82	12.84	9.64	7.07	5.83	6.31	8.32	11.36	14.44	16.95	18.25
36°	17.85	15.96	13.15	10.05	7.53	6.32	6.77	8.76	11.70	14.64	17.04	18.20
34°	17.84	16.10	13.45	10.46	7.99	6.81	7.23	9.20	12.04	14.85	17.12	18.15
32°	17.82	16.23	13.76	10.87	8.45	7.30	7.68	9.64	12.37	15.05	17.21	18.10
30°	17.80	16.36	14.07	11.27	8.90	7.80	8.14	10.09	12.71	15.26	17.29	18.05
28°	17.70	16.39	14.25	11.61	9.32	8.24	8.60	10.47	12.95	15.36	17.22	17.92
26°	17.60	16.43	14.44	11.95	9.74	8.68	9.06	10.85	13.19	15.46	17.15	17.79
24°	17.50	16.46	14.62	12.29	10.16	9.12	9.52	11.22	13.43	15.56	17.08	17.65
22°	17.40	16.50	14.80	12.63	10.59	9.56	9.97	11.59	13.66	15.66	17.01	17.51
20°	17.29	16.53	15.00	12.97	11.02	10.00	10.42	11.95	13.90	15.76	16.95	17.37
18°	17.11	16.47	15.10	13.22	11.37	10.40	10.81	12.26	14.09	15.78	16.80	17.10
16°	16.93	16.42	15.20	13.48	11.73	10.80	11.20	12.56	14.28	15.79	16.65	16.83
14°	16.74	16.37	15.31	13.73	12.09	11.21	11.59	12.87	14.47	15.81	16.50	16.61
12°	16.55	16.32	15.41	13.98	12.45	11.62	11.98	13.17	14.65	15.83	16.35	16.49
10°	16.36	16.27	15.51	14.24	12.80	12.03	12.37	13.48	14.83	15.85	16.19	16.27
8°	16.08	16.11	15.54	14.44	13.12	12.40	12.71	13.73	14.93	15.76	15.97	15.99
6°	15.81	15.96	15.58	14.65	13.44	12.77	13.05	13.99	15.03	15.67	15.75	15.70
4°	15.54	15.81	15.62	14.85	13.76	13.15	13.39	14.25	15.13	15.59	15.53	15.41
2°	15.27	15.66	15.65	15.05	14.08	13.51	13.73	14.50	15.24	15.50	15.31	15.12
0°	15.00	15.51	15.68	15.26	14.41	13.90	14.07	14.75	15.34	15.42	15.09	14.83

TABLE I - R_A

Solar radiation on a horizontal surface at the limit of the atmosphere expressed as mm of evaporable water and for a solar constant = 2.00 $cal.cm^2.min^{-1}$

Northern Hemisphere

Lat N	J	F	M	A	M	J	J	A	S	O	N	D
50°	3.81	6.10	9.41	12.71	15.76	17.12	16.44	14.07	10.85	7.37	4.49	3.22
48°	4.33	6.60	9.81	13.02	15.88	17.15	16.50	14.29	11.19	7.81	4.99	3.72
46°	4.85	7.10	10.21	13.32	16.00	17.19	16.55	14.51	11.53	8.25	5.49	4.27
44°	5.30	7.60	10.61	13.65	16.12	17.23	16.60	14.73	11.87	8.69	6.00	4.70
42°	5.86	8.05	11.00	13.99	16.24	17.26	16.65	14.95	12.20	9.13	6.51	5.19
40°	6.44	8.56	11.40	14.32	16.36	17.29	16.70	15.17	12.54	9.58	7.03	5.68
38°	6.91	8.98	11,75	14.50	16.39	17.22	16.72	15.27	12.81	9.98	7.52	6.10
36°	7.38	9.39	12.10	14.67	16.43	17.16	16.73	15.37	13.08	10.39	8.00	6.62
34°	7.85	9.82	12.44	14.84	16.46	17.09	16.75	15.48	13.35	10.79	8.50	7.18
32°	8.32	10.24	12.77	15.00	16.50	17.02	16.76	15.58	13.63	11.20	8.99	7.76
30°	8.81	10.68	13.14	15.17	16.53	16.95	16.78	15.68	13.90	11.61	9.49	8.31
28°	9.29	11.09	13.39	15.26	16.48	16.83	16.68	15.71	14.08	11.95	9.90	8.79
26°	9.79	11.50	13.65	15.34	16.43	16.71	16.58	15.74	14.26	12.30	10.31	9.27
24°	10.20	11.89	13.90	15.43	16.37	16.59	16.47	15.78	14.45	12.64	10.71	9.73
22°	10.70	11.30	14.16	15.51	16.32	16.47	16.37	15.81	14.64	12.98	11.11	10.20
20°	11.19	12.71	14.41	15.60	16.27	16.36	16.27	15.85	14.83	13.31	11.61	10.68
18°	11.60	13.02	14.60	15.62	16.11	16.14	16.09	15.79	14.94	13.58	12.02	11.12
16°	12.00	13.32	14.69	15.64	15.99	15.92	15.91	15.72	15.04	13.85	12.43	11.57
14°	12.41	13.62	14.89	15.65	15.83	15.70	15.72	15.65	15.14	14.12	12.84	12.02
12°	12.82	13.93	15.08	15.66	15.67	15.48	15.53	15.58	15.24	14.38	13.25	12.47
10°	13.22	14.24	15.26	15.68	15.51	15.26	15.34	15.51	15.34	14.66	13.56	12.88
8°	13.58	14.50	15.34	15.59	15.29	14.99	15.09	15.39	15.34	14.81	13.86	13.27
6°	13.94	14.76	15.42	15.42	15.07	14.71	14.85	15.23	15.34	14.96	14.17	13.66
4°	14.30	15.01	15.50	15.50	14.85	14.44	14.59	15.07	15.34	15.11	14.48	14.05
2°	14.65	15.26	15.59	15.34	14.63	14.17	14.33	14.91	15.34	15.27	14.79	14.44
0°	15.00	15.51	15.68	15.26	14.41	13.90	14.07	14.75	15.34	15.42	15.09	14.83

σT_K^4 = Blackbody radiation expressed in mm of evaporable water for the prevailing air temperature;

e_a = saturation vapour pressure expressed in millibars;

e_d = vapour pressure for the period under consideration expressed in millibars;

$T°_C$ = air temperature measured in the meteorological shelter and expressed in degrees Celsius;

$T°_K$ = air temperature expressed in degrees Kelvin where $T°_K = T°_C + 273$;

$U_{m/s}$ = mean wind speed at an elevation of 2 m for the given period and expressed in m/sec.

4. Notes

1. When total radiation measurements expressed in $cal.cm^{-2}.day^{-1}$ are available, they may be introduced directly in the working sheet in the block marked R_G calories.

2. If air humidity is expressed as relative humidity, this can be transformed into mbs of vapour pressure by multiplying the saturation vapour pressure (table VII) for the given $T°_C$ by the relative humidity.

   For example, if RH = 78% and $T°_C$ = 22.4° table VII gives for e_a a value of 27.08 mbs, e_d will be 0.78 x 27.08 = 21.12 mbs.

3. The data required for the computations which are entered in the column of boxes on the left-hand side of the form should all be for the same period, e.g. the monthly mean of the daily value. The final result of the calculations will then be E_T or Eo in mm/day and the monthly value could be found by multiplying by 28, 29, 30 or 31.

5. Tables

The 10 different tables necessary for the above computations are attached. Their numbers are referred to in the calculation working sheets in Roman numerals between brackets appearing under some of the blocks of the working sheet.

a) Potential evapotranspiration

$$E_T = \frac{\frac{p_0}{p} \cdot \frac{\Delta}{\gamma}\left[0.75 R_A \left(a + b\,\frac{n}{N}\right) - \sigma T_K^4 (0.56 - 0.079\sqrt{e_d})(0.10 + 0.90\,\frac{n}{N})\right] + 0.26(e_a - e_d)(1.00 + 0.54\,U)}{\frac{p_0}{p} \cdot \frac{\Delta}{\gamma} + 1.00}$$

b) Evaporation of a free water surface

$$E_o = \frac{\frac{p_0}{p} \cdot \frac{\Delta}{\gamma}\left[0.95 R_A \left(a + b\,\frac{n}{N}\right) - \sigma T_K^4 (0.56 - 0.079\sqrt{e_d})(0.10 + 0.90\,\frac{n}{N})\right] + 0.26(e_a - e_d)(0.50 + 0.54\,U)}{\frac{p_0}{p} \cdot \frac{\Delta}{\gamma} + 1.00}$$

3. Explanation of the units used in the formula

The terms intervening in the formulae and in the working sheets are defined hereunder and expressed in the following units:

E_T = estimation of the potential evapotranspiration for a given period, expressed in mm;

Eo = estimation of the evaporation from a free water surface for a given period, expressed in mm;

p_o = mean atmospheric pressure expressed in millibars at sea level;

p = mean atmospheric pressure expressed in millibars as a function of altitude, for the station where the estimate is calculated;

Δ = rate of change with temperature of the saturation vapour pressure expressed in millibars per degree °C;

γ = the psychometric coefficient for the psychometer with forced ventilation = 0.66;

0.75 and 0.95: factors expressing the reduction in the incoming short wave radiation on the evaporating surfaces and corresponding respectively to an albedo of 0.25 and 0.05;

R_A = short wave radiation received at the limit of the atmosphere expressed in mm of evaporable water (1 mm = 59 calories) and taking for the solar constant the value of 2.00 $cal.cm^{-2}.min^{-1}$;

a and b = coefficients for the estimation of total radiation from the sunshine duration (see paragraph 2.1);

n = sunshine duration for the period considered in hours and tenths;

N = sunshine duration astronomically possible for the given period;

In order to remedy this situation, verified in extreme climates, the coefficient affecting the wind speed at 2 m above the ground (U) has been modified in the following way:

Monthly mean minimum temperature	Difference between mean monthly maximum and minimum temperatures	Coefficient of U
-	$\overline{T}_M - \overline{T}m \leq 12°C$	0.54
> 5°C	$12° < \overline{T}_M - \overline{T}m \leq 13°C$	0.61
> 5°C	$13° < \overline{T}_M - \overline{T}m \leq 14°C$	0.68
> 5°C	$14° < \overline{T}_M - \overline{T}m \leq 15°C$	0.75
> 5°C	$15° < \overline{T}_M - \overline{T}m \leq 16°C$	0.82
> 5°C	$16° < \overline{T}_M - \overline{T}m$	0.89

The tables VIII and IX have been divided into six to accommodate the various coefficients for the calculation of evapotranspiration and evaporation.

2.4 Other coefficients have also been proposed for the estimation of the effective radiation. Results of research in this field, however, are not very conclusive. For this reason the coefficients first proposed by Brunt have been maintained.

3. Description of the working sheet

Realizing these difficulties and the importance of trying to simplify the calculations involved in the Penman formula, with particular reference to field projects where elaborate calculating facilities are not often readily available, two simple working sheets have been prepared, allowing the calculations to be made step by step, with the help of tables valid for altitudes between 50°N and 50°S.

A copy of the two working sheets, one for the computation of potential evapotranspiration and the other for the computation of the evaporation of a free water surface, are presented.

The two sheets differ from one another in the figure adopted for the albedo*, this being 25% for the vegetative cover and only 5% for the water surface. Another difference appears in the so-called aerodynamic term, where the constant factor associated with the wind speed is 1.00 in the case of the vegetation, to allow for greater roughness of the evaporating surface, and 0.50 in the case of the evaporation of water.

The two formulae for the computation of potential evapotranspiration and evaporation from a free surface of water now read as follows:

* The albedo expresses the percentage of short wave incoming radiation reflected by the soil cover or the water surface.

1. Introduction

The formula, designed in 1948 by Penman for the estimation of evaporation from a free water surface and of potential evapotranspiration from a vegetative cover, has been widely used throughout the world for the last 30 years with generally satisfactory results. The method has been widely applied in FAO activities requiring the knowledge of potential evapotranspiration.

One of the main difficulties for the user is not so much the rather large number of climatic parameters involved in the formula, as the computation itself, particularly if these parameters are expressed in units different from those originally used by Penman. When using the formula it is essential either to keep to the units originally used by Penman or to adopt the appropriate conversion coefficients.

In view of these difficulties a first version of this note was prepared in 1972. It is felt that, in spite of the progress made since then in the area of pocket and desk minicomputers, it is still useful to have available a simple method for field calculations of the Penman formula.

2. Coefficients used in the formula

The original formula was designed for the environmental conditions of southern England. Some small modifications to the original formula have been introduced to take into account experience gathered in FAO with the use of the formula around the world.

2.1 The coefficients a and b used in the Angström formula for the estimation of the total radiation from the data of sunshine duration are often subject to discussion. Many tests made within FAO projects have shown that three sets of coefficients allow good results to be obtained in the various zones of the world. These sets of coefficients are:

a	b	
0.18	+ 0.55	for the cold and temperate zones
0.25	+ 0.45	for dry tropical zones
0.29	+ 0.42	for humid tropical zones

The map attached, based on Trewartha (1957) shows these different zones. The zones shown on the map have only an indicative value.

2.2 The values of radiation at the limit of the atmosphere have been calculated on the basis of a solar constant of 2.00 $cal.cm^{-2}.min^{-1}$.

2.3 Estimations of evapotranspiration made in very dry environments, characterized by annual average minimum temperatures above 5°C and differences between monthly average maximum and minimum temperatures of more than 12°C, show an underestimation of potential evapotranspiration due in most cases to the advection of dry air.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Mtera	Rainfall	54%	69%	67%	120%	180%	395%	0%	0%	305%	424%	150%	64%	27%
	Pan Evaporation	18%	19%	20%	20%	16%	11%	12%	11%	9%	6%	11%	17%	6%
Igawa	Rainfall	52%	38%	43%	91%	155%	228%	469%	0%	335%	184%	147%	54%	22%
	Pan Evaporation	14%	16%	17%	17%	13%	12%	14%	11%	8%	16%	16%	20%	10%
Mbarali	Rainfall	33%	40%	38%	77%	176%	436%	447%	424%	424%	188%	103%	47%	18%
	Pan Evaporation	12%	13%	18%	10%	9%	11%	11%	5%	6%	10%	12%	22%	4%

Table 4.27[8] - Monthly and annual coefficients of variation for rainfall and pan evaporation

	Intercept (α)	Slope (β)	Correlation coefficient	Standardized variable	Student fractile 95% level of signif.	Slope significantly different from zero?
JAN	91.1	0.239	0.27	0.74	2.365	no
FEB	75.6	0.207	0.22	0.55	2.447	no
MAR	133.3	-0.141	0.092	-0.24	2.365	no
APR	118.3	-0.0095	0.014	-0.04	2.365	no
MAY	121.8	0.046	0.061	0.16	2.365	no
JUN	134.4	0.036	0.029	0.08	2.365	no
JUL	147.1	0.055	0.061	0.17	2.306	no
AUG	213.2	-0.175	0.33	-0.93	2.365	no
SEP	145.1	0.348	0.39	1.13	2.365	no
OCT	299.9	-0.422	0.46	-1.39	2.365	no
NOV	145.6	0.316	0.38	1.01	2.447	no
DEC	62.2	0.558	0.58	2.02	2.306	no
YEARLY	843.9	0.642	0.748	1.95	3.182	no

Table 4.28[8] - Linear regression analysis between pan evaporation stations ($Y = \alpha + \beta X$, $Y \sim$ Mbarali, $X \sim$ Igawa)

	Intercept (α)	Slope (β)	Correlation coefficient	Standardized variable	Student fractile 95% level of signif.	Slope significantly different from zero?
JAN	54.3	0.796	0.55	2.28	2.179	yes
FEB	130.1	-0.034	0.027	-0.09	2.201	no
MAR	187.3	-0.348	0.20	-0.72	2.179	no
APR	218.5	-0.546	0.35	-1.28	2.179	no
MAY	137.6	0.294	0.15	0.54	2.179	no
JUN	206.0	-0.314	0.27	-0.97	2.179	no
JUL	152.7	0.151	0.15	0.52	2.179	no
AUG	236.1	-0.157	0.16	-0.57	2.160	no
SEP	313.3	-0.449	0.36	-1.33	2.179	no
OCT	248.1	-0.063	0.092	-0.26	2.306	no
NOV	218.2	0.267	0.32	1.09	2.228	no
DEC	157.7	0.229	0.16	0.52	2.228	no
ANNUAL	2761.3	-0.26	0.20	-0.51	2.447	no

Table 4.29[8] - Linear regression analysis between pan evaporation stations ($Y = \alpha + \beta X$, $Y \sim$ Mtera, $X =$ Igawa).

Station: 100.3510 Songea

	FAO	Woodhead	Consultants	FAO	Woodhead	Consultants	Consultants	Consultants	Consultants	FAO
	E_p	E_p*	E_p	E_0*	E_0	E_0	E_{pan}	E_p/E_0	E_p/E_{pan}	E_0/E_{pan}	E_p/E_{pan}
Period	15 yrs	1955/1964	1955/1977	15 yrs	1955/1964	1955/1977	1971/1975				
Jan.	126	112	112	158	140	145	161	0.77	0.70	0.90	0.78
Feb.	106	94	106	133	117	136	74	0.78	1.43	1.84	1.43
Mar.	116	98	104	145	123	133	160	0.78	0.65	0.83	0.73
Apr.	103	95	94	129	119	123	161	0.76	0.58	0.76	0.64
Maj	90	96	83	113	120	127	156	0.65	0.53	0.81	0.58
June	79	86	76	99	108	98	119	0.78	0.64	0.82	0.66
July	85	92	77	106	115	99	131	0.59	0.59	0.76	0.65
Aug.	103	112	92	129	140	116	165	0.56	0.56	0.70	0.62
Sept.	136	139	120	170	174	140	167	0.86	0.72	0.84	0.81
Oct.	162	170	148	203	213	281	198	0.82	0.75	0.91	0.82
Nov.	148	155	139	185	194	170	176	0.82	0.79	0.97	0.84
Dec.	128	126	126	160	158	157	158	0.80	0.80	0.99	0.81
Annual	1381	1377	1277	1726	1721	1625	1826	0.79	0.70	0.89	0.76

Table 4.24[8] - Comparison of Penman estimates and pan measurements. E_p - potential evapotranspiration (Penman), E_o - potential evaporation (Penman), E_{pan} - pan measurements. Asterisks indicate derived values under the assumption of $E_p/E_o = 0.8$. All figures are in mm.

Station: 98.3301 Mbeya

	FAO	Woodhead Consultants		FAO	Woodhead Consultants		Consultants	Consultants	Consultants	FAO
	E_p	E_p*	E_p	E_0*	E_0	E_0	E_{pan}	E_p/E_0	E_p/E_{pan}	E_0/E_{pan}	E_p/E_{pan}
Period	30 yrs	1955/ 1964	1963/ 1978	30 yrs	1955/ 1964	1963/ 1978	1971/ 1979				
Jan.	102	100	104	128	125	131	123	0.79	0.85	1.07	0.83
Feb.	90	82	99	113	103	120	124	0.83	0.80	0.97	0.73
Mar.	93	98	103	116	123	130	124	0.79	0.83	1.05	0.75
Apr.	86	99	98	108	124	126	126	0.79	0.78	1.00	0.68
May	83	100	90	104	125	115	131	0.78	0.69	0.88	0.63
June	74	93	83	93	116	106	135	0.77	0.61	0.79	0.55
July	85	100	90	106	125	117	156	0.77	0.58	0.75	0.54
Aug.	104	122	124	130	153	155	179	0.80	0.69	0.87	0.58
Sept.	131	147	168	164	184	199	216	0.84	0.78	0.92	0.61
Oct.	160	170	197	200	212	276	224	0.83	0.88	1.05	0.71
Nov.	135	142	157	169	178	202	199	0.78	0.79	1.02	0.68
Dec.	110	116	114	138	145	154	146	0.74	0.78	1.05	0.75
Annual	1252	1370	1426	1565	1713	1791	1883	0.80	0.76	0.95	0.66

Table 4.23[8] - Comparison of Penman estimates and pan measurements. E_p - potential evapotranspiration (Penman), E_o - potential evaporation (Penman), E_{pan} - pan measurements. Asterisks indicate derived values under the assumption of $E_p/E_o = 0.8$. All figures are in mm.

Station: 97.3513 Mduli

	FAO	Woodhead	Consultants	FAO	Woodhead	Consultants	Consultants	Consultants	Consultants	FAO
	E_p	E_p*	E_p	E_0*	E_0	E_0	E_{pan}	E_p/E_0	E_p/E_{pan}	E_0/E_{pan}	E_p/E_{pan}
Period	2 yrs	1960/1962	1970/1979	2 yrs	1960/1962	1970/1979	1973/1979				
Jan.	143	119	112	179	149	142	148	0.79	0.76	0.96	0.97
Feb.	121	105	107	151	131	137	136	0.78	0.79	1.01	0.89
Mar.	133	119	107	166	149	135	126	0.85	0.85	1.07	1.06
Apr.	137	116	96	171	145	120	121	0.80	0.79	0.99	1.13
May	143	119	93	179	149	116	141	0.66	0.66	0.82	1.01
June	136	114	82	170	143	104	153	0.54	0.54	0.68	0.89
July	140	120	92	175	150	115	172	0.53	0.53	0.67	0.81
Aug.	154	134	104	193	168	129	195	0.81	0.53	0.66	0.79
Sept.	197	147	126	246	184	154	211	0.82	0.60	0.73	0.93
Oct.	184	159	143	230	199	171	228	0.84	0.63	0.75	0.81
Nov.	171	149	140	214	186	170	216	0.82	0.65	0.79	0.79
Dec.	153	133	123	191	166	154	175	0.80	0.70	0.88	0.87
Annual	1817	1535	1325	2271	1919	1647	2022	0.80	0.66	0.81	0.90

Table 4.22[8] - Comparison of Penman estimates and pan measurements. E_p - potential evapotranspiration (Penman), E_o - potential evaporation (Penman), E_{pan} - pan measurements. Asterisks indicate derived values under the assumption of $E_p/E_o = 0.8$. All figures are in mm.

Station Number	Station Name	Region	Source of meteorological data	Period of record	Altitude (meters above sea level)	Mean annual potential evaporation in mm (E_o)	Estimated mean annual potential evapotranspiration in mm (E_p)
97.3500	Iringa	Iringa	DOM	1955-64	1540	1929	1543
97.3513	Nduli	Iringa	DOM	1960-62	1428	1919	1535
98.3301	Mbeya Airfield	Mbeya	DOM	1955-64	1750	1713	1370
98.3302	Chunya	Mbeya	DOM	1946-54	1500	2034	1627
98.3322	Mbeya Range	Mbeya	DOM	1957-66	2400	1522	1218
98.3406	Igawa	Mbeya	Maji	1957,1958, 1964	1150	2038	1630
98.3408	Mbarali	Mbeya	Maji	1957, 1963-65	1050	2391	1913
98.3529	Sao Hill	Iringa	DOM	1940-50	1980	1592	1274
99.3415	Njombe	Iringa	DOM	1955-64	1900	1458	1166
99.3429	Igeri	Iringa	Maji	1964-66	2250	1298	1038
100.3500	Songea Town	Ruvuma	DOM	1940-55	1150	1628	1302
100.3510	Songea Airfield	Ruvuma	DOM	1955-64	1100	1721	1377

Table 4.18[8] - Penman estimates of mean annual potential evaporation (E_o) (Woodhead, 1968). Mean annual potential evapotranspiration (E_p) is derived under the assumption of $E_p/E_o = 0.8$.

Station Number	Station Name	Region	Source of Meteorological data	Years of Record	Altitude (meters above sea level)	Mean annual potential evapotranspiration in mm (E_p)
97.3500	Iringa	Iringa	DOM	26	1640	1610
97.3513	Nduli	Iringa	DOM	2	1428	1817
98.3301	Mbeya Airfield	Mbeya	DOM	30	1750	1252
98.3302	Chunya	Mbeya	DOM	8	1500	1426
98.3406	Igawa	Mbeya	Maji	3	1150	1541
98.3529	Sao Hill	Iringa	DOM	10	1980	1580
99.3415	Njombe	Iringa	DOM	12	1900	1077
100.3500	Songea Town	Ruvuma	DOM	15	1150	1426
100.3510	Songea Airfield	Ruvuma	DOM	5	1100	1381

Table 4.19[8] - Penman estimates of mean annual potential evapotranspiration (E_p) (FAO).

Station Number	Station Name	Region	Source of Meteorological data	Period of Record	Altitude (meters above sea level)	Mean annual potential evapotranspiration in mm (E_p)
97.3573	Nduli	Iringa	DOM	1970-79	1428	1389
98.3301	Mbeya Airfield	Mbeya	DOM	1963-78	1750	1426
100.3510	Songea Airfield	Ruvuma	DOM	1955-77	1100	1377

Table 4.20[8] - Penman estimates of mean annual potential evapotranspiration (E_p) (Consultants).

Station: 101.3409 Mbamba Bay

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1977							185		145	174	120	171	
1978	96	102	87					145	88	163	172	91	
1979	113	110	167	139								182	
1980	124	120	132	92	87	27	46	111	168	158			
Means	111	111	129	116	87	27	115	128	134	165	146	148	

Sum of monthly means: 1417

Table 4.16[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual (sum of monthly means)
96.3301 Rungwa	95 (4)	104 (4)	106 (4)	108 (4)	101 (4)	105 (4)	100 (4)	148 (2)	150 (2)	212 (2)	105 (2)	93 (3)	1427
97.3511 Mtera	150 (16)	132 (15)	150 (15)	154 (17)	173 (17)	164 (17)	177 (17)	205 (17)	229 (17)	275 (15)	262 (17)	190 (15)	2261
97.3513 Nduli	101 (5)	95 (6)	88 (5)	85 (6)	99 (6)	106 (6)	120 (6)	136 (5)	148 (5)	160 (7)	151 (6)	123 (7)	1412
98.3301 Mbeya Airfield	85 (7)	87 (7)	90 (7)	87 (7)	89 (7)	93 (5)	106 (5)	126 (6)	153 (5)	162 (6)	145 (6)	109 (6)	1332
98.3309 Galula	130 (4)	124 (2)	129 (3)	141 (2)	146 (2)	189 (3)	143 (2)	192 (2)	209 (2)	207 (3)	184 (3)	136 (3)	1930
98.3318 Lupatinga tinga	90 (4)	85 (4)	89 (4)	92 (4)	91 (3)	78 (2)	102 (3)	142 (4)	140 (4)	124 (4)	86 (2)	68 (3)	1187
98.3400 Madibira	106 (10)	85 (10)	87 (9)	85 (10)	112 (12)	115 (12)	122 (12)	134 (11)	150 (11)	155 (13)	134 (11)	109 (10)	1394
98.3406 Igawa	122 (16)	112 (15)	123 (16)	113 (16)	134 (16)	136 (17)	155 (15)	166 (17)	181 (16)	199 (14)	186 (14)	152 (16)	1779
98.3408 Mbarali	117 (11)	100 (11)	118 (11)	115 (11)	128 (11)	140 (10)	154 (11)	186 (10)	207 (11)	224 (12)	204 (12)	142 (12)	1835
99.3316 Chivanjee	77 (3)	85 (4)	107 (4)	122 (4)	53 (4)	49 (4)	50 (4)	67 (4)	89 (4)	121 (4)	113 (3)	83 (3)	1016
99.3335 Tenende	106 (17)	106 (17)	170 (16)	201 (14)	175 (13)	100 (15)	82 (16)	93 (15)	105 (17)	128 (17)	128 (16)	122 (16)	1516
99.3411 Bulongwa	80 (4)	68 (4)	55 (4)	60 (2)	90 (2)	50 (4)	49 (4)	59 (4)	80 (4)	95 (4)	87 (4)	67 (4)	840
99.3414 Madaba	104 (3)	105 (3)	147 (3)	126 (4)	68 (4)	65 (4)	63 (3)	85 (3)	112 (3)	140 (3)	133 (3)	129 (3)	1277
100.3510 Songea Airport	113 (4)	52 (4)	112 (5)	113 (5)	109 (5)	83 (3)	92 (4)	115 (4)	117 (4)	139 (3)	123 (5)	111 (5)	1279
101.3409 Mbamba Bay	111 (3)	111 (3)	129 (3)	116 (2)	87 (1)	27 (1)	115 (2)	128 (2)	134 (3)	165 (3)	146 (2)	148 (3)	1417

Table 4.17[8] - Annual and monthly means of pan evaporation in mm adjusted with a pan coefficient of 0.7. Figures in brackets are numbers of underlying years.

Station: 99.3411 Bulongwa

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1977	72	75	39			57	41	43	57	78	82	74	
1978	87	67	76	82	48	38	46	50	84	102	90	56	825
1979	85	52	41			53	56	80	92	104	82	67	
1980	78	79	63	38	132	53	54	63	88	96	95	69	
Means	80	68	55	60	90	50	49	59	80	95	87	67	

Sum of monthly means: 840

Table 4.13[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station: 99.3414 Madaba

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1977				88	78	55	56	83	95	119	134	176	
1978	102	127	191	116	61	59	61	91	113	143	126	91	1281
1979	98	78	152	97	69	67	72	83	128	158	139	119	1260
1980	113	110	98	78	65	78							
Means	104	105	147	126	68	65	63	85	112	140	133	129	1270

Sum of monthly means: 1277

Table 4.14[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Station: 100.3510 Songea Airport

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1971			166	164	151		101	125	141	121	152	179	
1972	91	80	133	101	120		96	154	114	157	158	81	
1973	102	37	69	110	108	83	103	112	142		207	145	
1974	141	47	112	92	85	88	69		72		179	73	
1975	117	44	80	96	81	80		70		138	98	77	
Means	113	52	112	113	109	83	92	115	117	139	123	111	

Sum of monthly means: 1279

Table 4.15[8] - Adjusted monthly pan evaporation in mm (pan coefficient = 0.7).

Appendix 3
Refers to Volume 7, Chapter 5.

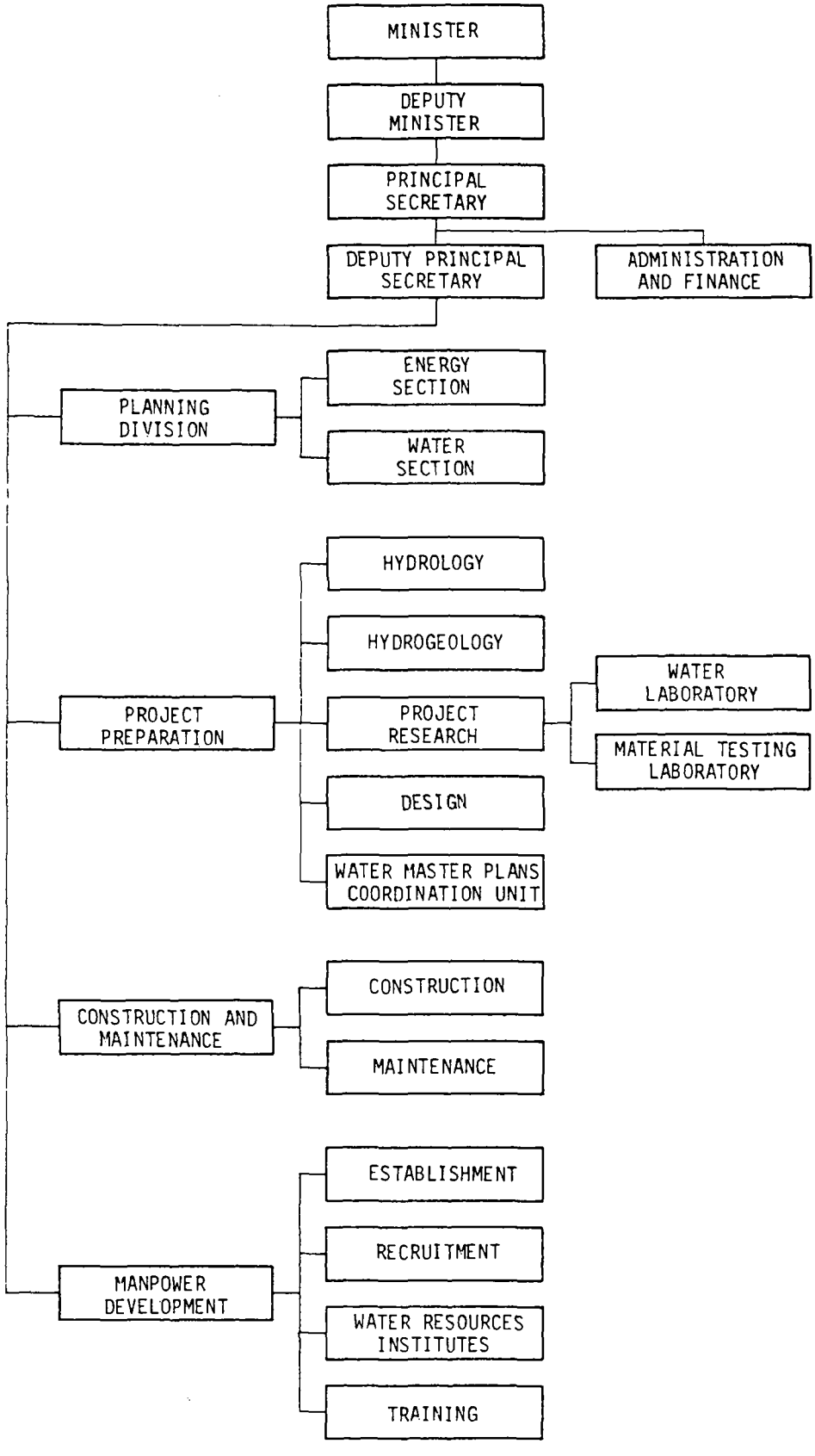


FIGURE 5.3[8]

MAJI - ORGANIZATION CHART

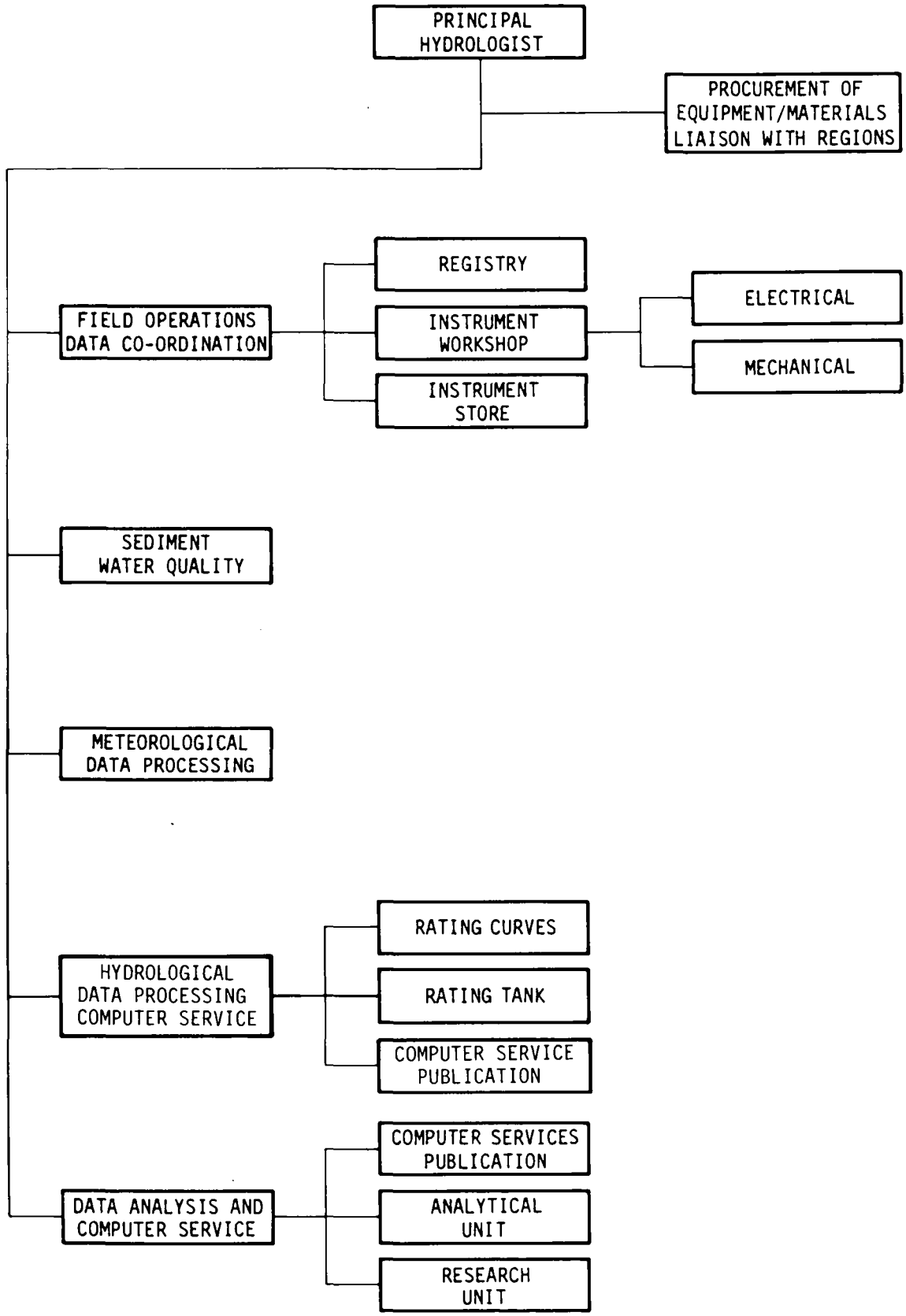


FIGURE 5.4[8]

ORGANIZATION CHART - MAJI HYDROLOGICAL SECTION - HEADQUARTERS

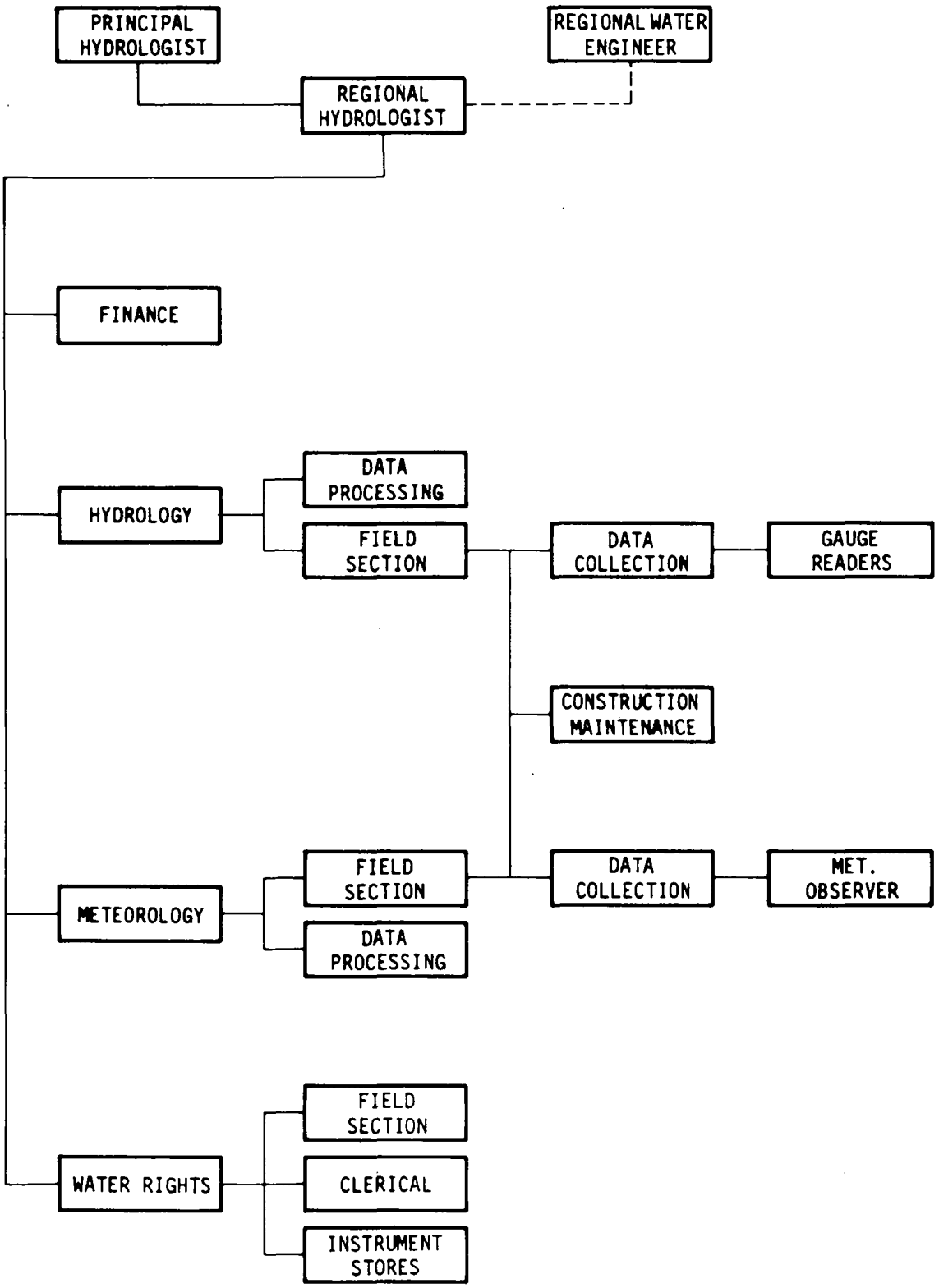


FIGURE 5.5[8]

ORGANIZATION CHART - REGIONAL MAJI HYDROLOGY SECTION

STATION NUMBER 1KA 22

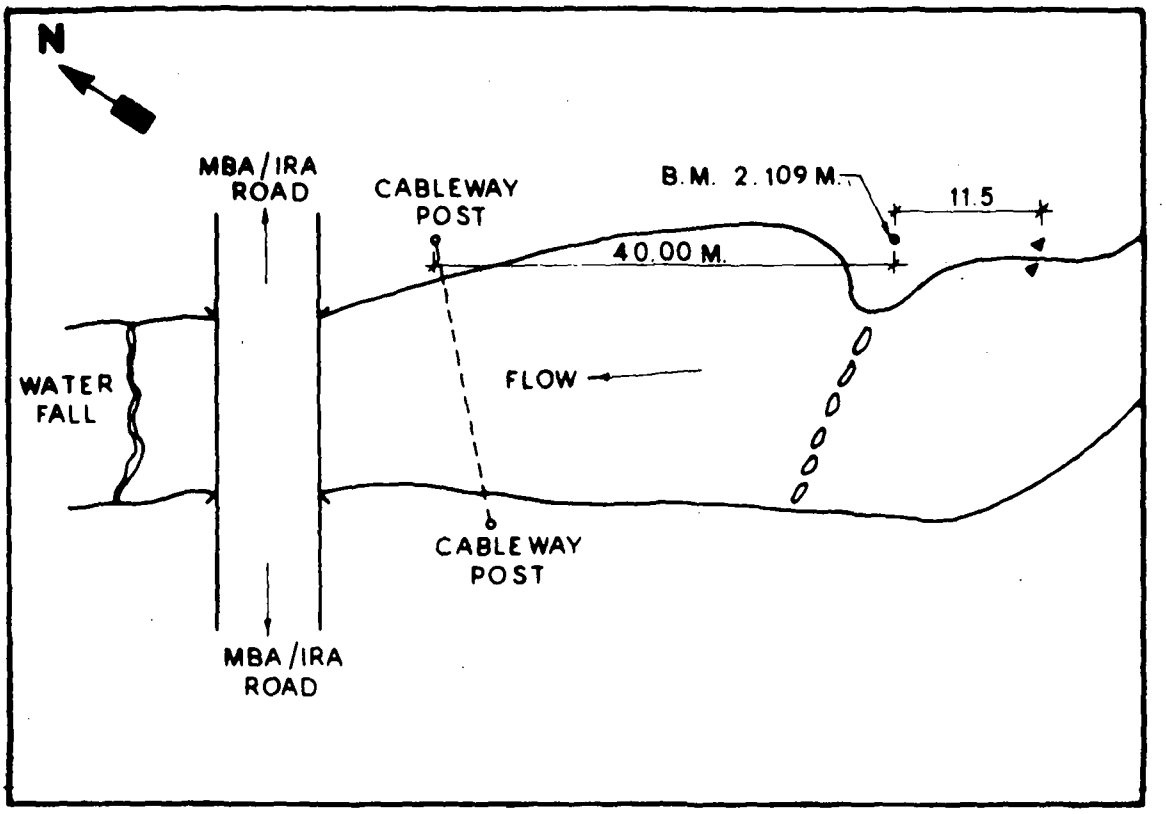


Figure 5.8[8] - Station sketch.

STATION NUMBER 1KA 37A

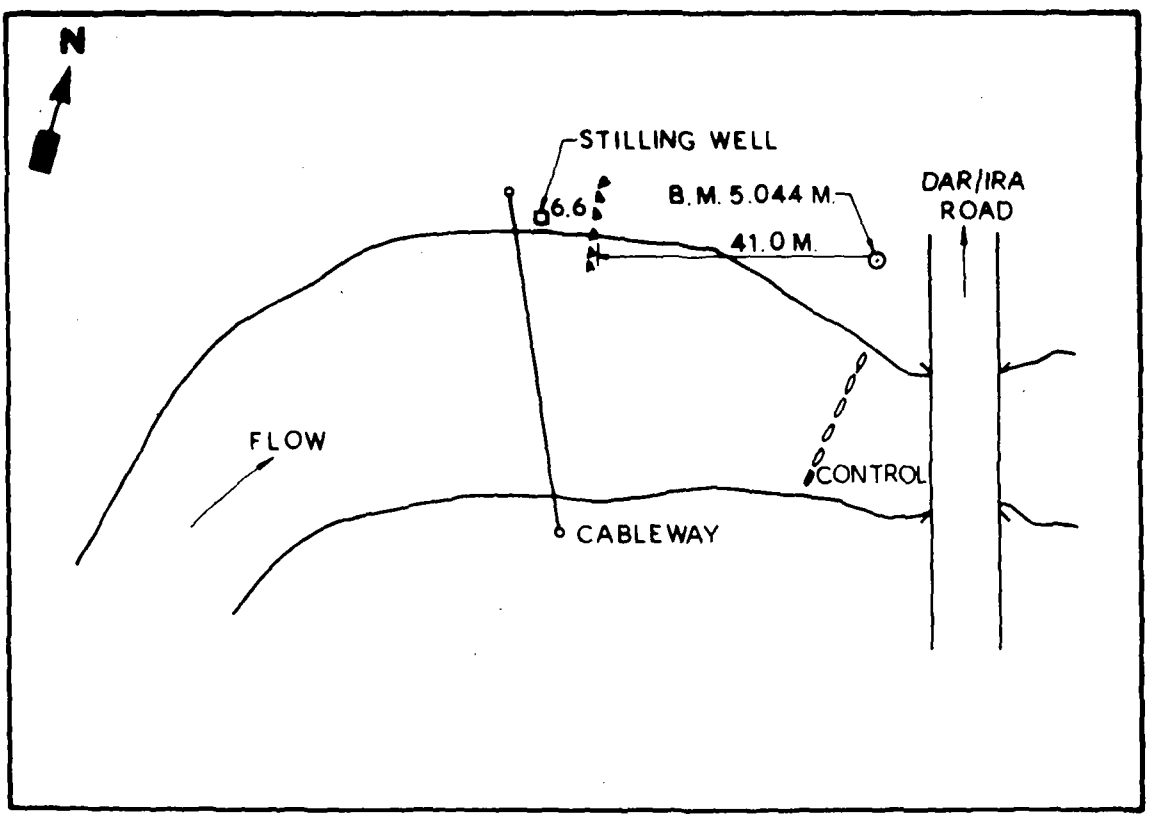


Figure 5.9[8] - Station sketch.

STATION NUMBER 3A8

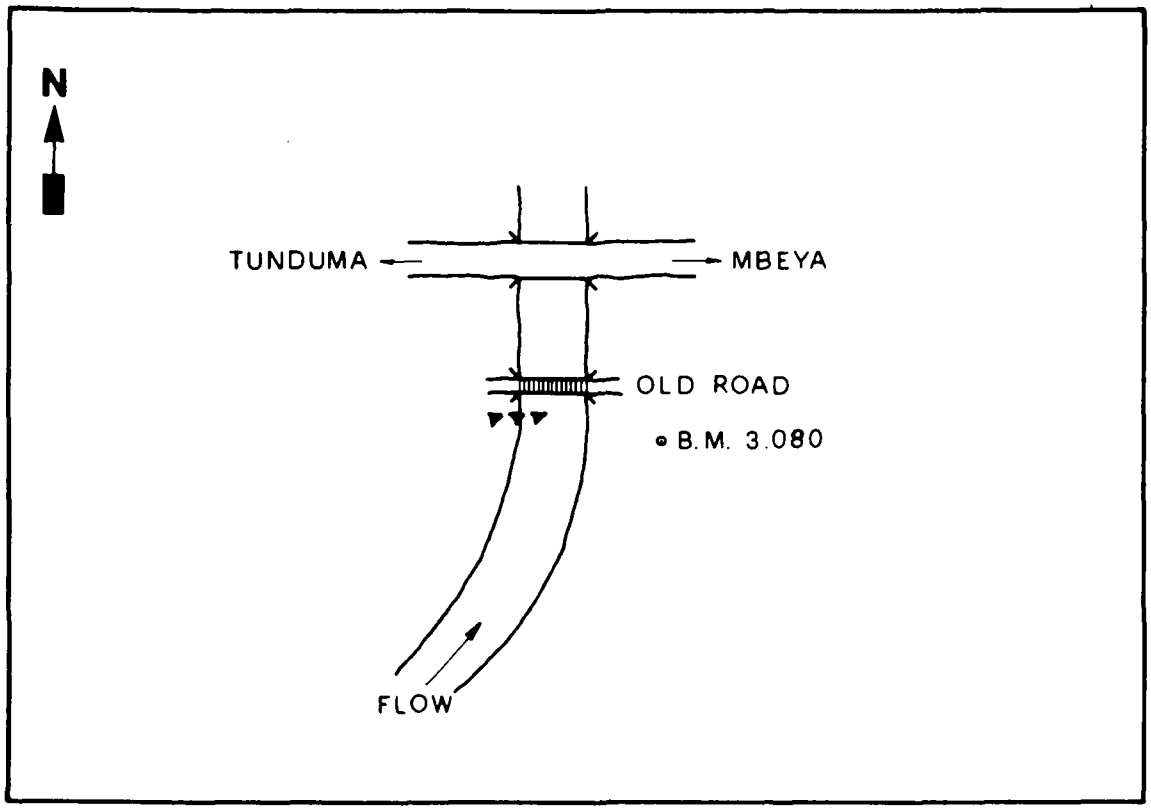


Figure 5.10[8] - Station sketch.

STATION NUMBER 1RC5A

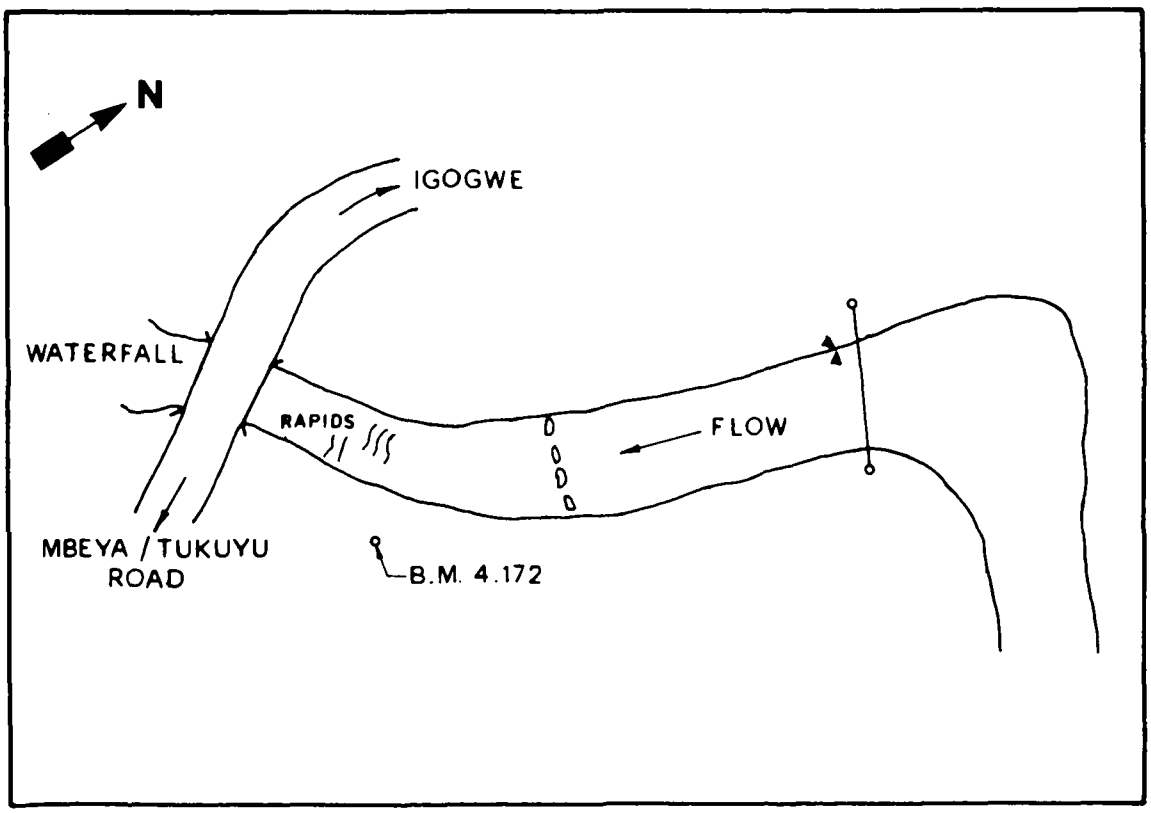


Figure 5.11[8] - Station sketch.

STATION NUMBER 1KB 19

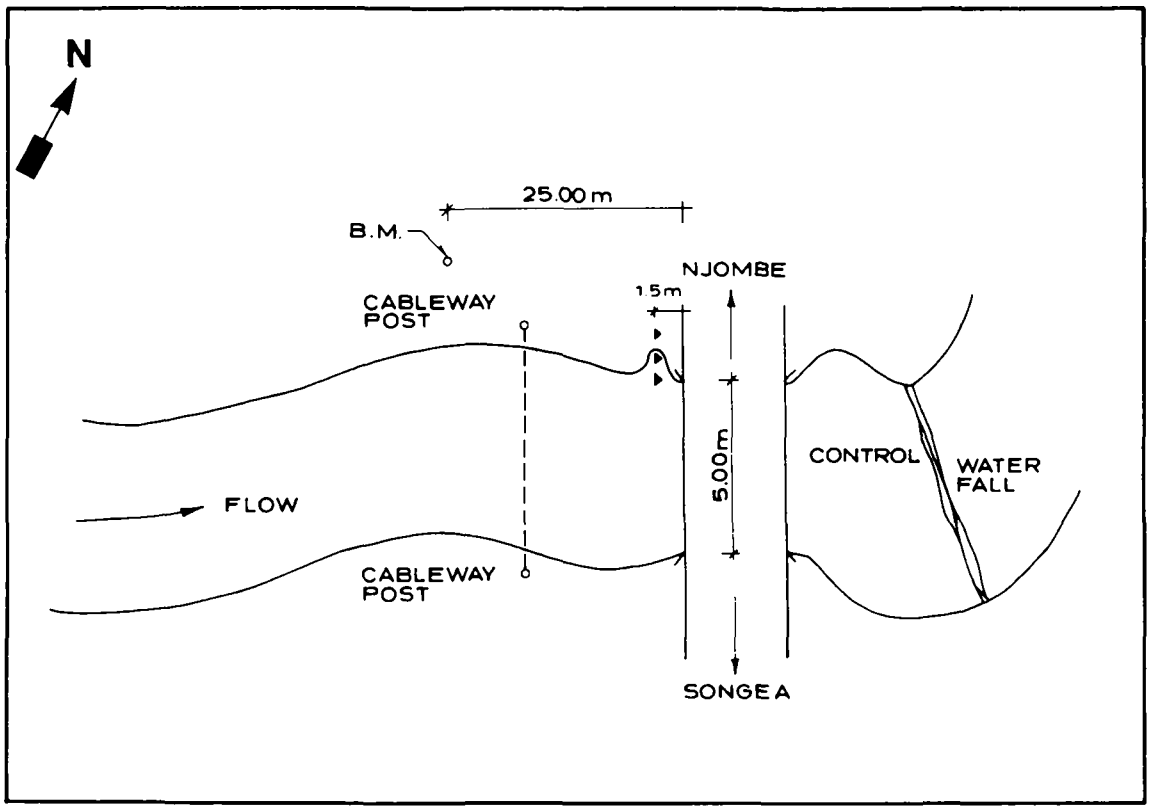


Figure 5.12[8] - Station sketch.

STATION NUMBER 1KA7A

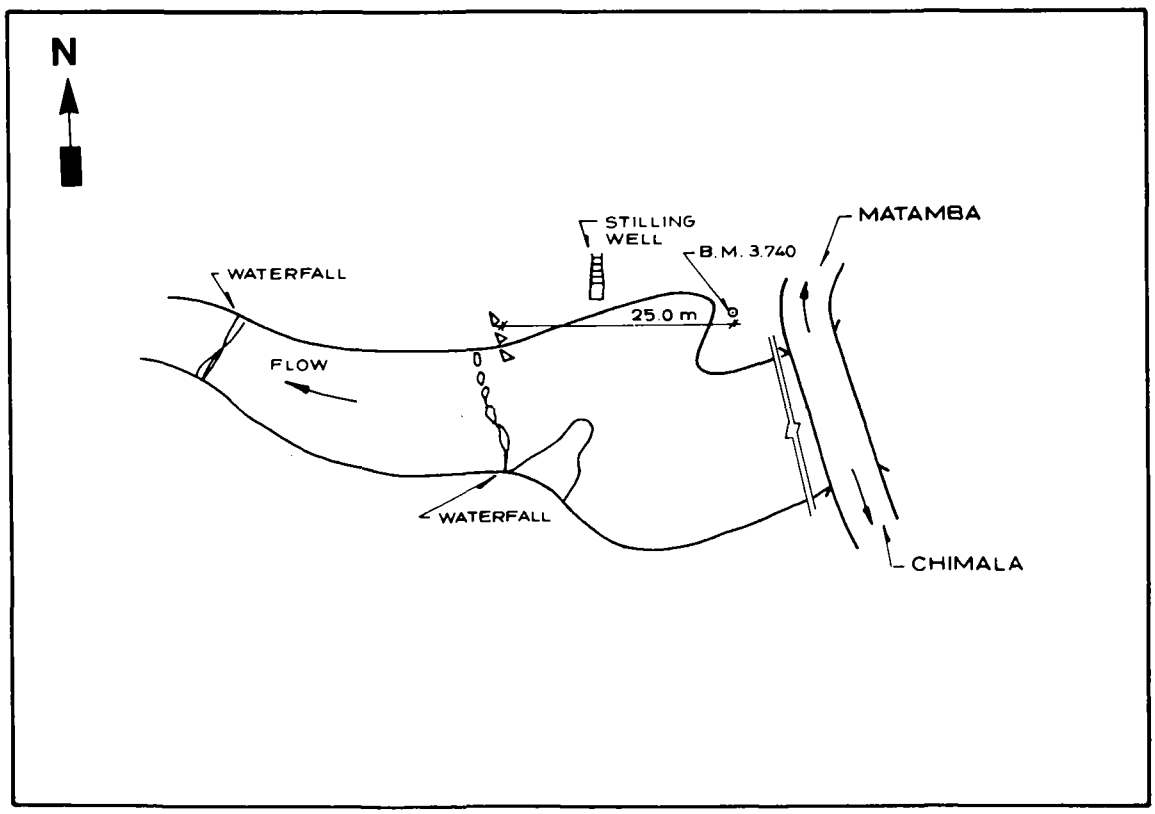


Figure 5.13[3] - Station sketch.

STATION NUMBER 1KA 23A

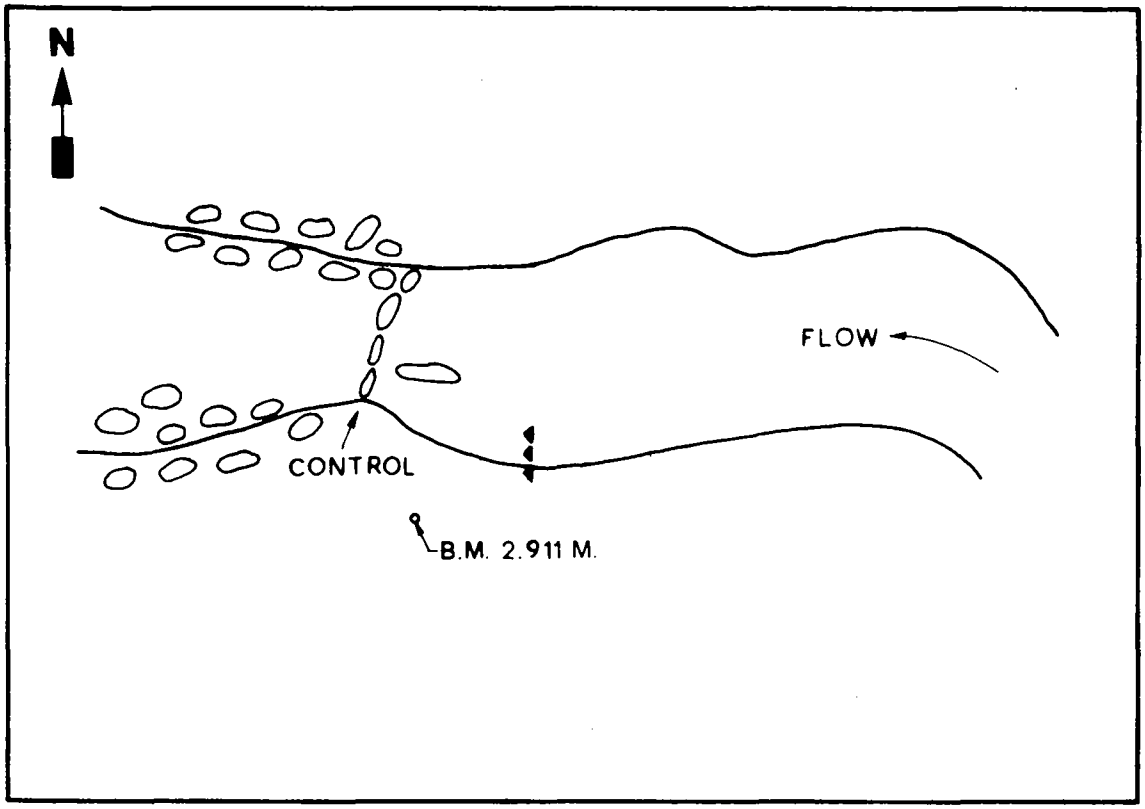


Figure 5.14[8] - Station sketch.

STATION NUMBER 1KA 32A

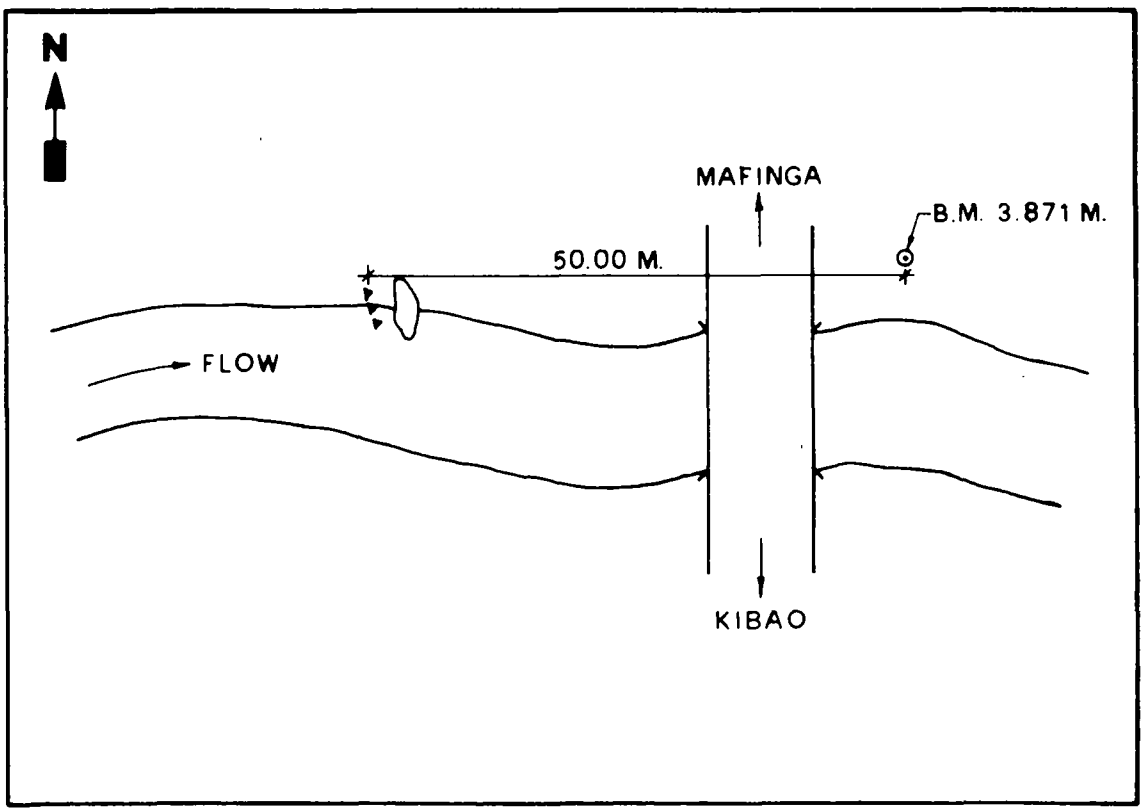


Figure 5.15[8] - Station sketch.

STATION NUMBER 1RC 3A

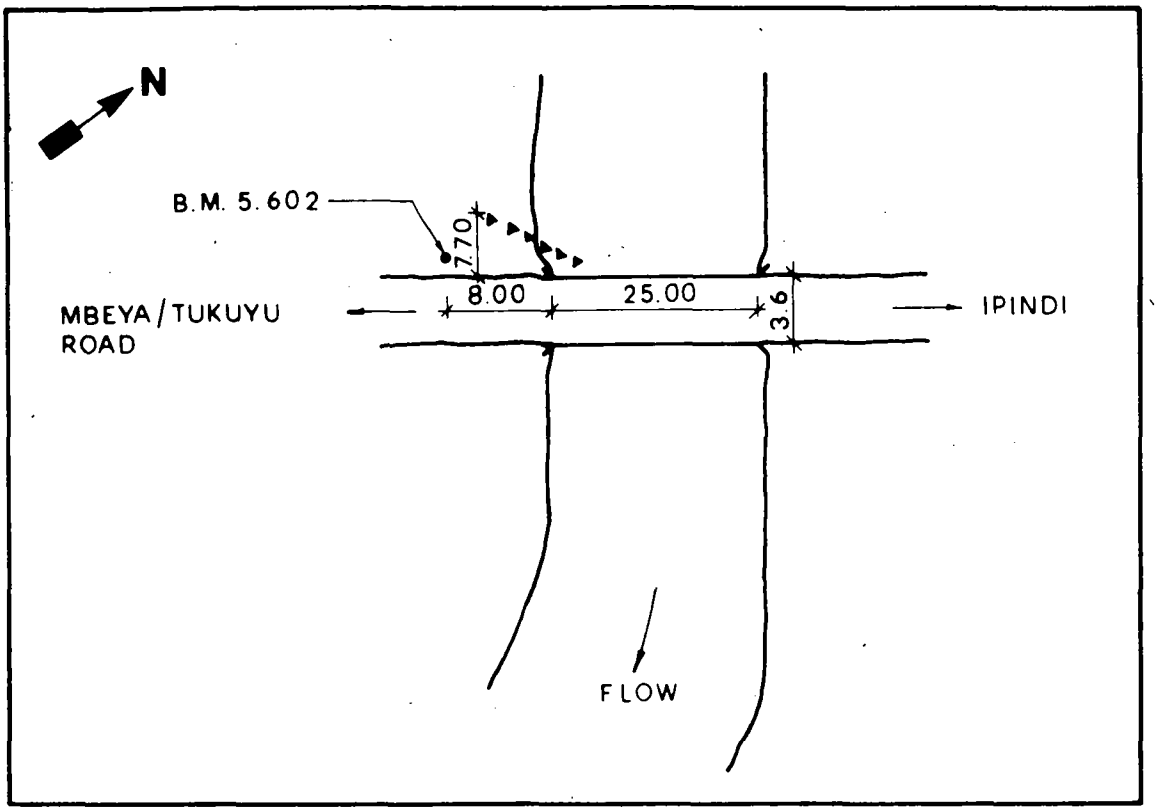


Figure 5.16[8] - Station sketch.

STATION NUMBER 3B14

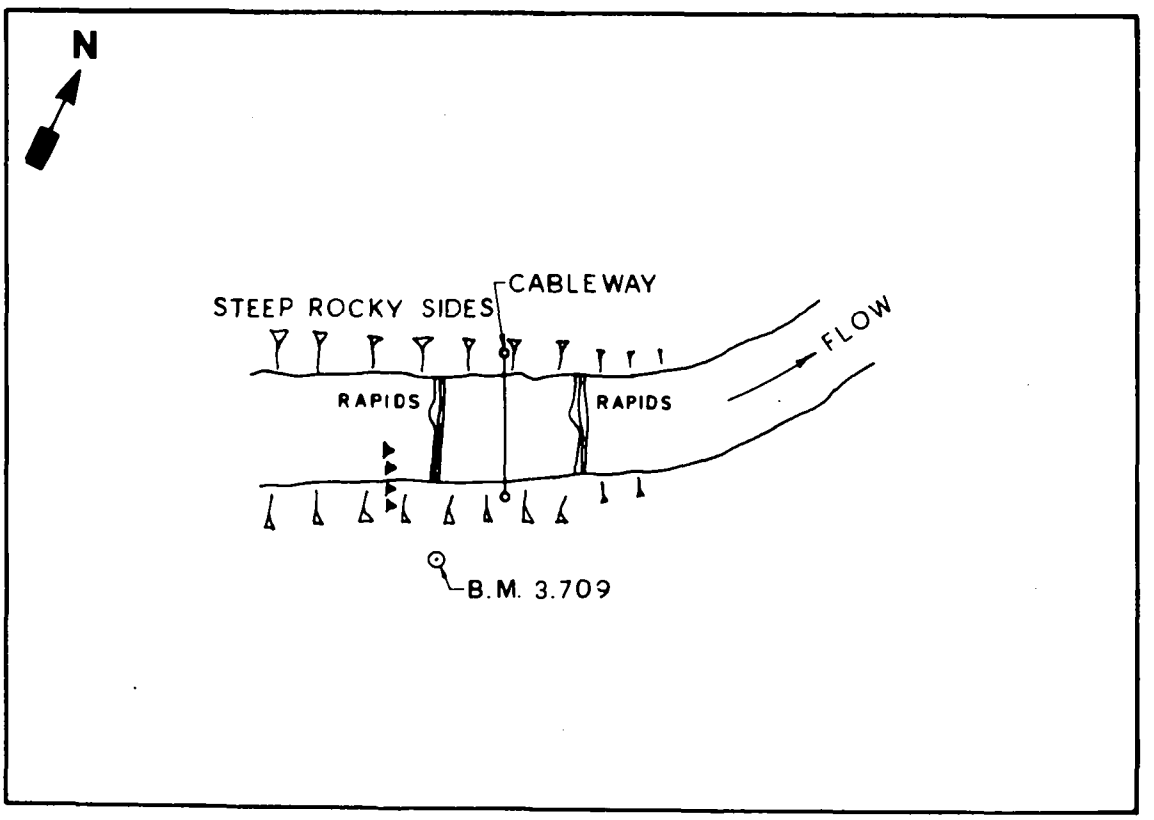


Figure 5.17[8] - Station sketch.

STATION NUMBER 1Q10

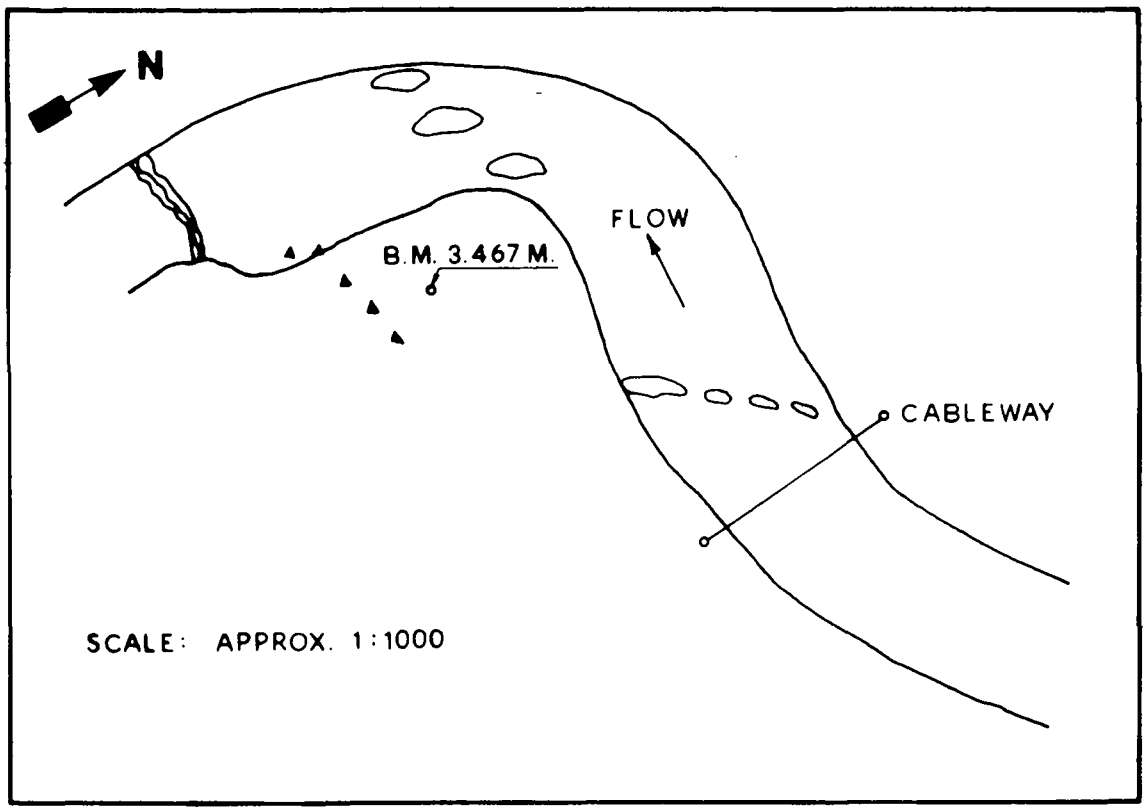


Figure 5.18[8] - Station sketch.

STATION NUMBER 1RB2

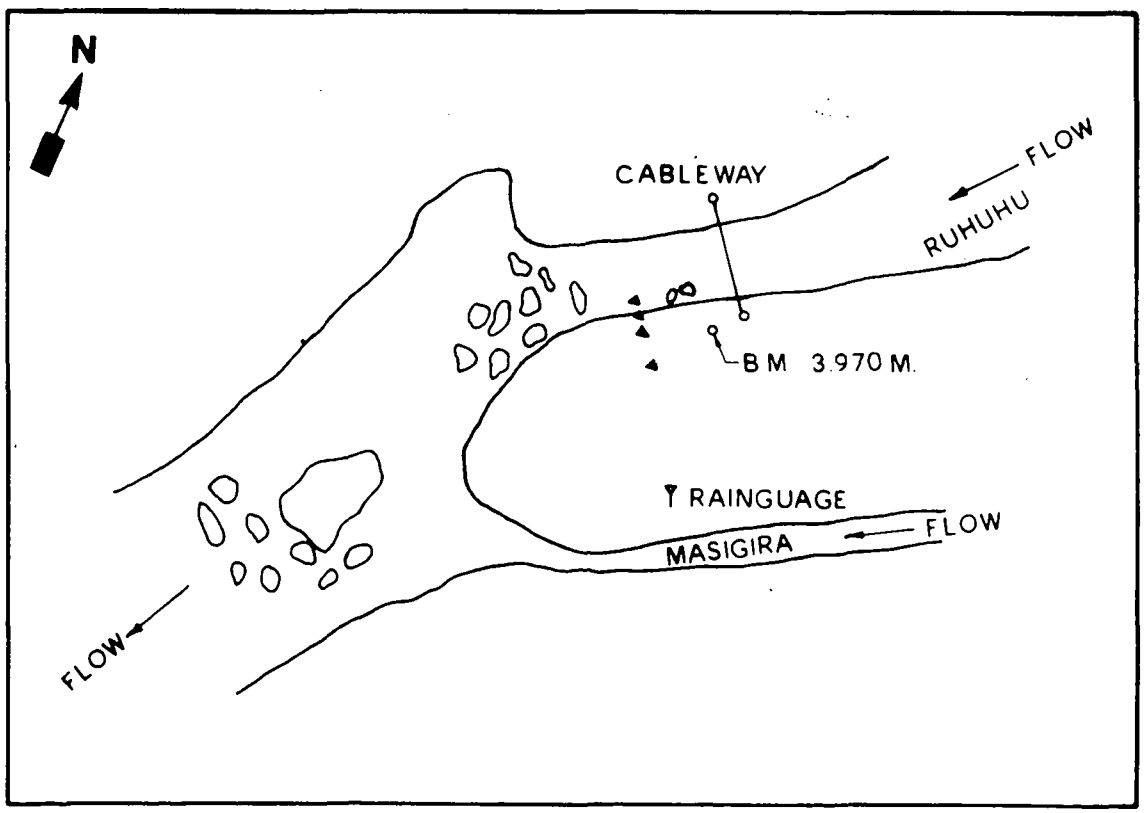


Figure 5.19[9] - Station sketch.

STATION NUMBER 1RB 10

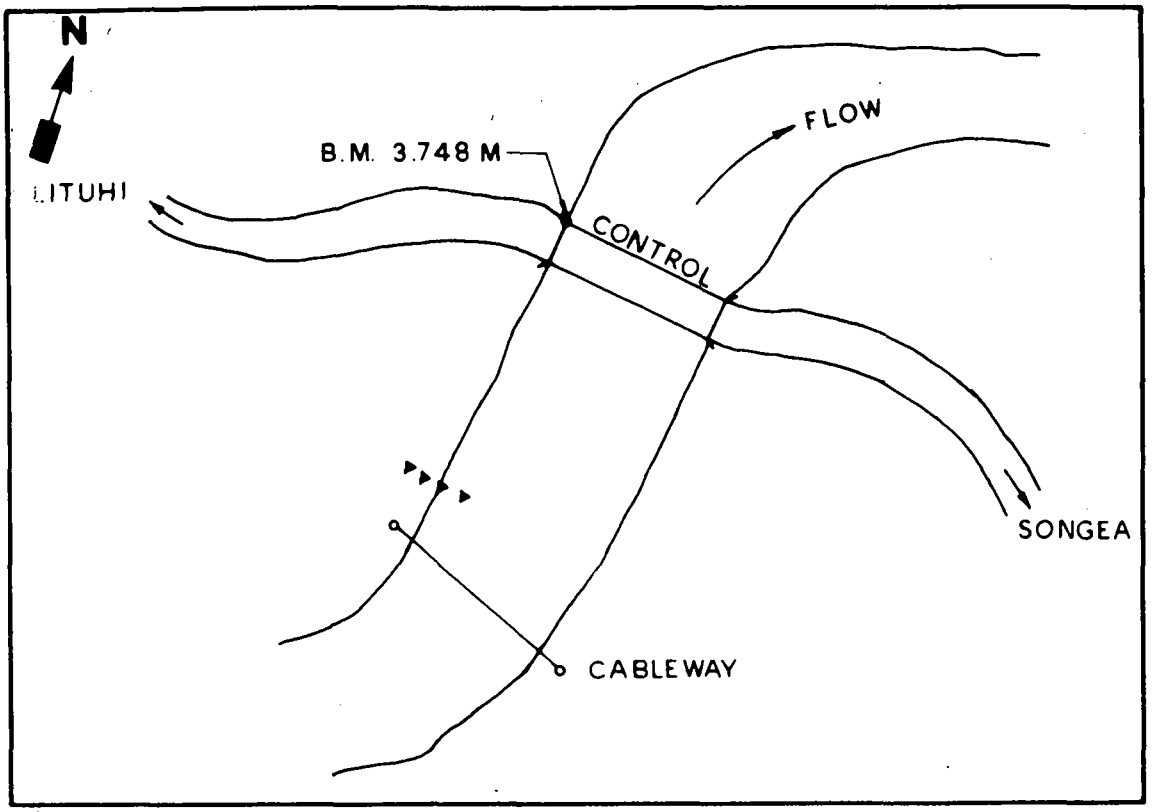


Figure 5.20[8] - Station sketch.

STATION NUMBER 1RB 11

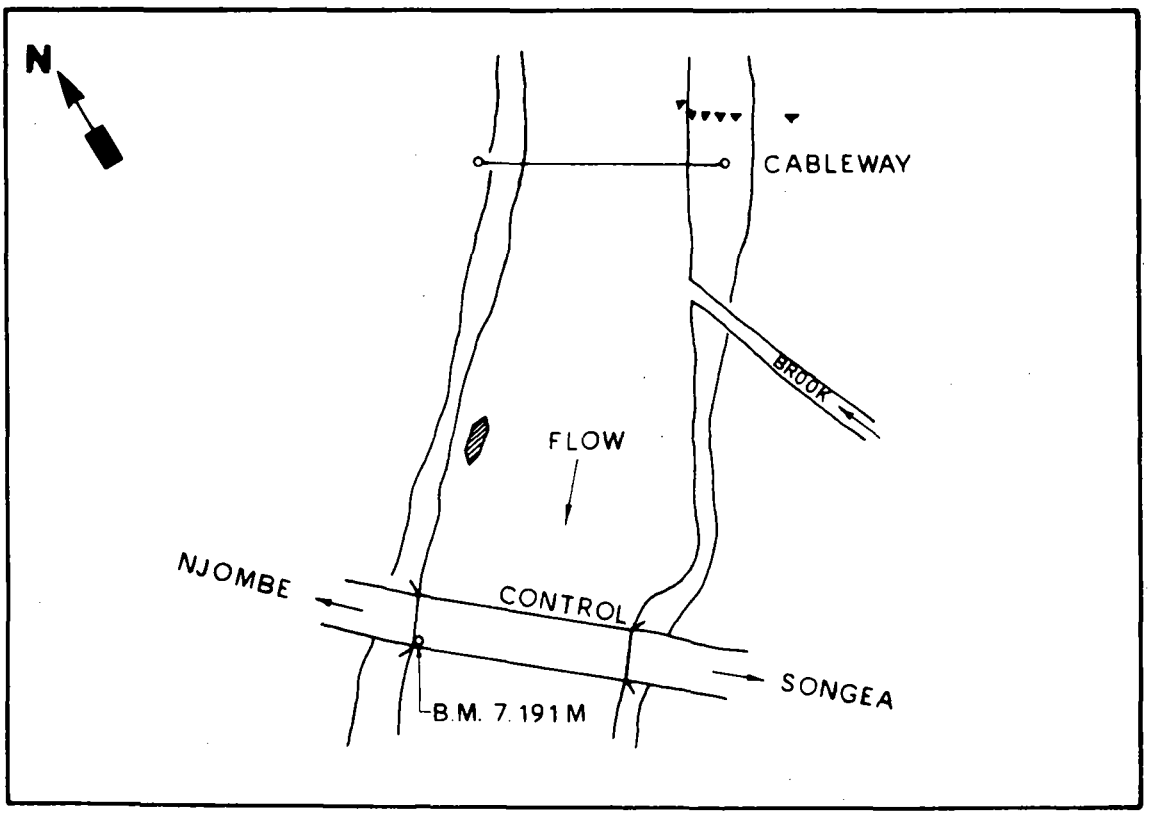


Figure 5.21[8] - Station sketch.

STATION NUMBER 1RB6

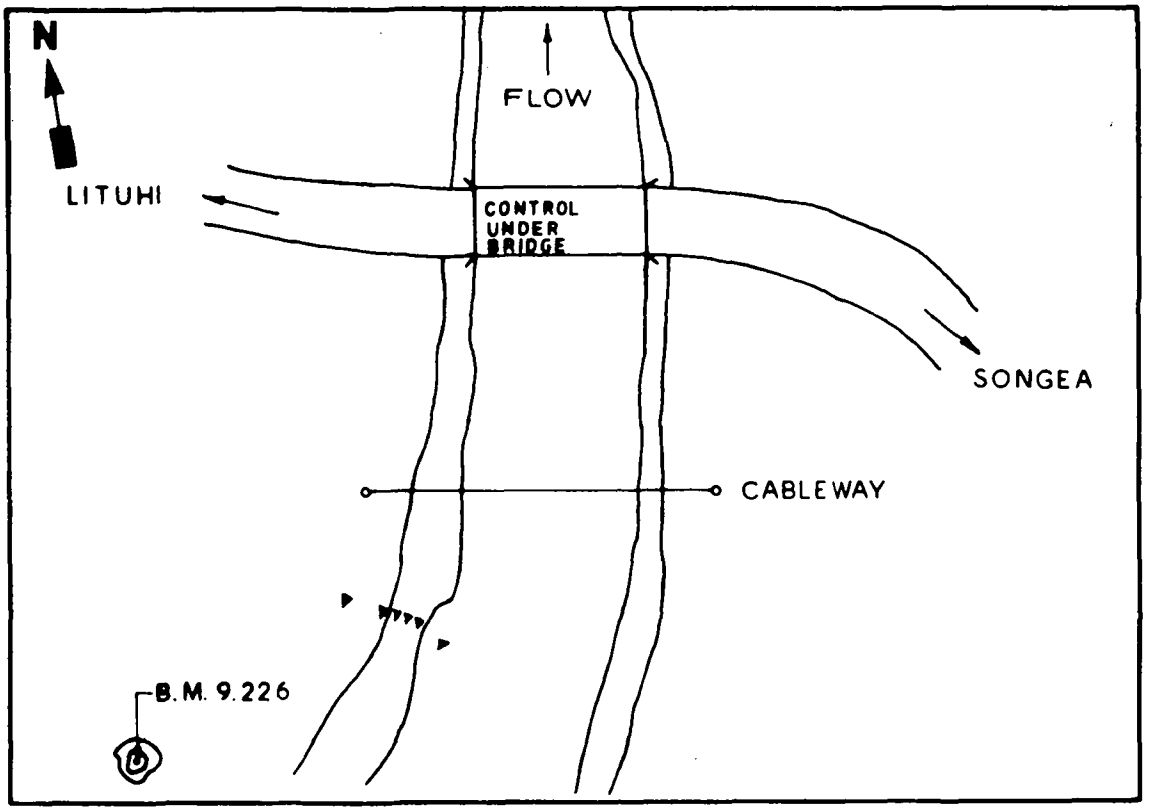


Figure 5.22[8] - Station sketch.

STATION NUMBER 1KB 18B

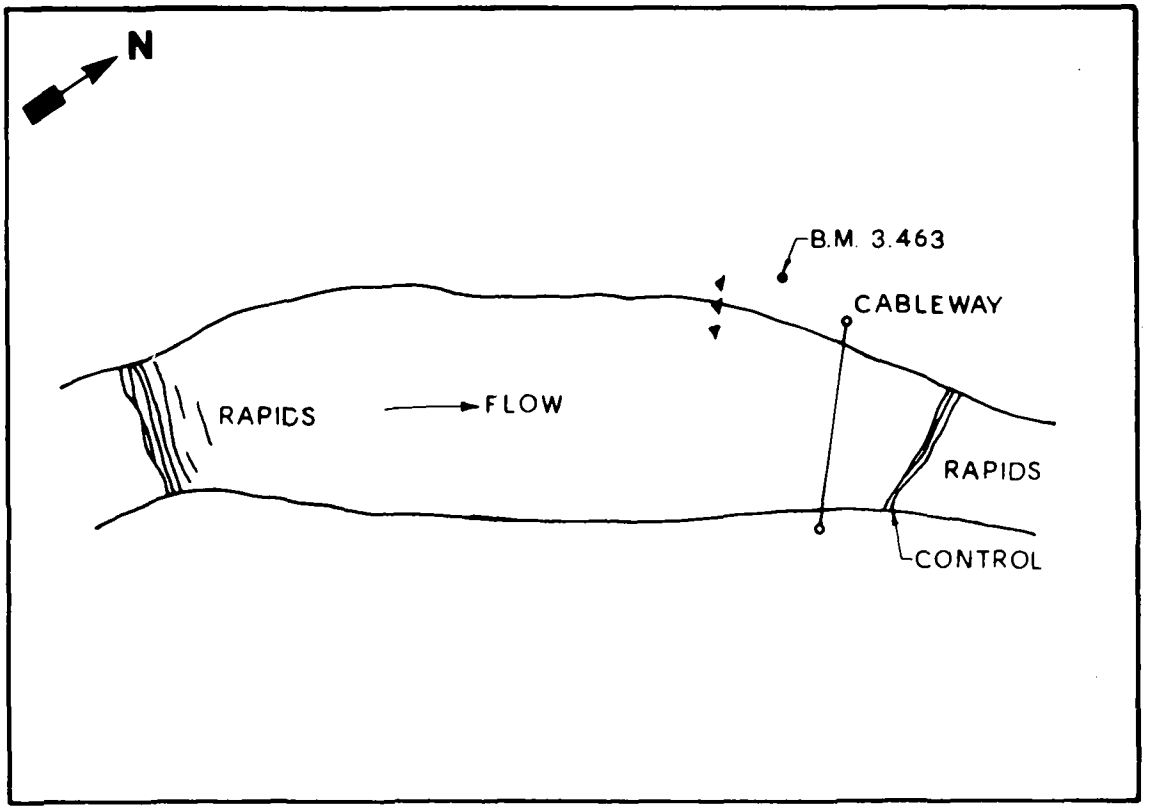


Figure 5.23[8] - Station sketch.

STATION NUMBER 3DA3

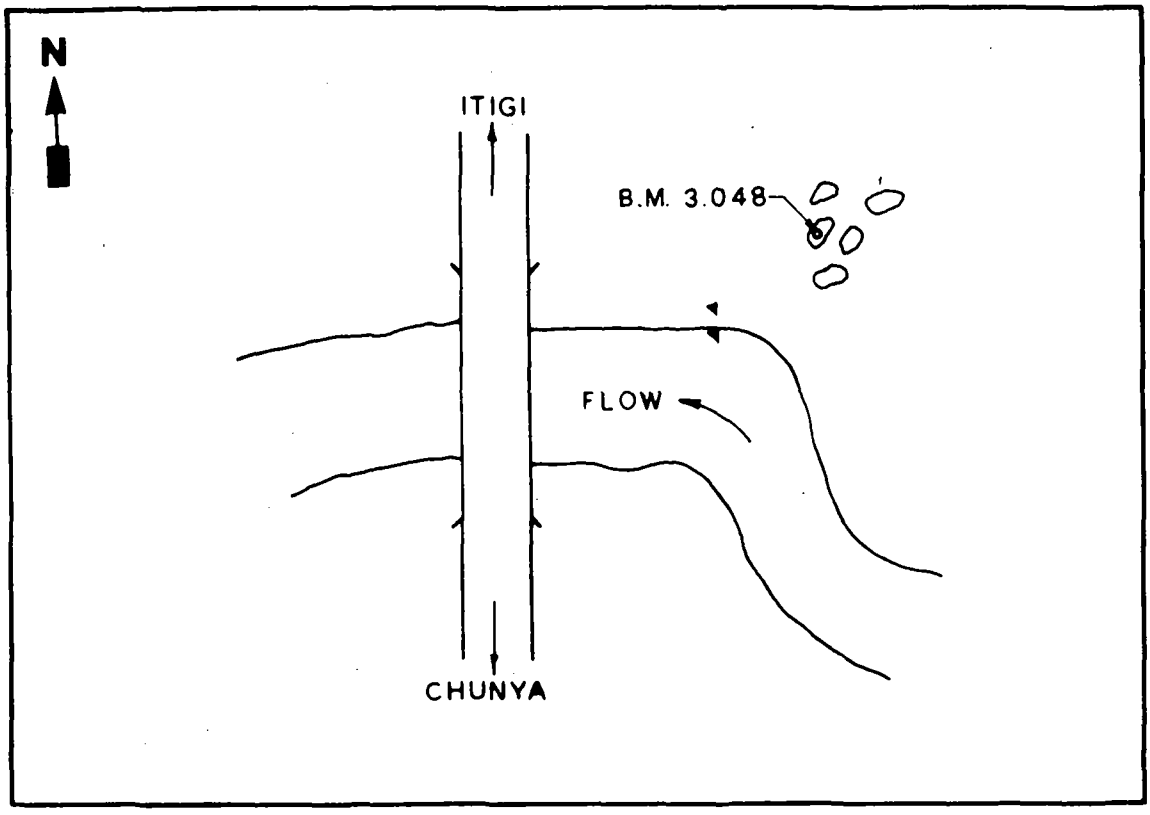


Figure 5.24[8] - Station sketch.

STATION NUMBER 3D4

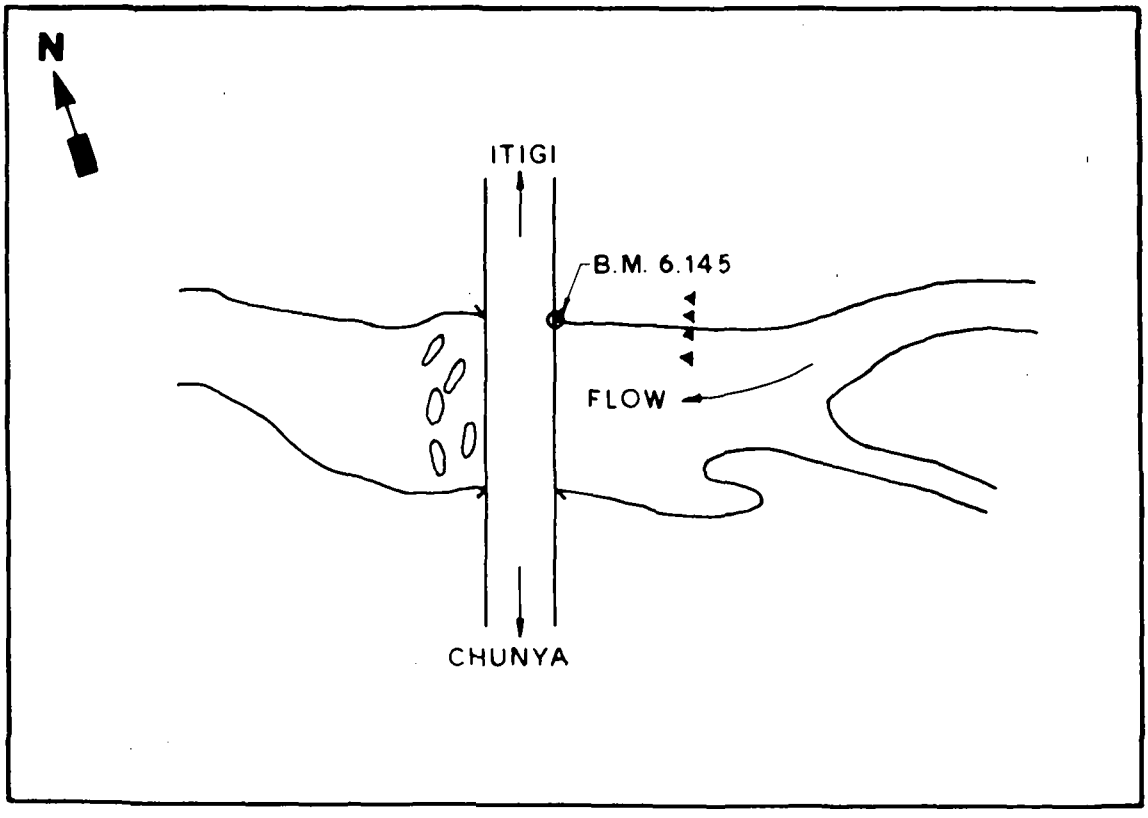


Figure 5.25[C] - Station sketch.

STATION NUMBER 3E1

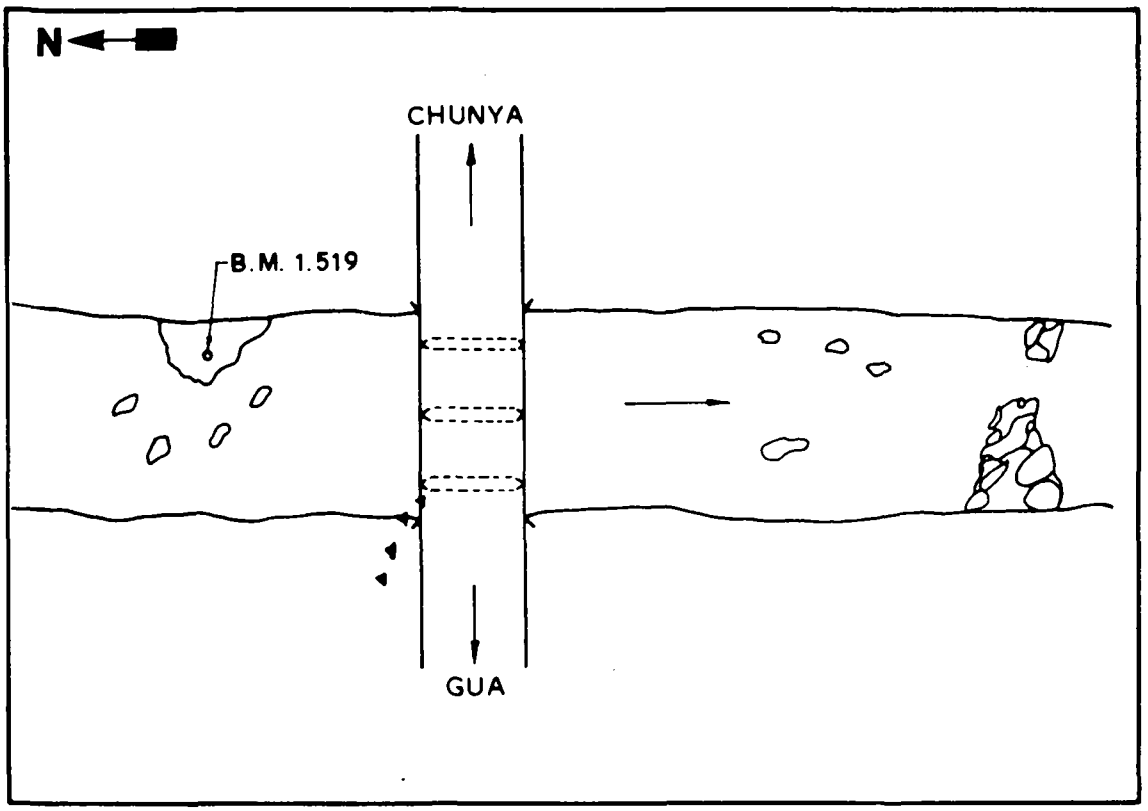


Figure 5.26[8] - Station sketch.

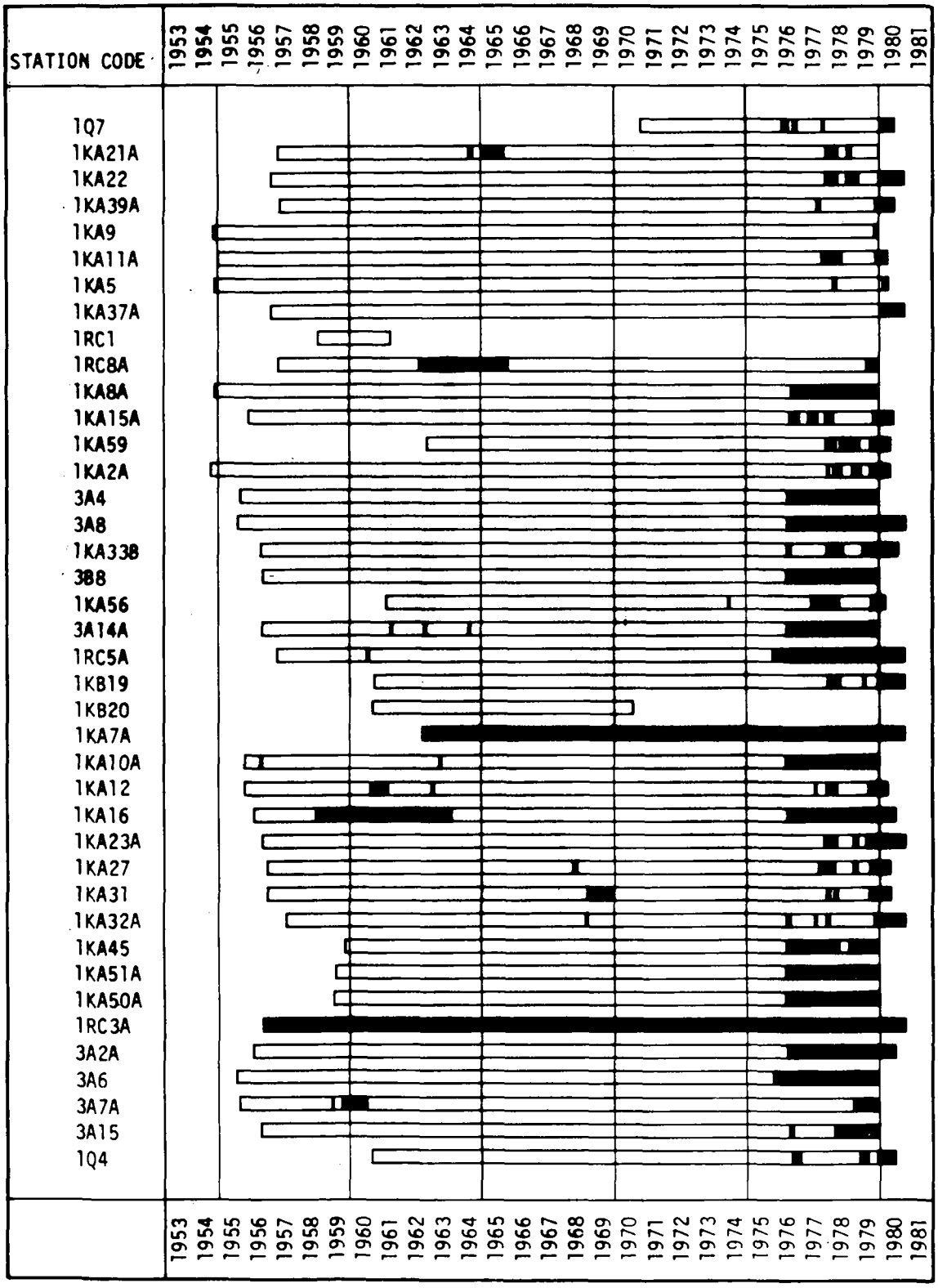


FIGURE 5.29[8] - BAR CHART - WATER LEVEL DATA

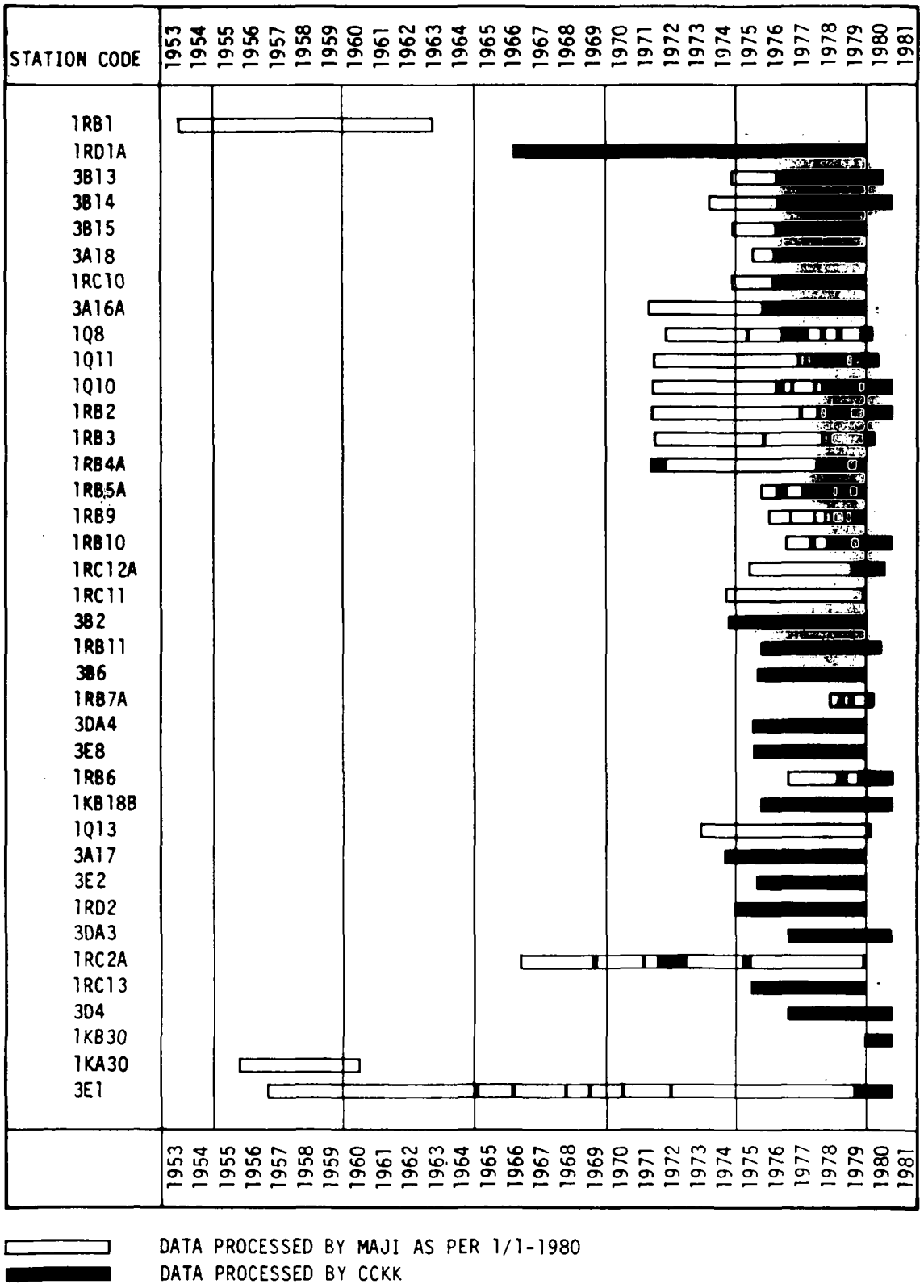


FIGURE 5.29[8] - BAR CHART - WATER LEVEL DATA (CONTD.)

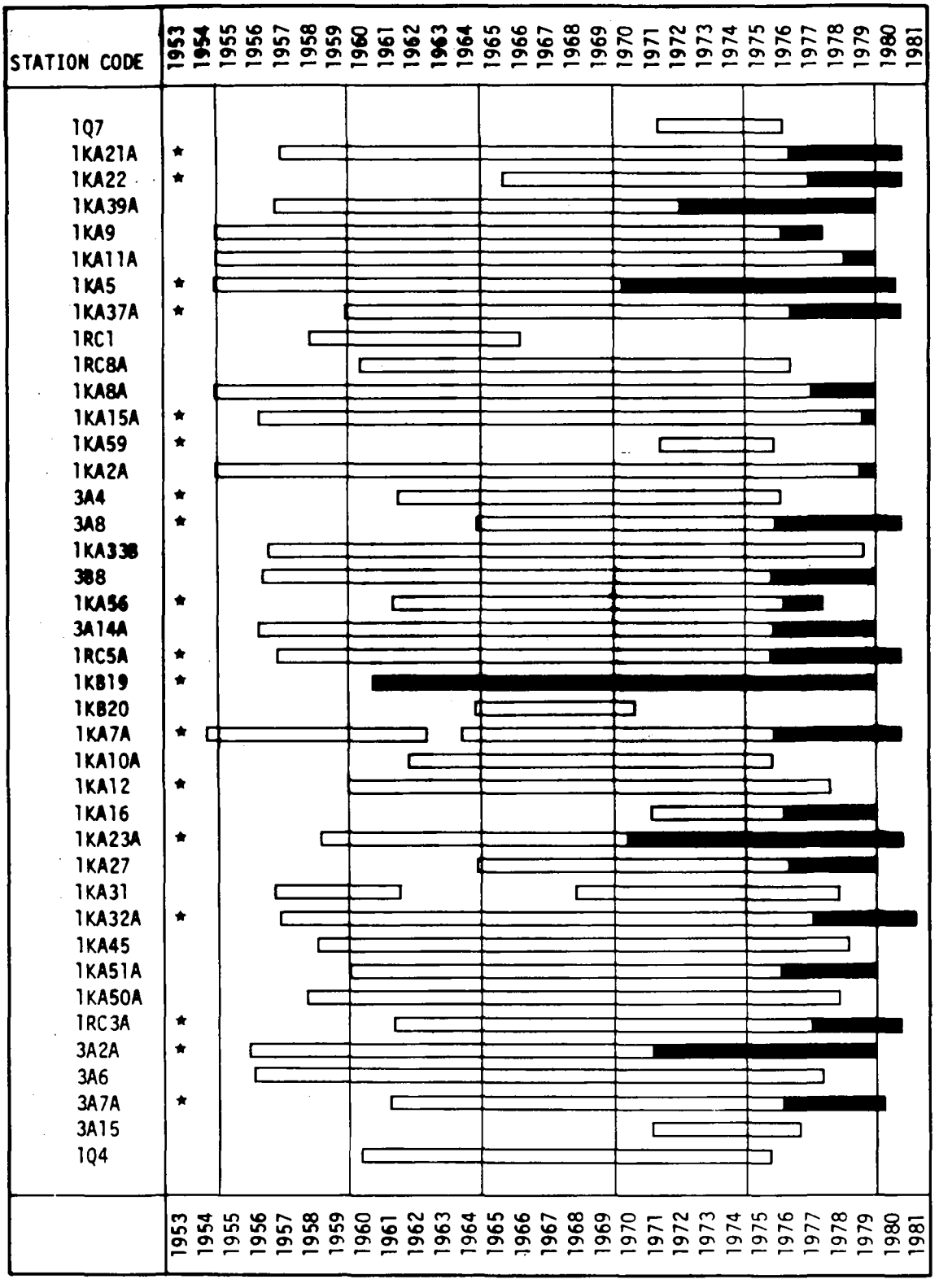


FIGURE 5.31[8] - BAR CHART - RATING TABLES AND CURVES

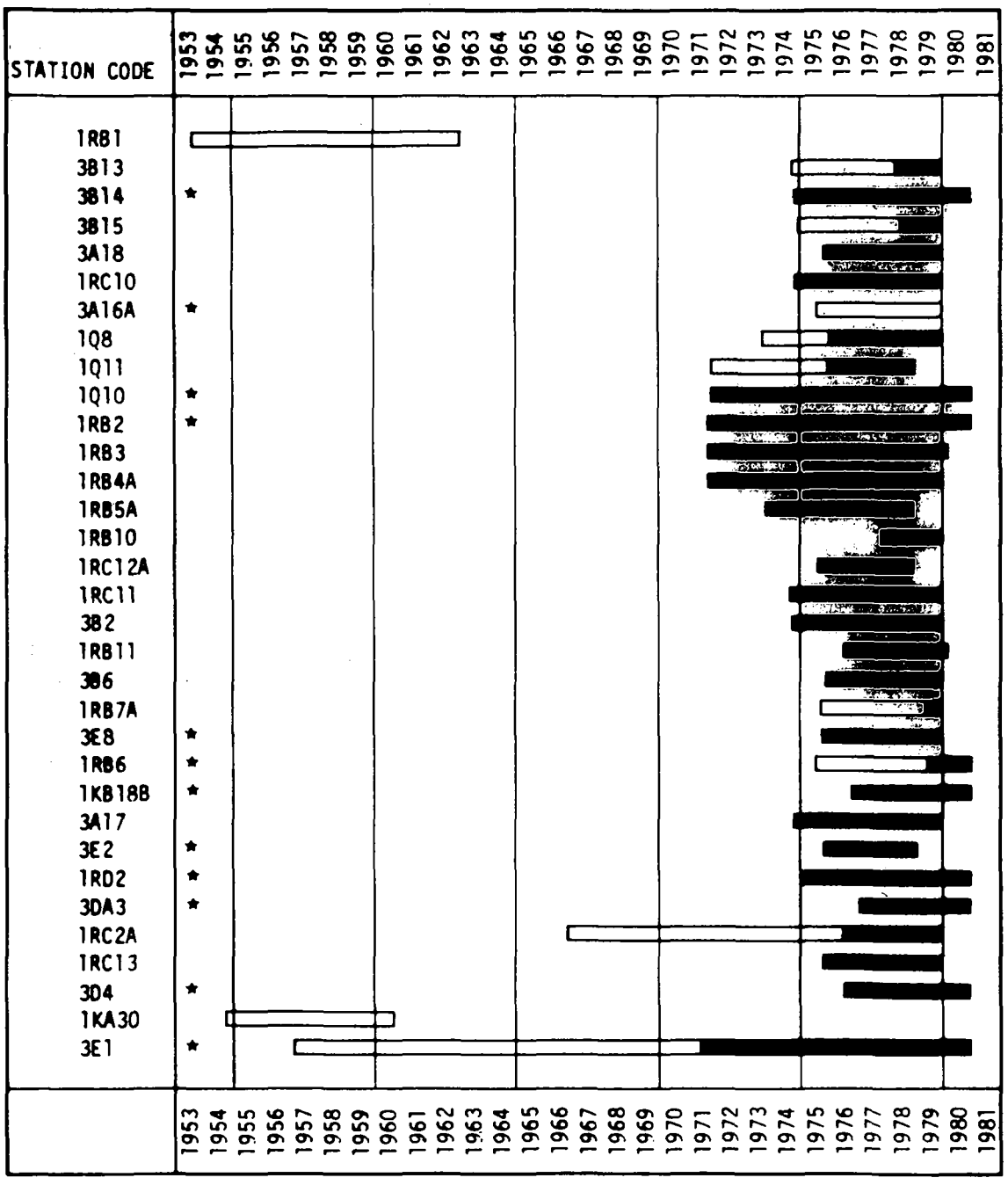


FIGURE 5.31[8] - BAR CHART - RATING TABLES AND CURVES (CONTD.)

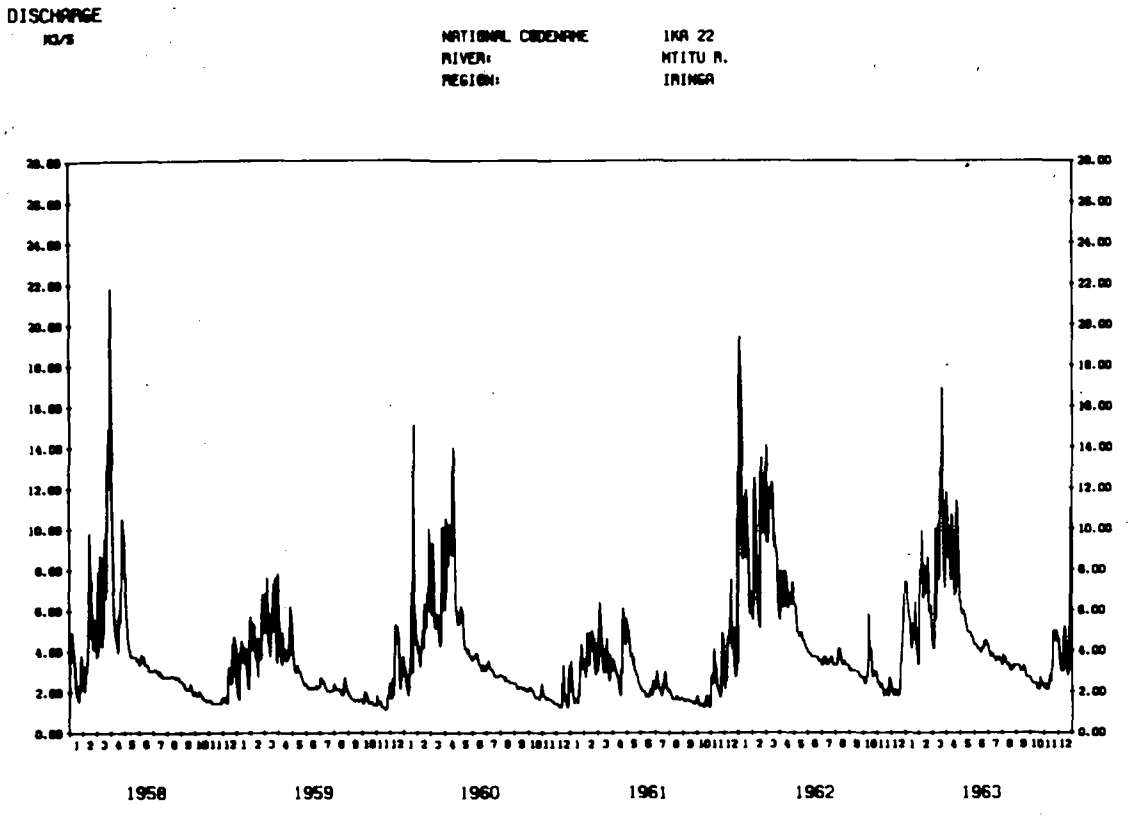


Figure 5.33[8] - Hydrograph - priority station.

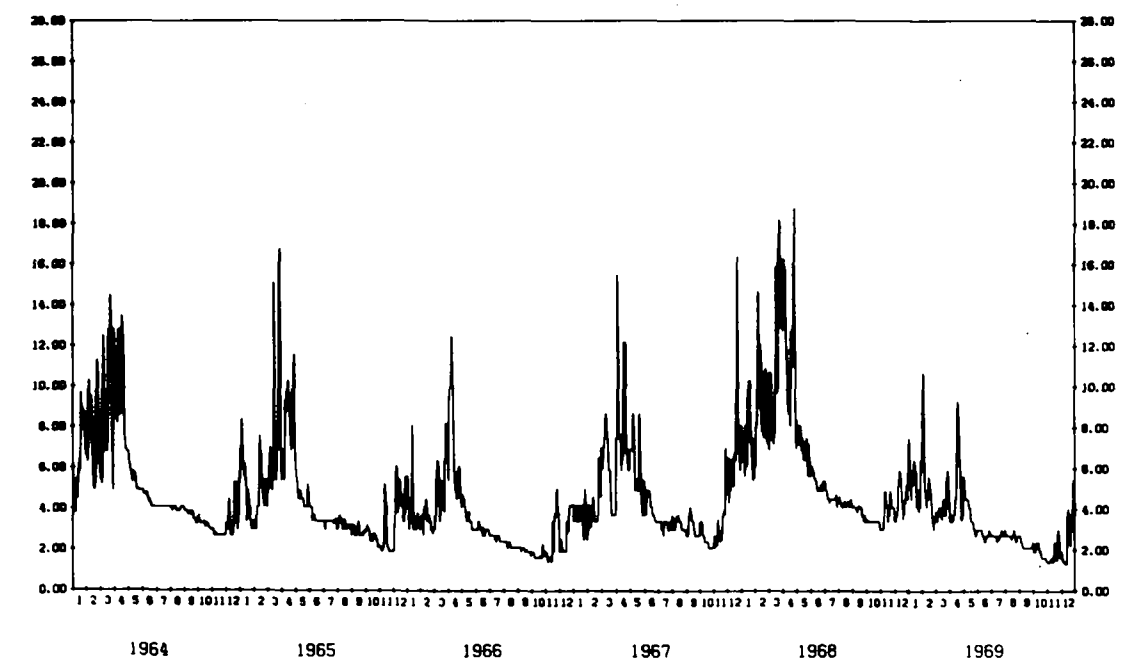


Figure 5.33[8] - Hydrograph - priority station.

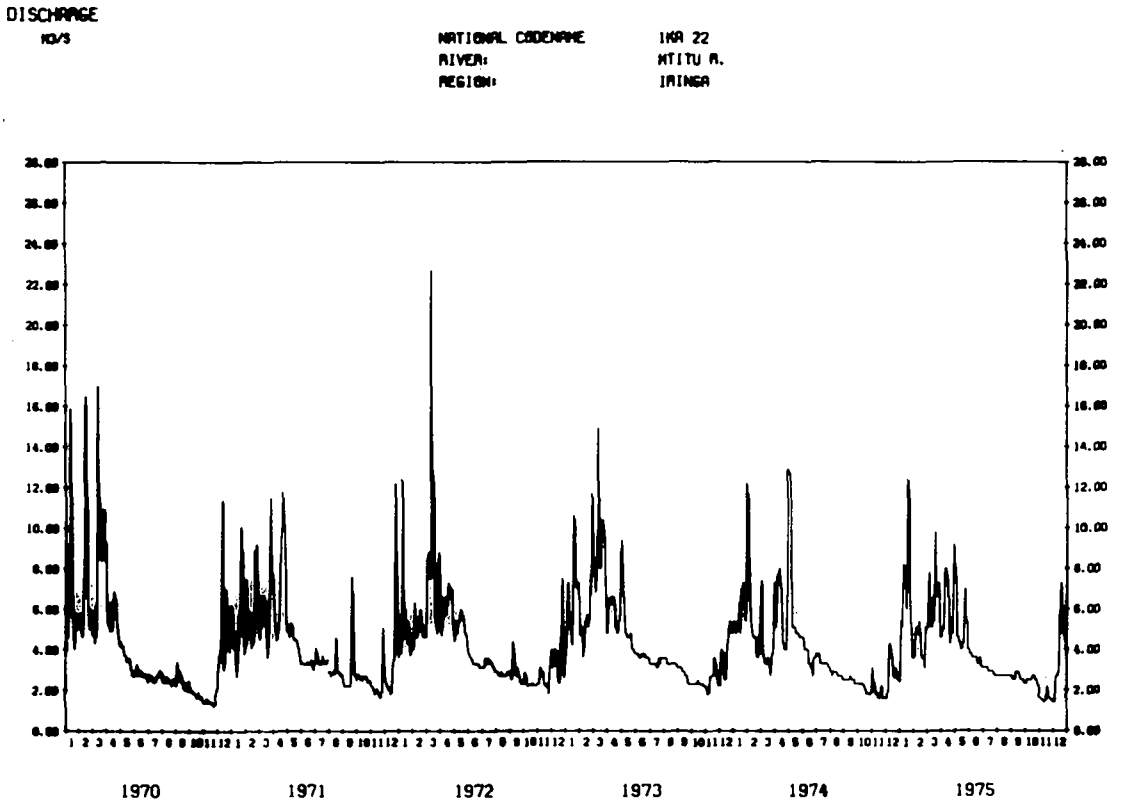


Figure 5.33[8] - Cont'd.

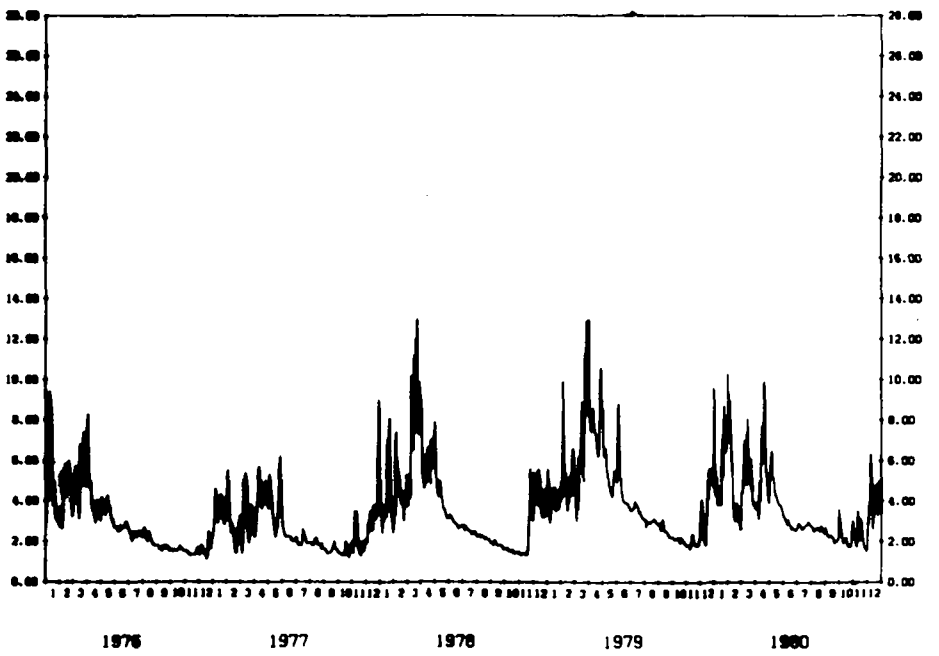


Figure 5.33[8] - Cont'd.

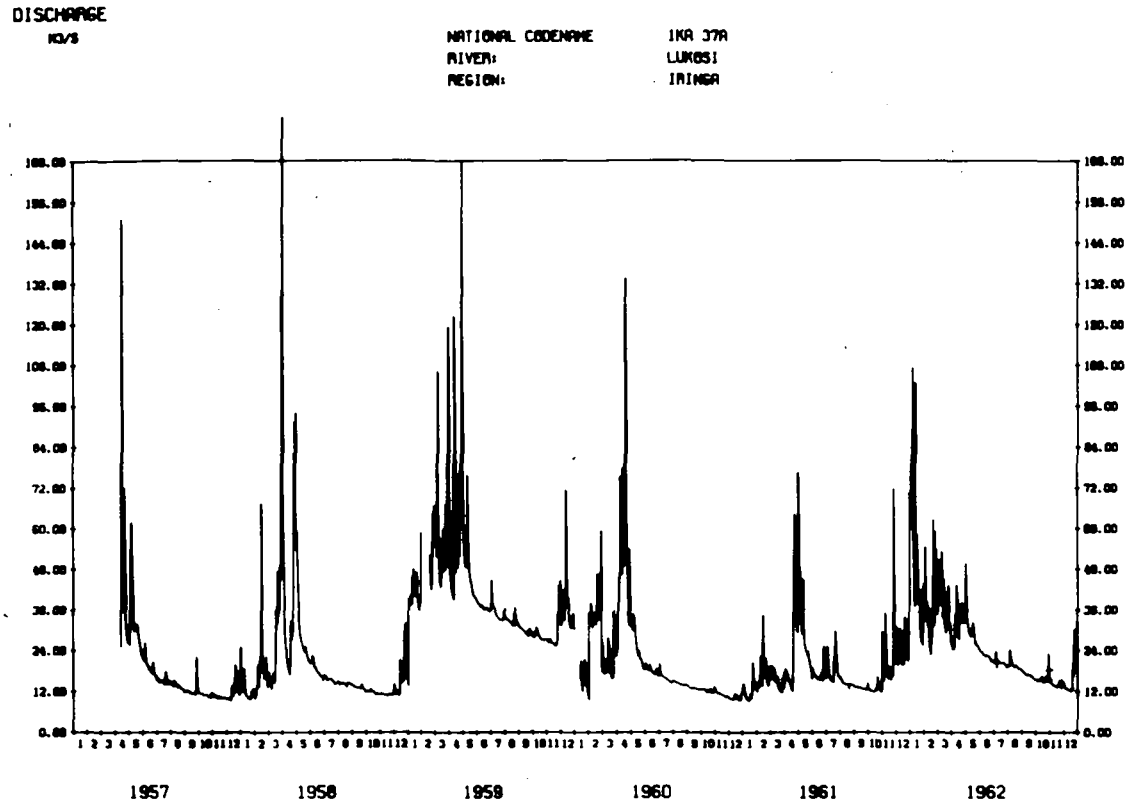


Figure 5.34[8] - Hydrograph - priority station.

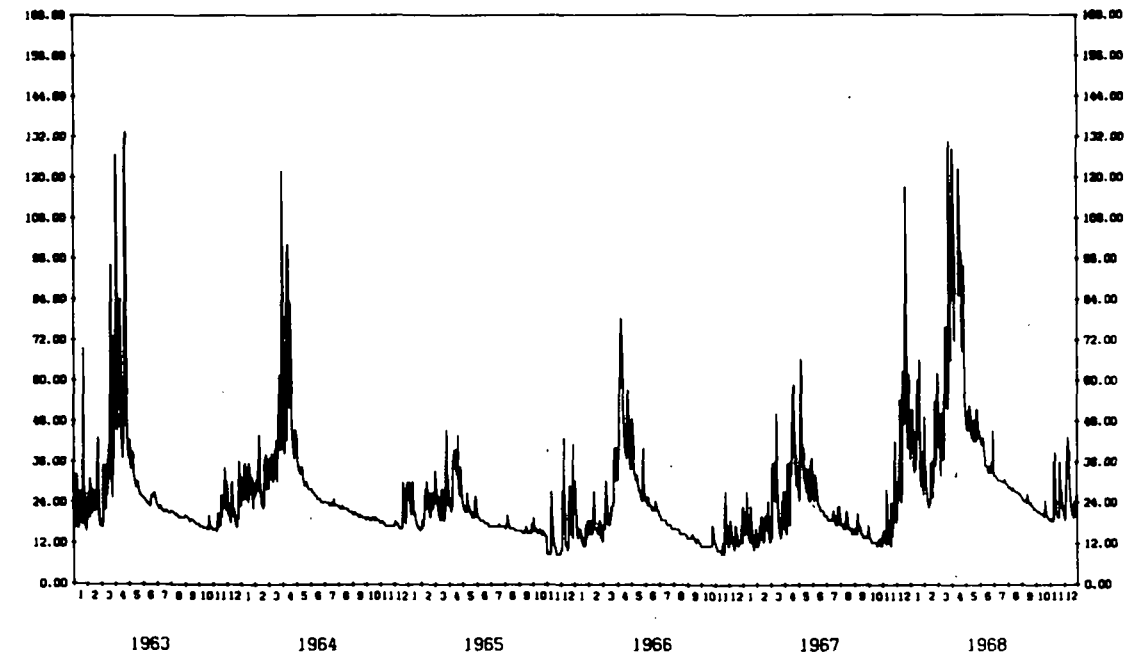
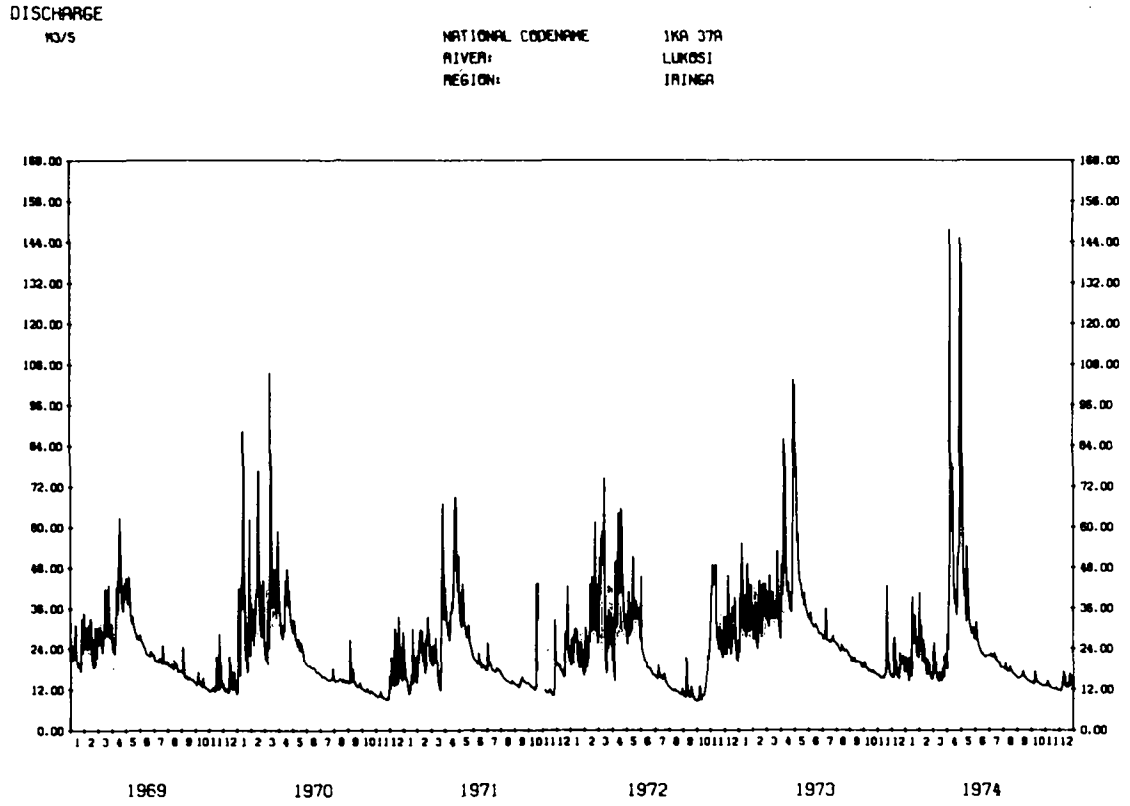


Figure 5.34[8] - Hydrograph - priority station.



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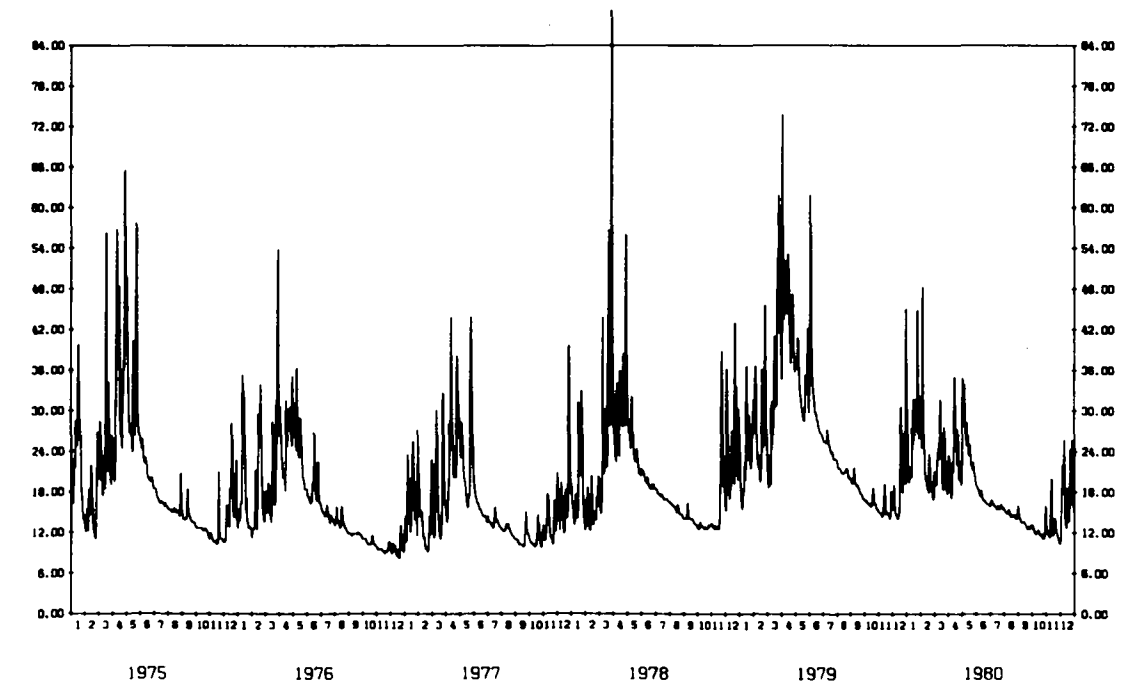

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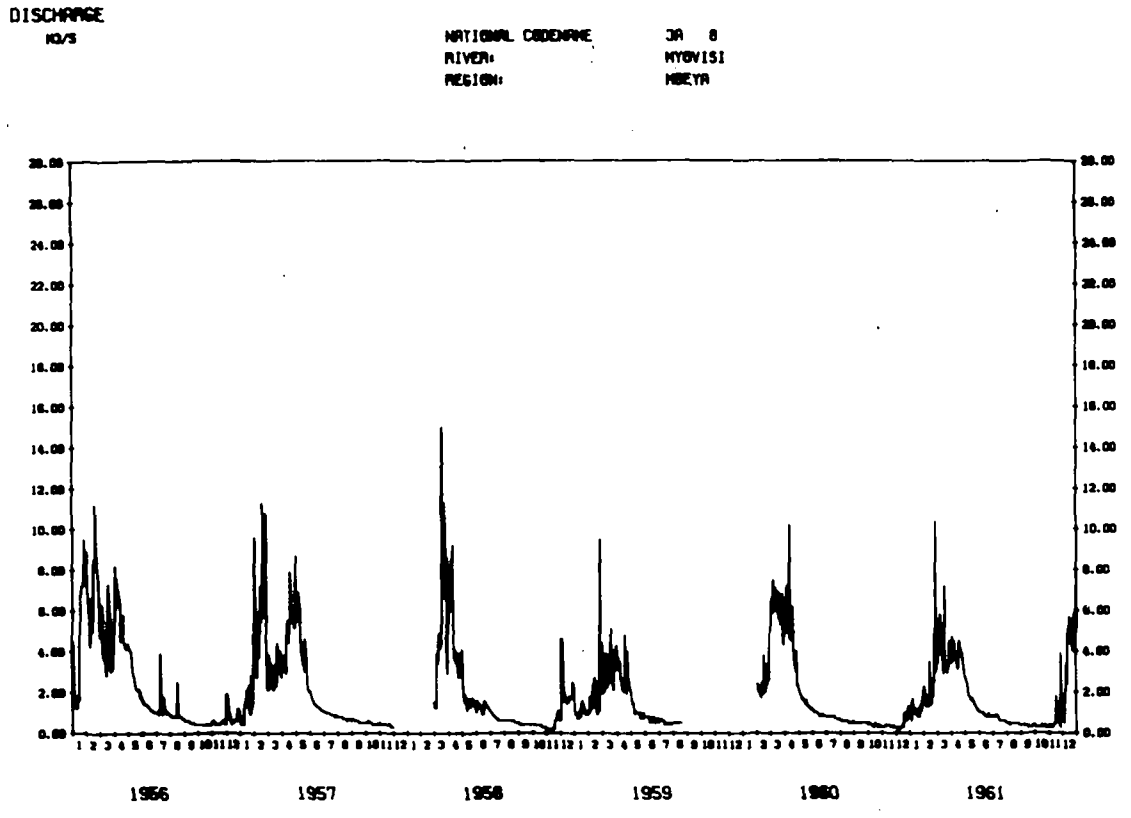


Figure 5.35[8] - Hydrograph - priority station.

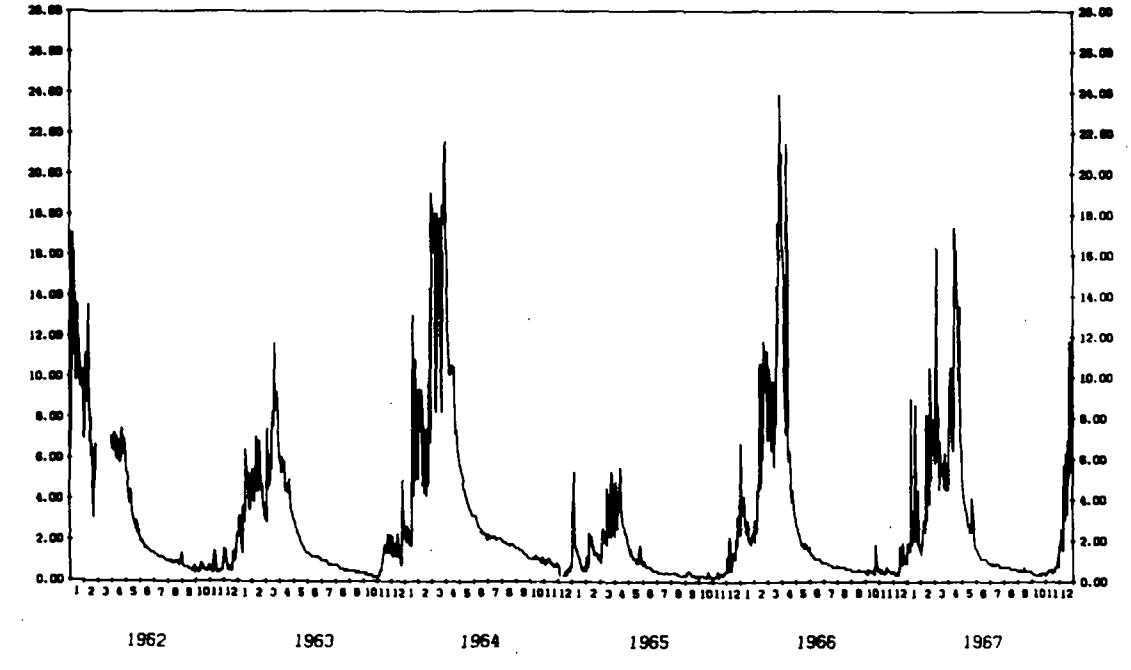


Figure 5.35[8] - Hydrograph - priority station.

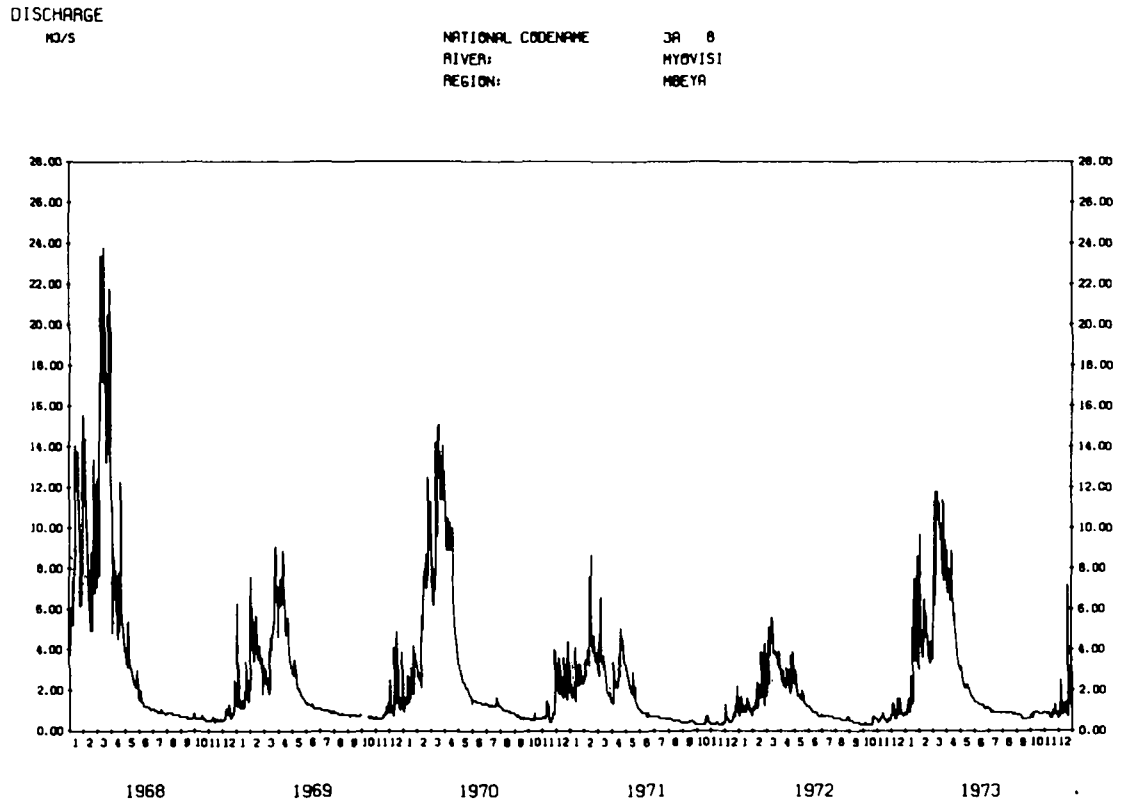
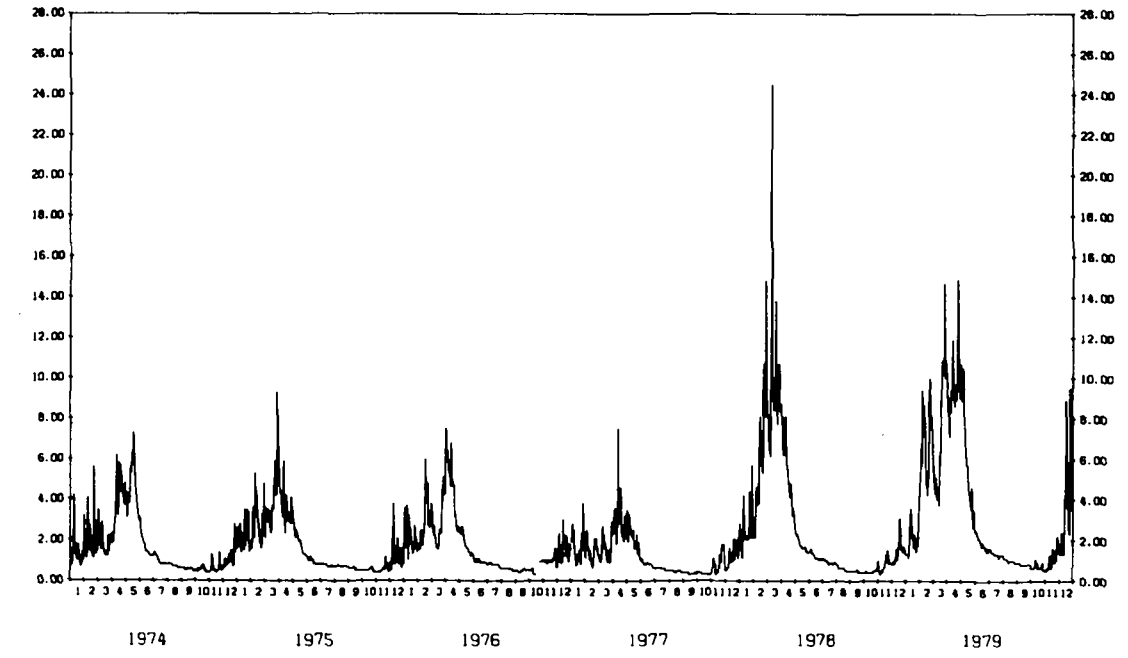


Figure 5.35[8] - Cont'd.



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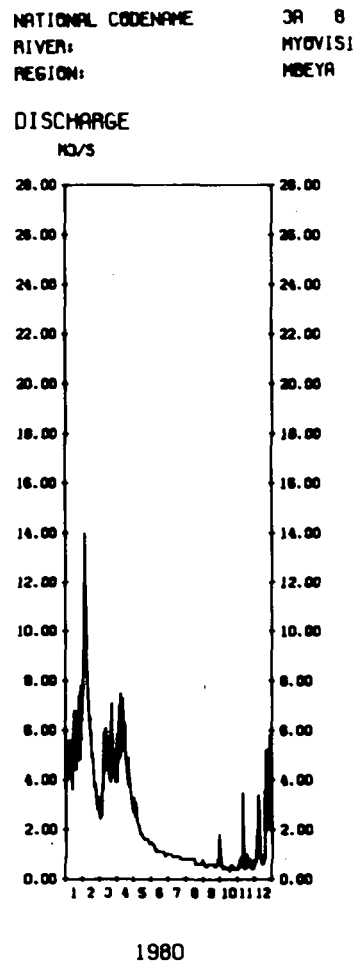

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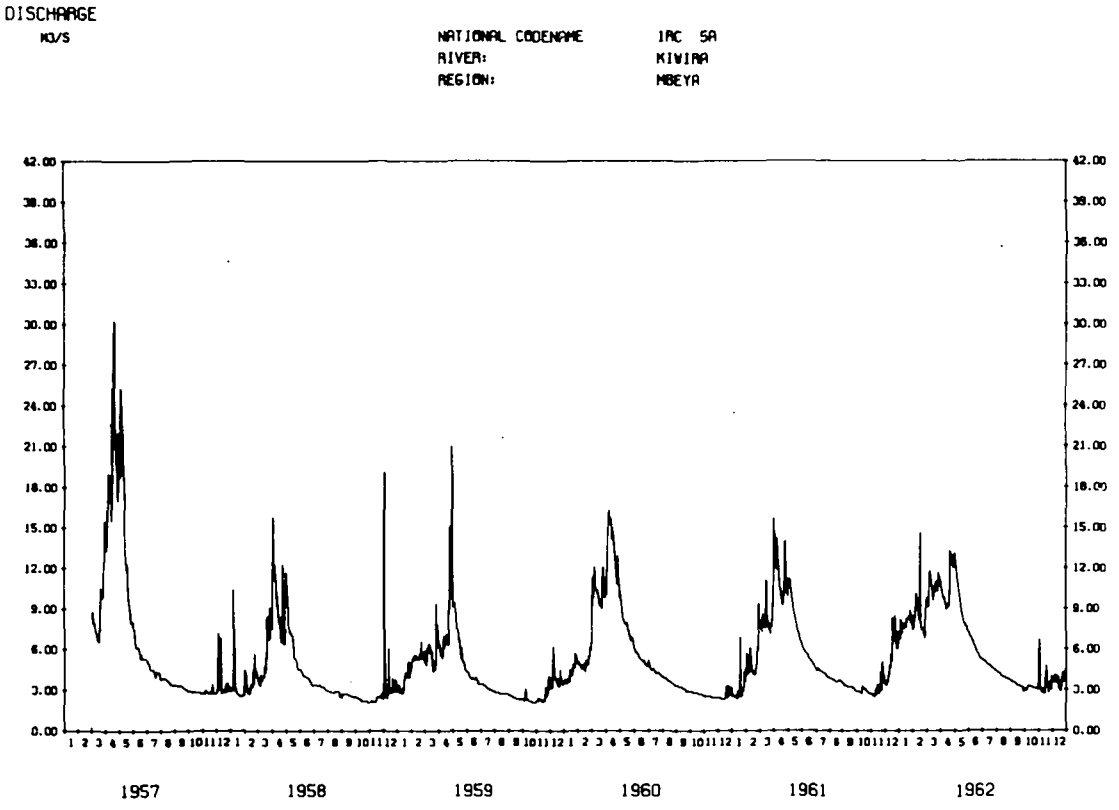


Figure 5.36[8] - Hydrograph - priority station.

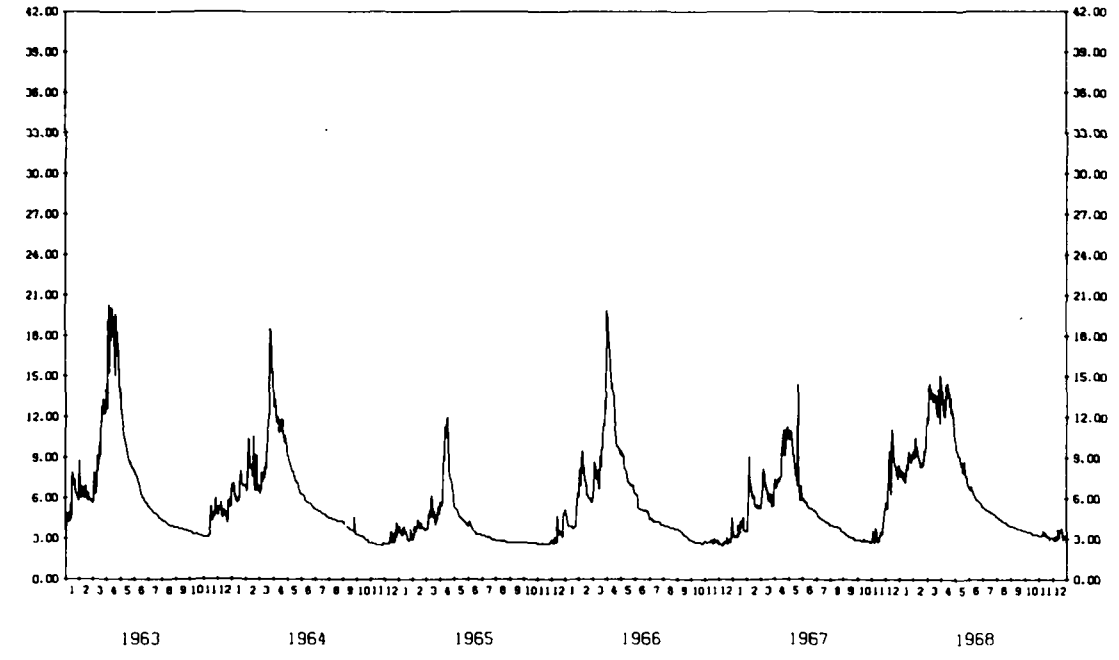


Figure 5.36[8] - Hydrograph - priority station.

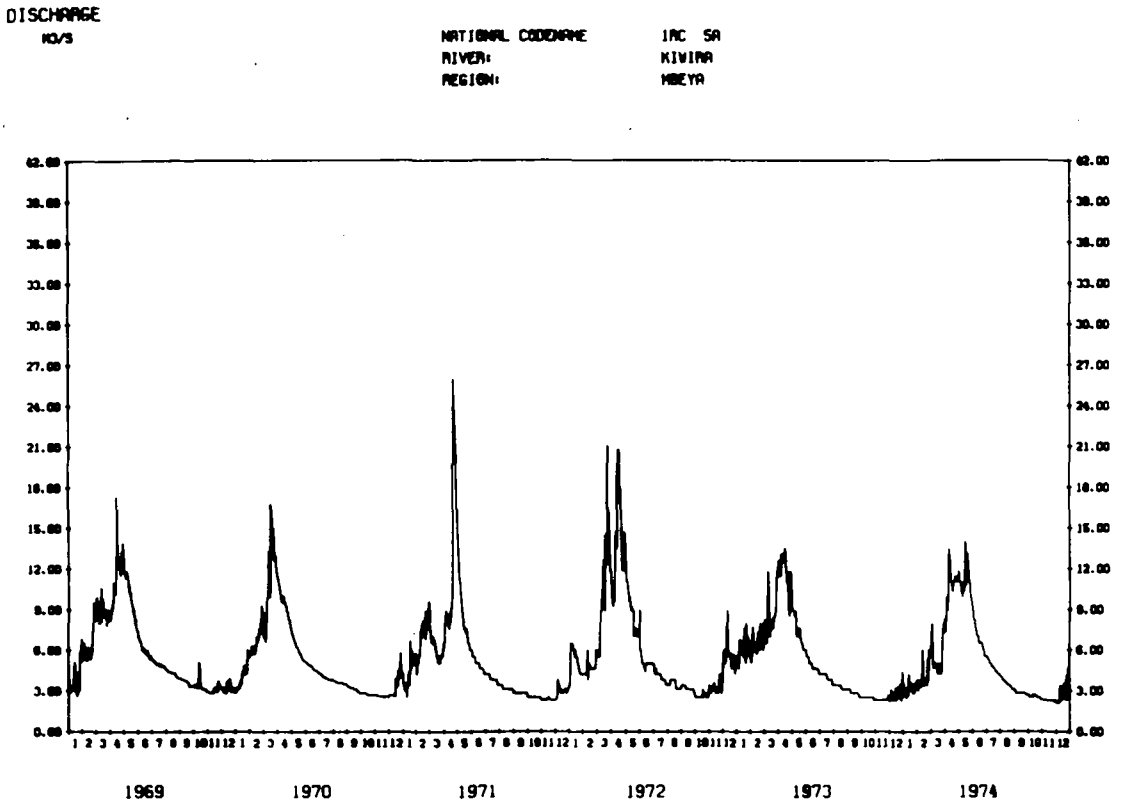
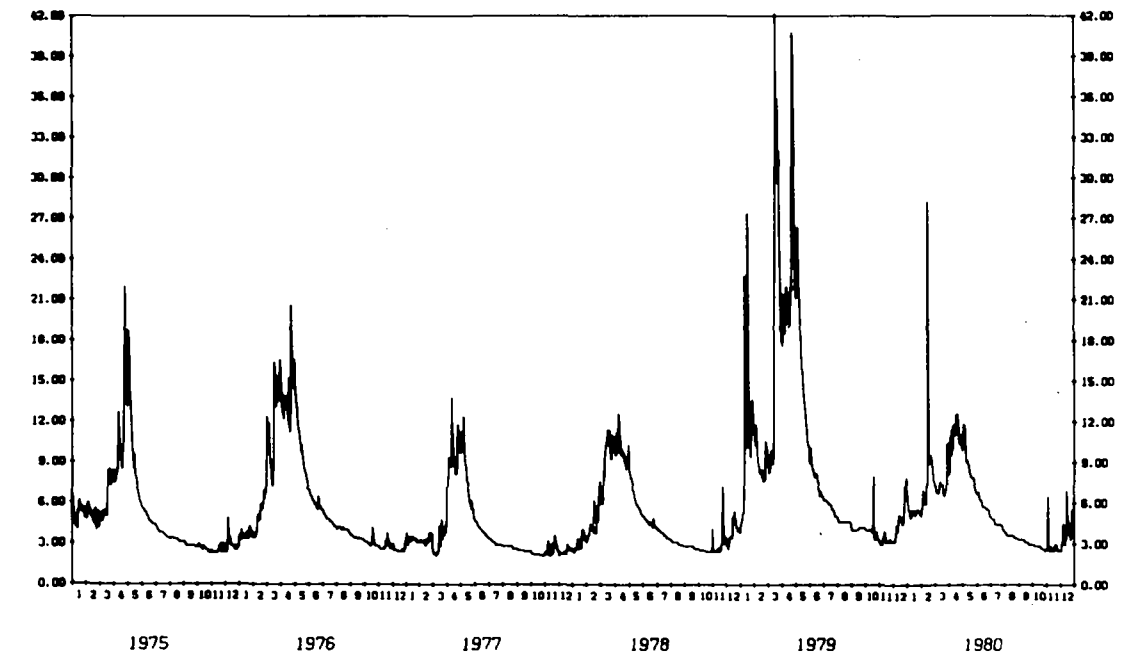


Figure 5.36[8] - Cont'd.



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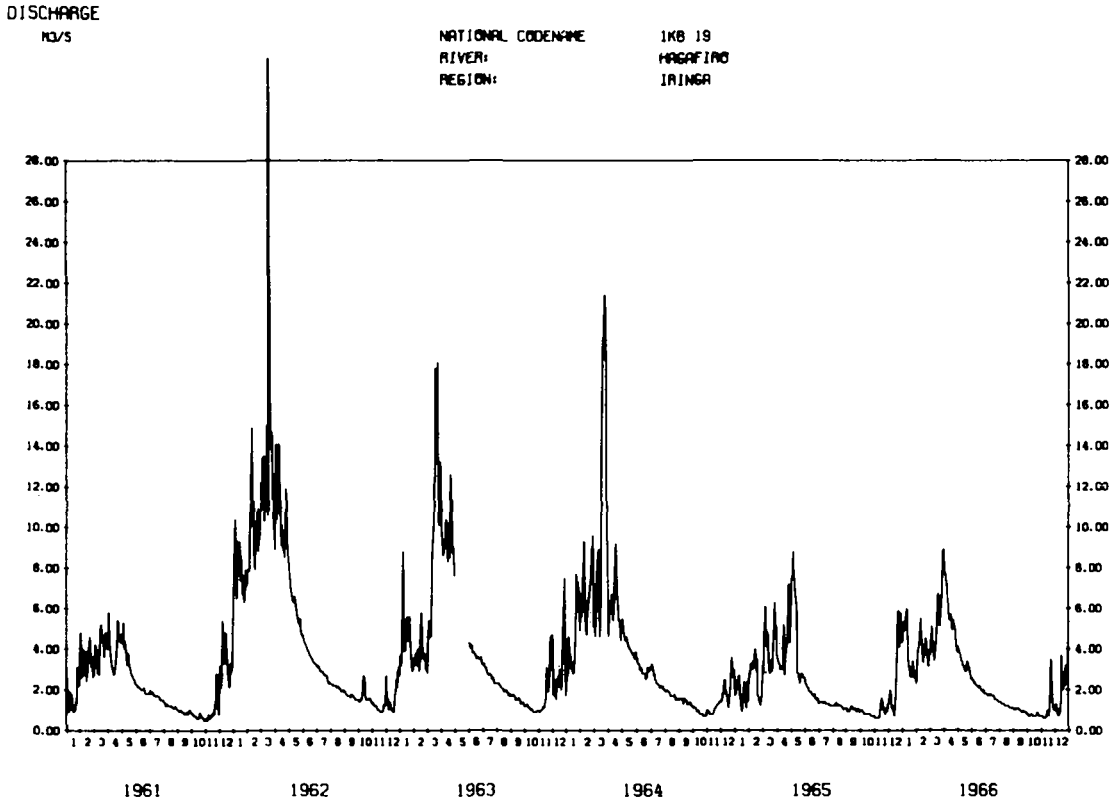


Figure 5.37[8] - Hydrograph - priority station.

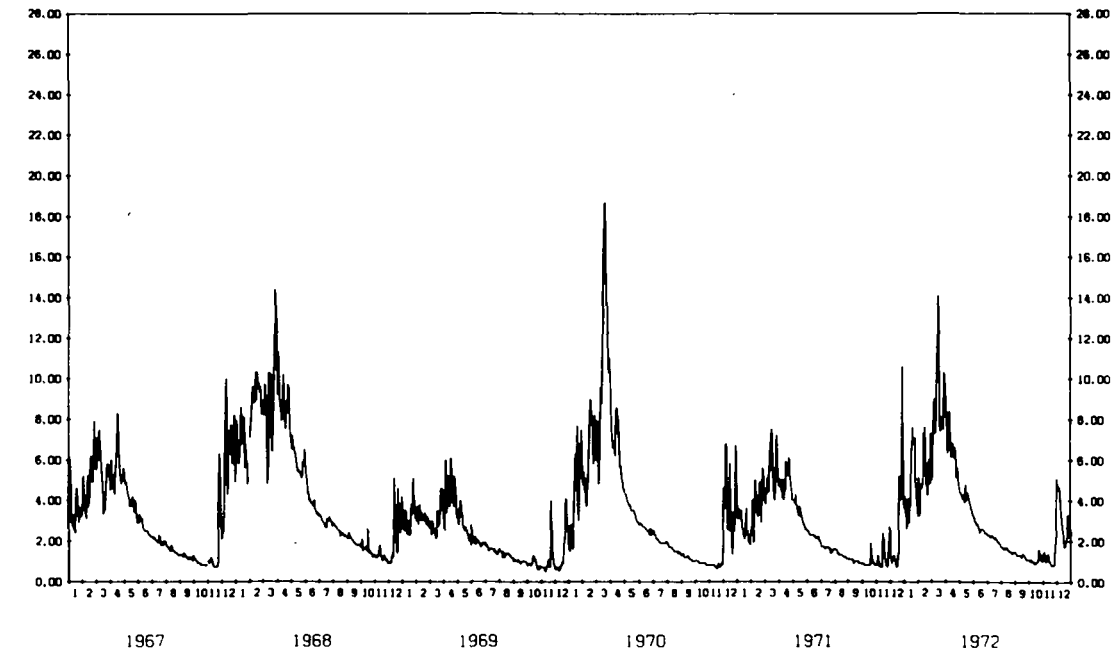


Figure 5.37[8] - Hydrograph - priority station.

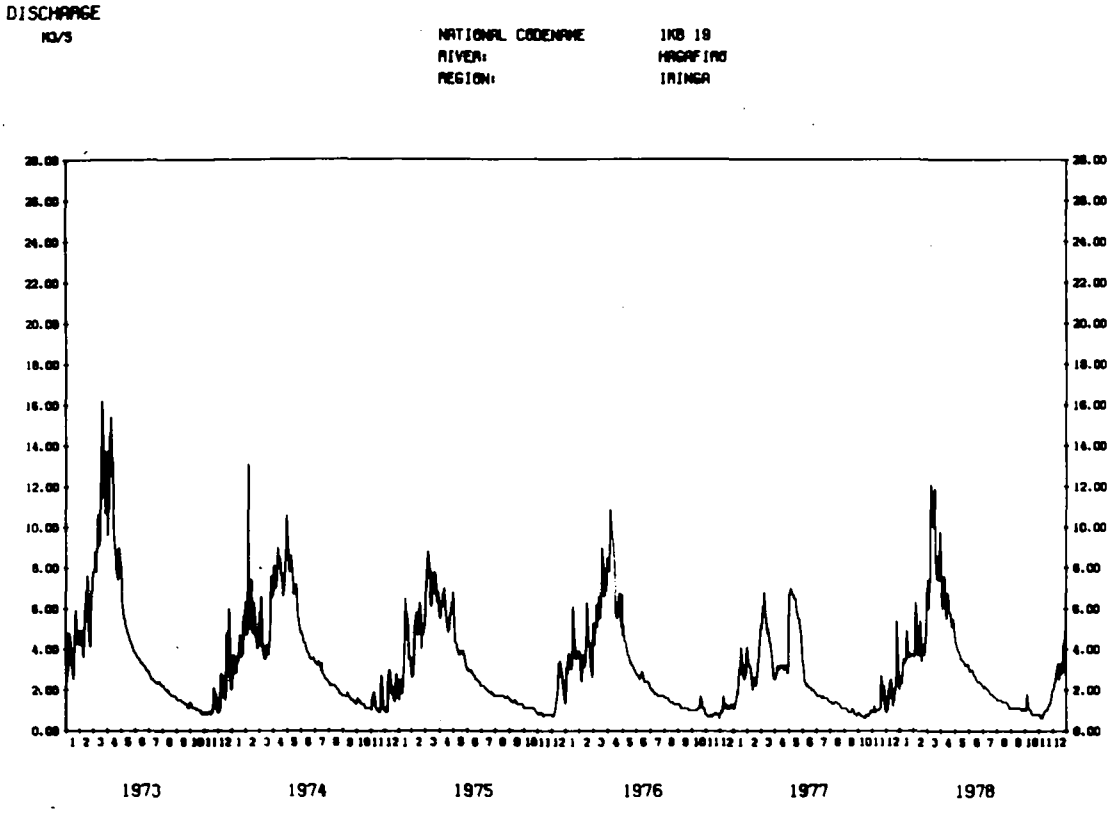


Figure 5.37[8] - Cont'd.

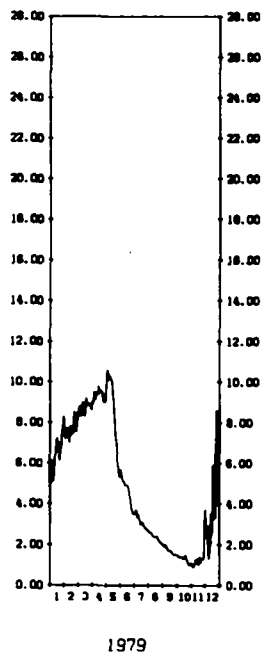


Figure 5.37[8] - Cont'd.

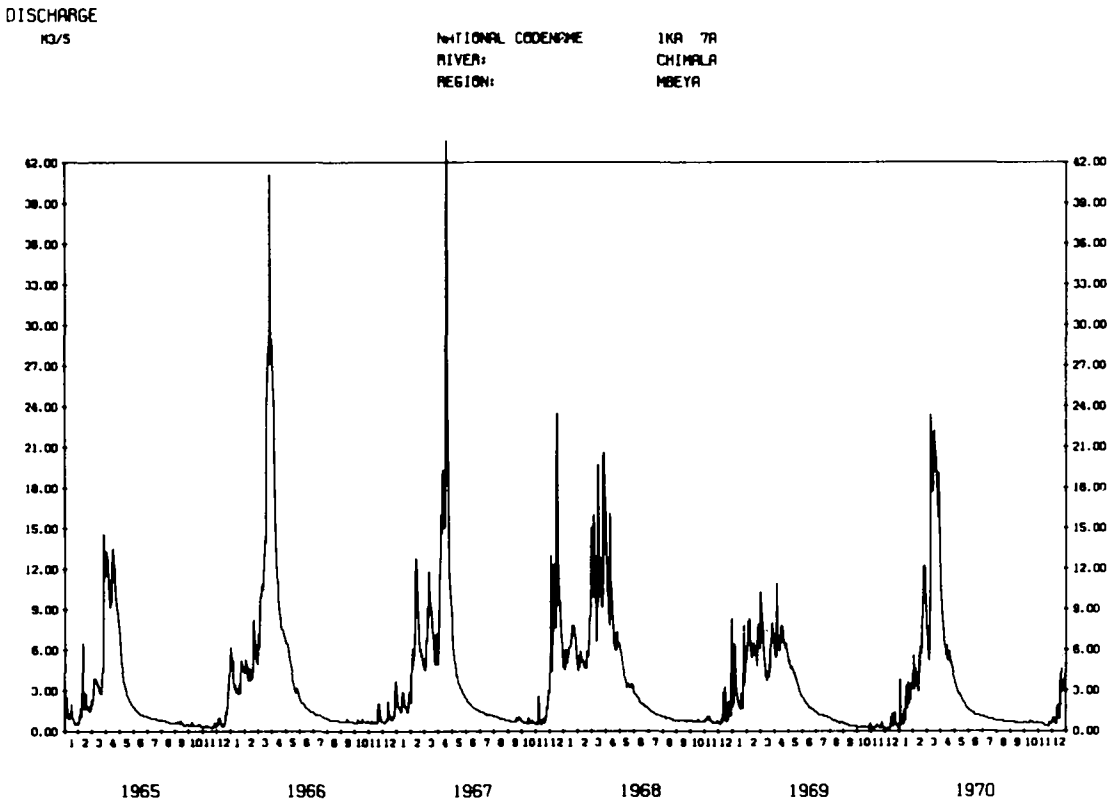


Figure 5.38[8] - Hydrograph - priority station.

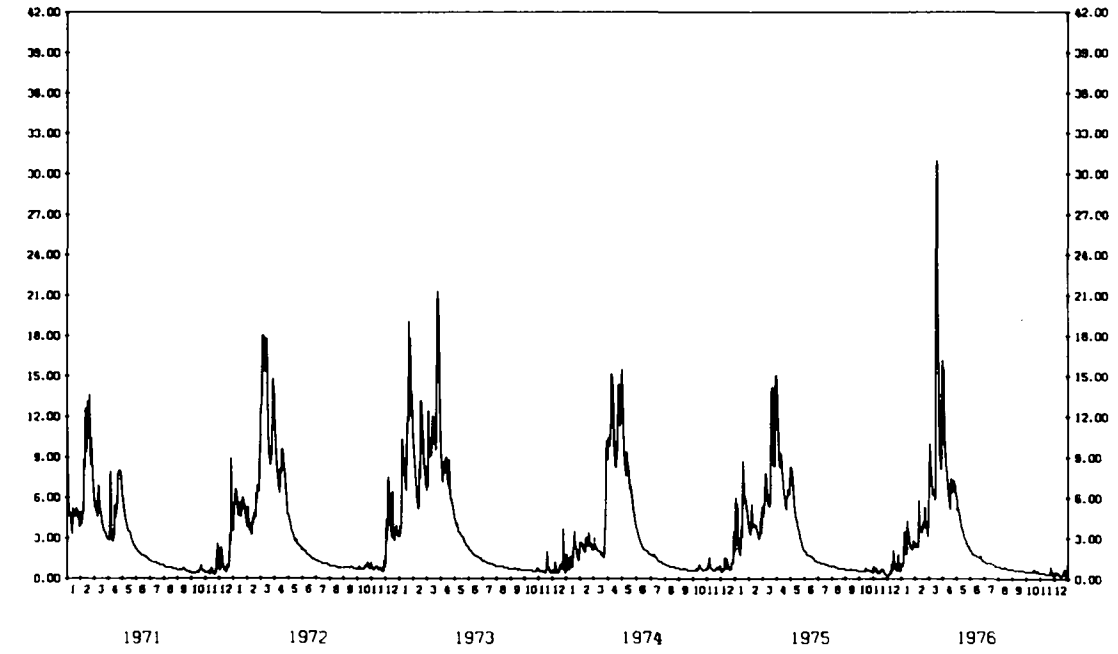


Figure 5.38[8] - Hydrograph - priority station.

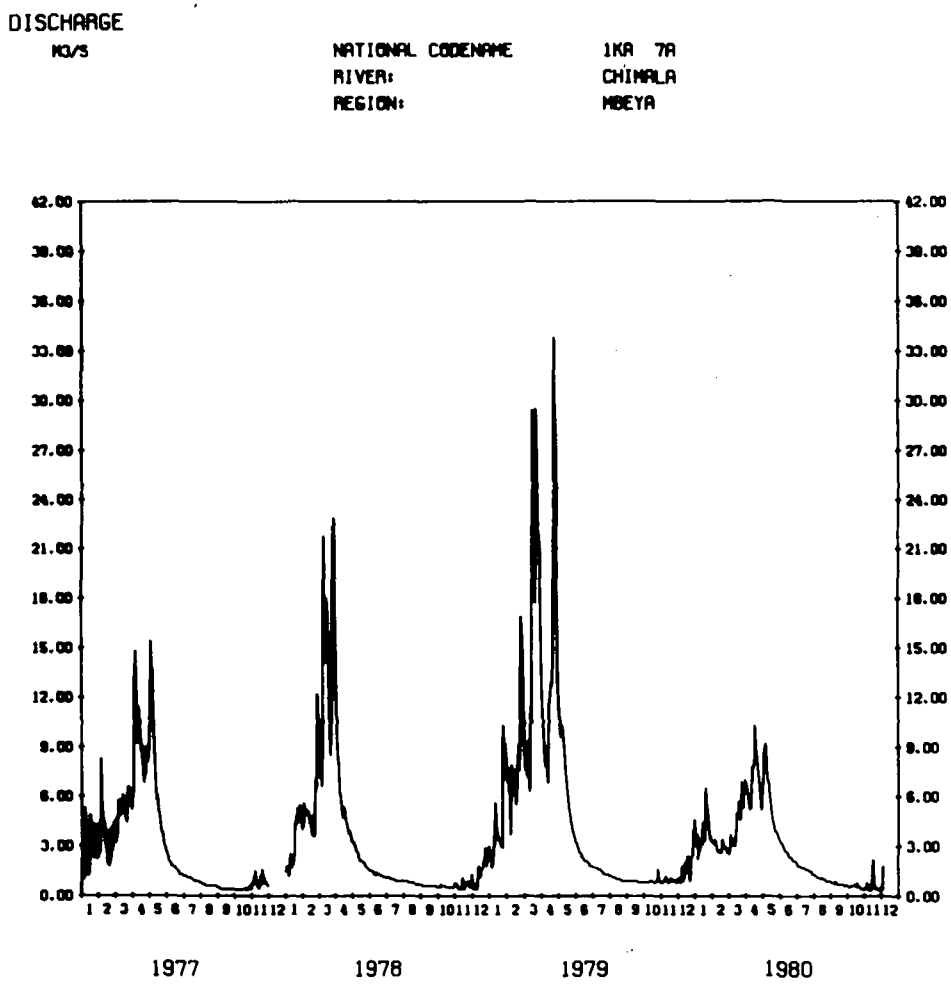


Figure 5.38[8] - Cont'd.

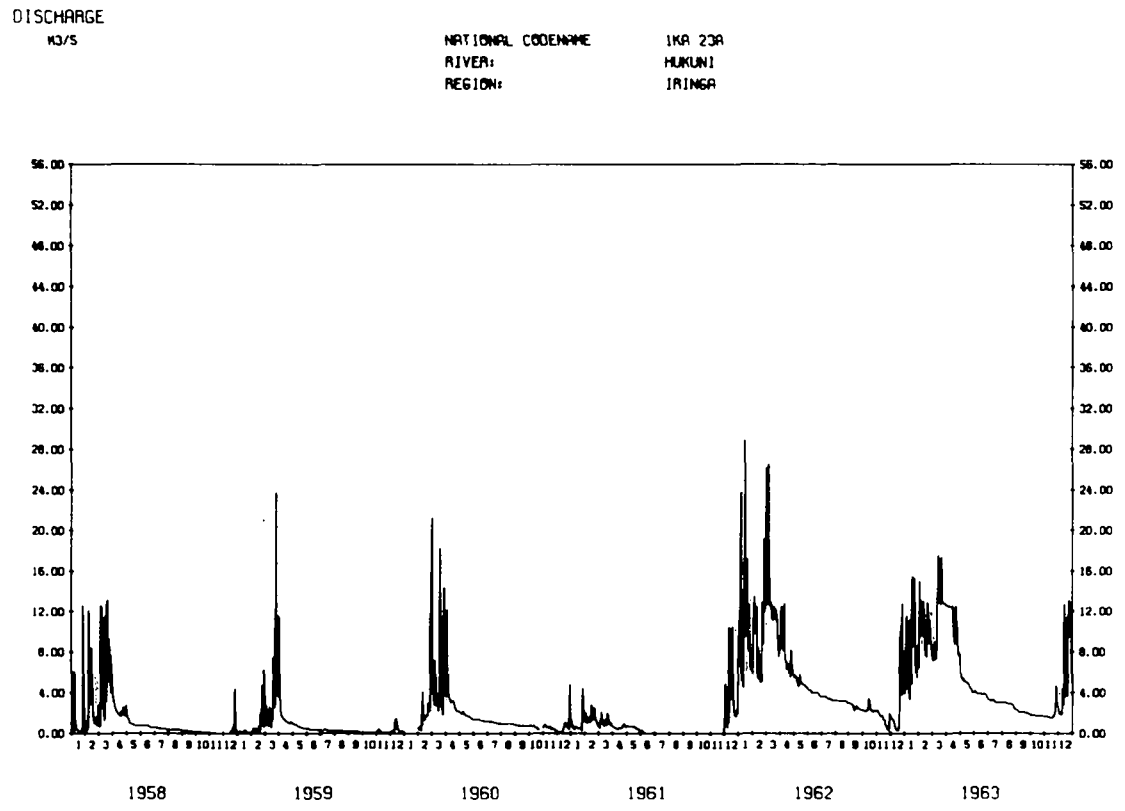


Figure 5.39[8] - Hydrograph - priority station.

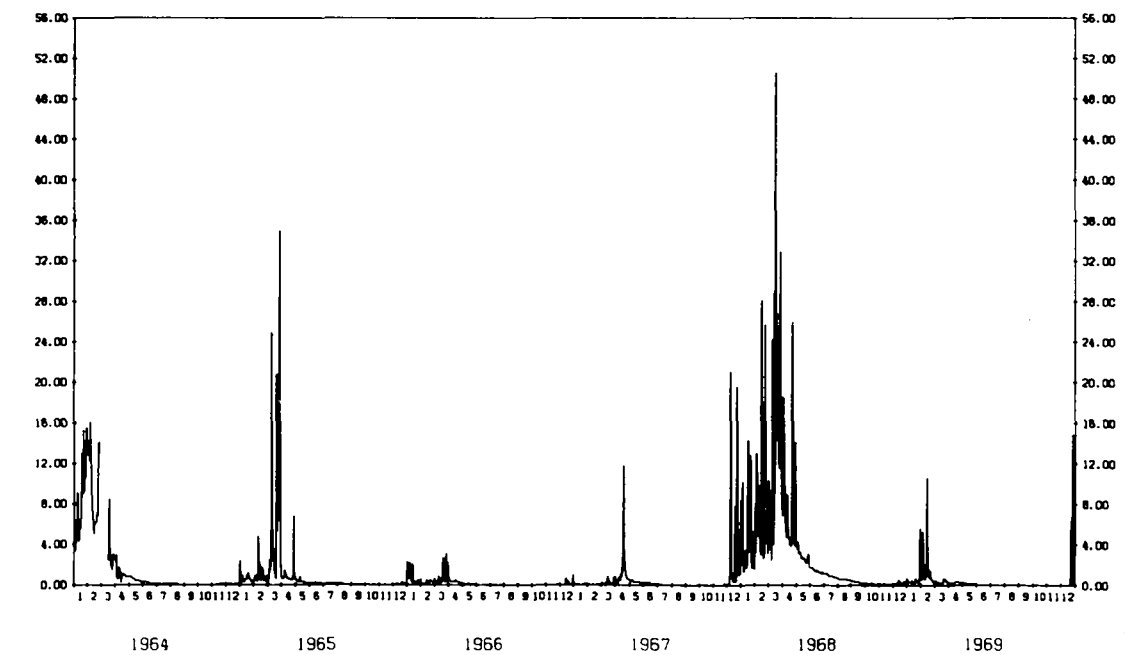


Figure 5.39[8] - Hydrograph - priority station.

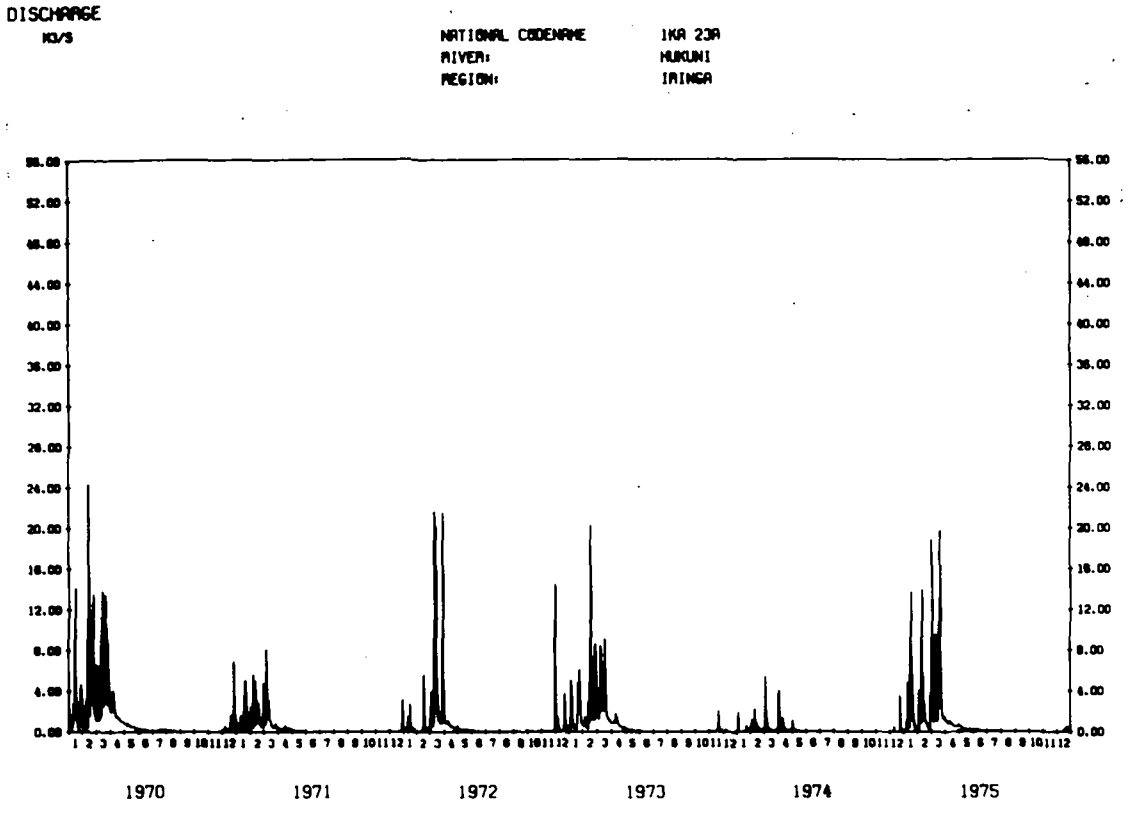


Figure 5.39[8] - Cont'd.

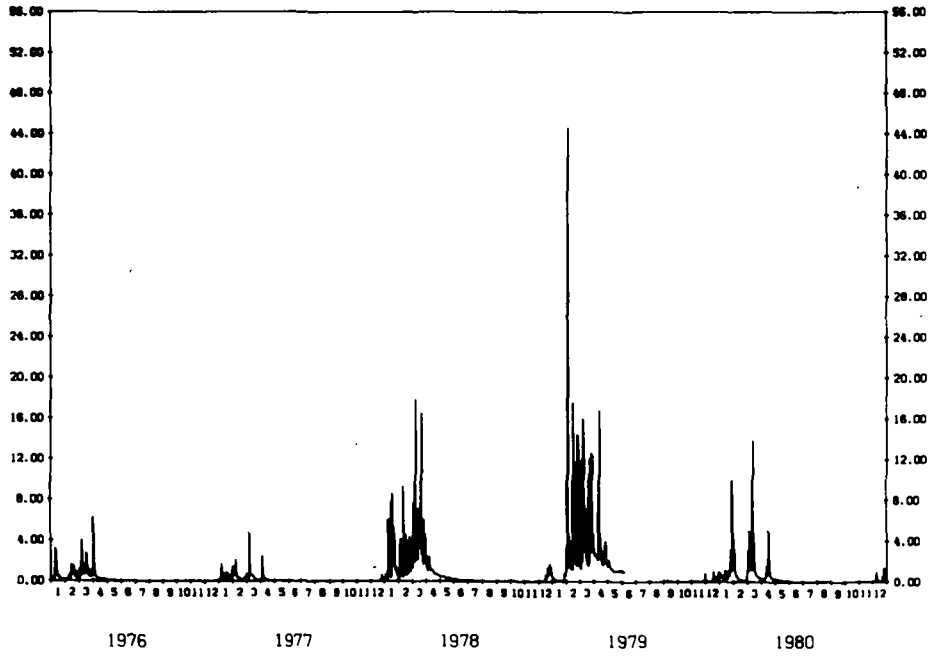


Figure 5.39[8] - Cont'd.

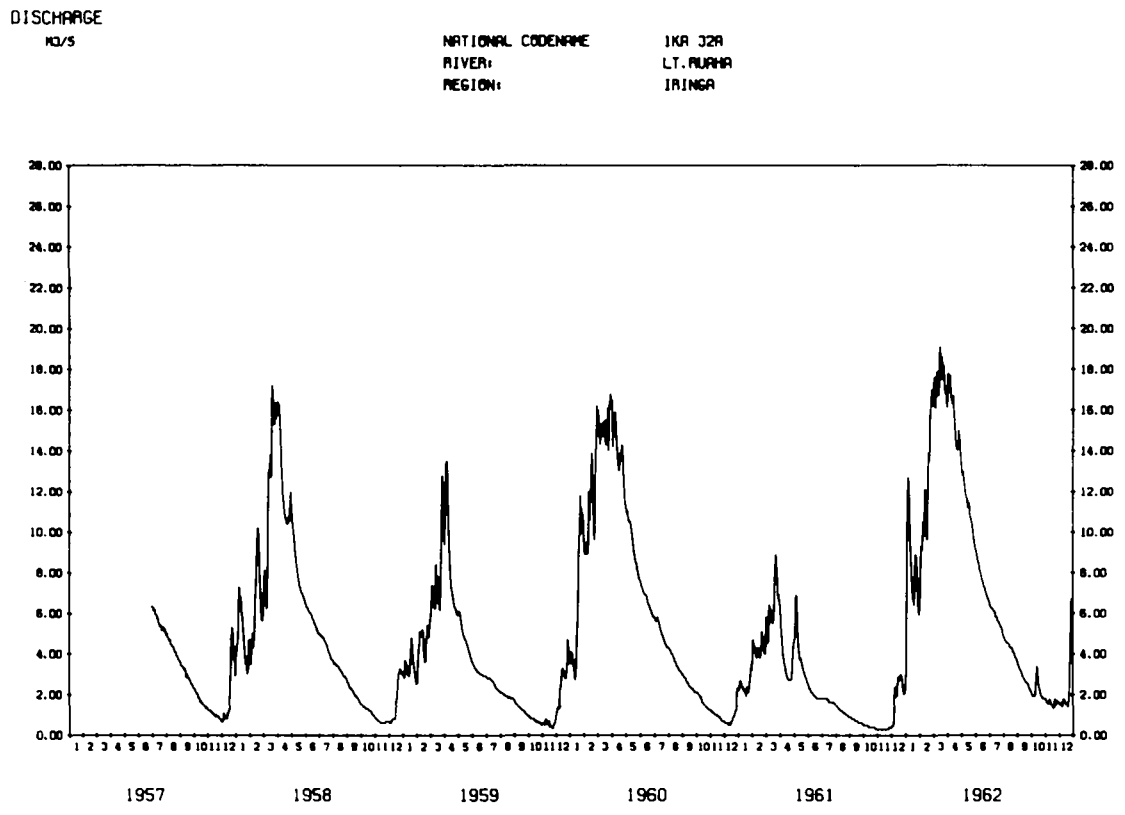


Figure 5.40[8] - Hydrograph - priority station.

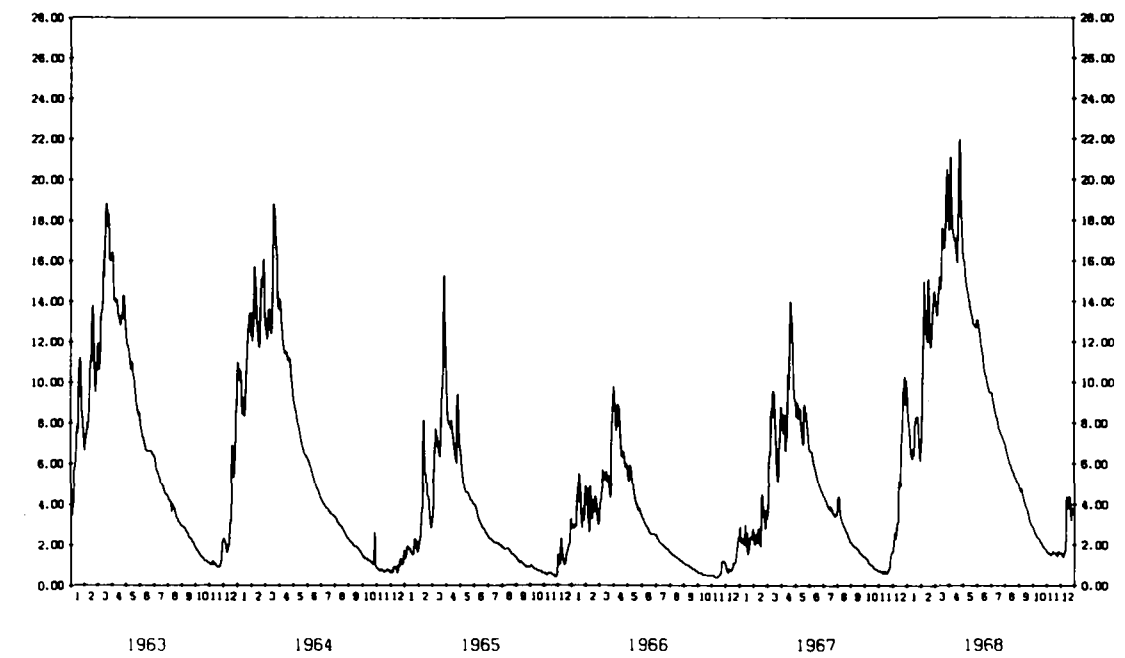


Figure 5.40[8] - Hydrograph - priority station.

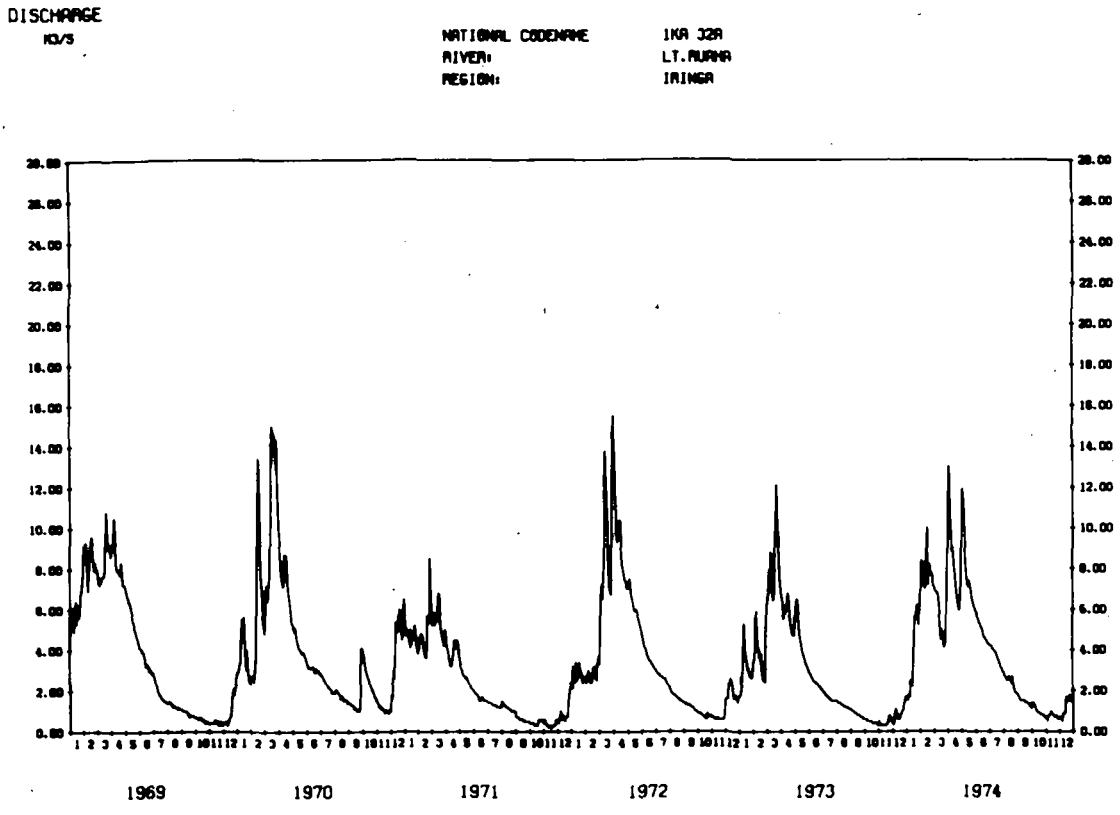


Figure 5.40[8] - Cont'd.

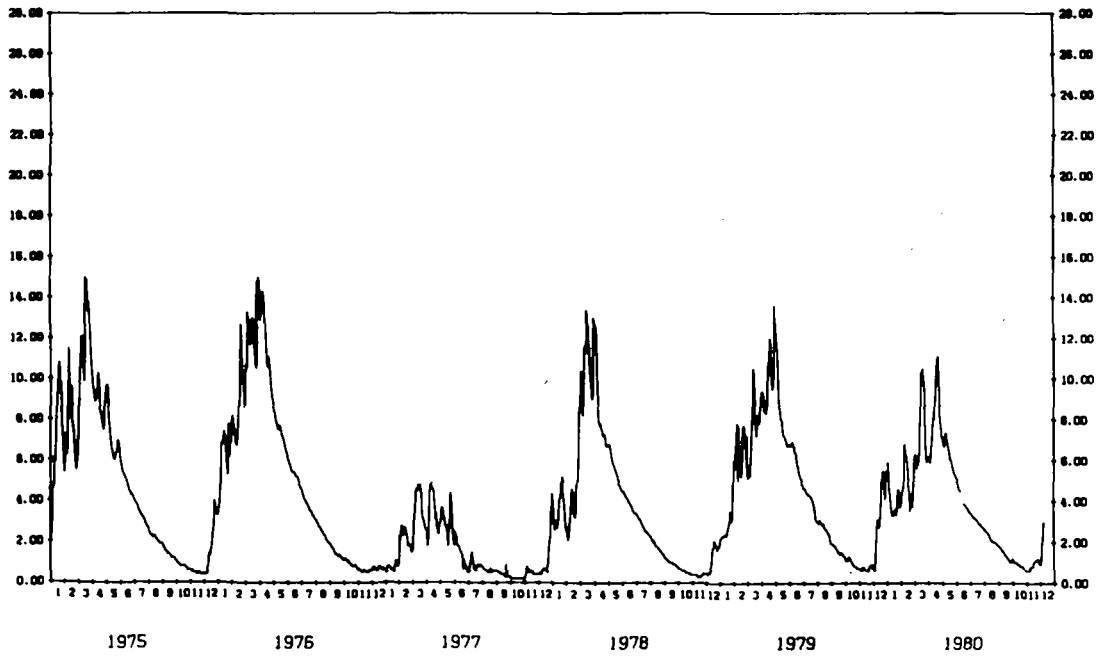


Figure 5.40[8] - Cont'd.

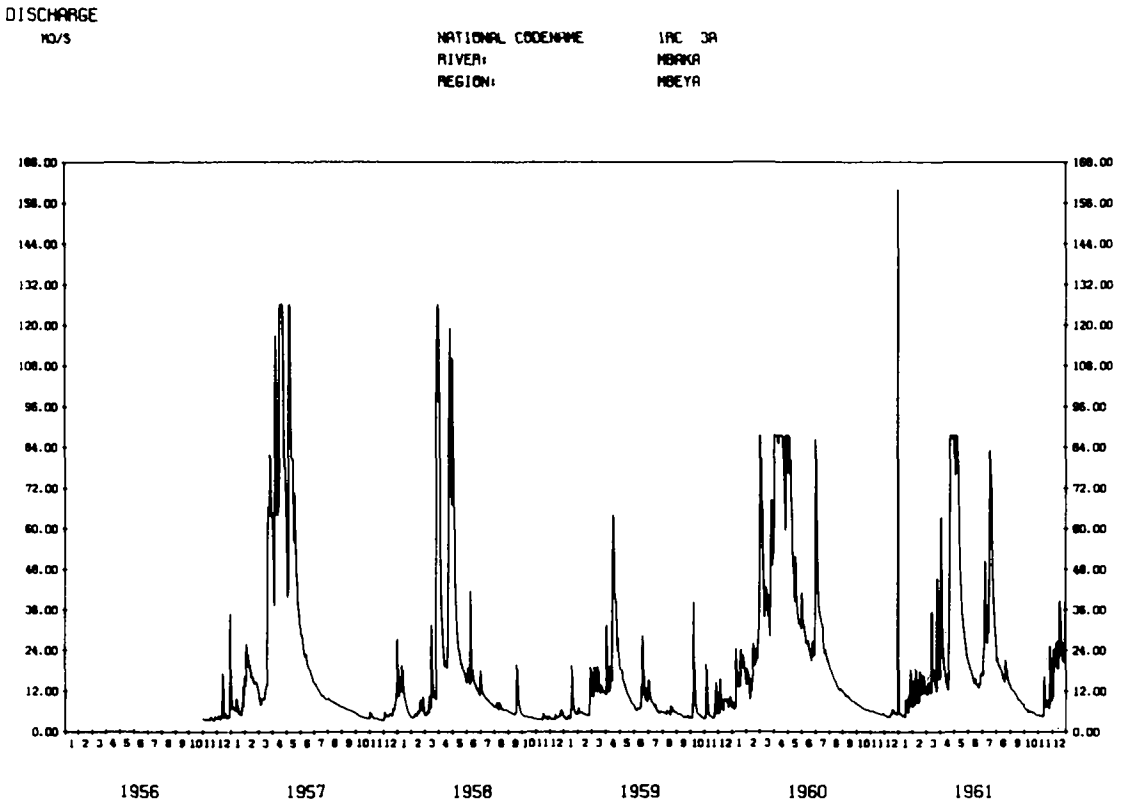


Figure 5.41[8] - Hydrograph - priority station.

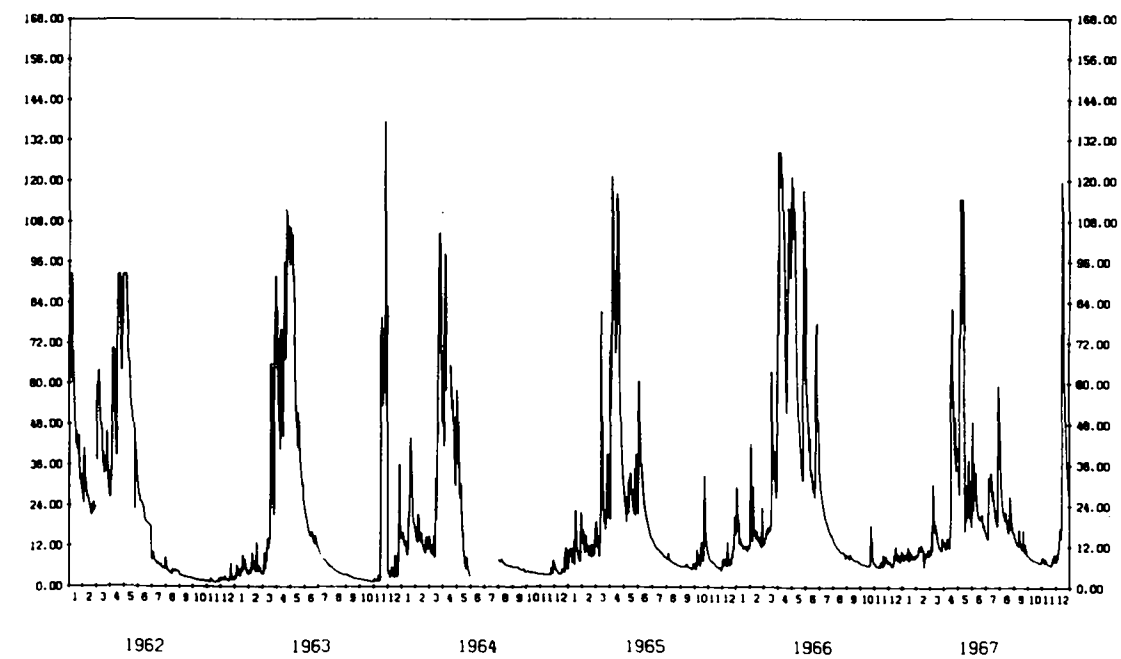


Figure 5.41[8] - Hydrograph - priority station.

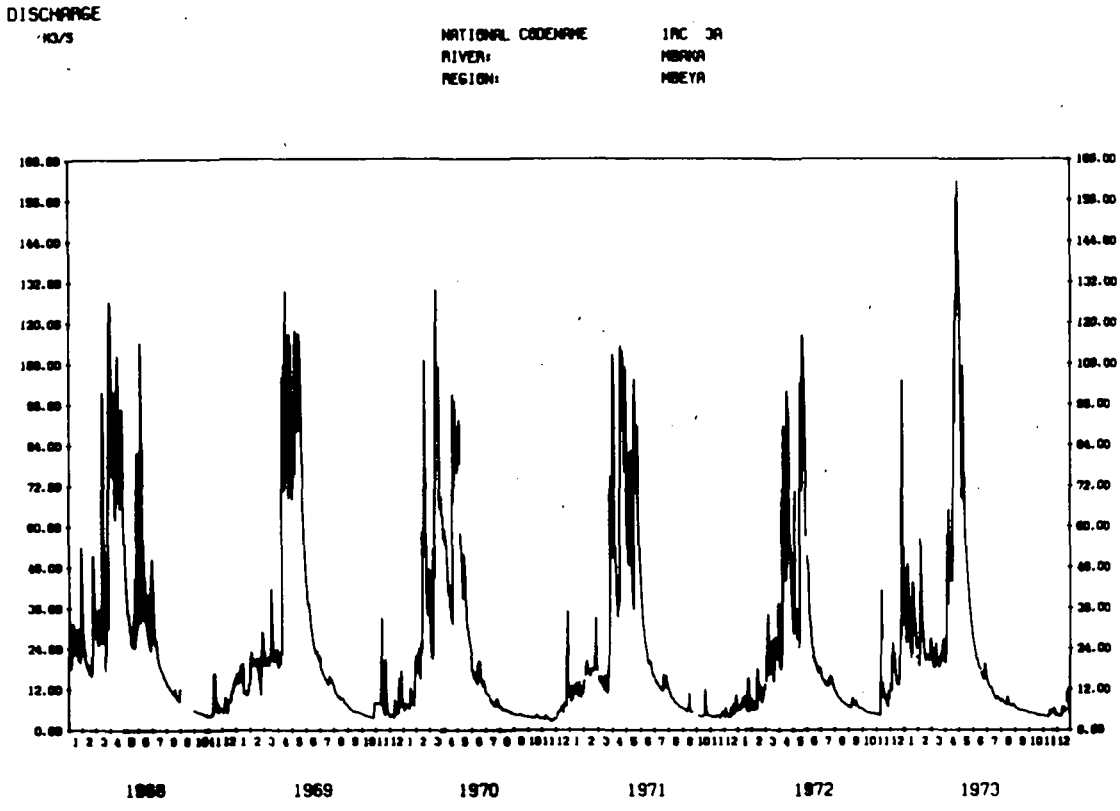


Figure 5.41[8] - Cont'd.

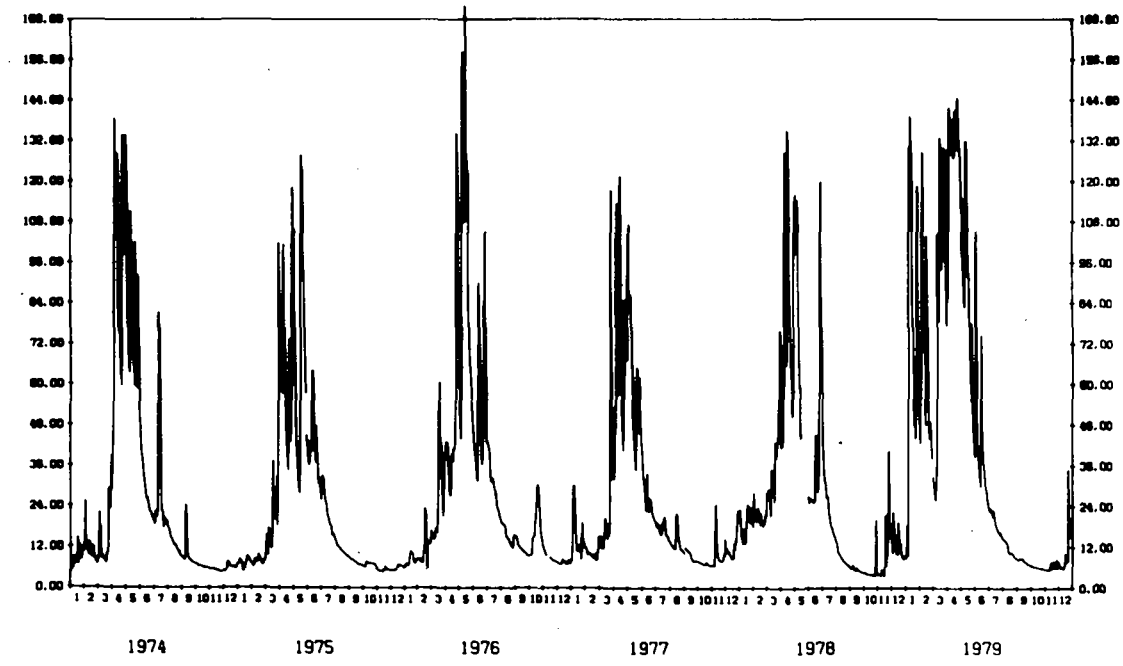


Figure 5.41[8] - Cont'd.

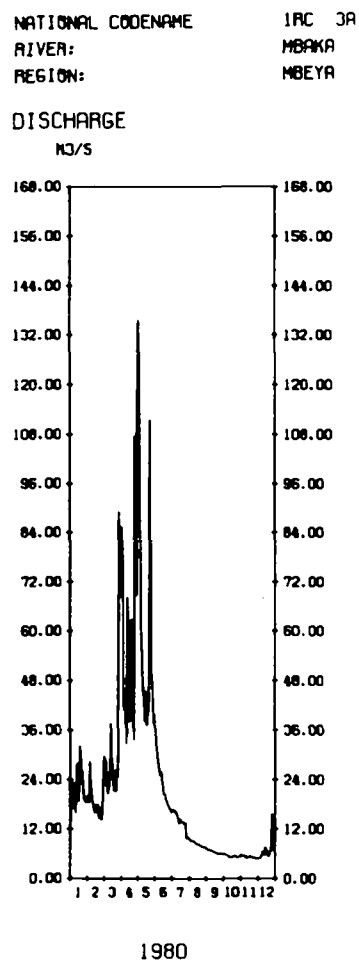


Figure 5.41[8] - Cont'd.

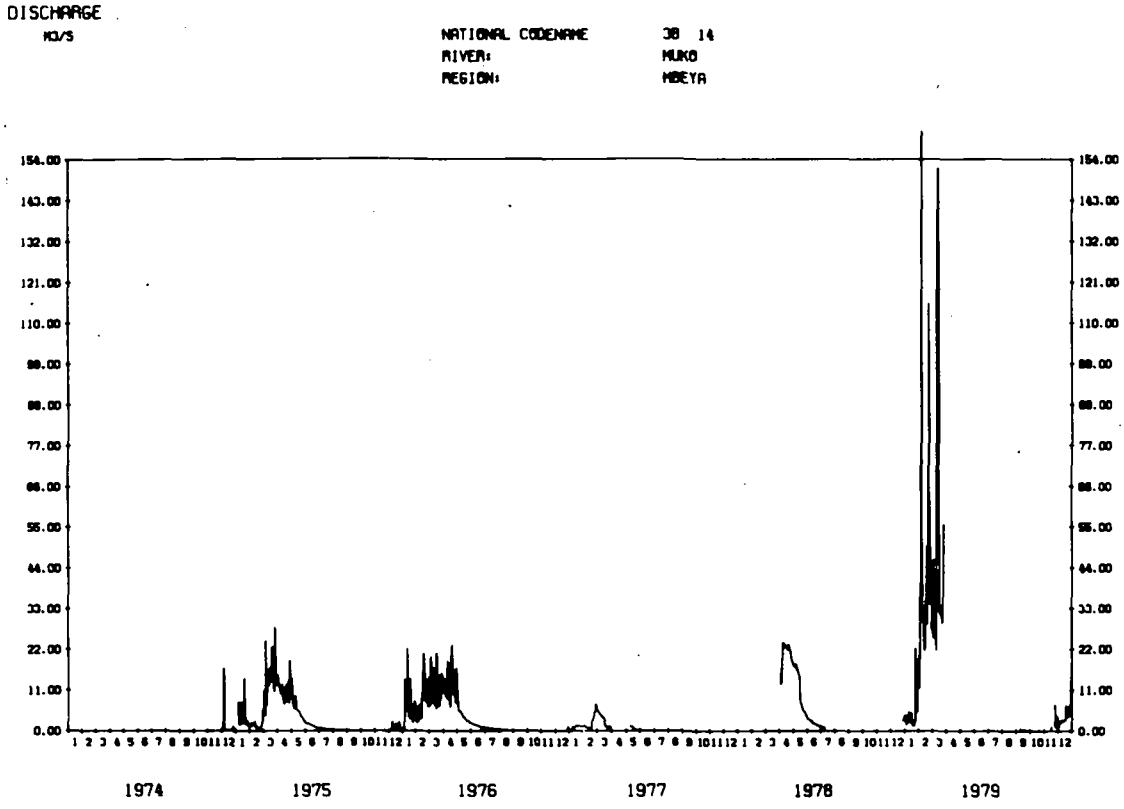


Figure 5.42[8] - Hydrograph - priority station.

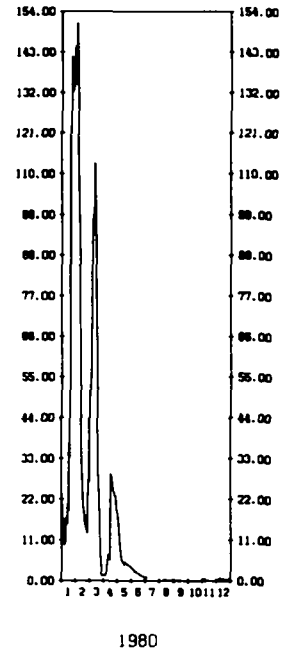


Figure 5.42[8] - Hydrograph - priority station.

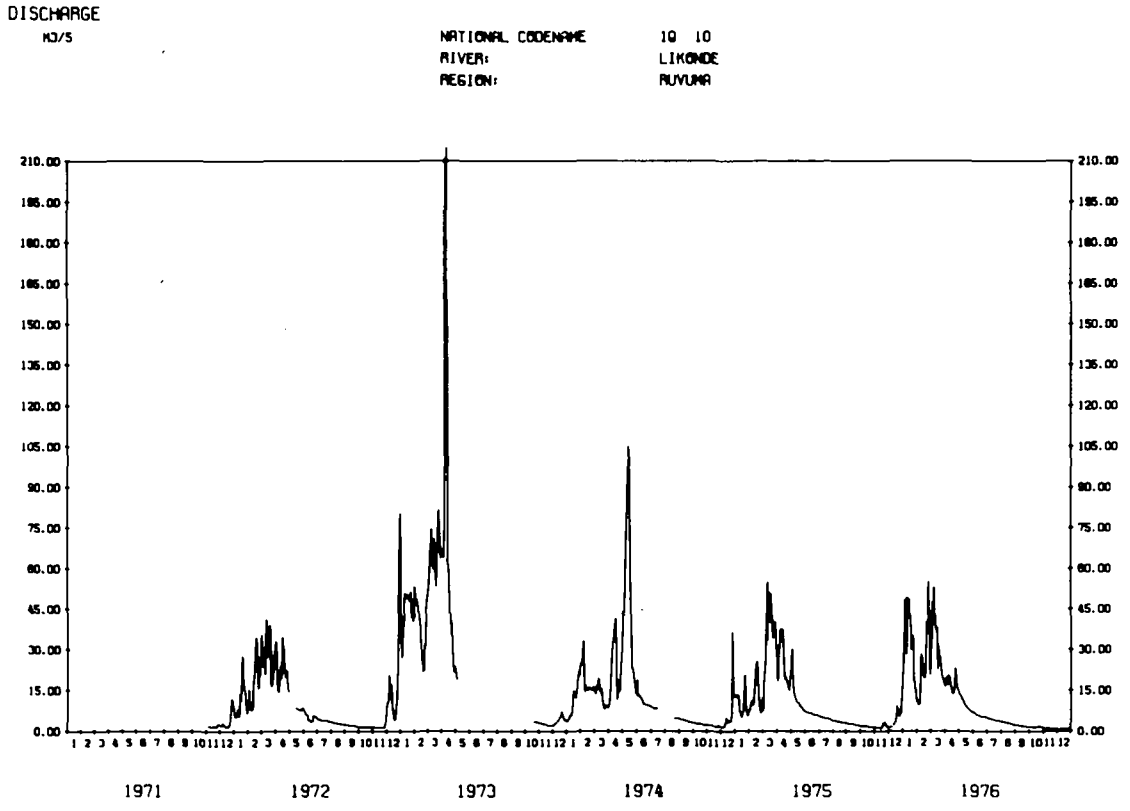


Figure 5.43[8] - Hydrograph - priority station.

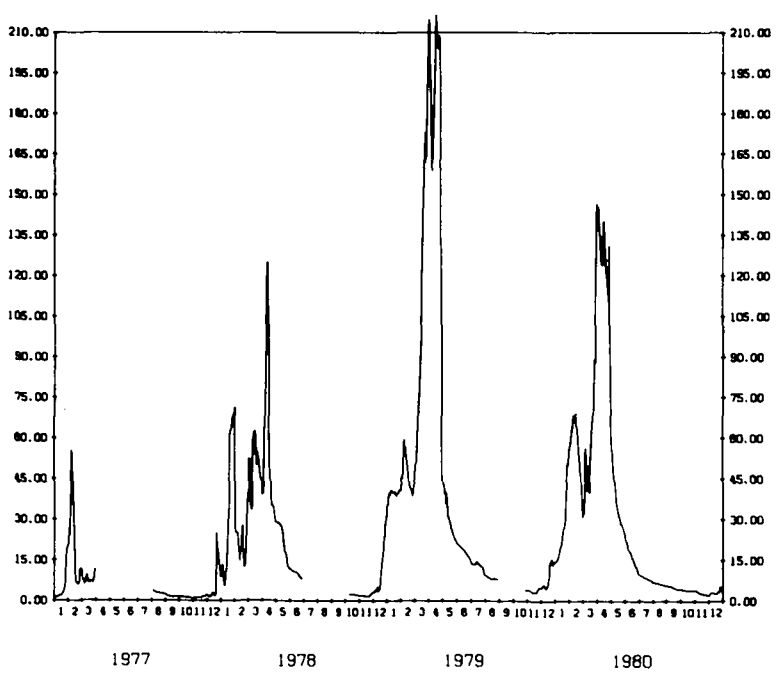


Figure 5.43[8] - Hydrograph - priority station.

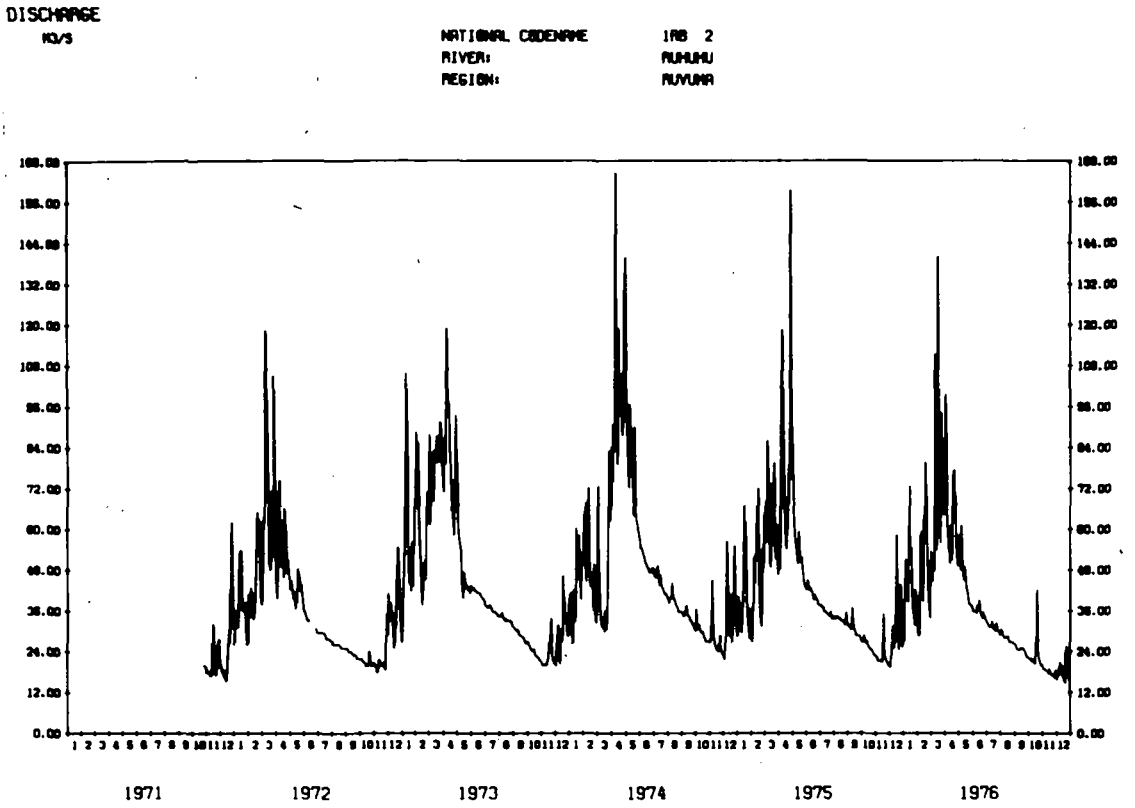


Figure 5.44[8] - Hydrograph - priority station.

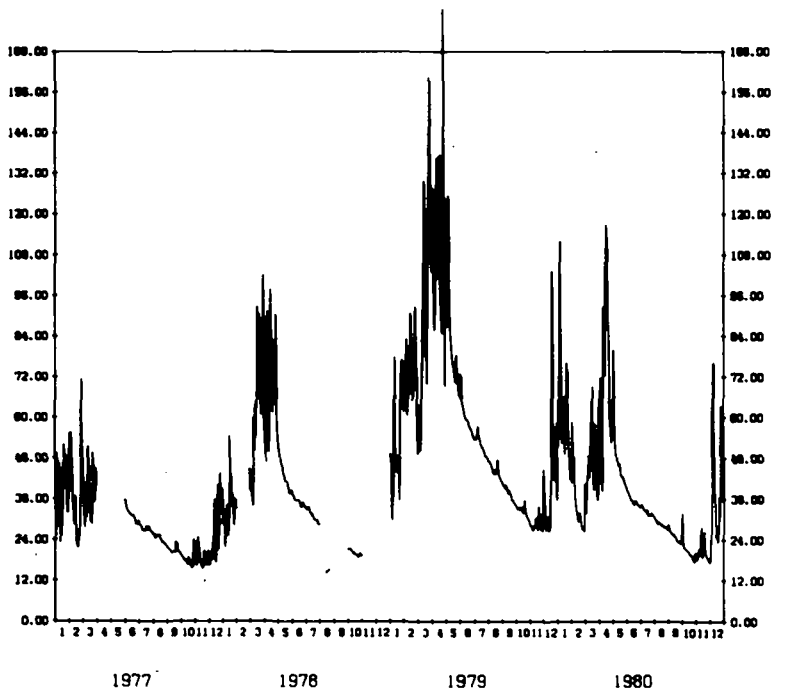


Figure 5.44[8] - Hydrograph - priority station.

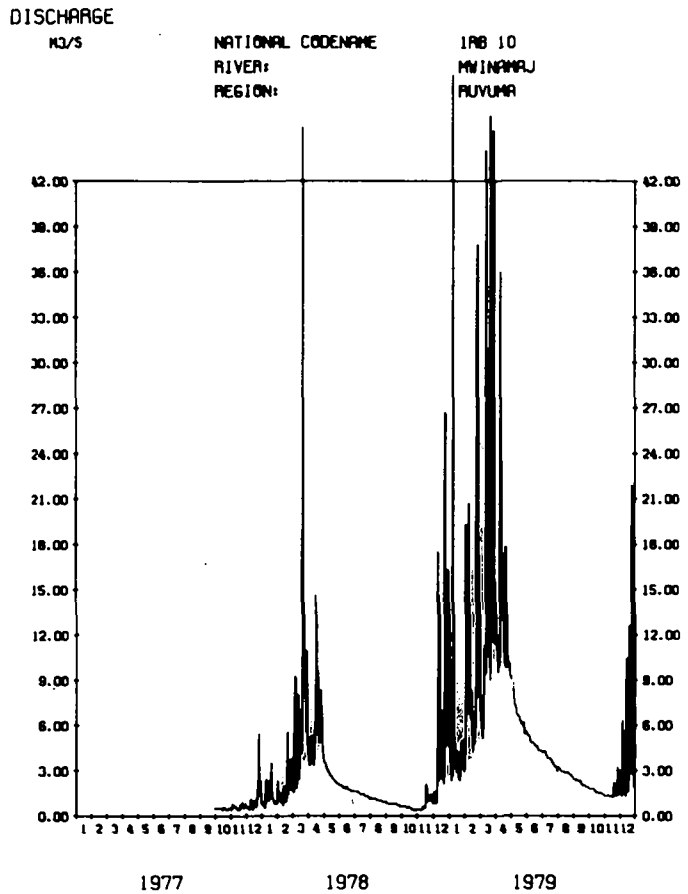


Figure 5.45[8] - Hydrograph - priority station.

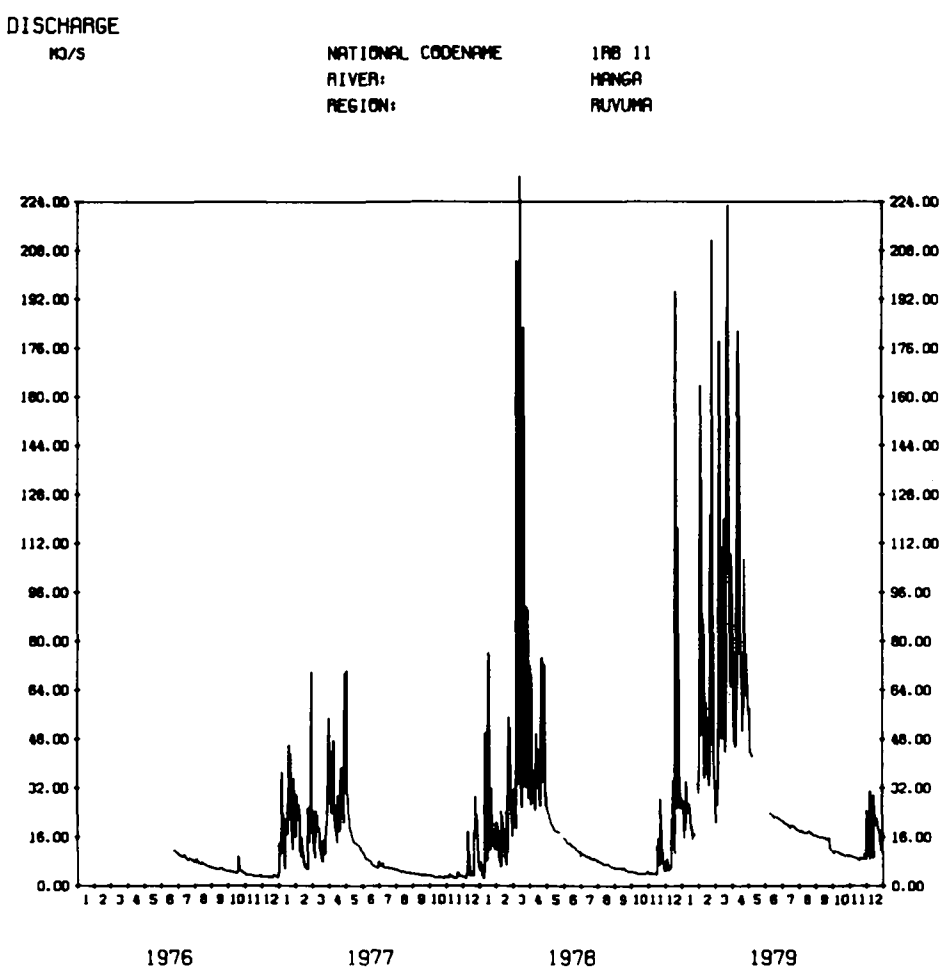


Figure 5.46[8] - Hydrograph - priority station.

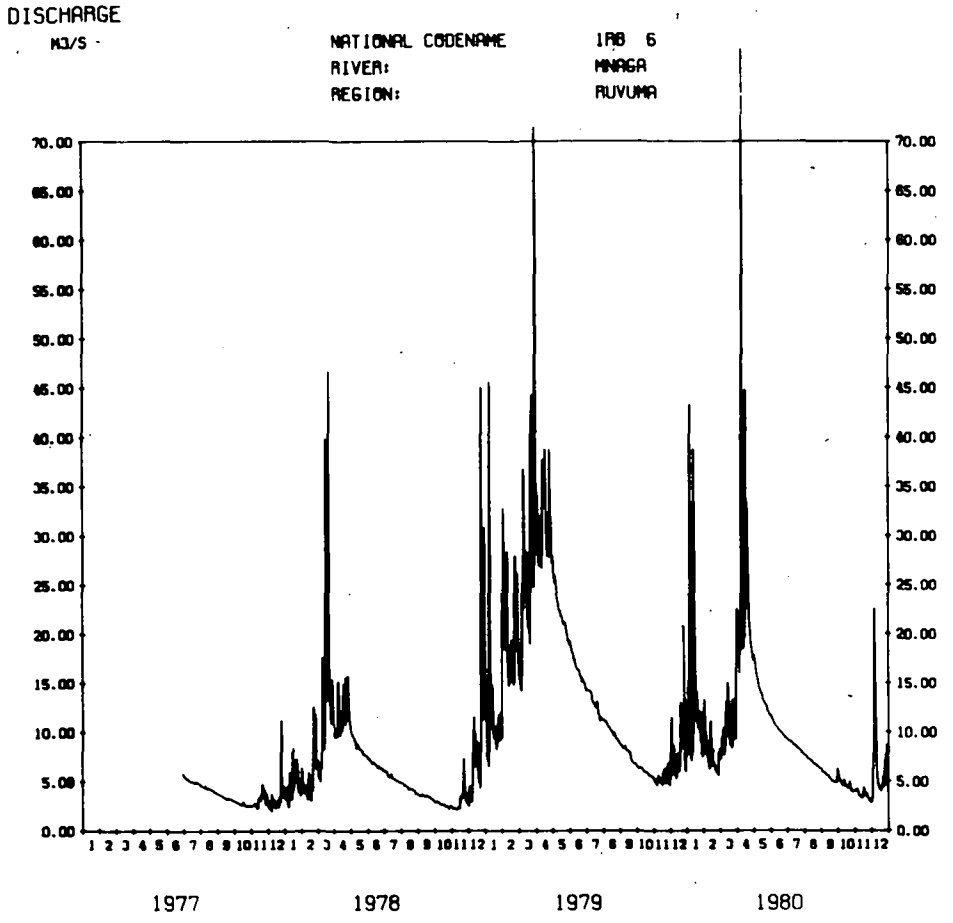


Figure 5.47[8] - Hydrograph - priority station.

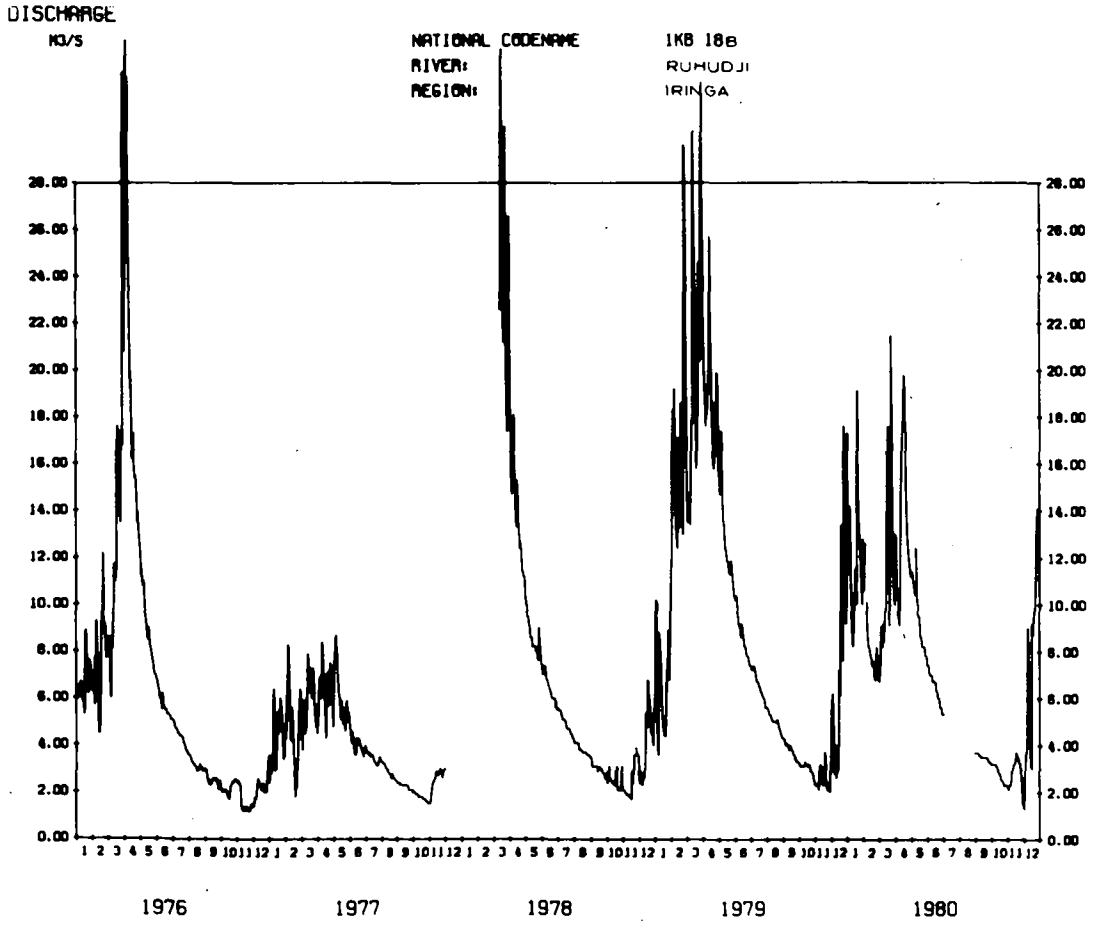


Figure 5.48[8] - Hydrograph - priority station.

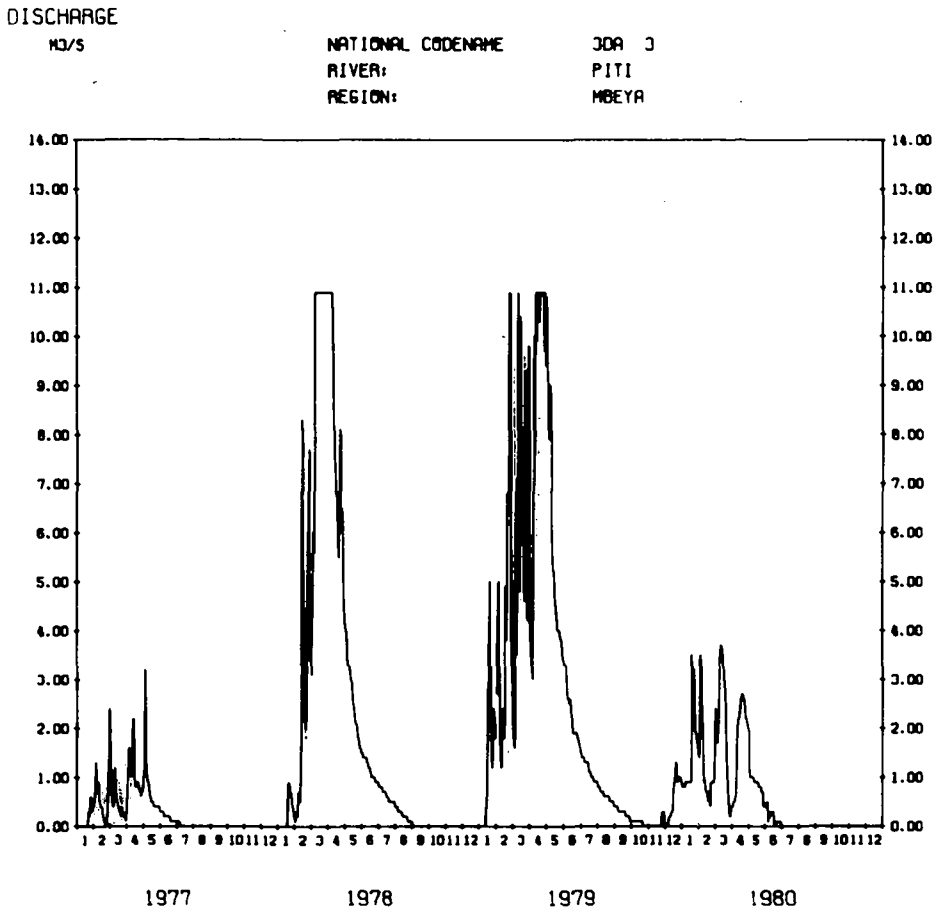


Figure 5.49[8] - Hydrograph - priority station.

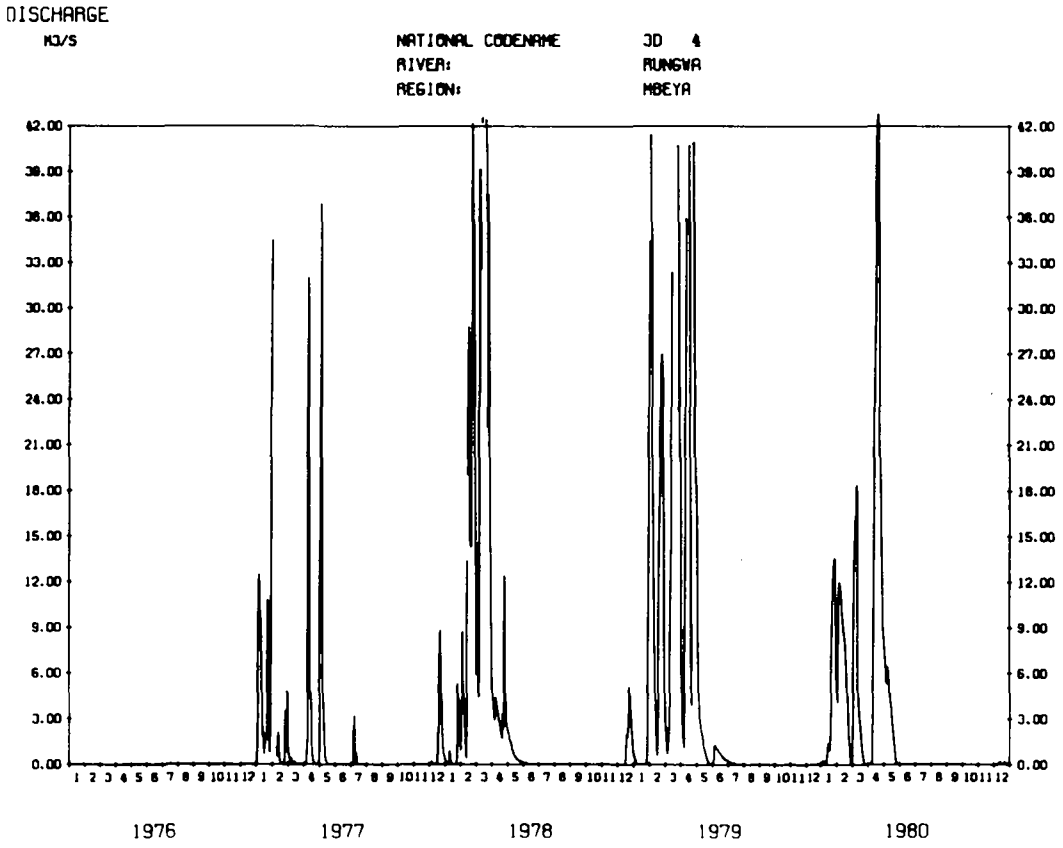


Figure 5.50[8] - Hydrograph - priority station.

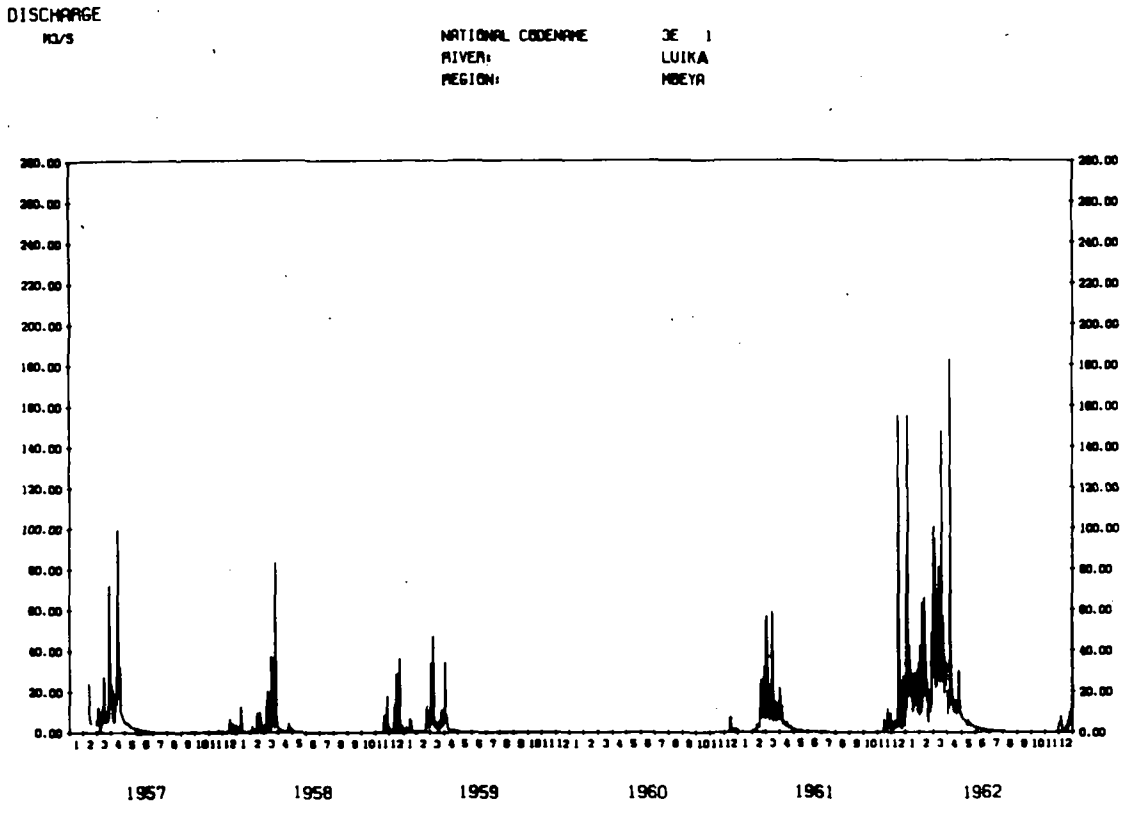


Figure 5.51[8] - Hydrograph - priority station.

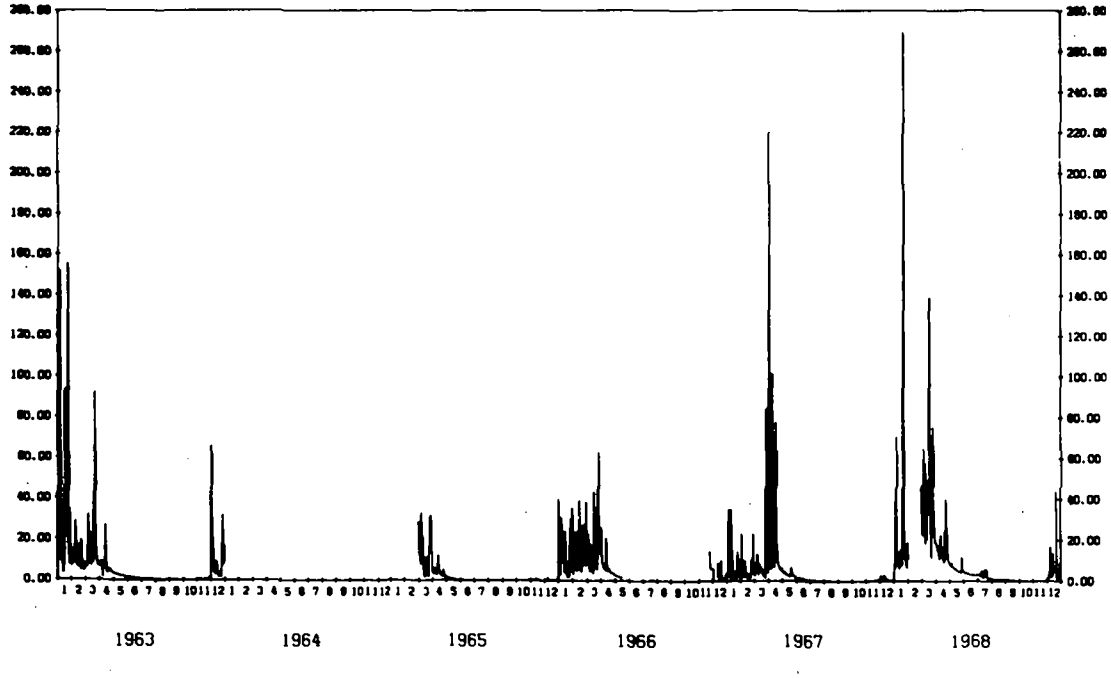


Figure 5.51[8] - Hydrograph - priority station.

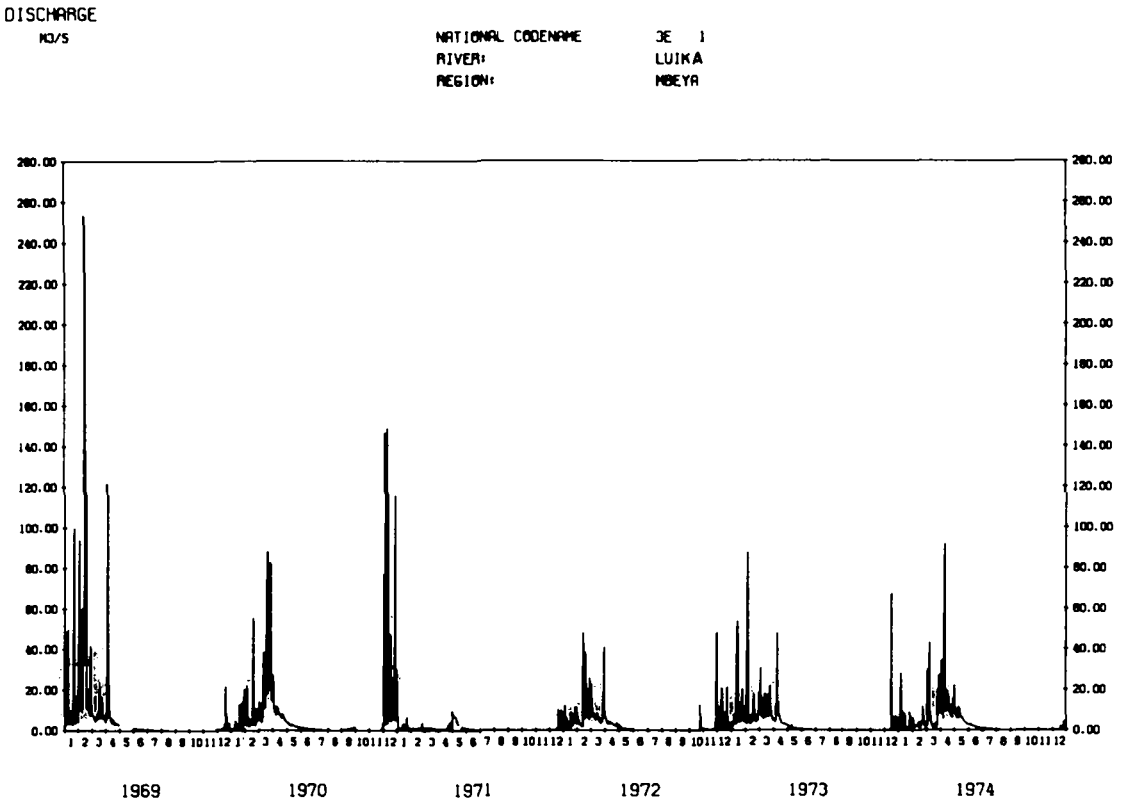


Figure 5.51[8] - Cont'd.

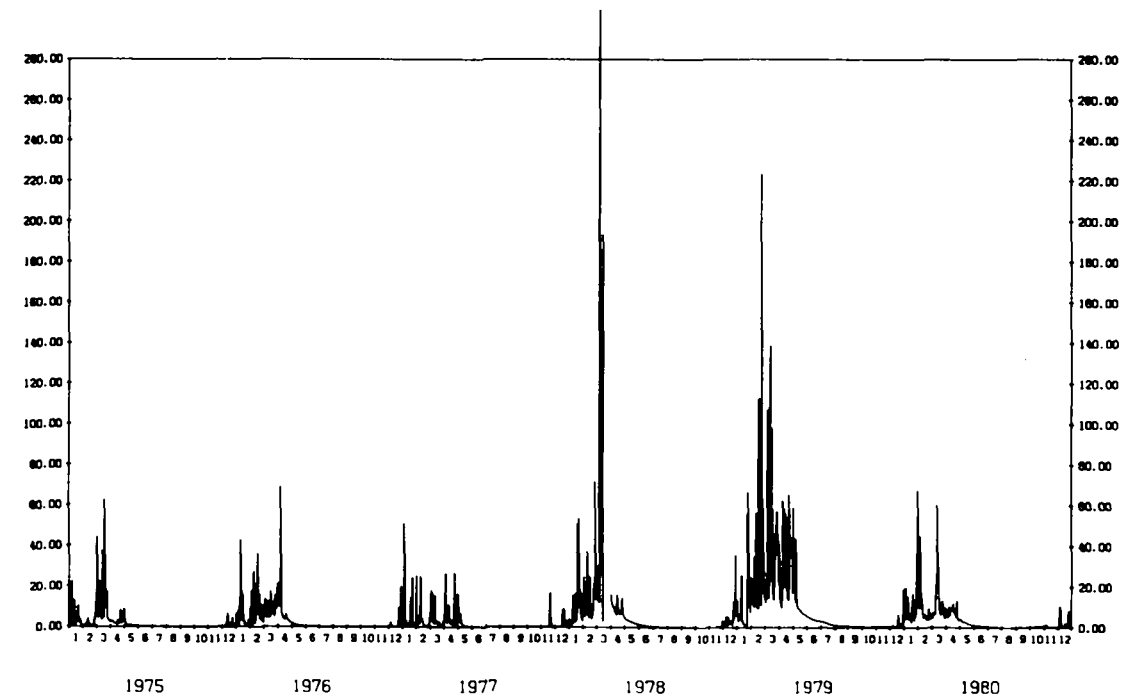


Figure 5.51[8] - Cont'd.

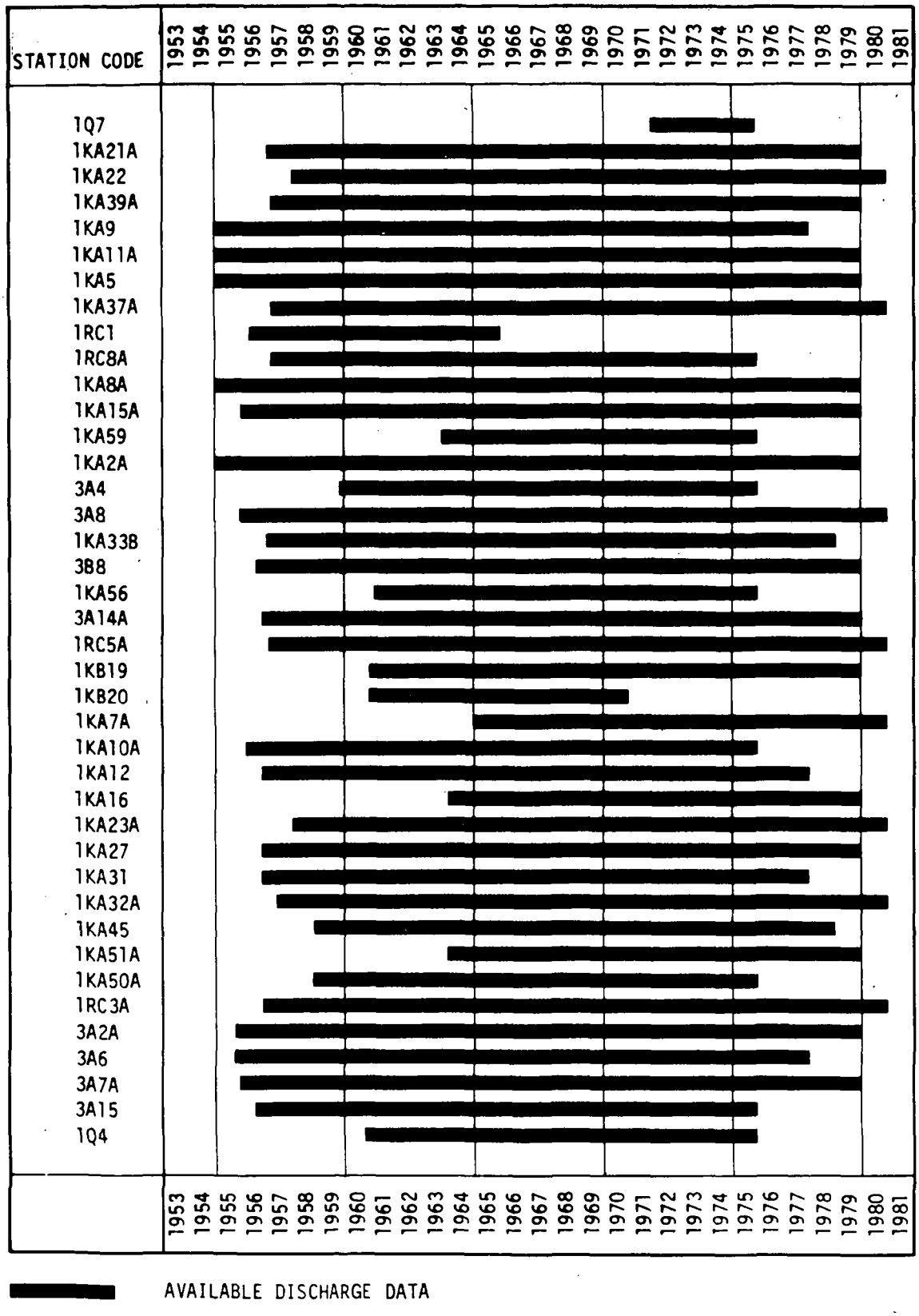


FIGURE 5.52[8] - BAR CHART - DISCHARGES

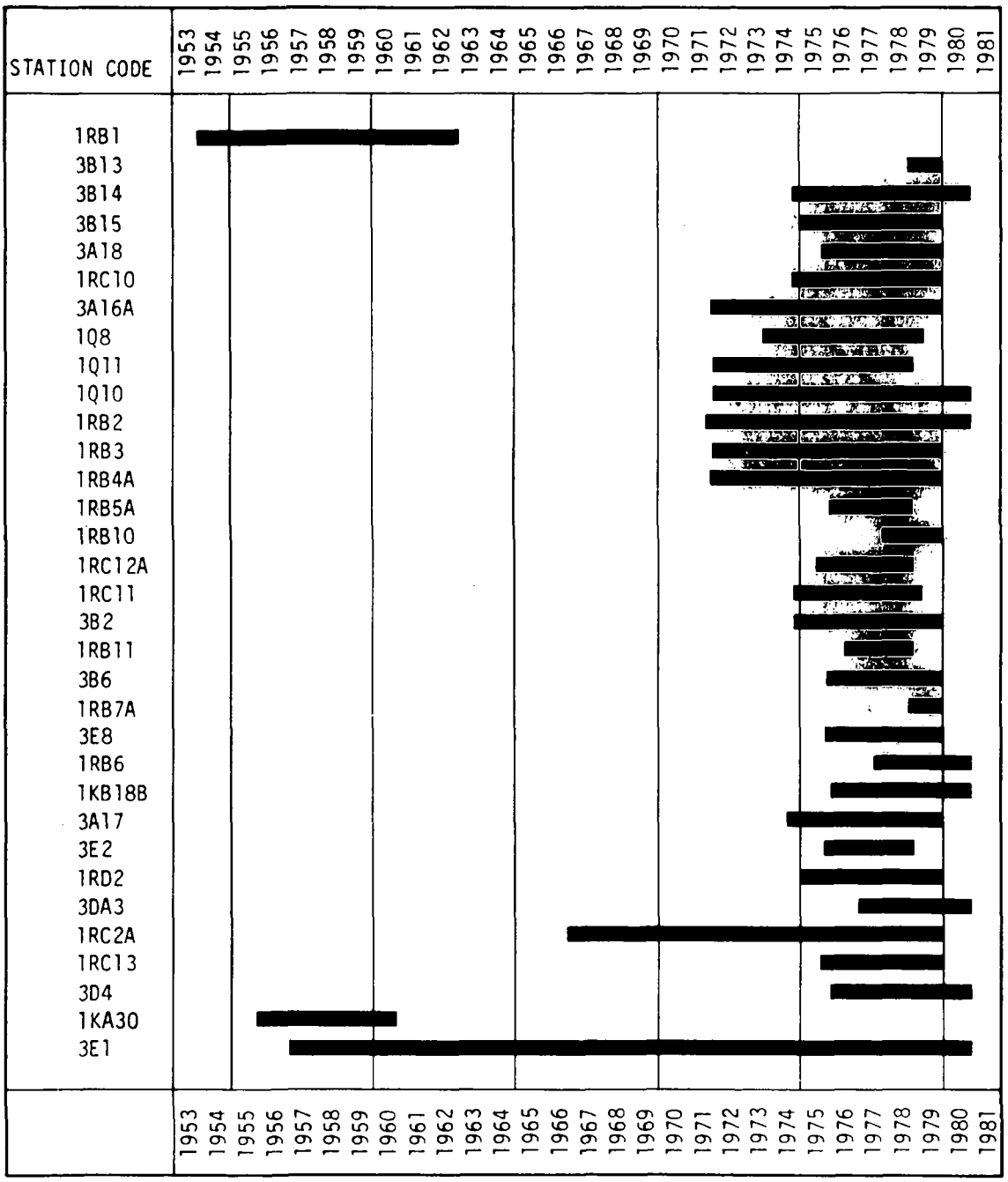


FIGURE 5.52[8] - BAR CHART - DISCHARGES (CONTD.)

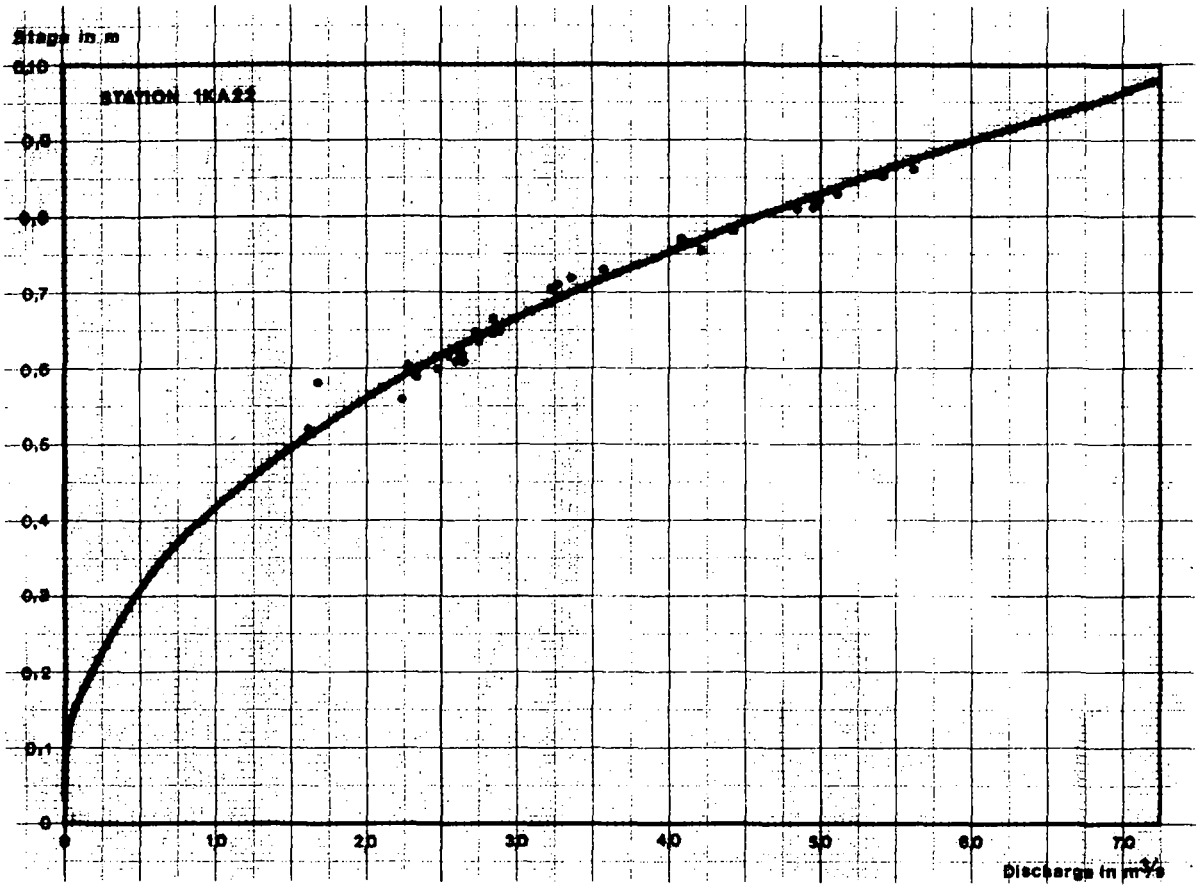


Figure 5.55[8]. Rating curve for Station 1KA22. Discharge measurements plotted.

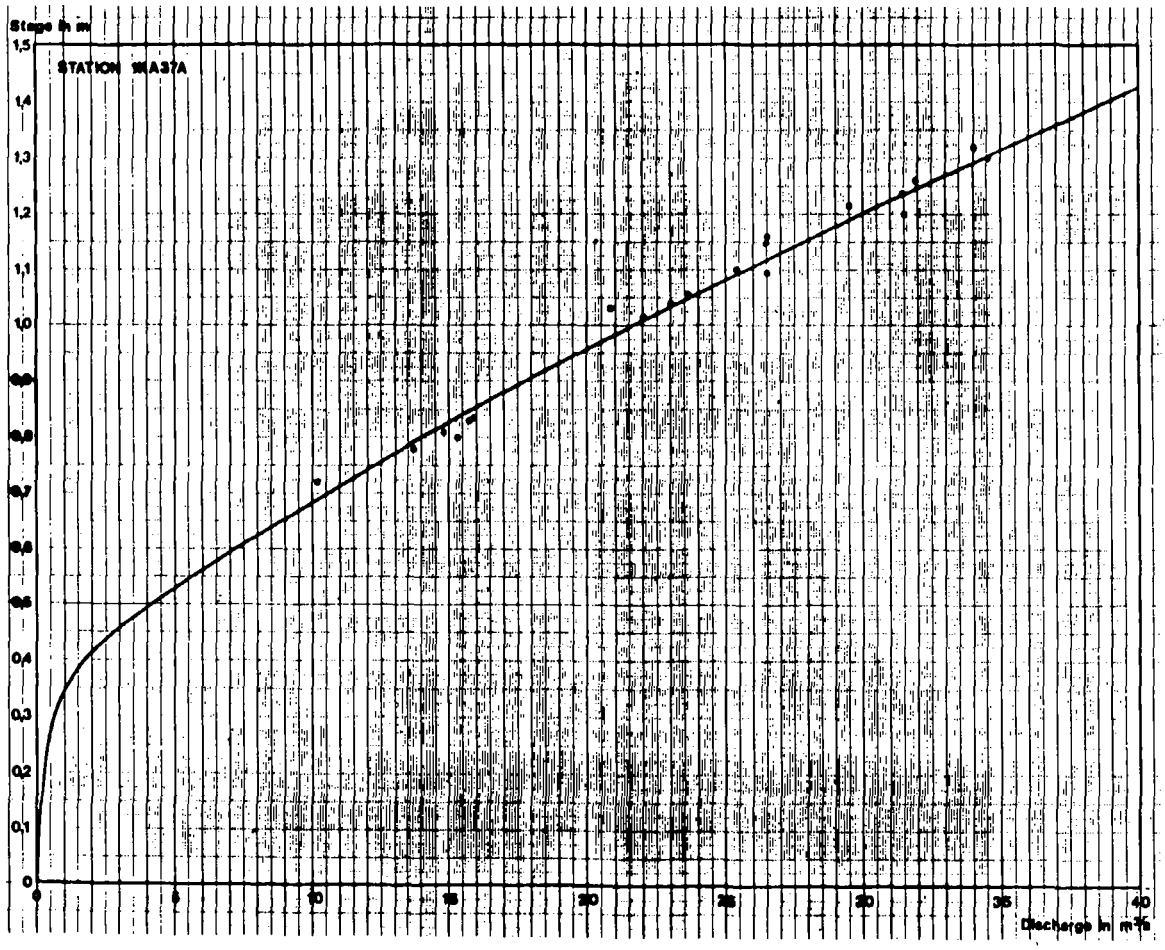


Figure 5.56[8]. Rating Curve for Station 1KA37A. Discharge measurements plotted.

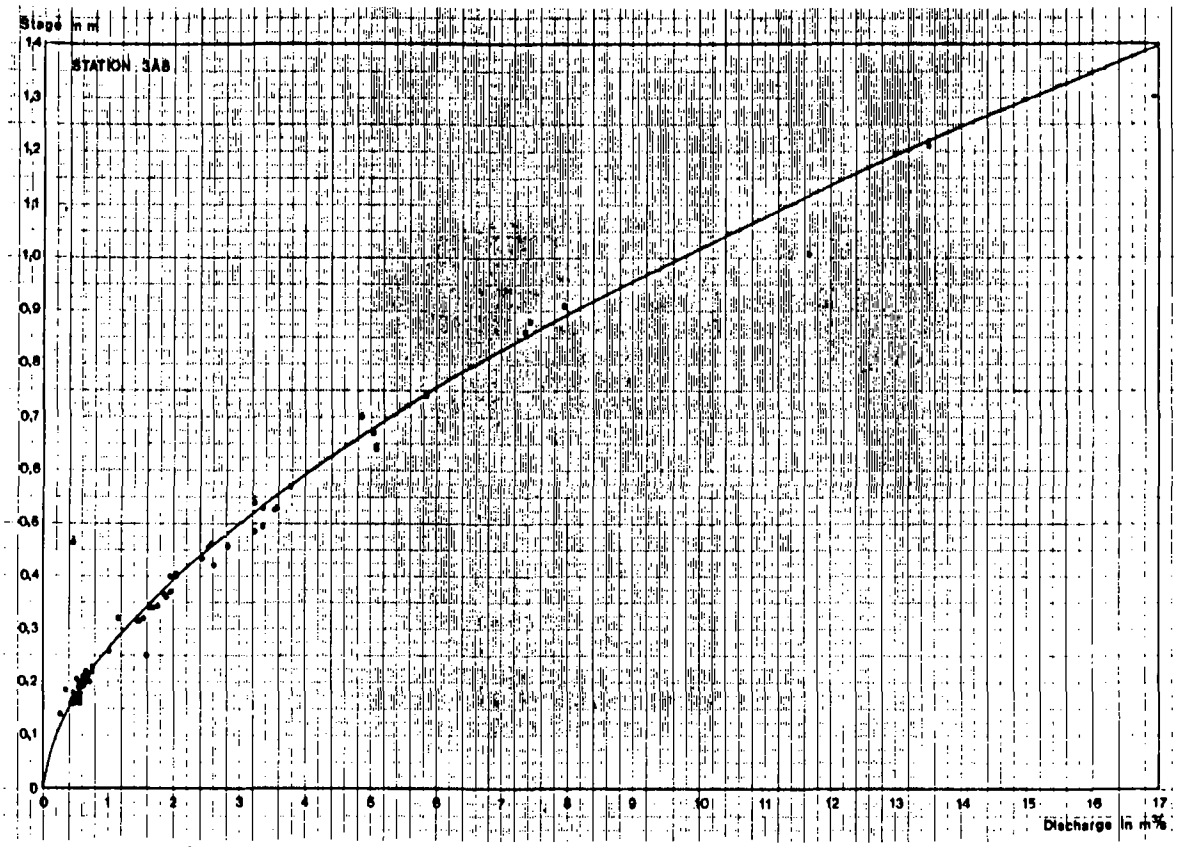


Figure 5.57[8]. Rating curve for Station 3A8. Discharge measurements plotted.

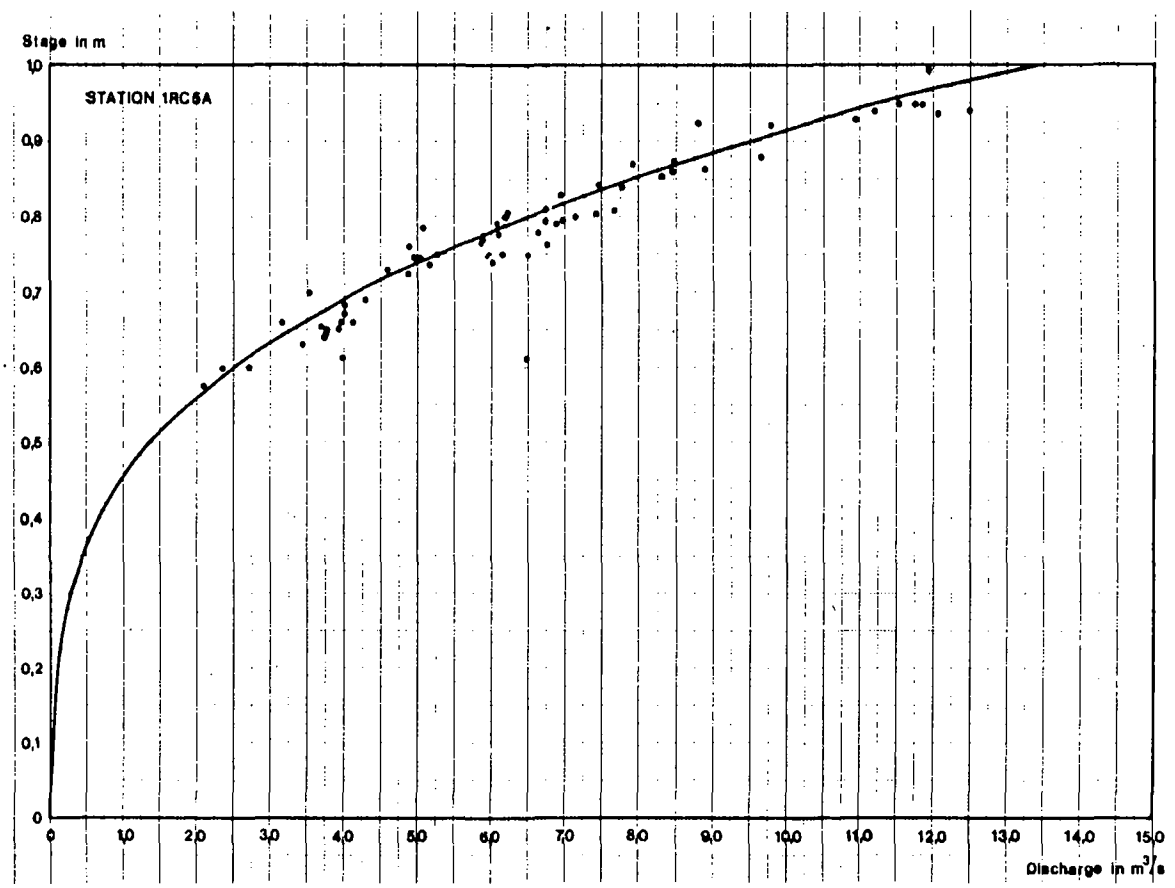


Figure 5.58[8]. Rating curve for Station 1RC5A. Discharge measurements plotted.

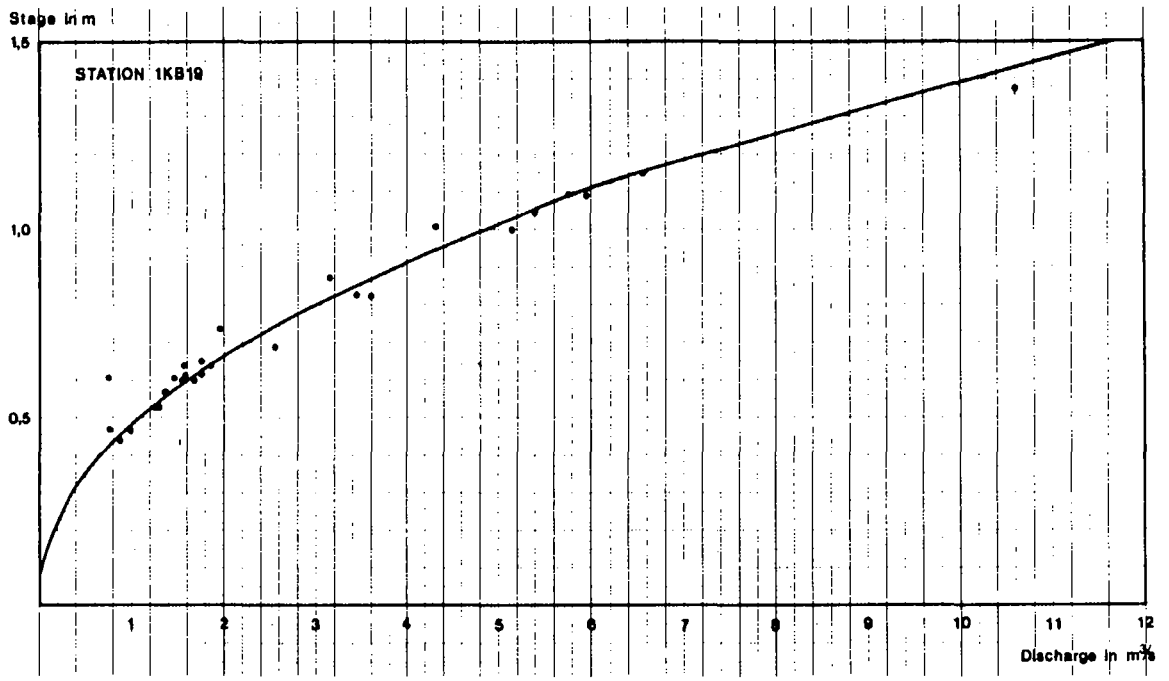


Figure 5.59[8]. Rating curve for Station 1KB19. Discharge measurements plotted.

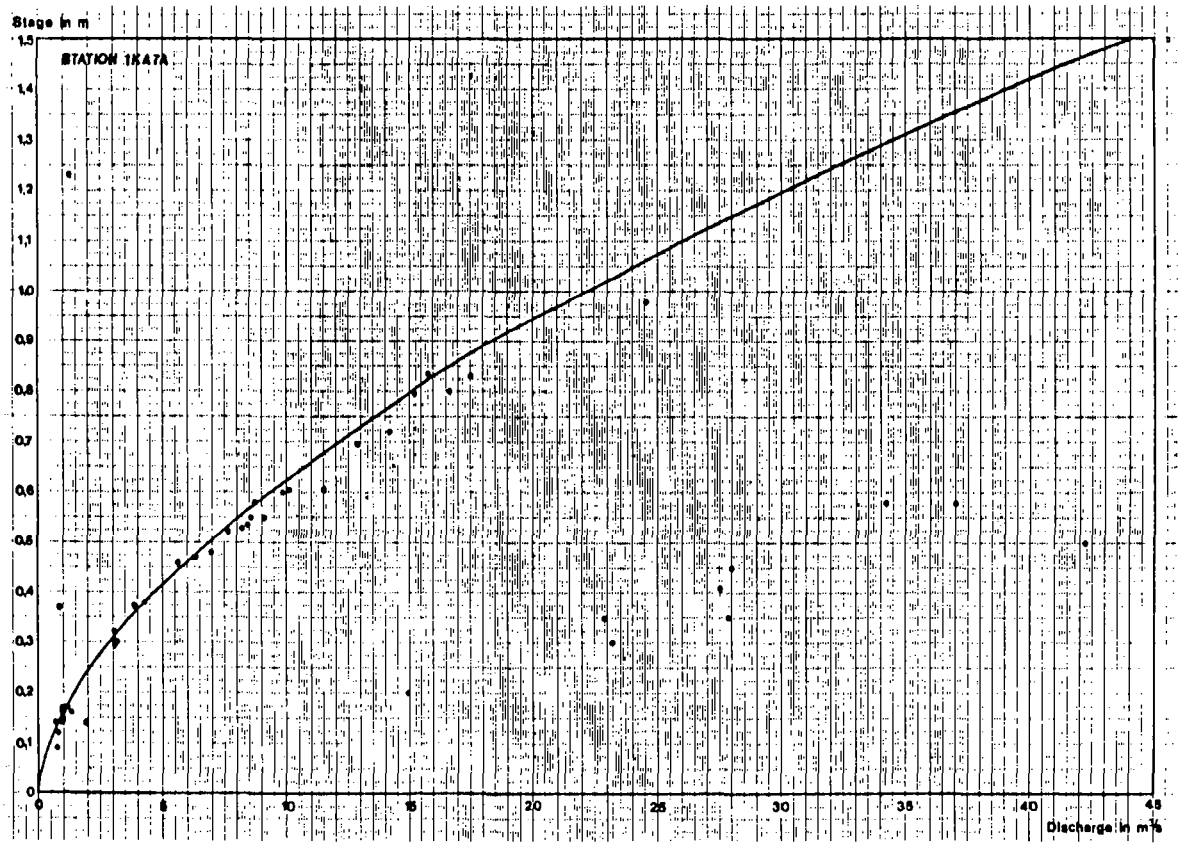


Figure 5.60[8]. Rating curve for Station 1KA7A. Discharge measurements plotted.

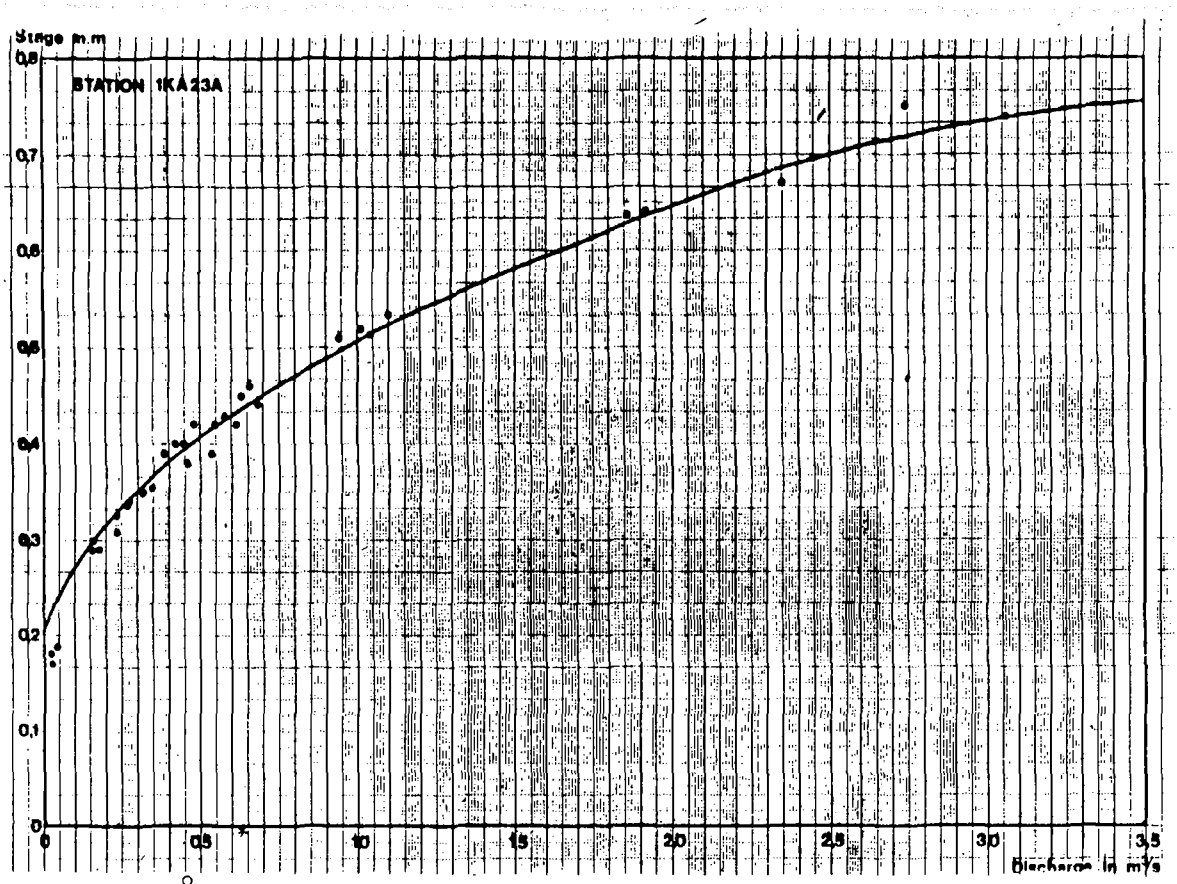


Figure 5.61[8]. Rating curve for Station 1KA23A. Discharge measurements plotted.

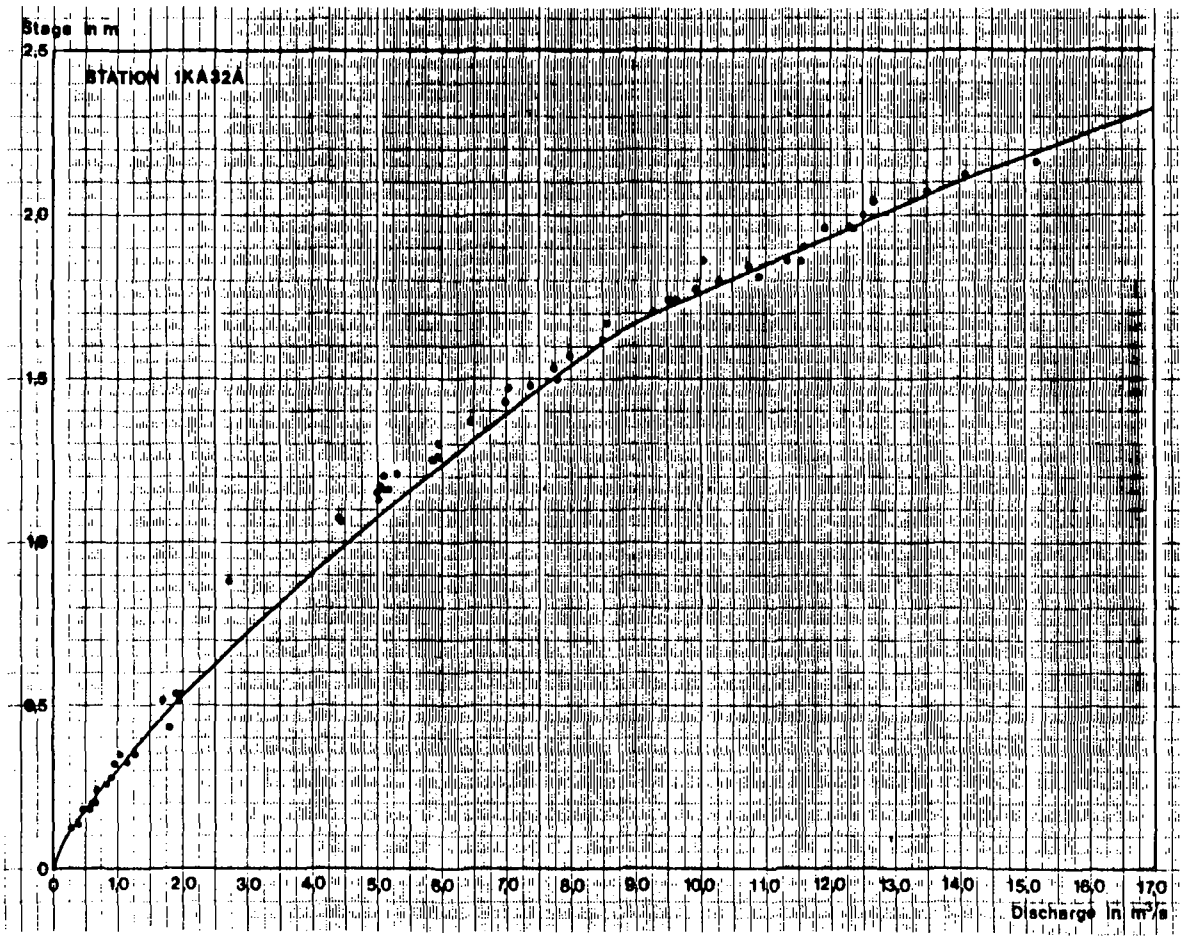


Figure 5.62[8]. Rating curve for Station 1KA32A. Discharge measurements plotted.

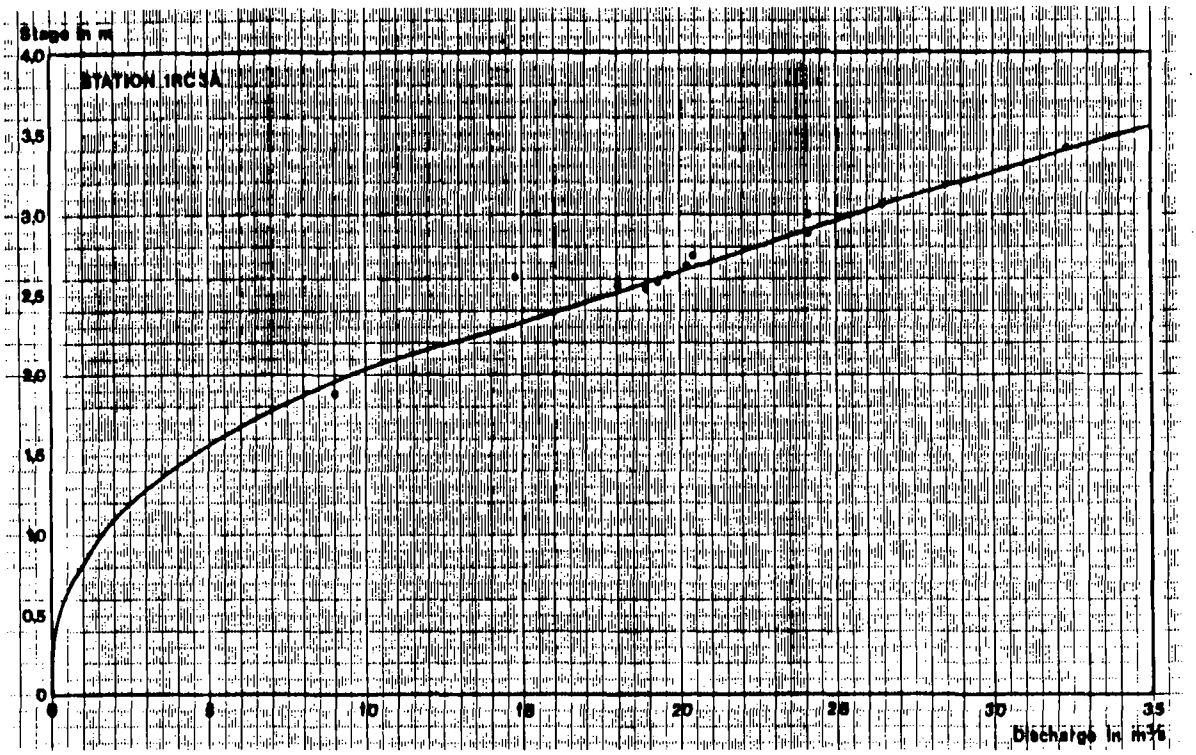


Figure 5.63[8]. Rating curve for Station 1RC3A. Discharge measurements plotted.

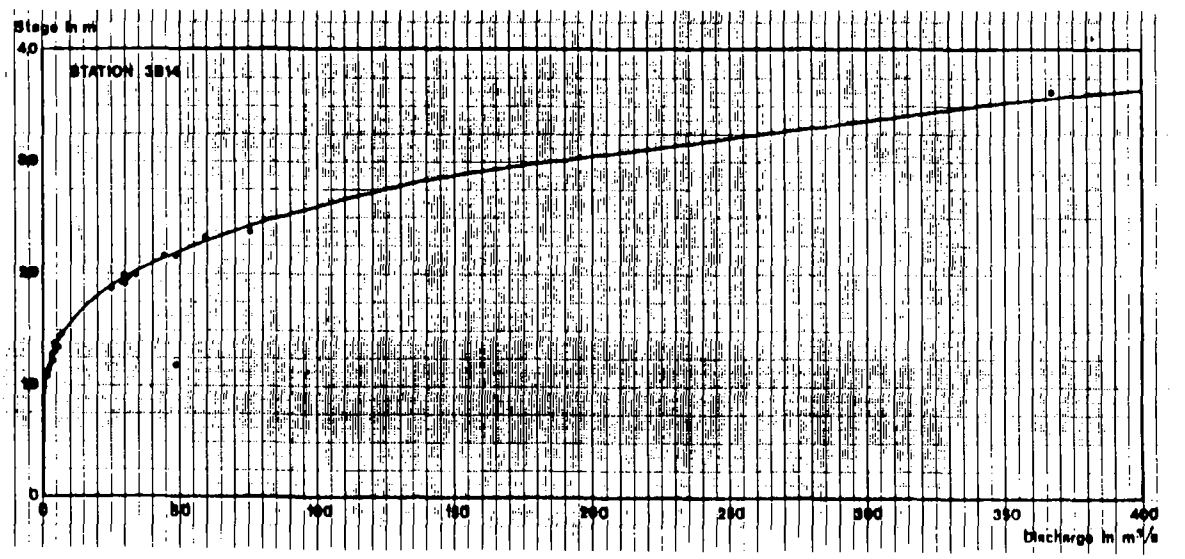


Figure 5.64[8]. Rating curve for Station 3B14. Discharge measurements plotted.

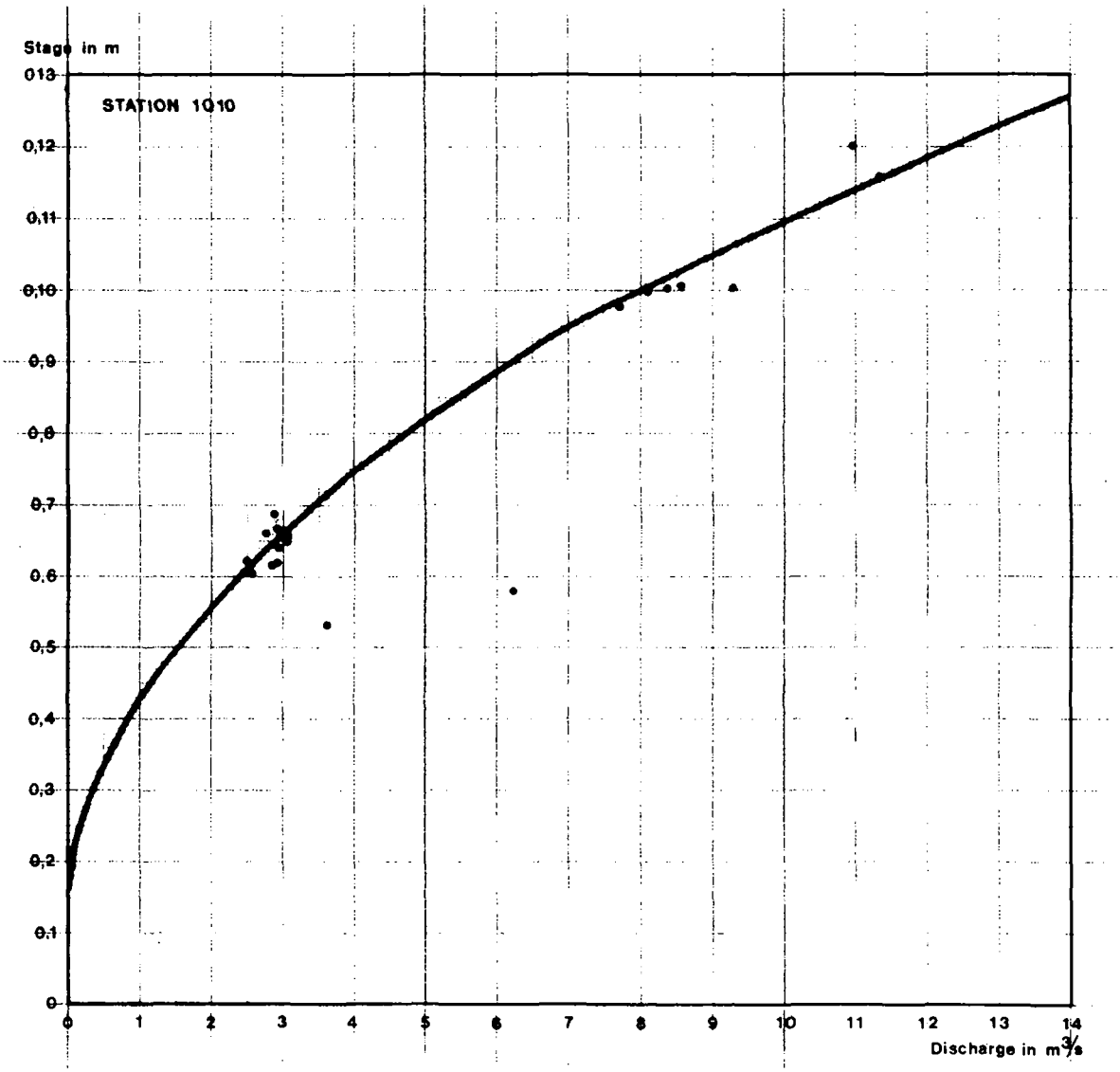


Figure 5.65[8]. Rating curve for Station 1Q10. Discharge measurements plotted.

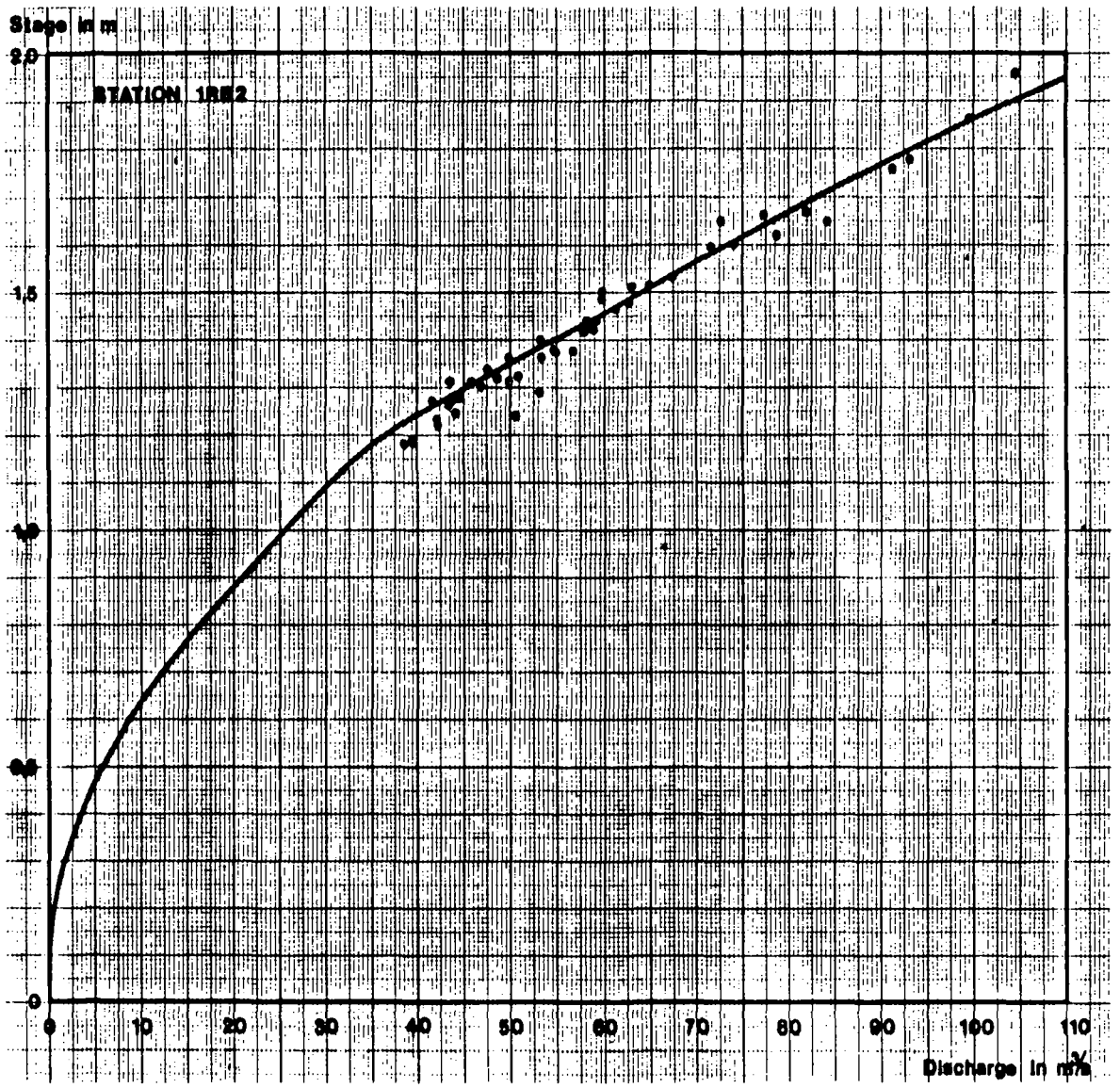


Figure 5.66[8]. Rating curve for Station 1RB2. Discharge measurements plotted.

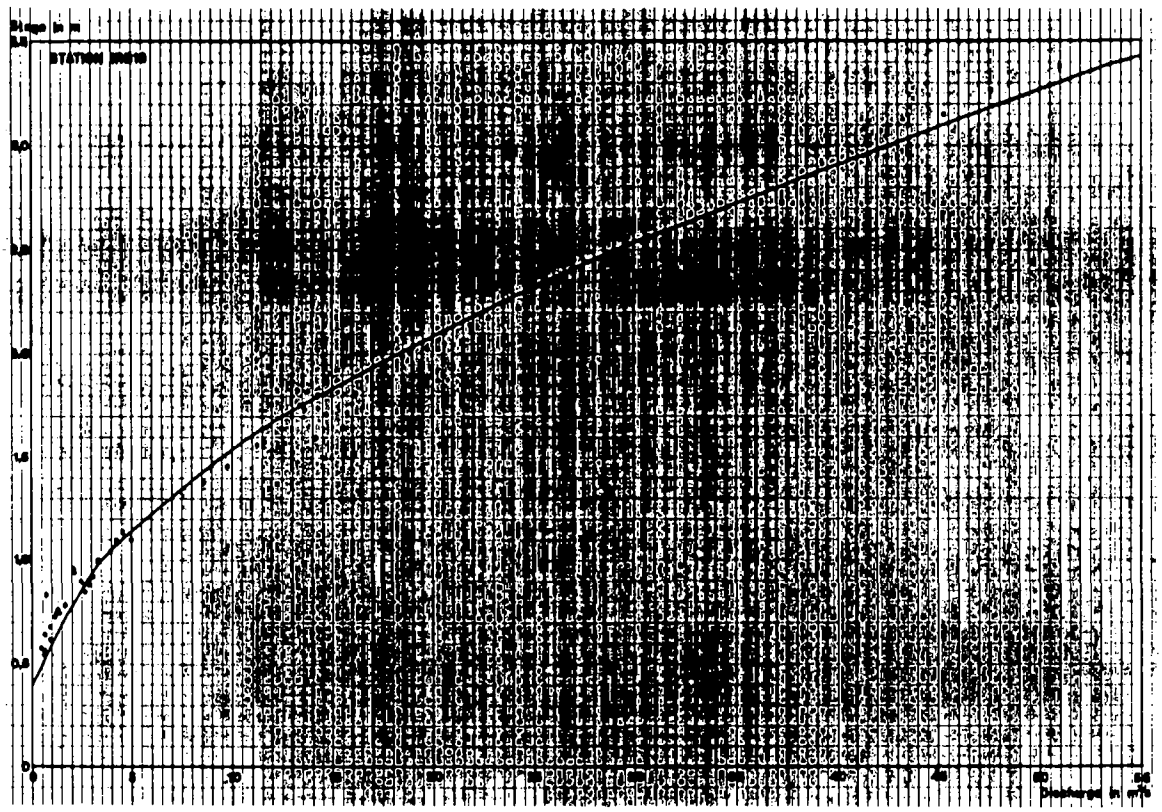


Figure 5.67[8]. Rating curve for Station 1RB10. Discharge measurements plotted.

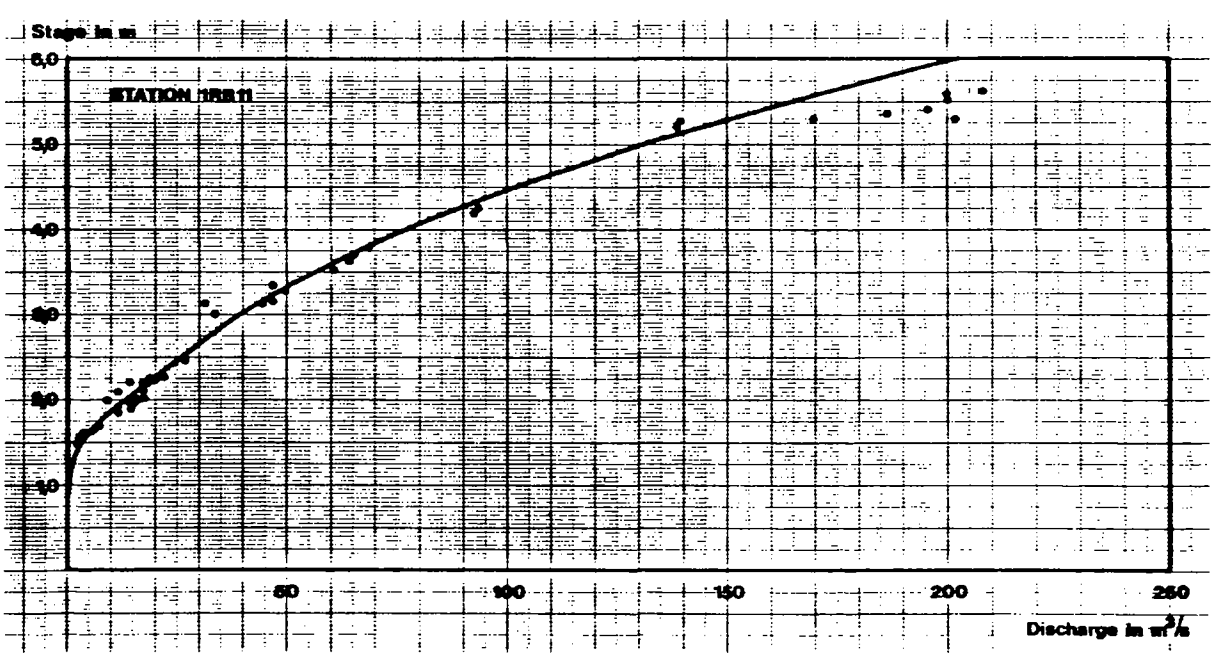


Figure 5.68[8]. Rating curve for Station 1RB11. Discharge measurements plotted.

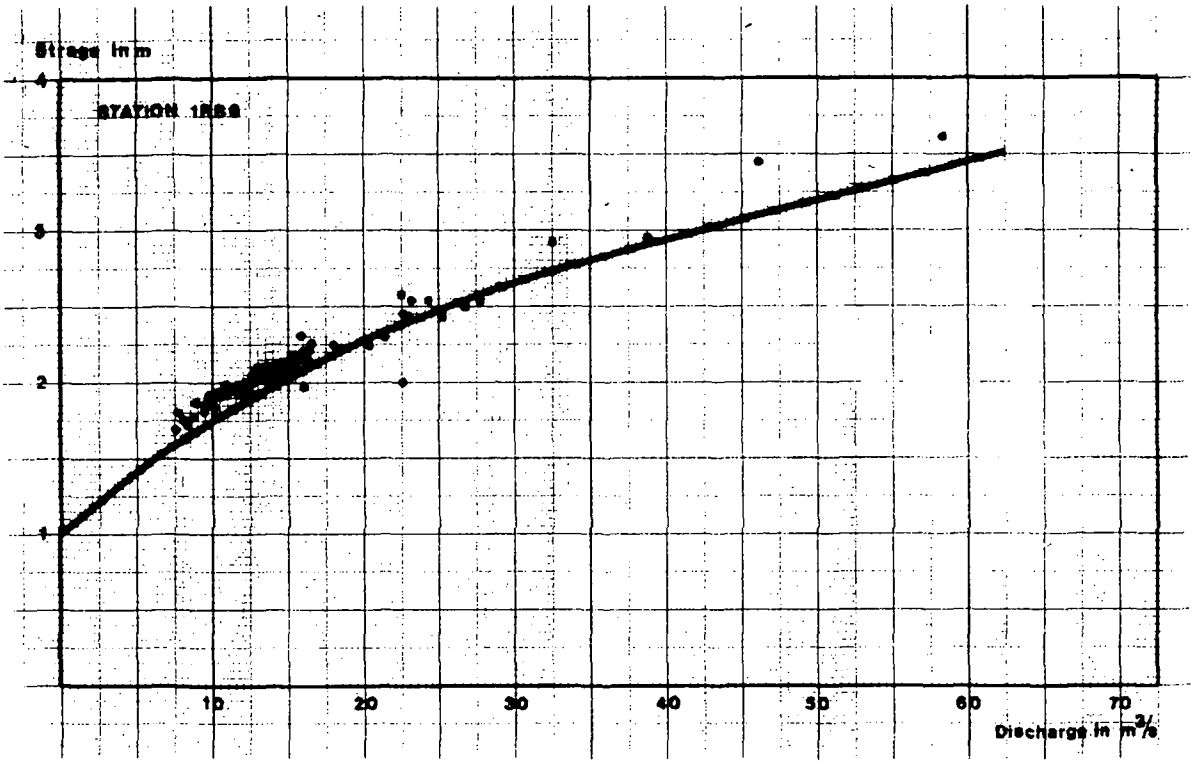


Figure 5.69[8]. Rating curve for Station 1RB6. Discharge measurements plotted.

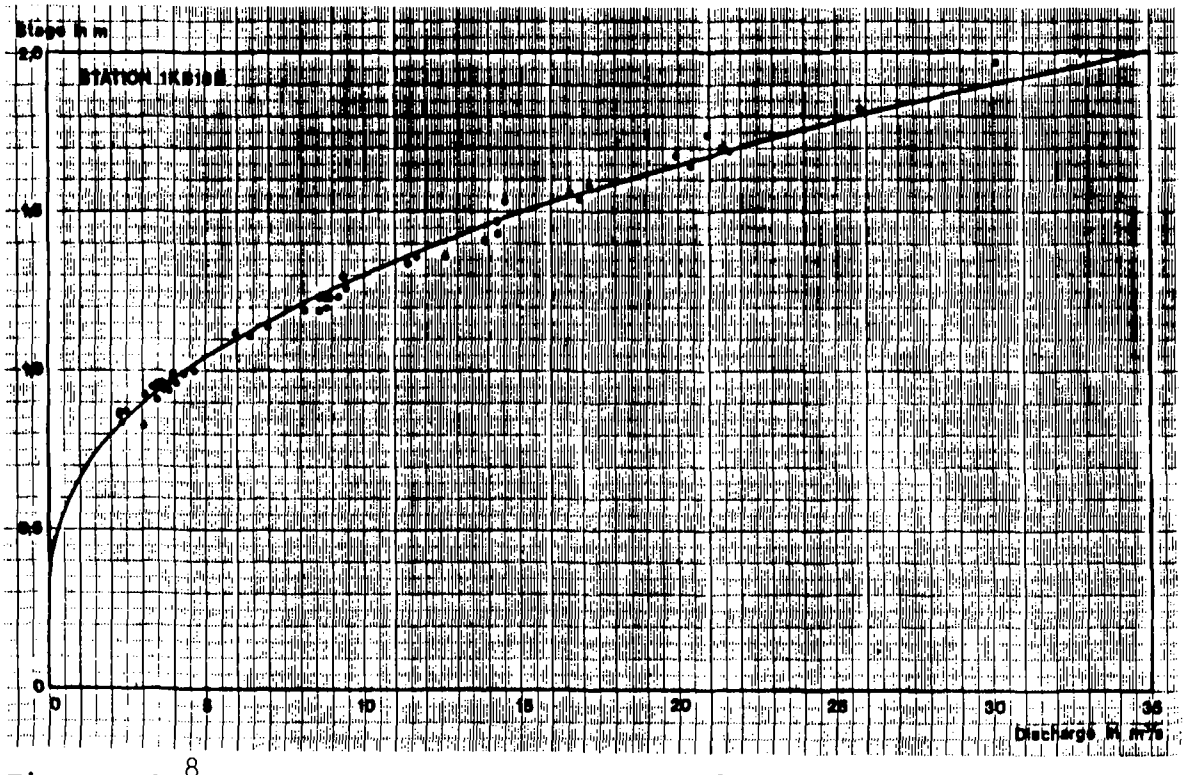


Figure 5.70[8]. Rating curve for Station 1KB18B. Discharge measurements plotted.

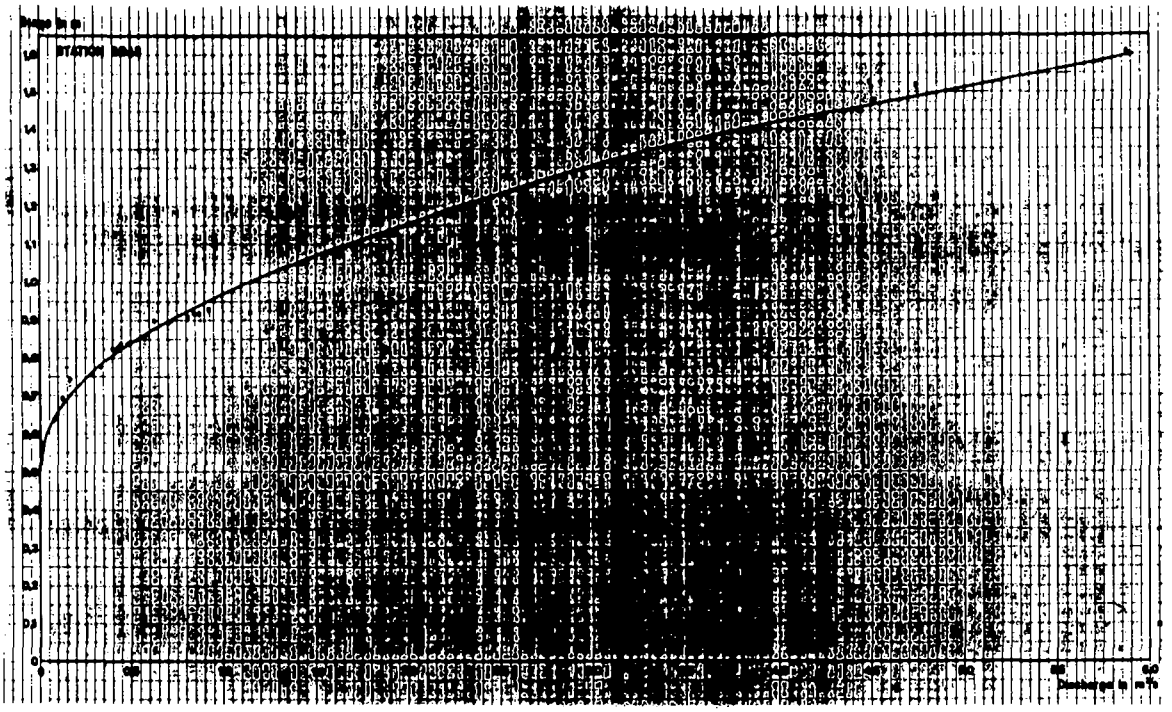


Figure 5.71[8]. Rating curve for Station 3DA3. Discharge measurements plotted.

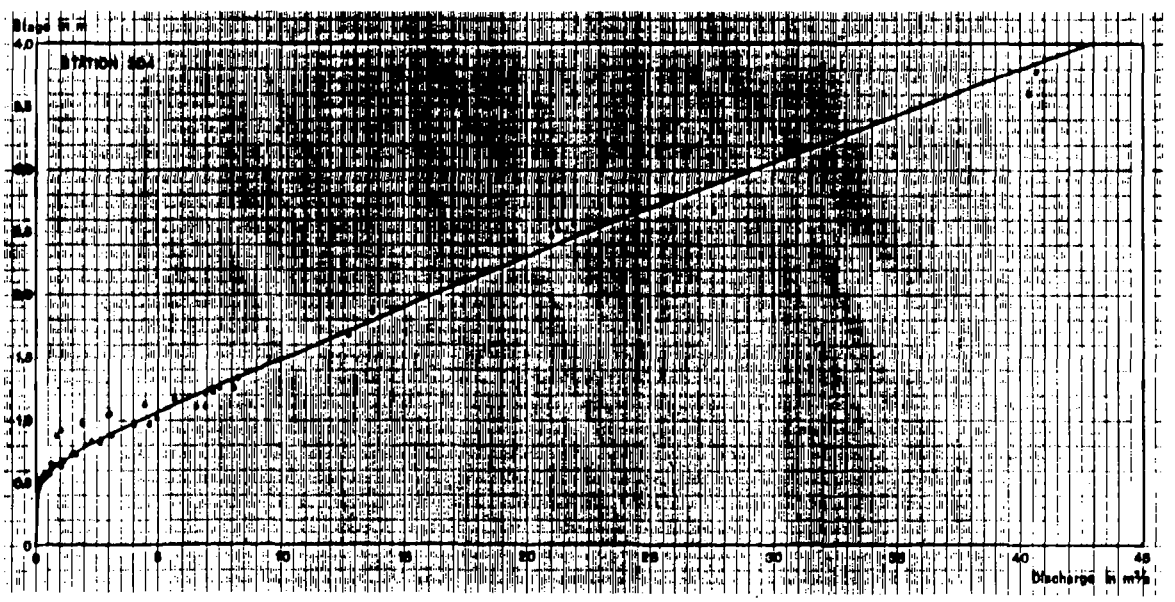


Figure 5.72[8]. Rating curve for Station 3D4. Discharge measurements plotted.

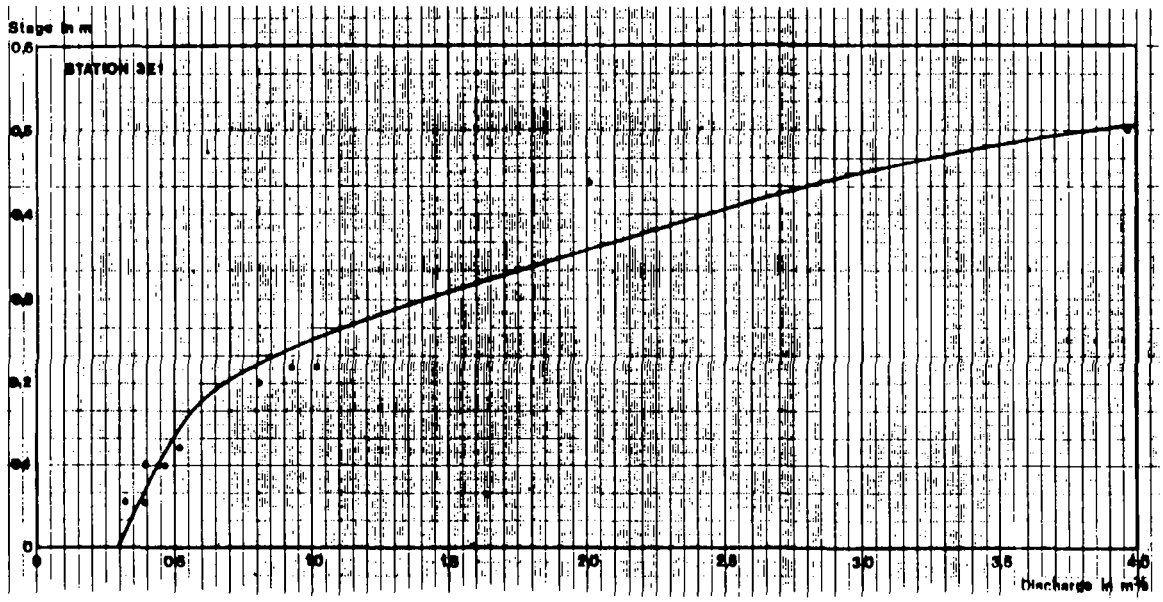


Figure 5.73[8]. Rating curve for Station 3E1. Discharge measurements plotted.

Station Code	Station Name	Type of Station	Location	Altitude (m)	Catchm. Area (km^2)	Year establ.	Visited by CCKK	Reliability of Water Level Recs.	Remarks
1KA21A	Little Ruaha at Ihimbo	RCS	7°54'10"S 35°47'40"E	1550	2480	1967	YES	High	
1KA22*	Mtitu at Mtitu Bridge	SC	7°58'50"S 35°46'50"E	1680	445	1957	YES	High	
1KA39A	Little Ruaha at Iwawa	SC	8°02'35"S 35°41'35"E	1800	1740	1964	YES	High	
1KA5	Great Ruaha at Mtera	SC	7°03'15"S 35°48'00"E		67950	1954	YES	High	
1KA37A*	Lukosi at Mtandika	RSC	7°37'00"S 36°25'20"E	760	2890	1959	YES	High	
1KA15A	Ndembera at Ilongo	SC	8°12'30"S 35°13'05"E		1360	1960	YES	High	
1KA59	Great Ruaha at Msembe	RSC	7°42'30"S 34°59'30"E	915	24620	1963	YES	High	
1KA2A	Little Ruaha at Ndiuka	SC	7°47'20"S 35°43'40"E	1530	2920	1964	YES	High	
1KA56	Ruaha at Malangali	SC	8°33'40"S 34°50'55"E	1200	151	1961	YES	Fair	Artificial weir broken
1KB19*	Hagafiro at Hagafiro	SC	9°23'55"S 34°45'00"E	1935	153	1960	YES	High	
1KA12	Halali at Iyayi	SC	8°51'25"S 34°41'15"E	1370	470	1954	YES	High	
1KA23A*	Huhuni at Iyayi	SC	8°51'25"S 34°41'15"E	1370	803	1963	YES	High	
1KA31	Little Ruaha at Mawande	SC	7°30'30"S 35°30'30"E		5193	1956	YES	High	
1KA32A*	Little Ruaha at Makalala	SC	8°22'05"S 35°19'45"E	1650	759	1964	YES	High	
1KB18B*	Ruhuji below Kifunga Falls	SC	9°17'35"S 34°50'10"E	1845	500	1976	YES	High	
1KB20	Ijonilo at Kibena	SC	9°19'00"S 34°45'00"E		95	1960	NO		Station closed in 1970
1KB6B	Kigogo Ruaha at Frick Brdg.	S	8°44'00"S 35°18'00"E			1977	NO	Low	

Iringa Region (*priority stations).

Station Code	Station Name	Type of Station	Location	Altitude (m)	Catchm. Area (km^2)	Year establ.	Visited by CCKK	Reliability of water Level Records	Remarks
1Q7	Ruvuma at Muhiga	SC	11°13'00"S 35°17'40"E	800	4125	1971	YES	High	proposed as water level station only
1Q4	Muhuwesi at Muhuwesi	SC	10°55'05"S 37°30'15"E	550		1968	YES	High	Proposed as water level station only
1Q8	Mbesa at Mbesa	SC	11°24'00"S 37°08'45"E	550		1971	YES	High	
1Q11	Msinjewe at Mtwara	SC	11°16'55"S 37°40'00"E	400		1971	YES	Low	
1Q10*	Likonde at Ligowonga	SC	11°06'00"S 35°51'00"E	650	1442	1971	YES	High	
1RB2*	Ruhuhu at Masigira	RSC	9°56'30"S 35°11'30"E	920	2220	1971	YES	High	
1RB3	Ruhuhu at Kikonge	RSC	9°26'30"S 34°48'00"E	600	13490	1971	YES	High	
1RB4A	Kitewaka at Muhumbi	RSC	10°15'30"S 34°48'00"E	900	2480	1971	NO	High	
1RB5A	Rutukira at Road Bridge	SC	10°18'05"S 35°08'30"E	800	4060	1977	YES	High	Established by WTP
1RB9	Kitewaka at Maboga	SC	9°53'00"S 34°48'00"E	1300	970	1975	NO	High	Established by WTP
1RB10*	Mwinamaji at Road Bridge	SC	10°32'30"S 34°58'00"E	870	544	1975	YES	High	Established by WTP
1RB11*	Hanga at Road Bridge	SC	10°10'00"S 35°39'30"E	780	1400	1978	YES	Fair	Establ.by WTP. Morning Water Lev. not always read
1RB7A	Lumecha at Njoganjoga	SC	10°16'30"S 35°23'00"E	800	1810	1978	YES	High	Established by WTP
1RB6*	Mngaka at Road Bridge	SC	10°33'30"S 35°00'01"	600	688	1976	YES	High	Established by WTP
1Q13	Msanjesi at Maundi	S	11°27'00"S 36°36'15"E	500			NO		

Ruvuma Region (*priority station).

Table 5.2[8] - Discharge gauging stations.

Station Code	Station Name	Type of Station	Location	Altitude (m)	Catchm. Area (km^2)	Year establ.	Visited by CCKK	Reliability of Water Level Recs.	Remarks
1KA9	Kimani at Gt. North Road	RSC	8°51'00"S 34°11'00"E	1160	448	1954	Yes	High	
1KA11A	Mbarali at Igawa	RSC	8°46'00"S 34°22'40"E	1050	1600	1964	Yes	Fair	
1RC8A	Kiwira at Natural Bridge	RSC	9°16'00"S 33°33'00"E	1200	655	1957	Yes	High	
1KA8A	Great Ruaha at Salimwani	RSC	8°51'20"S 34°05'30"E	1220	795	1964	Yes	High	
3A4	Mbalizi at Great North R	S	8°56'00"S 33°21'30"E	1450	131	1955	Yes	Low	Continuous change of gauge readers
3A8*	Myovisi at Great North R	S	8°58'20"S 33°03'55"E	1525	152	1955	Yes	High	
1KA33A	Ndembera at Madibira	SC	8°14'20"S 34°48'05"E		2190	1979	No		
3B8	Mpemba at Great North R	S	9°14'00"S 32°44'20"E	1370	65	1956	Yes	High	
3A14A	Mbowo at Great North Road	S	9°00'00"S 33°00'00"E	1525	176	1961	Yes	Fair	
1RC5A*	Kiwira at Kiwira Vill.	SC	9°16'00"S 33°31'55"E	1360	217	1970	Yes	High	
1KA7A*	Chimala at Chitekelo	RSC	8°55'15"S 33°58'30"E	1890	167	1963	Yes	High	
1KA10A	Mlomboji at Mlomboji	SC	8°48'20"S 34°21'00"E	1150	235	1964	Yes	Low	
1KA16	Liosi at Igurusi	S	8°50'10"S 33°52'35"E	1190	77	1956	Yes	Low	
1KA27	Great Ruaha at Mkupule	SC	8°00'00"S 34°35'00"E		19.941	1956	No		
1KA45	Ipatagwa at Great North R	S	8°49'00"S 33°41'00"E	1220	40	1958	Yes	Fair	
1KA51A	Umrobo at Great North R	S	8°49'00"S 33°41'10"E	1120	55	1958	Yes	High	
1KA50A	Mswiswi at Wilima	S	8°46'00"S 33°46'50"E	1100	104	1964	Yes	Low	
1RC3A*	Mbaka at Mwaya	S	9°32'25"S 33°53'20"E	490	645	1961	Yes	High	
3A2A	Songwe at Iwe	SC	8°54'00"S 33°13'00"E	1130	763	1964	Yes	Fair	
3A6	Nzovwe at Great North R	S	8°56'00"S 33°25'00"E	1500	114	1955	Yes	Fair	
3A7A	Ruanda at Great North R	S	9°06'00"S 33°00'00"E	1570	50	1955	Yes	High	
3A15	Lupa at Itigi Road	S	8°27' S 33°25' E			1956	No		
1RD1A	Songwe at Kasumulu	RS	9°35'00"S 33°40'00"E	610	3.530		Yes	Fair	
3B13	Mpemba at Kombe	SC	8°59'00"S 32°38'00"E	1130	1.035	1974	Yes	Low	Established by WTP
3B14*	Muko at Kaziala	SC	9°08'20"S 32°38'30"E	1250	328	1974	Yes	Fair	Established by WTP
3B15A	Mtembwa at Lwasho	RSC	8°47'00"S 32°22'00"E	1375	8.000	1977	No		Established by WTP
3A18	Lupa at Lupatingatinga	S	8°00'20"S 33°15'45"E	1400		1975	Yes	Fair	Established by WTP
1RC10	Lufirio at Lufirio	RSC	9°18'00"S 33°54'00"E	1150		1974	No	High	Established by WTP
3A16A	Lupa at Lupa market	RSC	8°40'00"S 33°40'00"E	1000	1.250	1977	No		Established by WTP
1RC11	Rumakali at Lamange	SC	9°20'00"S 34°02'00"E	1980	414	1974	Yes	High	Established by WTP
3B2	Momba at Tontera	RSC	8°41'00"S 32°23'00"E	1100	1.055	1974	No		Established by WTP

Mbeya Region (*priority stations).

Table 5.2[8] - Cont'd.

Station Code	Station Name	Type of Station	Location	Altitude (m)	Catchm. Area (km^2)	Year establ.	Visited by CCKK	Reliability of Water Level Recs.	Remarks
1RC12A	Nyitule at Kidope	S	9°16'00"S 34°02'00"E	2440	109	1975	NO	High	Established by WTP
3B6	Saisi at Mombo	RSC	8°45'00"S 31°57'00"E		2782	1975	NO		Established by WTP
3DA4	Muise at Itajiri	SC	7°16'00"S 32°34'00"E	1370			NO		Established by WTP
3E8	Lukwate at Mkundo Hill	RSC	7°58'00"S 32°27'00"E	1070	955	1975	NO	High	Established by WTP
3A17	Songwe at Galula	SC	8°37'00"S 33°02'00"E	800	2587	1974	YES	Fair	Established by WTP
3E2	Kikamba at Kapalala	SC	8°03'00"S 32°38'00"E	1000	2080	1975	YES	High	Established by WTP
1RD2	Itumba at Kushisakwa	SC	9°25'00"S 33°11'00"E	1500	292	1974	NO	High	Established by WTP
3DA3*	Piti at Itigi Road Bridge	S	7°26'00"S 33°25'30"E	1450	800	1977	YES	High	Established by WTP
1RC2A	Kiwira at Kyela	RSC	9°37'00"S 33°52'00"E	480	1660	1966	YES	High	
1RC13	Lumbira at Lumbira	RSC	9°35'00"S 34°09'00"E	520	1414	1975	NO	High	Established by WTP
3D4*	Rungwa at Itigi Road	S	6°57'15"S 33°31'00"E	1220	3240	1976	YES	High	Established by WTP
3E1	Lwika at Gua Road	S	8°24'00"S 32°55'00"E	1050	1700	1957	YES	Fair	

Mbeya Region (*priority stations).

Table 5.2[8] - Cont'd.

National Drainage basin	Main river within basin	Main tributary	Station Number	Number of times moved	Number or letter Referring to
1					Indian Ocean Basin
3					Lake Rukwa Basin
3	A				Sira River Basin
3	B				Momba River Basin
3	D				Rungwa River Basin
3	D	A			Rungwa Tributaries
3	E				North East Lake Rukwa Basin
1	K				Rufiji River Basin
1	K	A			Great Ruaha River Basin
1	K	B			Kilombero River Basin
1	R				Lake Nyasa Basin
1	R	B			Ruhuhu River Basin
1	R	C			Kiwira, Mbaka, Lufirio and Lumbira River Basins
1	R	D			Songwe River Basin
1	Q				Ruvuma River Basin
			33		Station number
			33	A	Station moved once a short distance from old station
			33	B	Station moved twice a short distance from old station
1	K	A	33	A	A station of the Indian Ocean Basin, of the Rufiji and Great Ruaha basin. It is the 33rd station, and it has been moved once.

Table 5.3[8] - National station code by subdivision of National Drainage Basins.

Region: Iringa

River Name: Mtitu

Station Name: Mtitu at Mtitu

National Station Code: 1 KA 22

Code No.: 10

Latitude: 7^{o} 58' 50"

Longitude: 35^{o} 46' 50"

Altitude: 1680 m

Catchment Area: 445 km^2

Established: 1957.05.26

Observation Frequency: Twice daily

Period of Discharge Measurements: 1957.06.08 - to date

Range of Water Level: 0.44 - 3.43 m

Range of Discharge Measurements: 1.4 - 13.7 m^3/sec.

No. of Valid Discharge Measurements: 152

Range of Computed Discharges: 1.1 - 37.7 m^3/sec.

No. of Curves: One

Type: Formula

Curve Stability: Good

Extrapolation:

Description of Control: Rock bar across the channel

Control Stability: Stable

Description and Location of Installations: 0-2 m standard vertical staff gauges attached to angle iron on right bank 70 m from bridge. Portable traveller just upstream bridge. Old gauges 0'-7'.

Table 5.4[8] - Priority discharge gauging station.

Region: Iringa

River Name: Lukosi

Station Name: Lukosi at Mtandika

National Station Code: 1 KA 37 and 1 KA 37 A

Code No.: 21

Latitude: 7^{o} 37' 00"

Longitude: 36^{o} 25' 20"

Altitude: 760 m

Catchment Area: 2890 km^2

Established: April 1957 and 1959.11.25

Observation Frequency: Twice daily

Period of Discharge Measurements: 1957.04.25 - to date

Range of Water Level: 0.31 - 4.05 m

Range of Discharge Measurements: 10.0 - 117.1 m^3/sec.

No. of Valid Discharge Measurements: 17 and 144

Range of Computed discharges: 8.2 - 180.7 m^3

No. of Curves: One

Type: Formula

Curve Stability: Good

Extrapolation: Satisfactory

Description of Control: Rock bar across the channel

Control Stability: stable

Description and location of Installations: 0-5 m standard vertical staff gauges attached to angle iron on left bank 50 m upstream of bridge and 10 m downstream the automatic water level recorder house. Cableway traveller is further upstream. Old gauges 0-15'.

Table 5.5[8] - Priority discharge gauging station.

Region: Mbeya

River Name: Myovisi

Station Name: Myovisi at Great North Road

National Station Code: 3 A 8

Code No.: 47

Latitude: 8^{o} 58' 20"

Longitude: 33^{o} 03' 55"

Altitude: 1525 m

Catchment Area: 152 km^2

Established: 1955.09.30

Observation Frequency: Twice daily

Period of Discharge Measurements: 1955.10.14 - to date

Range of Water Level: 0.01 - 2.31 m

Range of Discharge Measurements: 0.3 - 16.9 m^3/sec.

No. of Valid Discharge Measurements: 174

Range of Computed Discharges: 0.2 - 39.0 m^3/sec.

No. of Curves: One

Type: Formula

Curve Stability: Reasonable

Extrapolation: Satisfactory

Description of Control: Artificial control between bridge abutments

Control Stability: stable

Description and Location of Installations: 0-3 m standard vertical staff gauges attached to angle iron on left bank, just upstream the bridge.

Table 5.6[8] - Priority discharge gauging station.

Region: Mbeya

River Name: Kiwira

Station Name: Kiwira at Kiwira Village

National Station Code: 1 RC 5 and 1 RC 5 A

Code No.: 64

Latitude: 9^{o} 10' 15"

Longitude: 33^{o} 31' 55"

Altitude: 1360 m

Catchment Area: 217 km^2

Established: 1957.03.02 and 1970.12.27

Observation Frequency: Twice daily

Period of Discharge Measurements: 1957.03.02 - to date

Range of Water Level: 0.03 - 1.48 m

Range of Discharge Measurements: 2.1 - 14.4 m^3/sec.

No. of Valid Discharge Measurements: 57 and 32

Range of Computed Discharges: 2.0 - 49.1 m^3/sec.

No. of Curves: One

Type: Formula

Curve Stability: Good

Extrapolation:

Description of Control: Rock bar jut upstream the waterfall

Control Stability: stable

Description and Location of Installations: 0.2 m standard vertical staff gauges attached to angle iron. The cableway is just upstream the staff gauges.

Table 5.7[8] - Priority discharge gauging station.

Region: Iringa

River Name: Hagafiro

Station Name: Hagafiro at Hagafiro

National Station Code: 1 KB 19

Code No.: 68

Latitude: 9^{o} 23' 55"

Longitude: 34^{o} 49' 00"

Altitude: 1935 m

Catchment Area: 153 km^2

Established: 1960.12.19

Observation Frequency: Twice daily

Period of Discharge Measurements: 1960.12.19 - to date

Range of Water Level: 0.36 - 3.01 m

Range of Discharge Measurements: 0.6 - 18.8 m^3/sec.

No. of Valid Discharge Measurements: 91

Range of Computed Discharges: 0.5 - 53.7 m^3/sec.

No. of Curves: One

Type: Formula

Curve Stability: Fair

Extrapolation: Reasonable

Description of Control: Rock bar across the channel at the waterfall

Control Stability: stable

Description and Location of Installations: 0-3 m standard vertical staff gauges attached to angle iron on the left bank just upstream the bridge. The portable traveller posts are just upstream the staff gauges.

Table 5.8[8] - Priority discharge measuring stations

Region: Mbeya

River Name: Chimala

Staiton Name: Chimala at Chitekelo

National Station Code: 1 KA 7 and 1 KA 7 A

Code No.: 100

Latitude: 8^{o} 55' 15"

Longitude: 33^{o} 58' 30"

Altitude: 1890 m

Catchment Area: 167 km^2

Established: November 1954 and 1963.01.01

Observation Frequency: Twice daily

Period of Discharge Measurements: 1954.08.29 - to date

Range of Water Level: 0.05 - 1.53 m

Range of Discharge Measurements: 0.5 - 24.6 m^3/sec.

No. of Valid Discharge measurements: 62 and 122

Range of Computed Discharges: 0.2 - 41.1 m^3/sec.

No. of Curves: One

Type: Formula

Curve Stability: Reasonable for medium and high stages.

Extrapolation: Satisfactory for high stages.

Description of Control: Rock bar across the channel at the waterfall

Control Stability: stable

Description and Location of Installations: 0-3 m standard vertical staff gauges attached to angle iron on the right bank downstream the bridge. Automatic water level recorder is situated just upstream the staff gauges. Old gauges 0-20'.

Table 5.9[8] - Priority discharge gauging station.

Region: Iringa

River Name: Huhuni

Station Name: Huhuni at Iyayi

National Station Code: 1 KA 23 and 1 KA 23 A

Code No.: 104

Latitude: 8^{o} 51' 25"

Longitude: 34^{o} 41' 15"

Altitude: 1370 m

Catchment Area: 803 km^2

Established: Dec. 1956 and 1963.07.01

Observation Frequency: Twice daily

Period of Discharge Measurements: 1959.01.22 - to date

Range of Water Level: 0.0 - 2.39 m

Range of Discharge Measurements: 0.02 - 11.6 m^3/sec.

No. of Valid Discharge Measurements: 26 and 93

Range og Computed Discharges: 0 - 73.1 m^3/sec.

No. of Curves: One

Type: Formula

Curve Stability: Reasonable

Description of Control: Rock bars across the channel

Control Stability: stable

Description and Location of Installations: 0-3 m standard vertical staff gauges attached to angle iron on the left bank of the river, 160 m upstream the road bridge. Old gauges 0-10'.

Table 5.10[8] - Priority discharge measurements at Iringa.

Region: Iringa

River Name: Little Ruaha

Station Name: Little Ruaha at Makalala

National Station Code: 1 KA 32 and 1 KA 32 A

Code No.: 107

Latitude: 8^{o} 22' 05"

Longitude: 35^{o} 19' 45"

Altitude: 1650 m

Catchment Area: 759 km^2

Established: 1957.06.26 and 1964.12.14

Observation Frequency: Twice daily

Period of Discharge Measurements: 1964.12.15 - to date

Range of Water Level: 0.08 - 3.91 m

Range of Discharge Measurements: 0.4 - 15.2 m^3/sec.

No. of Valid Discharge Measurements: 31 and 95

Range of Computed Discharges: 0.2 - 22.3 m^3/sec.

No. of Curves: One curve with two segments

Type: Formula

Curve Stability: Good

Extrapolation: Satisfactory

Description of Control: Rock bar across the channel and the bridge abutments for high stages.

Control Stability: stable

Description and Location of Installations: 0-3 m standard vertical staff gauges attached to angle iron on the left bank of the river just upstream the bridge. Old gauges 0-15'.

Table 5.11[8] - Priority discharge gauging station.

Region: Mbeya

River Name: Mbaka

Station Name: Mbaka at Mwaya

National Station Code: 1 RC 3 and 1 RC 3 A

Code No.: 124

Latitude: 9^{o} 32' 25"

Longitude: 33^{o} 53' 20"

Altitude: 490 m

Catchment Area: 645 km^2

Established: 1956.10.24 and 1961.02.10

Observation Frequency: Twice daily

Period of Discharge Measurements: 1956.10.24 - to date

Range of Water Level: 0.26 - 5.99 m

Range of Discharge Measurements: 4.0 - 138.0 m^3/sec.

No. of Valid Discharge Measurements: 46 - 183

Range of Computed Discharges: 1.3 - 172.0 m^3/sec.

No. of Curves: One curve with three segments

Type: Formula

Curve Stability: Good

Extrapolation: Doubtful for high stages

Description of Control: Fallen bridge abutments for low stages, and the new bridge for medium and high stages.

Control Stability: Fair

Description and Location of Installations: 0-6 m standard vertical staff gauges attached to angle iron on the right bank of the river immediately upstream the bridge.

Table 5.12[8] - Priority discharge gauging station.

Region: Mbeya

River Name: Muko

Station Name: Muko at Kaziala

National Station Code: 3 B 14

Code No.: 179

Latitude: 9^{o} 08' 20"

Longitude: 32^{o} 38' 30"

Altitude: 1250 m

Catchment Area: 328 km^2

Established: 1974.11.22

Observation Frequency: Twice daily

Period of Discharge Measurements: 1979.01.01 - to date

Range of Water Level: 0.22 - 3.06 m

Range of Discharge Measurements: 0.002 - 109.6 m^3/sec.

No. of Valid Discharge Measurements: 46

Range of Computed Discharges: 0 - 161.6 m^3/sec.

No. of Curves: One

Type: Formula

Curve Stability: Reasonable

Extrapolation: Satisfactory

Description of Control: Rock bar across the river

Control Stability: stable

Description and Location of Installations: 0-4 m standard vertical staff gauges attached to angle iron on the right bank of the river, upstream the cableway.

Table 5.13[8] - Priority discharge gauging station.

Region: Ruvuma

River Name: Likonde

Station Name: Likonde at Ligowonga

National Station Code: 1 Q 10

Code No.: 227

Latitude: 11^{o} 06'

Longitude: 35^{o} 51'

Altitude: 650 m

Catchment Area: 1442 km^2

Established: 1971.11.09

Observation Frequency: Three times daily

Period of Discharge Measurements: 1972.05.04 - to date

Range of Water Level: 0.30 - 4.04 m

Range of Discharge Measurements: 3.5 - 11.4 m^3/sec.

No. of Valid Discharge Measurements: 20

Range of Computed discharges: 0.5 - 219.0 m^3/sec.

No. of Curves: One

Type: Formula

Extrapolation:

Description of Control: Rock bar across the channel

Control Stability: stable

Description and Location of Installation: 0-5 m standard vertical staff gauges attached to angle iron on the left bank of the river downstream the cableway.

Table 5.14[8] - Priority discharge gauging station.

Region: Ruvuma

River Name: Ruhuhu

Station Name: Ruhuhu at Masigira

National Station Code: 1 RB 2

Code No.: 228

Latitude: 9^{o} 56' 30"

Longitude: 35^{o} 11' 30"

Altitude: 920 m

Catchment Area: 2220 km^2

Established: 1971.11.28

Observation Frequency: Three times daily

Period of Discharge Measurements: 1976.03.13 - to date

Range of Water level: 0.76 - 2.60 m

Range of Discharge Measurements: 23.9 - 104.5 m^3/sec.

No. of Valid Discharge Measurements: 70

Range of Computed Discharges: 14.6 - 201.5 m^3/sec.

No. of Curves: One

Type: Formula

Curve Stability: Fair

Extrapolation: Acceptable

Description of Control: Rock bar across the channel

Control Stability: stable

Description and Location of Installations: 0-4 m standard vertical staff gauges attached to angle iron on the left bank of the river downstream the measuring section. The automatic water level recorder is situated just downstream the gauges.

Table 5.15[8] - Priority discharge gauging station.

Region: Ruvuma

River Name: Mwinamaji

Station Name: Mwinamaji at Road Bridge

National Station Code: 1 RB 10

Code No.: 243

Latitude: 10° 32' 30"

Longitude: 34° 58' 00"

Altitude: 870 m

Catchment Area: 544 km^2

Established 1975.07.03

Observation Frequency: Dry season twice daily, wet season three times daily

Period of Discharge Measurements: 1975.07.03 - to date

Range of Water Level: 0.54 - 4.54 m

Range of Discharge Measurements: 0.5 - 53.6 m^3/sec.

No. of Valid Discharge Measurements: 56

Range of Computed Discharges: 0.4 - 84.2 m^3/sec.

No. of Curves: One curve with two segments

Type: Formula

Curve Stability: Fair

Extrapolation: Not required at present

Description of Control: Channel control low stages and bri abutments for medium and high stages

Control Stability: Channel control is shifting, abutments are stable

Description and Location of Installations: Standard vertical staff gauges on the left bank of the river, 0-1 m hammered into riverbed, 1-5 m set in concrete, downstream the cableway.

Table 5.16[8] - Priority discharge gauging station.

Region: Ruvuma

River Name: Hanga

Station Name: Hanga at Road Bridge

National Station Code: 1 RB 11

Code No.: 248

Latitude: 10^{o} 10' 00"

Longitude: 35^{o} 39' 30"

Altitude: 780 m

Catchment Area: 1400 km^2

Established: 1976.06.25

Observation Frequency: Twice daily

Period of Discharge Measurements: 1976.09.02 - to date

Range of Water Level: 1.40 - 8.14 m

Range of Discharge Measurements: 3.2 - 208.9 m^3/sec.

No. of valid discharge measurements: 49

Range of Computed Discharges: 2.4 - 419.5 m^3/sec.

No. of Curves: One curve with two segments

Type: Formula

Curve Stability: Fair

Extrapolation: Satisfactory

Description of Control: Channel control for low stages bridge abutments for medium and high stages.

Control Stability: Channel control is shifting, abutments are stable

Description and Location of Installations: 0-7 m standard vertical staff gauges attached to angle iron on the left bank of the river upstream the bridge and the cableway.

Table 5.17[8] - Priority discharge [illegible]

Region: Ruvuma

River Name: Mngaka

Station Name: Mngaka at Road Bridge

National Station Code: 1 RB 6

Code No.: 292

Latitude: 10^{o} 33' 30"

Longitude: 35^{o} 00' 01"

Altitude: 800 m

Catchment Area: 688 km^2

Established: 1976.07.04

Observation Frequency: Dry season twice daily, wet season three times daily

Period of Discharge Measurements: 1976.05.08 - to date

Range of Water Level: 1.02 - 4.89 m

Range of Discharge Measurements: 4.7 - 78.5 m^3/sec.

No. of Valid Discharge Measurements: 60

Range of Computed Discharges: 1.9 - 133.8 m^3/sec.

No. of Curves: One

Type: Formula

Curve Stability: Reasonable

Extrapolation: Not required at present

Description of Control: Rock bar across the channel

Control Stability: stable

Description and Location of Installations: Standard vertical staff gauges 1-2 m hammered into riverbed 2-7 m set in concrete just upstream the bridge on the left bank of the river, upstream the cableway.

Table 5.18[8] - Priority discharge gauging station.

Region: Iringa

River Name: Ruhudji

Station Name: Ruhudji at Kifunga Falls

National Station Code: 1 KB 18 B

Code No.: 294

Latitude: 9^{o} 17' 35"

Longitude: 34^{o} 50' 10"

Altitude: 1845 m

Catchment Area: 410 km^2

Established: 1976.01.05

Observation Frequency: Twice daily

Period of Discharge Measurements: 1976.01.05 - to date

Range of Water Level: 0.69 - 2.04 m

Range of Discharge Measurements: 2.3 - 30.1 m^3/sec.

No. of Valid Discharge Measurements: 57

Range of Computed Discharges: 1.3 - 34.6 m^3/sec.

No. of Curves: One

Type: Formula

Curve Stability: Reasonable

Extrapolation: Satisfactory

Description of Control: Rock bar across the channel

Control Stability: stable

Description and Location of Installations: 0-3 m standard vertical staff gauges on the left bank of the river 5 m upstream the portable traveller posts.

Table 5.19 - Printout

Region: Mbeya

River Name: Piti

Station Name: Piti at Itigi Road Bridge

National Station Code: 3 DA 3

Code No.: 333

Latitude: 7^{o} 26' 00"

Longitude: 33^{o} 25' 30"

Altitude: 1450 m

Catchment Area: 800 km^2

Established: 1977.01.09

Observation Frequency: Twice daily

Period of Discharge Measurements: 1977.02.12 - to date

Range of Water Level: 0.0 - 1.98 m

Range of Discharge Measurements: 0.08 - 5.7 m^3/sec.

No. of Valid Discharge Measurements: 32

Range of Computed Discharges: 0 - 10.9 m^3/sec.

No. of Curves: One

Type: Formula

Curve Stability: Reasonable

Extrapolation:

Description of Control: Rock bar across the river

Control Stability: stable

Description and Location of Installations: 0-2 m standard vertical staff gauges attached to angle iron on the right bank of the river just upstream the bridge.

Table 5.20[8] - Priority discharge gauging station.

Region: Mbeya

River Name: Rungwa

Station Name: Rungwa at Itigi Road Bridge

National Station Code: 3 D 4

Code No.: 544

Latitude: 6^{o} 07' 15"

Longitude: 33^{o} 31' 00"

Altitude: 1220 m

Catchment area: 3240 km^2

Established: 1976.07.29

Observation Frequency: Twice daily

Period of Discharge Measurements: 1977.01.11 - to date

Range of Water Level: 0.0 - 3.99 m

Range of Discharge Measurements: 0.2 - 40.6 m^3/sec.

No. of Valid Discharge Measurements: 69

Range of Computed Discharges: 0 - 41.4 m^3/sec.

No. of Curves: One curve with two segments

Type: Formula

Curve Stability: Fair

Extrapolation: Satisfactory

Description of Control: Channel control for low stages and bridge abutments for medium and high stages.

Control Stability: Channel control is shifting, abutments are stable

Description and Location of Installations: 0-5 m standard vertical staff gauges attached to angle iron on the right bank of the river just upstream the bridge.

Table 5.21[8] - Priority discharge gauging station.

Region: Mbeya

River Name: Luika

Station Name: Luika at Gua Road Bridge

National Station Code: 3 E 1

Code No.: 953

Latitude: 8^{o} 24'

Longitude: 32^{o} 55'

Altitude: 1050 m

Catchment Area: 1700 km^2

Established: 1957.02.22

Observation Frequency: Twice daily

Period of Discharge Measurements: 957.02.22 - to date

Range of Water Level: - 0.50 - 3.98 m

Range of Discharge Measurements: 0.02 - 141.5 m^3sec.

No. of Valid Discharge Measurements: 111

Range of Computed Discharges: 0 - 304.4 m^3/sec.

No. of Curves: One curve with two segments

Type: Formula

Curve Stability: Fair

Extrapolation:

Description of Control: Rock bar across the channel for low and medium stages, bridge abutments for high stages.

Control Stability: stable

Description and Location of Installations: - 0.5 - 4 m standard vertical staff gauges attached to angle iron on the right bank of the river just upstream the bridge.

Table 5.22[8] - Priority discharge gauging station.

IRINGA

NAME	CODE	YEAR OF REGISTRATION	NO. OF SAMPLES
Little Ruaha Ndiuka	1KA2A	1970,71,72,75	9
Great Ruaha Mtera	1KA5	1956,57,58,59,60, 71,72,73,74,75	229
Ndembera Ilongo	1KA15A	1956,57,58,70,71	36
Little Ruaha Ihimbo	1KA21A	1958,59,70,71,72,75	83
Mtitu Mtitu	1KA22	1970,71,75	4
Huhuni Iyayi	1KA23A	1971,72,76	13
Njombe Ifumba	1KA29	1958	17
Little Ruaha Mawande	1KA31A	1970,71,73	34
Little Ruaha Makalala	1KA32A	1971	4
Lukosi Mtandika	1KA37A	1957,58,59,70,71, 72,74,75	17
Little Ruaha Iwawa	1KA39A	1970,71,75	11
Ruaha Malangali	1KA56	1971	5
Great Ruaha Msembe	1KA59	1970,71,74,75	227
Kigogo Ruaha Ficks Br.	1KB6	1958,59	57

Table 5.258 Sediment Data Availability, (cont.)

RUVUMA

NAME	CODE	YEAR OF REGISTRATION	NO. OF SAMPLES
Ruhuhu Masigira	1RB2	1976	40
Kitewaka Maboga	1RB9	1976	19
Ruvuma Muhiga	1Q7	1972	24
Likonde Ligowonga	1Q10	1972	7
Msinjewe Mtwara	1Q11	1973,74	32

Table 5.25[6] Sediment Data Availability.

MBEYA

NAME	CODE	YEAR OF OBSERVATION	NO. OF SAMPLES
Chimala Chiteleko	1KA7A	1970,71,74,76	5
Great Ruaha Salimwani	1KA8A	1970,71,72,73,74,76	14
Kimani G. N. Road	1KA9	1957,58,59,71,73,76	90
Mlomboji Mlomboji	1KA10A	1971,74,76	3
Liosi Igurusi	1KA16	1974,76	2
Mbarali Rujowa F.	1KA19	1958,59	35
Great Ruaha Mkupule	1KA27	1971,72,73	15
Ndembera Madibira	1KA33A	1970	1
Ipatagwa G. N. Road	1KA45A	1971,74	2
Mswiswi Willema	1KA50A	1971,74	2
Umrobo G. B. Road	1KA51A	1970,71,74	3
Kiwira Kyela	1RC2A	1970,71,72	4
Mbaka Mwaya	1RC3A	1969,70,71,72,73	11
Kiwira Natural Br.	1RC8	1970,71,72	6
Songwe Iwe	3A2A	1970,71,72,74,76	26
Mbalizi G. N. Road	3A4	1970,72,74,76	12

Table 5.25[8] Sediment Data Availability, (cont.)

MBEYA

NAME	CODE	YEAR OF REGISTRATION	NO. OF SAMPLES
Nzovwe G. N. Road	3A6	1970,72,73,76	7
Ruanda G. N. Road	3A7A	1970,72	2
Myovisi G. N. Road	3A8	1970,72,76	6
Mlowo G. N. Road	3A14A	1970,71,72,73	10
Lupa Itigi	3A15	1970,71	5
Lupa Lupa Market	3A16	1972,74	8
Songwe Galula	3A17	1976	11
Mpemba G. N. Road	3B8	1971,72,76	7

Table 5.25[8] Sediment Data Availability, (Cont.)

Station Code	Rating Curve Q_s = Tonnes/day	Limits	Validity
1KA5	$Q_s = 0.49 \times 10^{-1} Q_w^{1.794}$	25.0 $m^3/s < Q_w < 50.0$ m^3/s	17/3-1971 - 31/5-1971
	$Q_s = 0.85 Q_w^{0.813}$	50.0 $m^3/s < Q_w < 60.0$ m^3/s	1/6-1971 - 27/5-1975
1KA37A	$Q_s = 0.77 \times 10^{-5} Q_w^{4.282}$	10.0 $m^3/s < Q_w < 60.1$ m^3/s	29/5-1970 - 23/4-1974
1KA15A	$Q_s = 0.263\ Q_w^{0.979}$	10.0 $m^3/s < Q_w < 100.0$ m^3/s	10/12-1956 - 20/10-1971
3A4	$Q_s = 0.796\ Q_w^{1.696}$	0.1 $m^3/s < Q_w 2.5$ m^3/s	17/1-1970 - 5/5-1974
3A14A	$Q_s = 0.286\ Q_w^{1.669}$	0.5 $m^3/s < Q_w < 25.0$ m^3/s	19/6-1970 - 19/11-1973
1RC3A	$Q_s = 0.132\ Q_w^{1.567}$	3.0 $m^3/s < Q_w < 300.0$ m^3/s	10/12-1969 - 19/4-1976
3A2A	$Q_s = 3.07\ Q_w^{0.919}$	0.1 $m^3/s < Q_w < 35.0$ m^3/s	13/6-1970 - 11/10-1970
	$Q_s = 0.418 Q_w^{1.05}$	0.3 $m^3/s < Q_w < 40.0$ m^3/s	12/10-1970 - 2/6-1974
3A16A	$Q_s = 0.253\ Q_w^{1.271}$	1.0 $m^3/s < Q_w < 20.0$ m^3/s	15/12-1972 - 2/6-1974
3E1	$Q_s = 0.648\ Q_w^{1.884}$	0.1 $m^3/s < Q_w < 25.0$ m^3/s	13/3-1971 - 31/5-1971

Table 5.26[8] - Sediment rating curves.

Number	Estimated Flow L/S	Estimated Catchment Area km^2	Yield L/S/km^2	Date
7501	165.0	64.6	2.6	09.09.80
7502	4.2	1.0	4.2	06.08.80
7503	2.0	1.0	2.0	01.08.80
7504	19.5	3.7	5.3	03.07.80
7505	25.0	10.2	2.5	30.07.80
7601	85.0	37.3	2.3	20.08.80
7602	66.5	9.9	6.7	30.06.80
7603	236.0	18.5	12.7	01.07.80
7604	413.0	81.1	5.1	11.08.80
7605	90.0	159.3	0.6	25.08.80
8201	50.0	23.6	2.1	19.09.80
8301	165.0	22.4	7.3	10.10.80
8302	60.4	5.7	10.6	01.08.80
8303	43.7	42.8	1.0	09.10.80
8304	33.0	13.9	2.4	23.12.80
8305	16.8	13.6	1.2	21.07.80
8306	190.0	40.0	4.8	26.12.80
8307	5.0	4.1	1.2	08.07.80
8308	50.0	22.1	2.3	27.11.80
8309	10.0	4.0	2.5	28.11.80
8310	7.0	1.6	4.4	27.11.80
8311	23.9	3.2	7.5	26.12.80
8312	46.3	33.4	1.4	14.10.80
8313	336.0	177.3	1.9	16.10.80
8314	4.0	1.2	3.4	26.12.80
8315	1358.0	339.8	4.0	09.09.80
8316	41.3	5.2	5.1	13.05.80
8317	8.0	1.4	5.7	28.11.80
8318	14.0	23.9	0.6	27.11.80
8319	42.0	76.6	0.5	07.10.80
8401	274.0		<0.1	05.12.80
8501	24.0	12.5	1.9	15.12.80
8502	120.0	11.7	10.3	17.12.80
8503	48.0	3.2	14.8	15.12.80
8504	270.0	7.2	37.3	17.12.80
8505	48.0	3.7	12.8	16.12.80
8506	6.0	1.0	6.0	16.12.80
8507	67.0	4.7	14.2	21.07.80
8508	4.0	0.5	8.0	21.07.80
8509	20.0	1.2	16.7	21.07.80
8510	9.6	2.7	3.6	14.10.80
8511	5.6	1.0	5.6	14.10.80
8512	12.0	1.3	9.2	15.10.80
8513	5.6	0.7	8.0	13.10.80
8514	15.7	2.5	6.3	03.06.80
8515	15.0	1.6	10.0	25.07.80
8516	78.0	22.1	3.5	25.07.80
8517	8.0	2.4	3.3	30.06.80

Table 5.27[8] Stream gaugings (cf. Map Box 3-VIII).

Number	Estimated Flow L/S	Estimated Catchment Area	Yield L/S/km^2	Date
9201	66.3	11.8	5.7	23.10.80
9202	100.0	7.8	12.8	24.10.80
9203	6.5	2.5	2.7	23.10.80
9204	43.2	2.5	17.6	22.10.80
9205	15.0	8.4	1.8	03.10.80
9206	5.1	11.8	0.4	25.09.80
9207	119.0	73.7	1.6	11.07.80
9301	12.5	1.4	8.9	27.06.80
9302	450.0	9.3	48.4	18.06.80
9303	2544.0	51.0	49.9	19.06.80
9304	191.3	3.3	58.0	13.06.80
9305	7.0	0.9	7.8	12.06.80
9306	170.0	1.5	113.3	19.06.80
9307	84.0	8.6	9.8	12.06.80
9308	10.2	6.0	1.7	26.08.80
9309	48.8	34.4	1.4	26.08.80
9310	12.7	3.3	3.9	26.08.80
9311	216.3	18.3	11.8	26.08.80
9312	288.0	24.8	11.6	24.07.80
9313	33.6	3.8	8.8	29.07.80
9314	14.0	1.5	9.3	24.07.80
9315	87.5	3.8	23.0	22.07.80
9316	98.0	7.4	13.2	26.08.80
9317	46.1	1.2	38.5	26.08.80
9318	43.8	0.8	54.8	26.08.80
9319	11.9	7.8	1.5	08.12.80
9320	9.8	1.6	6.1	30.07.80
9321	48.0	3.6	13.5	25.09.80
9322	50.0	2.2	22.9	09.09.80
9323	77.0	3.1	24.5	11.12.80
9324	632.0	14.7	43.0	05.09.80
9325	727.0	16.4	44.4	05.09.80
9326	755.0	13.9	54.3	09.09.80
9327	202.2	8.9	22.7	16.12.80
9328	196.0	10.0	19.6	01.08.80
9329	291.0	17.4	16.7	10.10.80
9330	8.3	1.2	6.9	22.09.80
9331	16.8	1.0	16.8	21.01.81
9332	150.0	7.5	20.0	02.10.80
9333	250.0	29.7	8.4	30.09.80
9334	610.0	28.8	21.2	20.01.80
9335	39.0	0.7	55.9	18.10.80
9336	1300.0	53.2	24.4	22.10.80
9337	198.0	9.0	22.0	18.06.80
9338	11.2	5.2	2.1	23.10.80
9339	1.2	0.8	1.5	22.10.80
9340	75.5	14.4	5.3	04.06.80
9341	32.0	46.5	0.7	20.11.80
9342	1.5	2.9	0.5	19.08.80
9343	159.0	20.3	7.8	10.12.80
9344	10.0	10.5	1.0	22.07.80
9345	1175.0	117.5	10.0	16.12.80

Table 5.27 [8] cont.

Number	Estimated Flow L/S	Estimated Catchment Area km²	Yield L/S/km²	Date
9346	140.0	2.8	50.0	16.12.80
9347	484.4	18.1	26.8	19.06.80
9401	20.0	2.8	7.1	24.10.80
9402	20.0	2.0	10.0	04.11.80
9403	48.0	2.0	24.0	06.11.80
9404	28.0	1.8	16.0	04.11.80
9405	40.0	4.0	10.0	08.09.80
9406	3.0	0.8	3.8	04.12.80
9407	50.0	14.2	3.5	25.09.80
9408	5.0	0.4	12.5	03.09.80
9409	12.0	1.5	8.0	24.09.80
9410	24.0	1.5	16.0	10.09.80
9411	20.0	2.1	9.7	10.09.80
9412	12.0	1.5	8.0	25.09.80
9413	590.0	95.6	6.2	08.09.80
9414	70.0	7.7	9.1	22.09.80
9415	8.0	0.4	20.0	10.09.80
9416	26.4	2.5	10.6	04.11.80
9417	5.6	0.5	11.2	23.09.80
9418	20.0	1.3	16.0	06.11.80
9419	24.0	2.3	10.7	06.11.80
9420	4.0	1.4	2.9	04.12.80
9501	40.0	2.4	16.9	06.09.80
9502	20.0	1.4	14.6	05.09.80
9503	30.0	2.1	14.6	05.09.80
9504	15.2	1.0	15.2	23.10.80
9505	17.6	1.4	12.6	23.10.80
9506	2.4	0.3	8.0	24.09.80
9507	80.0	11.9	6.7	08.09.80
9508	350.0	4.5	78.0	04.09.80
9509	12.8	0.4	32.0	23.10.80
9510	11.2	0.8	14.9	22.10.80
9511	12.0	1.7	7.1	22.10.80
9512	36.0	1.8	20.5	04.09.80
9513	9.6	1.0	9.6	24.09.80
10401	3.2	1.0	3.2	18.11.80
10402	2.5	0.5	5.0	22.10.80
10403	56.0	2.0	28.0	22.10.80
10404	30.0	48.5	0.6	28.10.80
10405	80.0	9.4	8.5	01.12.80
10406	4.0	1.0	4.0	29.11.80
10407	2.0	1.0	2.0	28.11.80
10501	3.0	0.3	9.8	24.11.80
10502	4.0	0.2	20.0	24.11.80
10503	8.0	5.4	1.5	24.11.80
10504	8.0	1.5	5.4	23.11.80
10505	8.0	1.0	8.0	23.11.80
10506	5.0	1.5	3.3	05.11.80
10507	6.0	1.7	3.6	07.01.81

Table 5.27 8 cont.

Number	Estimated Flow L/S	Estimated Catchment Area	Yield L/S/km^2	Date
10508	4.0	1.4	3.5	25.11.80
10509	4.0	1.0	4.0	8:01.81
10510	8.0	14.3	0.6	7.11.80
10511	26.0	1.0	26.0	7.11.80
10512	28.0	12.3	2.3	13.10.80
1001	3.0	3.6	0.8	21.11.80
11401	15.0	0.7	21.0	2.12.80
11501	2.5	2.8	0.9	19.11.80

Table 5.27[8] cont.

Introduction

This working paper describes the main features of the programme package developed by DHI (Danish Hydraulic Institute) in cooperation with CCKK. The package is designed to deal with water level data, rating curve data and discharge data and corresponds to the techniques utilized by Maji.

Furthermore, the format and the management of the data allows a direct transfer to tapes compatible with the ICL-computer available to Maji at present.

As a part of the hydrologic investigations, to be carried out on the TWMP, the acquisition and analysis of hydrologic variables play an important role. In order to plan and execute this work as smooth as possible, a compact and easy accessible data base for the storage of hydrological data must be available. Such a data base has been designed at Maji-Ubungo, and contains today water level and discharge observations on daily basis for 55 stations over an average period of 16 years. Rating curves and tables - transfering water level to discharge values - are stored as well. The future maintenance of the data base will involve three different tasks, i.e. correction of existing data, extension of the number of stations included to 85, and finally updating of all records to 1980.

DHI has developed a series of interactive programs to serve these purposes. The programs have been constructed in order to utilize the system options of the NEUCC - IBM 3033 computer as much as possible, which implies that most of the work concerning correction and extension of data is controlled by the system editor and the operator during the execution of the programs. The possibility of false information needed to access a specific area in the base (a certain gauge-station in a certain period), is minimized in this way. The process of accessing and editing the data for a specific station in a specific period is done stepwise - the program continues posing questions to the operator until the entire data area is fully determined - and hereafter the data are displayed on ther terminal screen and the operator is allowed to do his corrections, simply by moving the cursor to the observations or parameters in question, By terminating the corrections, the modified data is copied into the data base on the right location.

In order to illustrate how the programs actually operate, an example of the process involved in correcting an existing rating curve is shown. We wish to correct the rating curve for station No. 9 with the validity period 21/11/1967-27/7/1971: The units are wrong and the parameters for curve No. 2 have been revised. Finally a third curve has been added, and should be included on the data base as well. The messages and questions from the program have been framed.

```
INPUT OF PARAMETERS FOR OPDATING
RCS DATA TYPE CODE NUMBER OF
STATION TO BE OPDATED
```

9

```
SELECT UPDATING-PROCEDURE 1 OR 2
1)  INSERTION OF NEW RATING
2)  CORRECTION OF EXISTING RATING
```

2

```
TYPE FIRST DAY OF VALIDITY-PERIOD
DAY, MONTH, YEAR
```

1967.11.21

The data field so specified is now being located on the rating curve file (Maji-structure maintained) and subsequently copied in a translated form to a temporaty file. This file is then assigned to the system editor, where it is displayed like this:

```
********************* TOP OF DATA ********************************
RATING CURVE
STATION CODE NUMBER:    9
VALIDITY PERIODE: 21/11 - 1967 TO 27/ 7   1971

CURVE FORMULATION  Q=G(H - H0)**N

NUMBER OF CURVES:   2
UNITS:  2   1=ALL ENGLISH   2=MWL/ENG,RC/MET   3=ALL MET   4=MWL/MET,RC/ENG

    CURVE NO      G      H0      N      LIMIT

         1      2.155   0.0    3.429     1.70
         2      4.241   0.0    2.145     ....
********************* BOTTOM OF DATA *****************************
```

The operator is now free to do the corrections: All possible corrections are allowed, new curves can be included after the two existing already, validity period can be changed etc. In the following example, however, the rating is modified to:

```
RATING CURVE
STATION CODE NUMBER:    9
VALIDITY PERIODE: 21/11 - 1967 TO 27/ 7 - 1971

CURVE FORMULATION: Q=C(H + HO)**N

NUMBER OF CURVES:  3
UNITS: 2  1=ALL ENGLISH  2=MWL/ENG,RC/MET  3=ALL MET  4=MWL/MET,RC/ENG

   CURVE NO      C       HO      N       LIMIT

        1      2.150    0.0    3.409     1.70
        2      3.251    0.2    1.951     9.00
        3      4.241    0.4    1.350    11.50
********************** BOTTOM OF DATA **********************************
```

The operator now terminates the editing phase by issuing a specific command, reassigning the execution control to the main program, which merges the corrected curve into the data base. The process is completed.

The program for updating the mean water level base has a similar structure. Whenever the rating or water level data has been updated, the discharge base has to be updated as well. For this purpose a third program has been developed, requiring data for station code and years to be updated only, the program locates and combines values of rating and water level automatically and stores the updated records in the base.

Summary

Programs to maintain the TWMP hydrological data base have been developed. For each hydrologic variable - water level, rating and discharge - a set of two programs have been constructed, one to opdata the series of records, and one to list the content of the base for a specified number of stations in a specified period. In Annex A of this note, examples of listings of variables are attached.

Examples of Data Layouts
for Station 1KA 21A

NATIONAL STATION CODE 1KA21A
STATION CODE NO 9

STAGE OBSERVATIONS (M OR FT)
YEAR 1972

RIVER LT KWAHA
LOCATION IHIMBU
REGION IRINGA

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1.59	1.76	2.07	3.11	2.16	1.90	1.62	1.51	1.32	1.32	1.27	1.48
2	1.62	1.73	2.04	2.90	2.15	1.88	1.62	1.50	1.32	1.32	1.24	1.50
3	1.78	1.74	2.02	2.85	2.10	1.86	1.62	1.49	1.32	1.32	1.25	1.54
4	1.97	1.78	2.10	2.74	2.10	1.84	1.62	1.48	1.32	1.32	1.25	1.62
5	2.04	1.98	2.35	2.64	2.10	1.82	1.63	1.48	1.32	1.32	1.26	1.76
6	1.81	2.21	2.62	2.61	2.12	1.82	1.62	1.48	1.31	1.33	1.28	1.80
7	1.78	2.82	2.50	2.28	2.10	1.80	1.62	1.48	1.33	1.32	1.25	1.80
8	2.65	2.80	2.37	2.67	2.07	1.78	1.63	1.47	1.39	1.30	1.24	1.94
9	2.38	2.88	2.38	2.65	2.07	1.78	1.62	1.46	1.47	1.29	1.24	1.77
10	2.29	1.87	2.40	2.64	2.06	1.77	1.61	1.46	1.49	1.27	1.28	1.60
11	2.09	1.88	2.59	2.58	2.07	1.76	1.60	1.45	1.46	1.25	1.32	1.59
12	2.15	1.88	2.78	2.53	2.06	1.76	1.59	1.45	1.48	1.26	1.34	1.56
13	2.16	1.94	2.82	2.54	2.08	1.74	1.60	1.45	1.48	1.25	1.34	1.55
14	2.18	1.88	2.95	2.58	2.08	1.72	1.60	1.45	1.46	1.25	1.31	1.46
15	2.26	1.81	2.70	2.78	2.07	1.74	1.60	1.44	1.37	1.24	1.28	1.43
16	2.37	2.18	3.06	2.65	2.12	1.72	1.60	1.44	1.37	1.25	1.25	1.45
17	2.25	2.28	1.46	2.45	2.19	1.69	1.60	1.43	1.37	1.24	1.24	1.54
18	2.28	2.08	2.86	2.42	2.07	1.68	1.58	1.42	1.38	1.23	1.23	1.50
19	2.13	1.95	2.79	2.42	2.06	1.66	1.61	1.42	1.39	1.23	1.22	1.48
20	1.93	1.95	2.71	2.42	2.04	1.66	1.61	1.41	1.38	1.23	1.24	1.52
21	1.98	1.91	2.60	2.41	2.04	1.66	1.60	1.41	1.37	1.23	1.28	1.98
22	2.14	1.90	2.53	2.42	2.00	1.64	1.60	1.41	1.36	1.24	1.28	2.00
23	2.04	1.79	2.44	2.41	2.00	1.63	1.60	1.41	1.34	1.32	1.23	2.07
24	1.91	1.80	2.39	2.38	2.00	1.62	1.59	1.41	1.33	1.34	1.21	2.04
25	1.84	1.79	2.41	2.33	2.00	1.63	1.57	1.41	1.32	1.32	1.20	2.04
26	1.76	1.78	2.44	2.32	2.00	1.64	1.55	1.41	1.32	1.28	1.21	1.99
27	1.67	2.03	2.51	2.30	1.99	1.63	1.53	1.41	1.31	1.25	1.21	1.71
28	1.72	2.98	2.56	2.30	1.98	1.63	1.53	1.41	1.31	1.24	1.20	1.58
29	1.78	1.88	2.60	2.30	1.97	1.64	1.55	1.41	1.31	1.24	1.20	1.60
30	1.80	*****	2.98	2.16	1.93	1.62	1.52	1.41	1.30	1.36	1.19	1.52
31	1.73	*****	3.36	*****	1.90	*****	1.51	1.40	*****	1.28	*****	1.55

DATE
5 MAR 1982
14 49 49

RATING TABLE

STATION CODE NUMBER 9 VALIDITY PERIODE 1/11 1959 TO 20/11 1967

NUMBER OF H/Q RELATIONS 67

UNITS 1 1=ALL ENGLISH 2=MWL/ENG, RC/MET 3=ALL METRIC 4=MWL/MET, RC/ENG

H	1.60	1.70	1.90	2.10	2.20	2.30	2.40	2.50	2.80	3.10
Q	135.00	141.00	155.00	171.00	180.00	190.00	202.00	215.00	257.00	302.00
H	3.50	4.00	4.30	4.80	5.20	5.70	6.20	6.70	7.20	7.80
Q	366.00	451.00	505.00	600.00	680.00	785.00	895.00	1010.00	1130.00	1280.00
H	8.20	8.30	8.40	8.60	8.80	8.90	9.20	9.60	9.90	10.00
Q	1384.00	1414.00	1448.00	1518.00	1590.00	1627.00	1741.00	1897.00	2017.00	2058.00
H	10.20	10.50	10.80	11.00	11.30	11.40	11.60	12.00	12.30	12.40
Q	2142.00	2271.00	2403.00	2493.00	2631.00	2678.00	2774.00	2970.00	3120.00	3171.00
H	12.60	12.80	13.10	13.40	13.60	13.80	14.00	14.30	14.60	14.80
Q	3275.00	3381.00	3543.00	3708.00	3820.00	3934.00	4050.00	4227.00	4407.00	4529.00
H	15.00	15.20	15.50	15.80	16.00	16.20	16.40	16.70	17.00	17.30
Q	4653.00	4779.00	4971.00	5166.00	5298.00	5432.00	5568.00	5775.00	5985.00	6198.00
H	17.40	17.60	17.80	18.10	18.30	18.60	18.90			
Q	6270.00	6416.00	6564.00	6790.00	6941.00	7172.00	7406.00			

RATING CURVE

STATION CODE NUMBER 9 VALIDITY PERIODE 28/ 7 1971 TO 29/ 4 1973

FORMULE/EQUATION OF RATING CURVE Q=C(H + HO)**N NUMBER OF CURVES 1

UNITS 3 1=ALL ENGLISH 2=MWL/ENG, RC/MET 3=ALL METRIC 4=MWL/MET, RC/ENG

CURVE NO	C	HO	N	LIMIT
1	11.2[illegible]	0.[illegible]	1.65[illegible]	[illegible]

NATIONAL STATION CODE 1KA21A

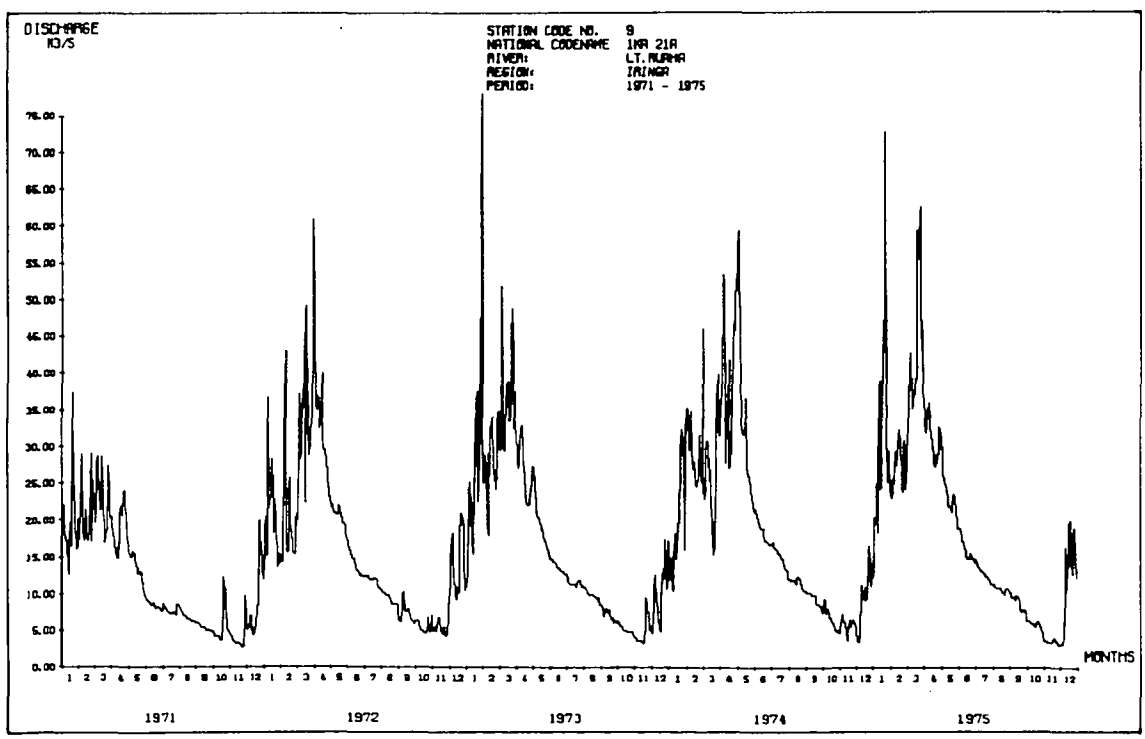
STATION CODE NO. 9

RIVER: LT.RUAHA
LOCATION: IMENDU
REGION: IRINGA

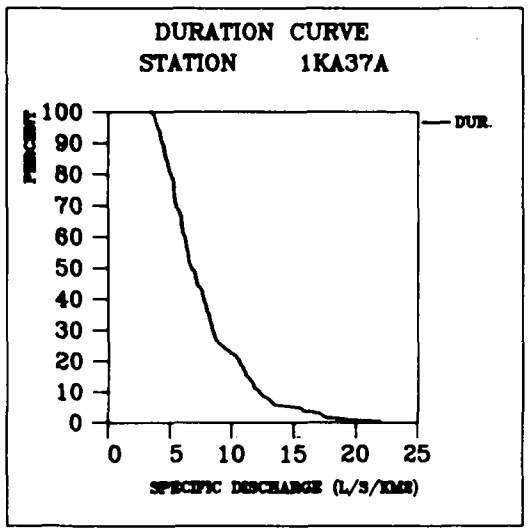
DISCHARGE IN M3/S

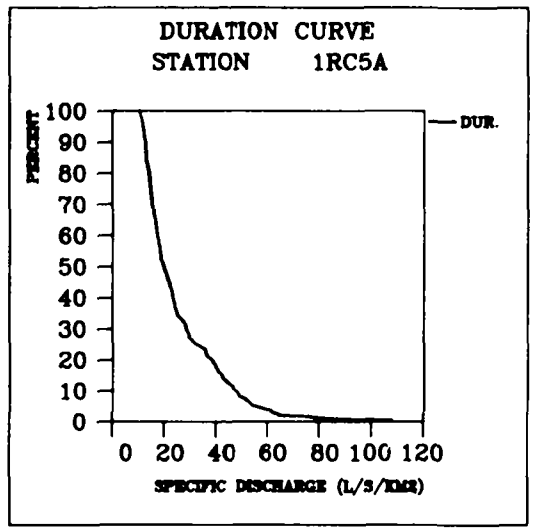
YEAR 1972

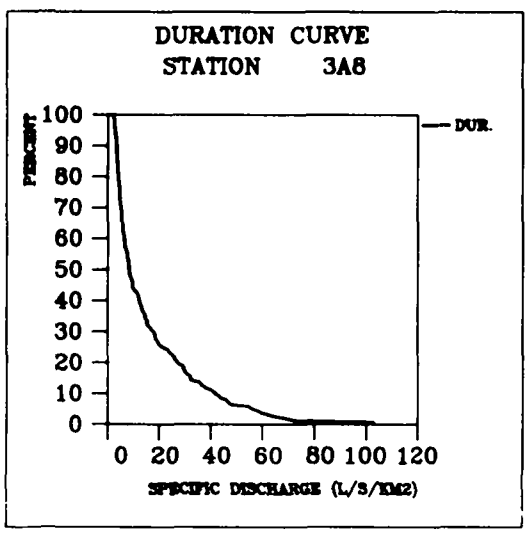
DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1	13.05	14.19	31.11	36.68	23.90	17.20	11.31	9.27	6.14	5.14	5.40	8.75	
2	11.32	13.31	30.10	45.42	23.24	16.75	11.31	9.06	6.14	6.14	4.98	9.09	
3	14.36	13.71	33.01	43.74	21.95	16.30	11.21	8.92	6.14	6.14	5.11	9.81	
4	14.26	14.45	23.52	39.58	21.68	15.75	11.31	8.74	6.14	6.14	5.11	12.09	
5	20.32	14.30	26.38	37.03	21.67	15.42	13.50	8.74	5.98	6.14	5.54	14.07	
6	15.06	24.07	38.65	36.16	22.68	15.42	11.31	8.74	5.98	5.89	5.54	17.20	
7	13.31	21.71	32.67	33.32	21.24	14.98	11.21	8.74	6.22	9.06	5.11	17.20	
8	37.37	41.17	26.00	38.01	21.11	14.56	11.50	8.57	7.15	9.76	4.97	18.02	
9	26.32	44.70	32.36	37.24	21.53	14.56	11.31	8.40	6.97	5.61	4.97	14.35	
10	26.94	36.80	29.99	37.08	20.99	14.34	11.02	8.31	6.92	5.40	5.68	10.84	
11	21.73	19.63	35.64	35.25	21.11	14.11	10.93	8.23	6.91	5.11	6.14	10.65	
12	23.12	16.79	38.45	33.76	20.66	14.13	10.84	8.23	7.39	5.11	6.44	10.18	
13	26.30	17.69	36.47	34.65	20.95	13.91	10.63	8.23	6.96	5.11	6.44	9.91	
14	23.50	14.58	46.95	36.21	20.74	13.71	10.93	8.23	6.91	5.11	5.99	8.31	
15	20.11	15.20	35.35	41.62	21.11	13.61	10.63	8.06	6.91	4.97	5.47	7.89	
16	20.40	24.34	30.88	37.45	22.48	13.20	10.63	7.97	6.91	5.11	5.04	8.15	
17	35.45	26.33	23.04	31.42	21.96	12.69	10.83	7.84	6.91	4.90	4.97	9.31	
18	26.67	19.54	44.10	30.56	21.23	12.39	10.55	7.72	7.07	4.83	4.83	9.09	
19	22.02	16.15	41.81	30.27	20.56	12.39	11.02	7.72	7.15	4.83	4.70	8.74	
20	17.89	18.23	36.27	30.56	20.50	12.09	11.12	7.56	7.07	4.83	4.90	9.36	
21	13.96	17.71	35.45	30.27	20.50	11.99	10.93	7.56	6.83	4.83	5.54	19.24	
22	23.04	17.03	33.76	30.56	19.53	11.80	10.93	7.56	6.67	4.97	5.47	19.84	
23	23.30	14.77	31.13	30.13	19.53	11.69	10.93	7.56	6.44	5.07	4.83	21.26	
24	17.32	14.59	30.71	29.42	19.53	11.31	10.84	7.56	6.21	5.44	4.46	20.37	
25	13.16	14.79	30.13	28.93	19.53	11.50	10.27	7.56	6.14	6.06	4.43	20.50	
26	14.14	14.56	31.13	27.76	19.53	11.70	9.99	7.56	6.06	5.47	4.49	19.21	
27	13.05	13.74	33.16	27.21	19.17	11.50	9.63	7.56	6.06	5.04	4.70	13.00	
28	13.32	19.05	34.35	26.13	19.05	11.50	9.45	7.56	5.98	4.97	5.33	10.46	
29	14.56	*******	34.56	24.41	19.70	11.31	9.45	7.56	5.98	4.97	5.84	9.09	
30	14.96	*******	46.24	23.50	17.86	11.31	9.36	7.56	5.76	4.70	7.15	9.46	
31	13.41	*******	43.39	*******	17.20	*******	9.27	7.39	*******	5.47	*******	9.99	
VOL (MCM)	55.46	46.81	92.85	89.37	55.51	34.77	28.75	21.03	17.37	14.75	13.77	34.18	ANNUAL: 504.25
MEAN	19.37	19.43	34.07	34.04	20.73	13.42	10.73	8.08	6.70	5.51	5.31	12.76	
MAX	43.81	45.42	75.08	53.70	23.50	17.20	11.50	9.27	9.09	7.56	7.39	23.50	
DATE	3	3	31	1	1	1	5	1	9	10	30	21	
MIN	10.36	12.89	0.0	23.50	17.20	11.31	9.27	7.39	5.76	4.83	4.43	7.39	
DATE	1	5	17	30	31	24	30	31	7	17	24	15	



Appendix 4
Refers to Volume 7, Chapter 6.







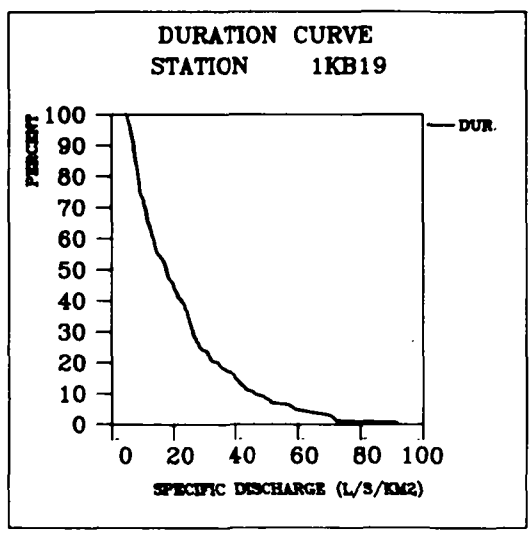
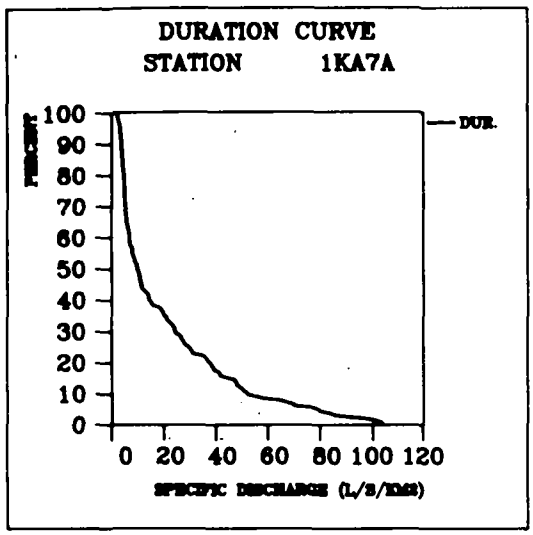
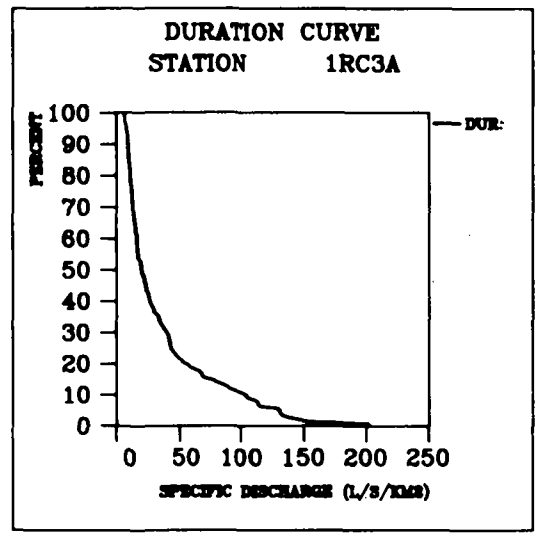
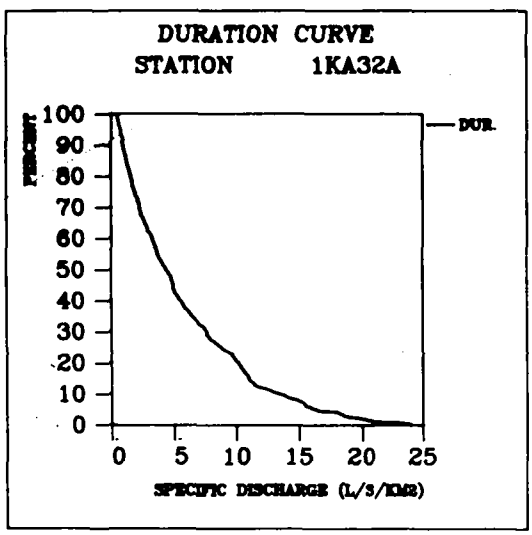


Figure 6.2[8] - Flow duration curves for priority stations based on monthly flowdata.







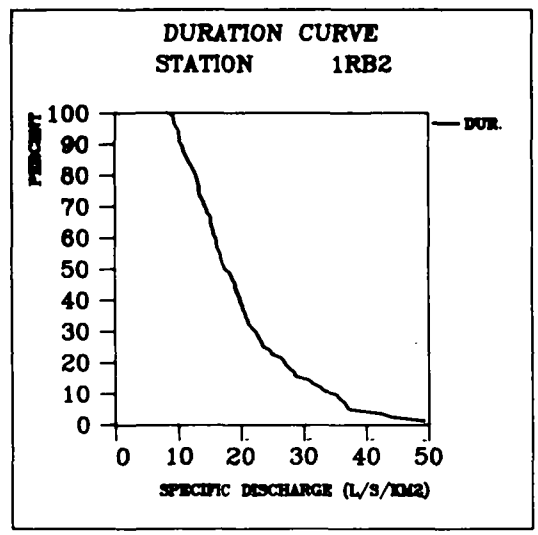
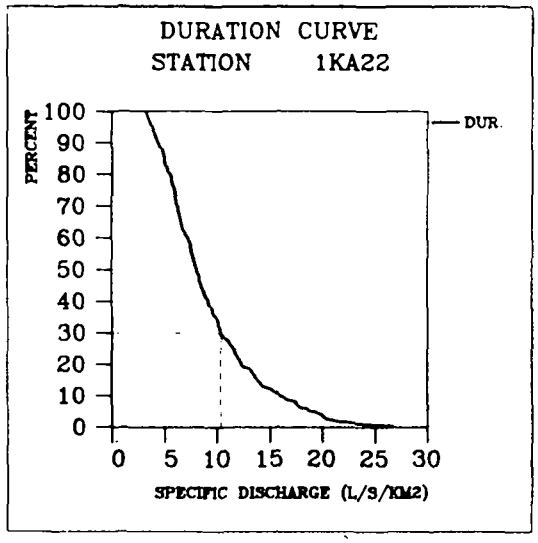
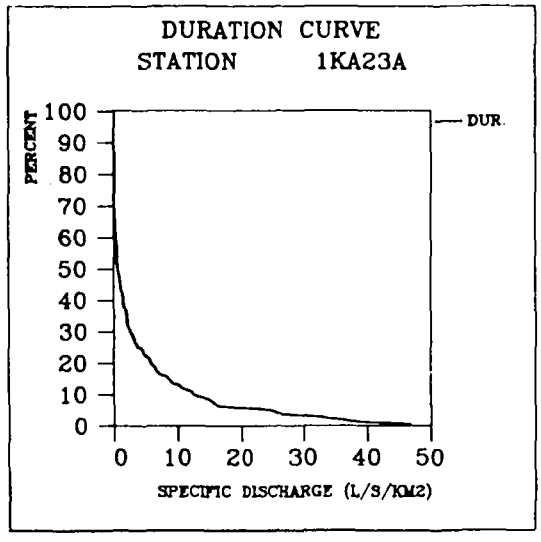


Figure 6.2[8] - Cont'd.





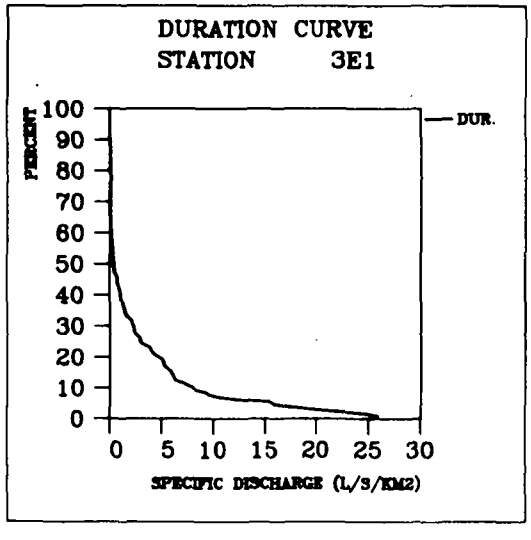


Figure 6.2[8] - Cont'd.

LOW FLOW FREQUENCY - DURATION CURVES

DURATION 1, 30 AND 120 DAYS

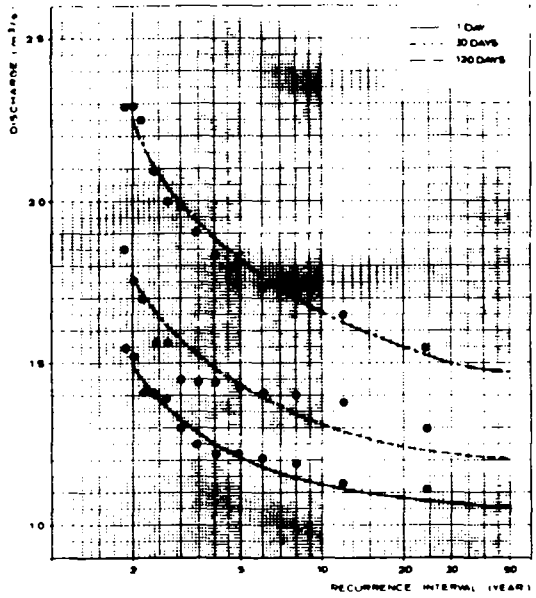
NATIONAL STATION CODE 1KA22

NUMBER OF YEARS USED IN ANALYSIS 23

Parameters: $L: 1{,}2292_{1}; 1{,}5222_{30}; 1{,}8056_{120}$

$\beta: 1{,}6593_{1}; 1{,}9539_{30}; 2{,}4535_{120}$

$\gamma: 1{,}0274_{1}; 1{,}1264_{30}; 1{,}3357_{120}$



LOW FLOW FREQUENCY - DURATION CURVES

DURATION 1, 30 AND 120 DAYS

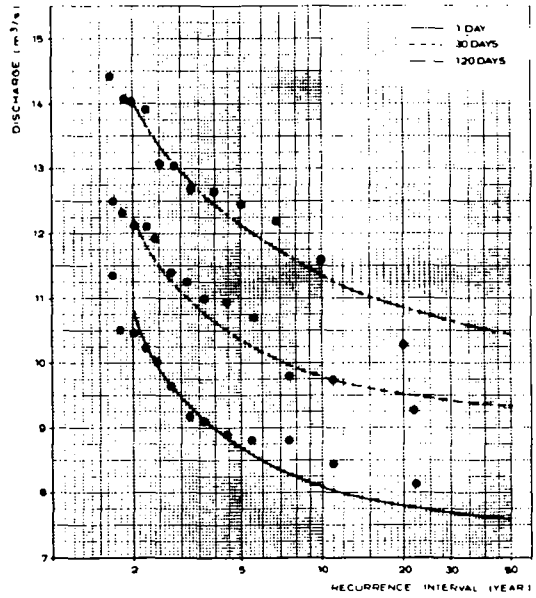
NATIONAL STATION CODE 1KA37A

NUMBER OF YEARS USED IN ANALYSIS 21

Parameters: $L: 1{,}1155_{1}; 1{,}0283_{30}; 1{,}9428_{120}$

$\beta: 12{,}186_{1}; 13{,}512_{30}; 14{,}938_{120}$

$\gamma: 7{,}4646_{1}; 9{,}3190_{30}; 9{,}7673_{120}$



LOW FLOW FREQUENCY - DURATION CURVES

DURATION 1, 30 AND 120 DAYS

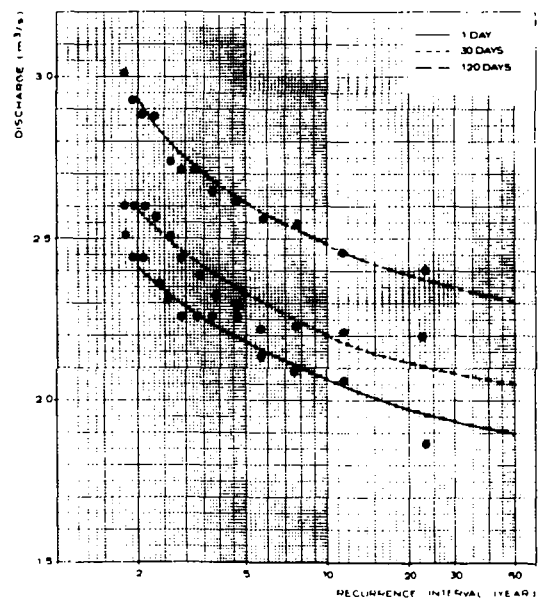
NATIONAL STATION CODE 1RC5A

NUMBER OF YEARS USED IN ANALYSIS 22

Parameters: $L: 2{,}6563_{1}; 2{,}3547_{30}; 2{,}1144_{120}$

$\beta: 2{,}5229_{1}; 2{,}7120_{30}; 3{,}0717_{120}$

$\gamma: 1{,}7157_{1}; 1{,}8916_{30}; 2{,}1783_{120}$



LOW FLOW FREQUENCY - DURATION CURVES

DURATION 1, 30 AND 120 DAYS

NATIONAL STATION CODE 1KB19

NUMBER OF YEARS USED IN ANALYSIS 18

Parameters: $L: 2{,}2923_{1}; 1{,}7893_{30}; 1{,}6674_{120}$

$\beta: 0{,}73679_{1}; 0{,}89353_{30}; 1{,}2178_{120}$

$\gamma: 0{,}42412_{1}; 0{,}57483_{30}; 0{,}83355_{120}$

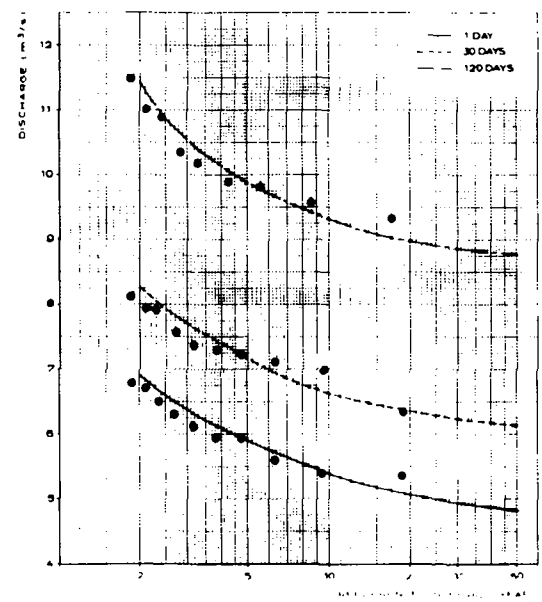


Figure 6.4[8] - Low flow frequency curves.

LOW FLOW FREQUENCY - DURATION CURVES

DURATION 1, 30 AND 120 DAYS

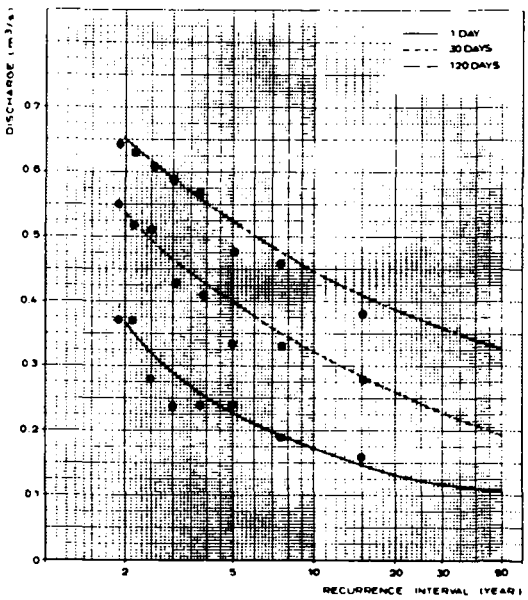
NATIONAL STATION CODE 1KA7A

NUMBER OF YEARS USED IN ANALYSIS 14

Parameters: $L: 1{,}9388_{1}; 3{,}8889_{30}; 4{,}7674_{120}$

$\beta: 0{,}43345_{1}; 0{,}59703_{30}; 0{,}70695_{120}$

$\gamma: 0{,}055829_{1}; 0{,}033110_{30}; 0{,}031933_{120}$



LOW FLOW FREQUENCY - DURATION CURVES

DURATION 1, 30 AND 120 DAYS

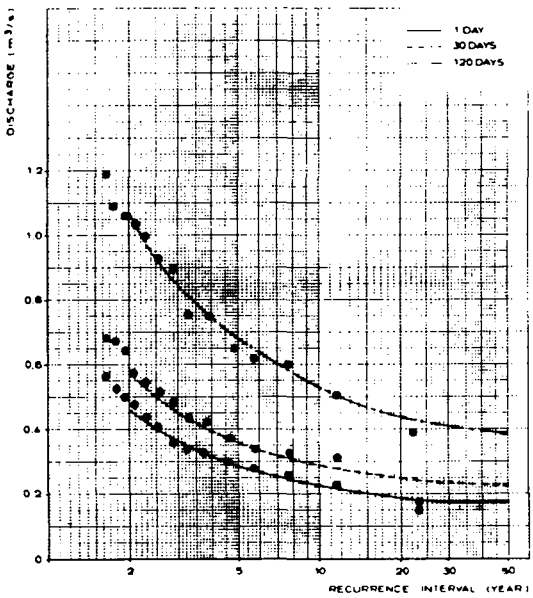
NATIONAL STATION CODE 1KA32A

NUMBER OF YEARS USED IN ANALYSIS 22

Parameters: $L: 1{,}1799_{1}; 1{,}2520_{30}; 1{,}5421_{120}$

$\beta: 0{,}56733_{1}; 0{,}69512_{30}; 1{,}2614_{120}$

$\gamma: 0{,}17058_{1}; 0{,}21214_{30}; 0{,}31220_{120}$



LOW FLOW FREQUENCY - DURATION CURVES

DURATION 1, 30 AND 120 DAYS

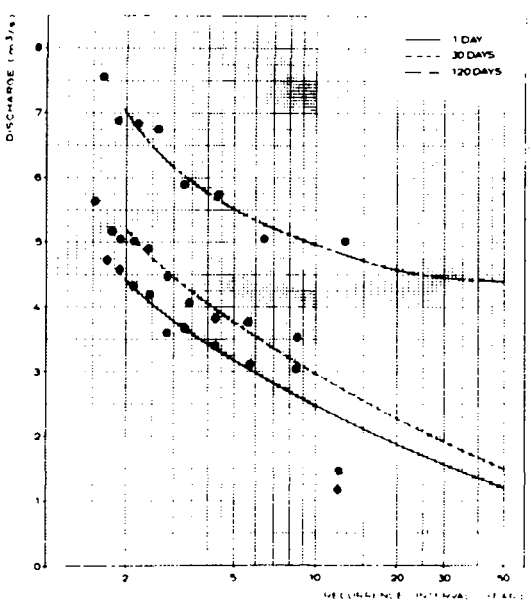
NATIONAL STATION CODE 1RC3A

NUMBER OF YEARS USED IN ANALYSIS 16

Parameters: $L: 7{,}4155_{1}; 6{,}7458_{30}; 1{,}5260_{120}$

$\beta: 4{,}8736_{1}; 5{,}7066_{30}; 7{,}8485_{120}$

$\gamma: 4{,}0253_{1}; 3{,}9316_{30}; 4{,}1033_{120}$



LOW FLOW FREQUENCY - DURATION CURVES

DURATION 1, 30 AND 120 DAYS

NATIONAL STATION CODE 1RB2

NUMBER OF YEARS USED IN ANALYSIS 8

Parameters: $L: 1{,}5353_{1}; 1{,}6143_{30}; 1{,}9685_{120}$

$\beta: 19{,}655_{1}; 22{,}044_{30}; 27{,}330_{120}$

$\gamma: 13{,}385_{1}; 15{,}367_{30}; 17{,}505_{120}$

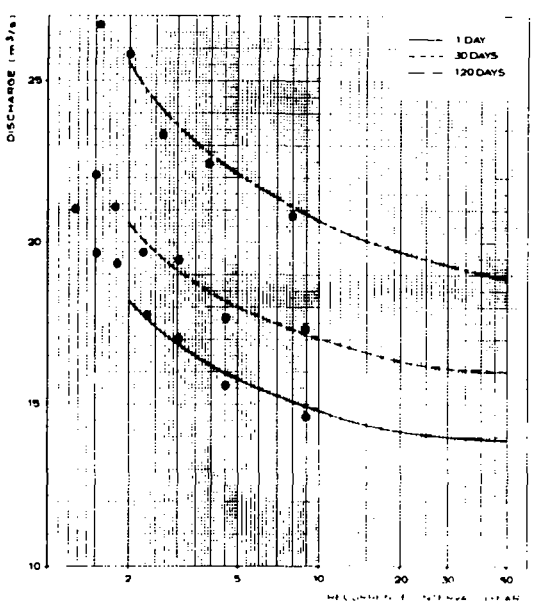


Figure 6.4[8] - Cont'd.

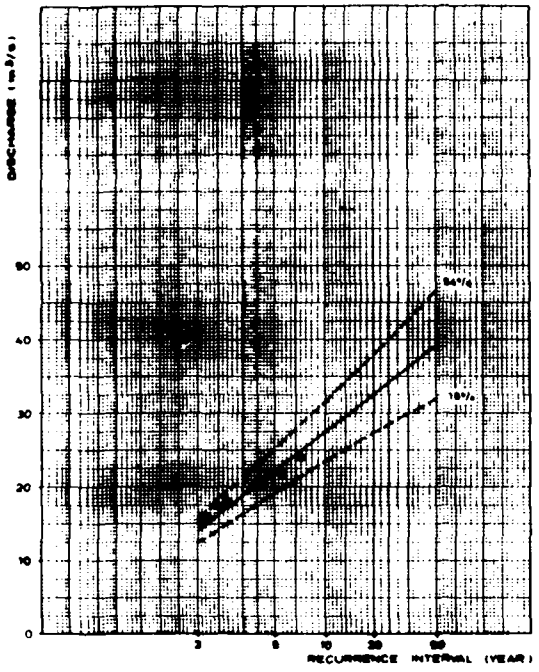
MAX FLOW FREQUENCY ANALYSIS

NATIONAL STATION CODE 1 KA 22

NUMBER OF YEARS USED IN ANALYSIS 17

Parameters: L = 0,17327

β = 11,933



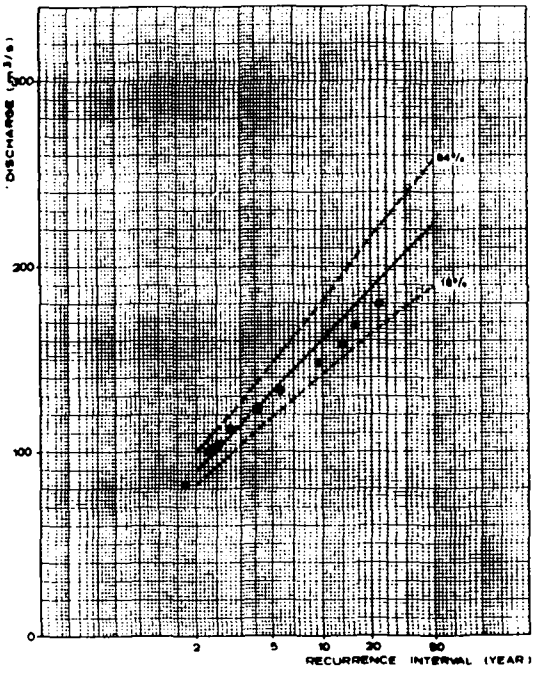
MAX FLOW FREQUENCY ANALYSIS

NATIONAL STATION CODE 1KA37A

NUMBER OF YEARS USED IN ANALYSIS 22

Parameters: L = 0,031649

β = 78,488



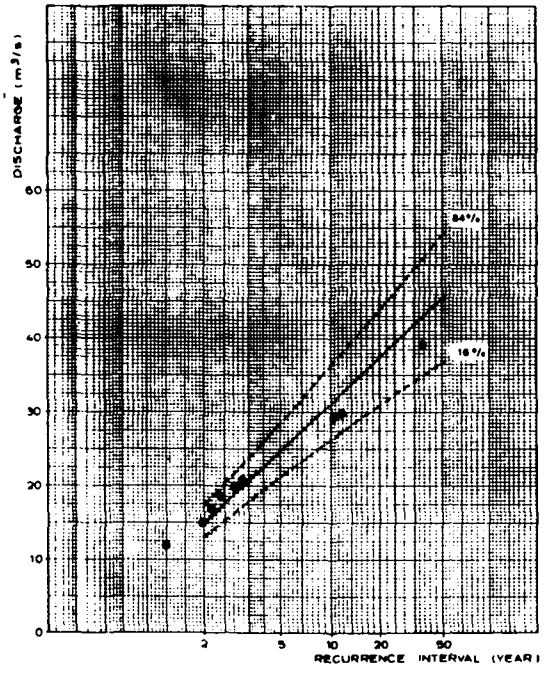
MAX FLOW FREQUENCY ANALYSIS

NATIONAL STATION CODE: 3 A 8

NUMBER OF YEARS USED IN ANALYSIS 18

Parameters: L = 0,14181

β = 12,278



MAX FLOW FREQUENCY ANALYSIS

NATIONAL STATION CODE: 1RC5A

NUMBER OF YEARS USED IN ANALYSIS 21

Parameters: L = 0,12605

β = 17,586

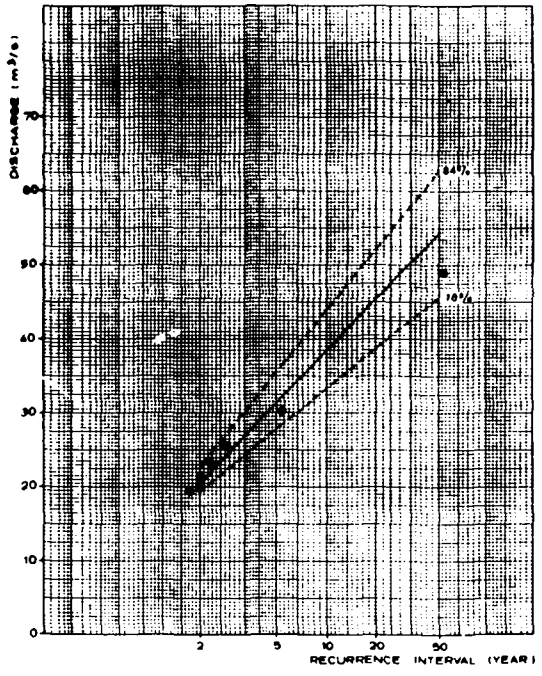


Figure 6.5[8] - Frequency analysis of maximum flows.

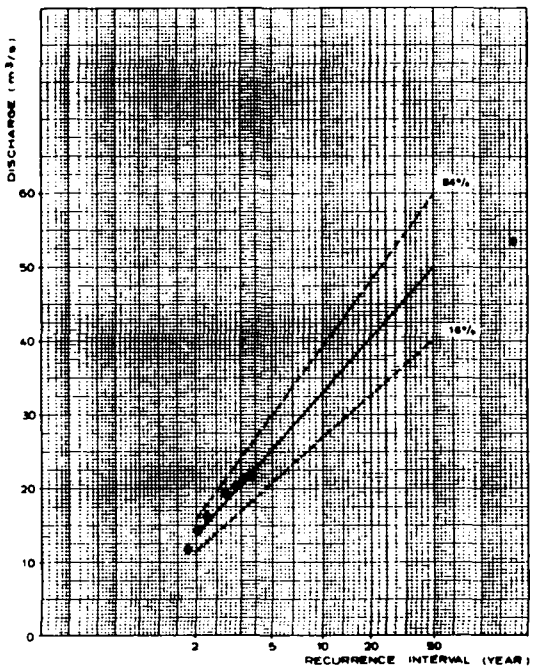
MAX FLOW FREQUENCY ANALYSIS

NATIONAL STATION CODE 1KB 19

NUMBER OF YEARS USED IN ANALYSIS 19

Parameters: L=0,11863

β=10,401



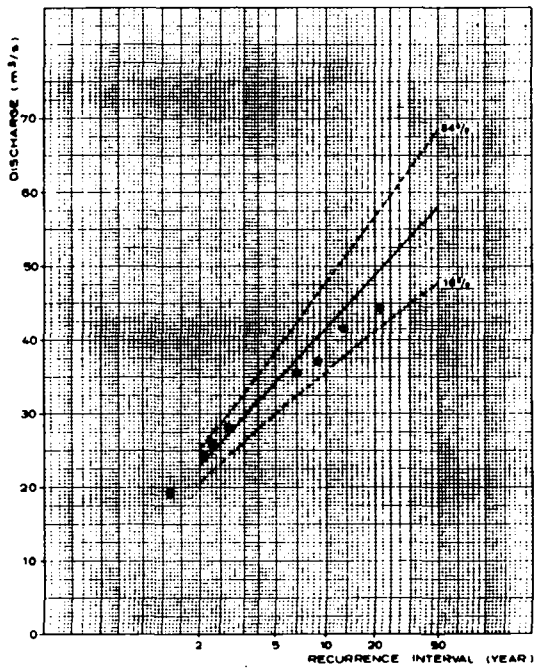
MAX FLOW FREQUENCY ANALYSIS

NATIONAL STATION CODE 1KA7A

NUMBER OF YEARS USED IN ANALYSIS 16

Parameters: L=0,12485

β=19,839



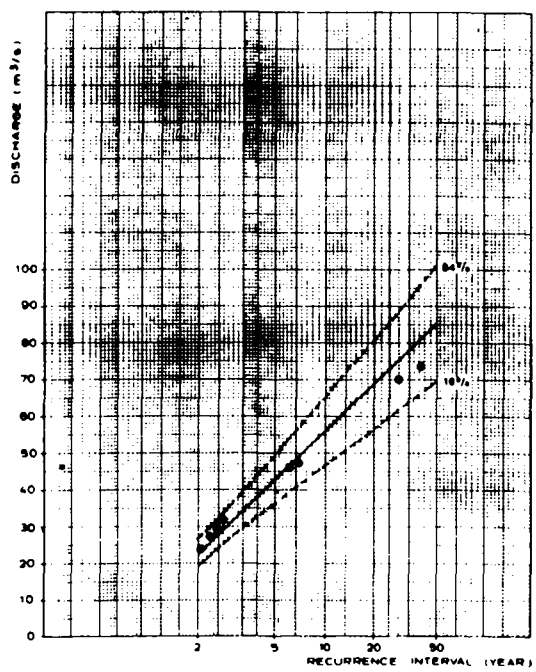
MAX FLOW FREQUENCY ANALYSIS

NATIONAL STATION CODE 1KA23A

NUMBER OF YEARS USED IN ANALYSIS 22

Parameters: L=0,067426

β=17,104



MAX FLOW FREQUENCY ANALYSIS

NATIONAL STATION CODE 1KA32A

NUMBER OF YEARS USED IN ANALYSIS 23

Parameters: L=0,34035

β=12,666

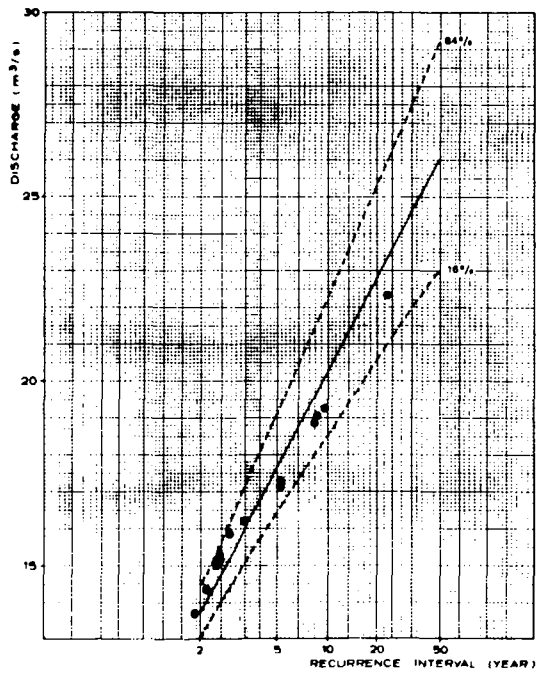


Figure 6.5[8] - Cont'd.

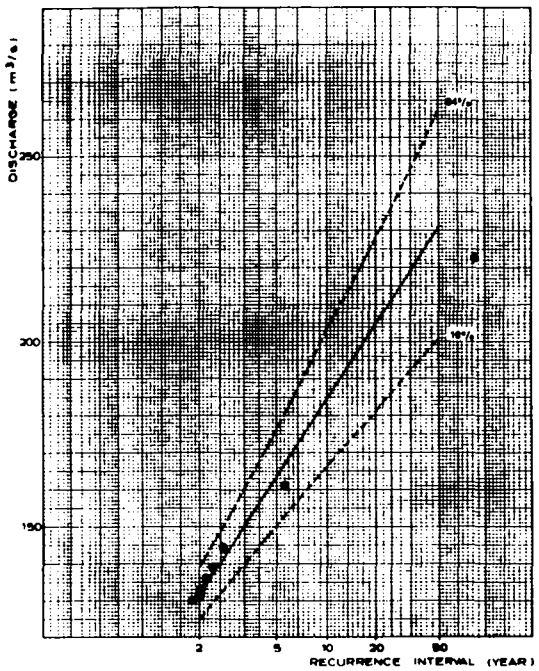
MAX FLOW FREQUENCY ANALYSIS

NATIONAL STATION CODE 1RC 3A

NUMBER OF YEARS USED IN ANALYSIS 15

Parameters : L=0,044978

β=12,371



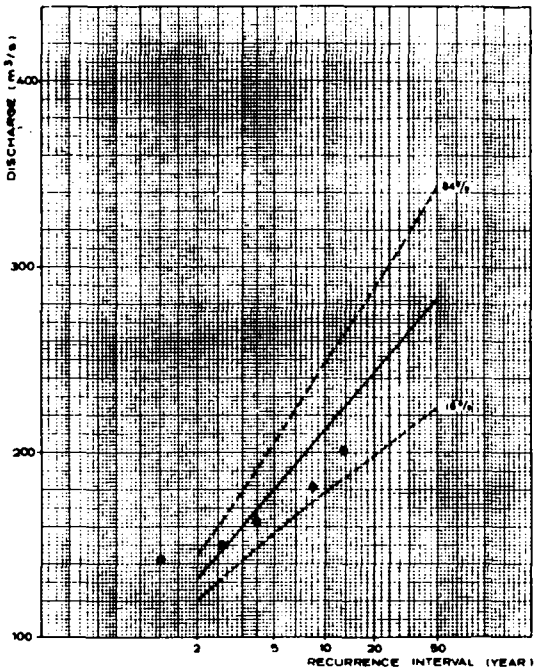
MAX FLOW FREQUENCY ANALYSIS

NATIONAL STATION CODE 1RB2

NUMBER OF YEARS USED IN ANALYSIS 9

Parameters: L=0,032405

β=120,36



MAX FLOW FREQUENCY ANALYSIS

NATIONAL STATION CODE 3E1

NUMBER OF YEARS USED IN ANALYSIS 17

Parameters : L=0,015461

β=112,69

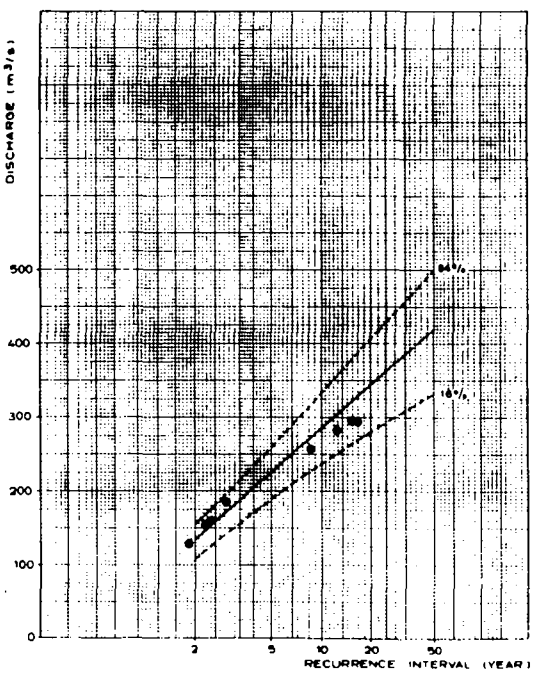
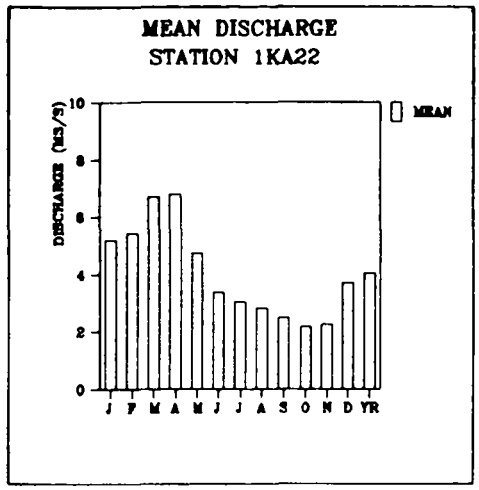
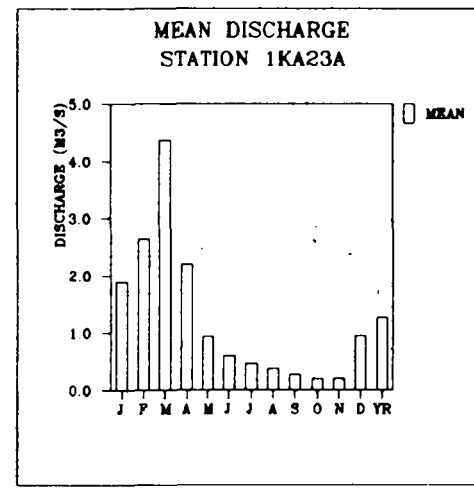
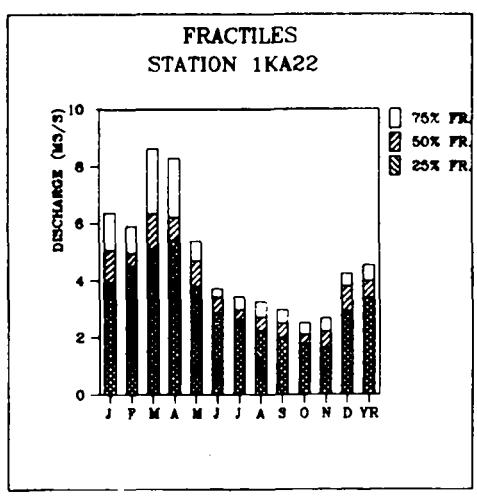


Figure 6.5[8] - Cont'd.







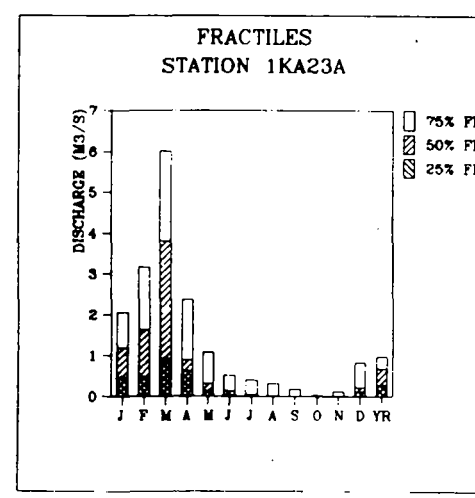
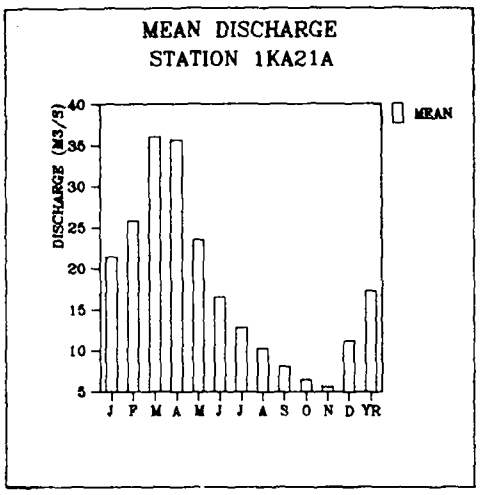
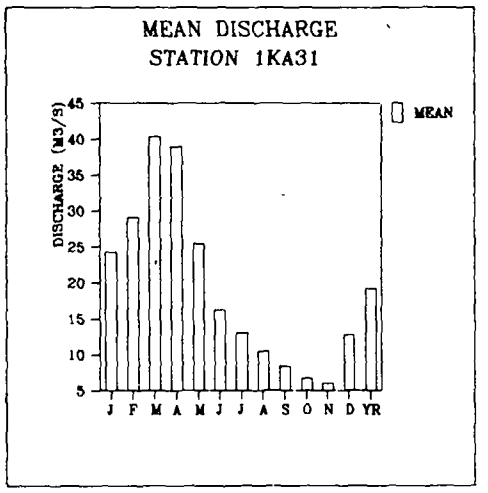
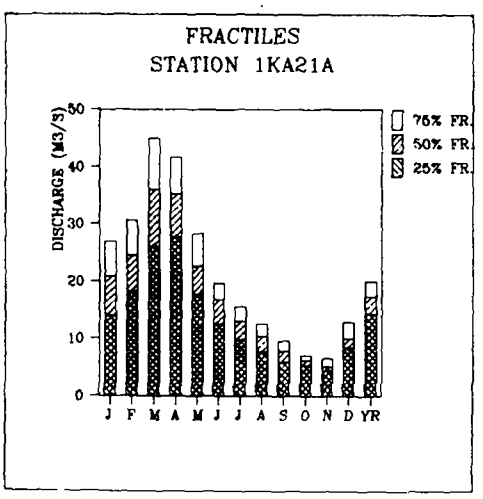


Figure 6.7[8] - Means, 25%, 50% and 75% fractiles of monthly flow series at the hydrological gauging stations.







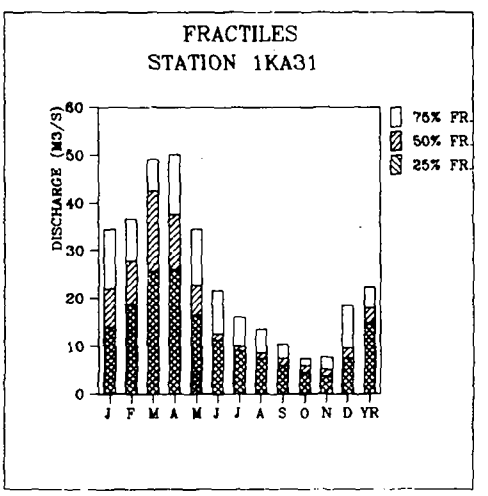
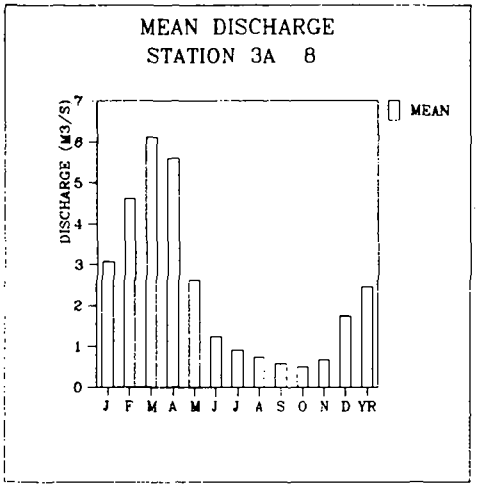
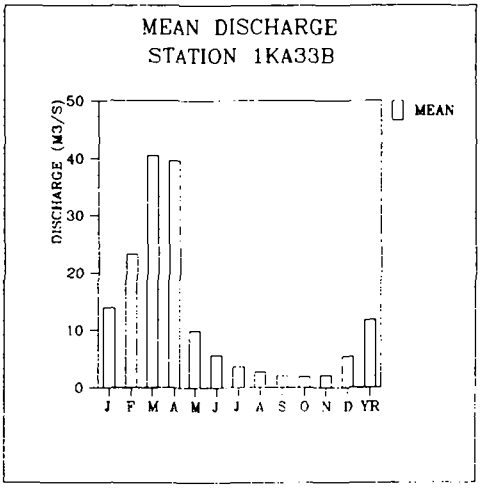
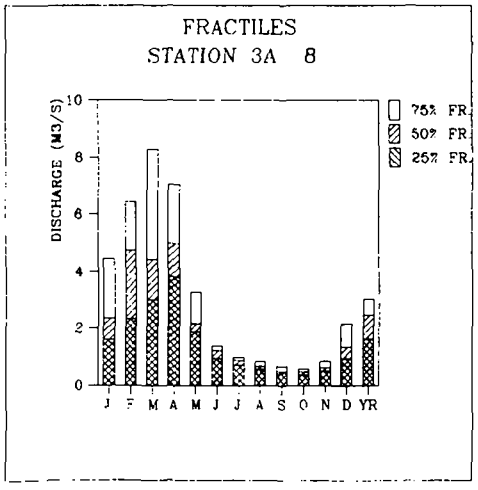


Figure 6.7[8] - Cont'd.







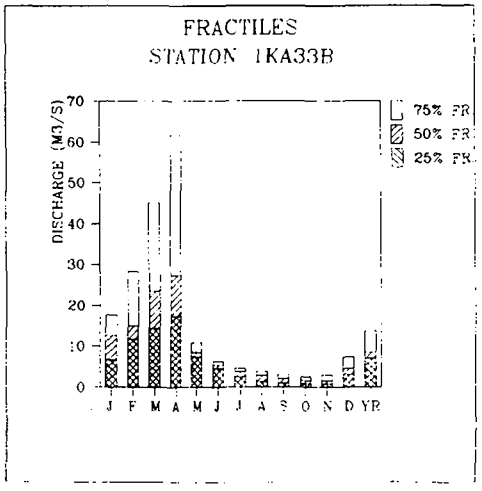
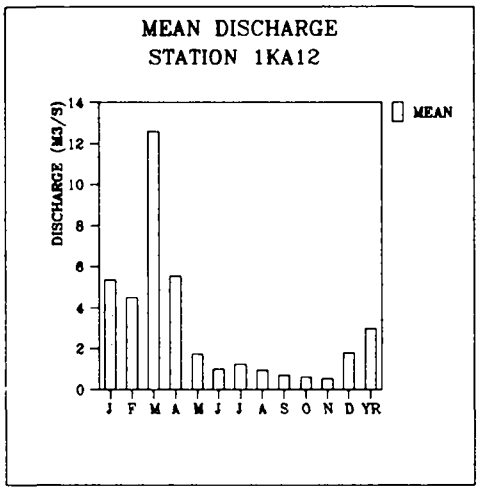
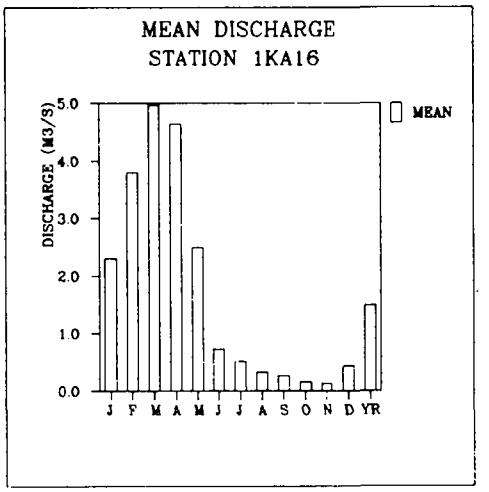
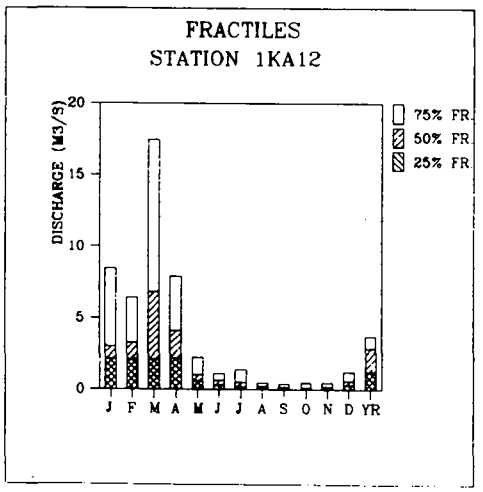


Figure 6.7[8] - Cont'd.







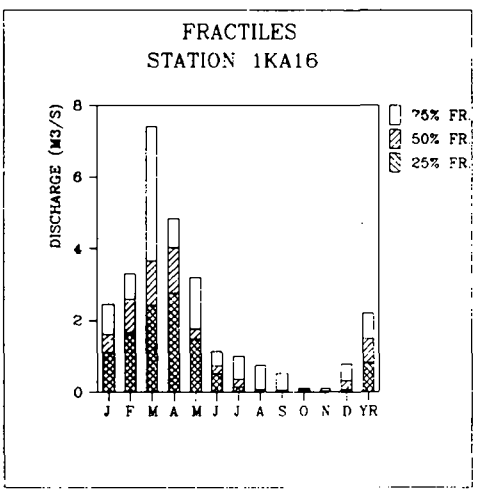
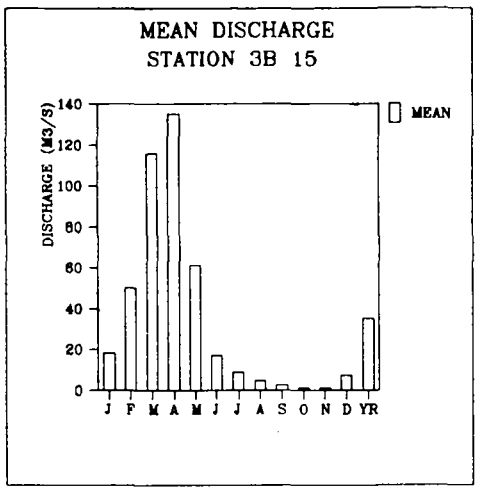
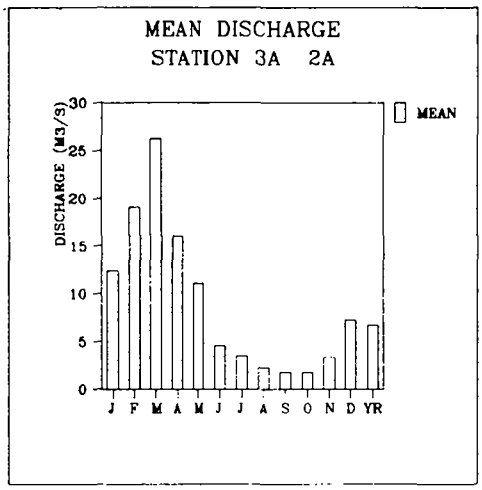
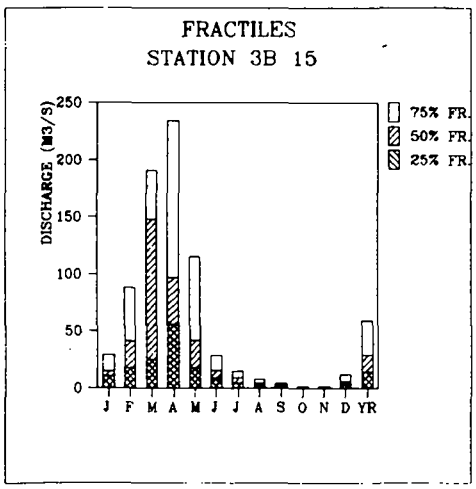


Figure 6.7[8] - Cont'd.







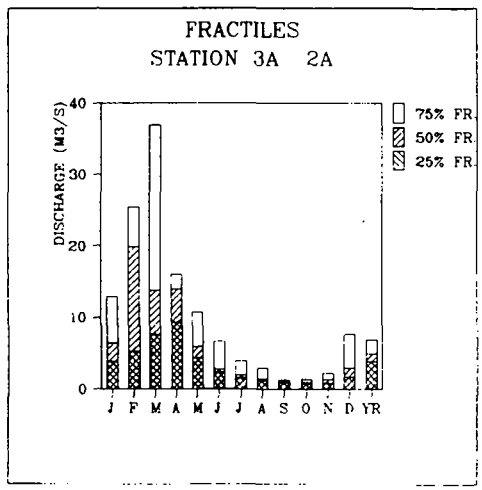
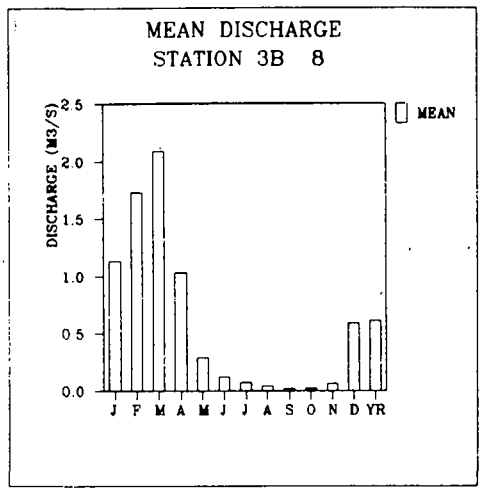
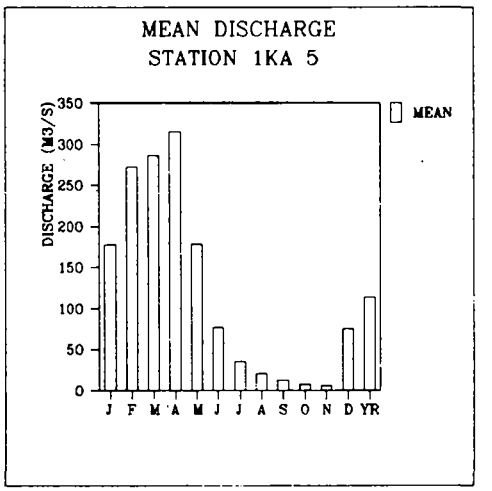
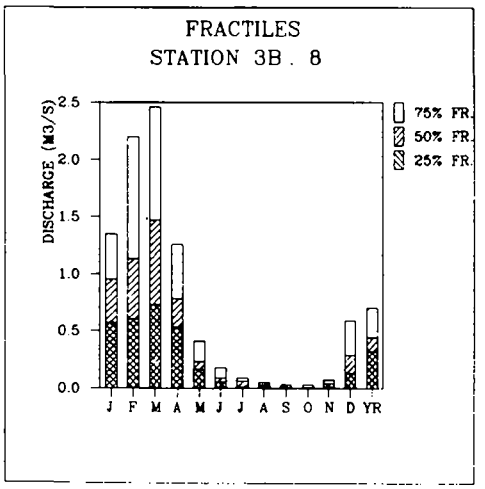


Figure 6.7[8] - Cont'd.







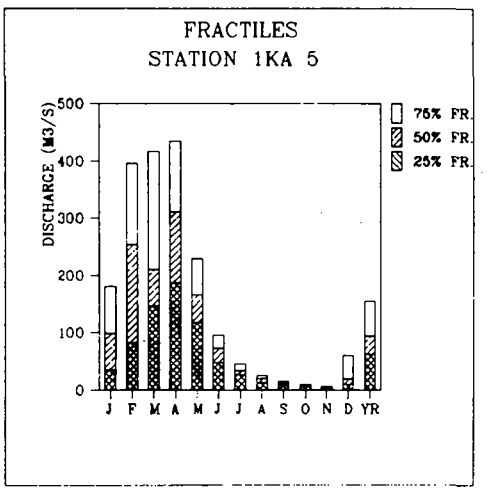
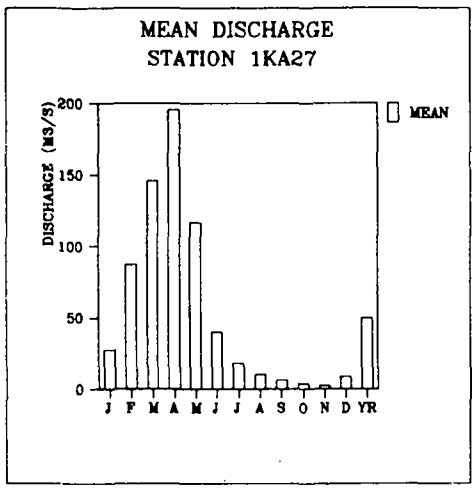
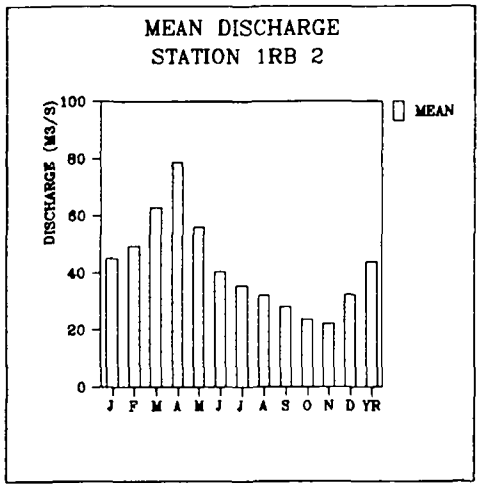
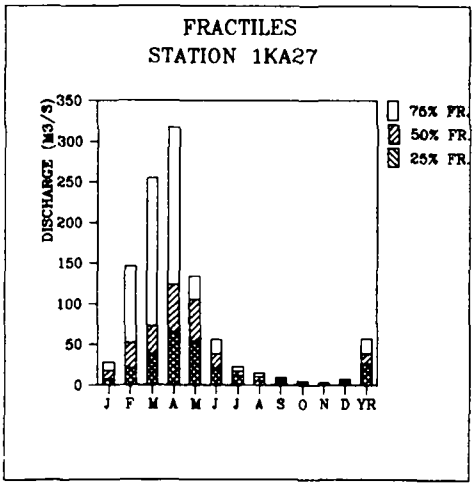


Figure 6.7[8] - Cont'd.







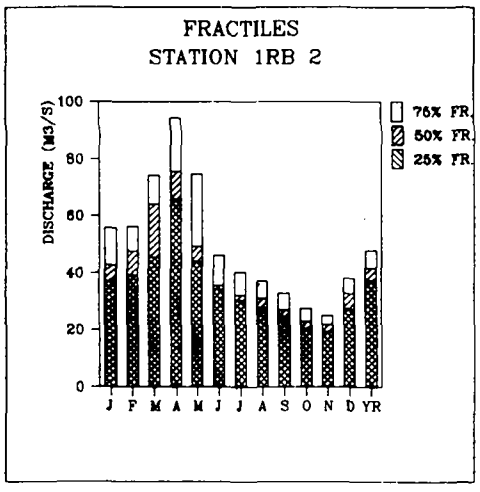
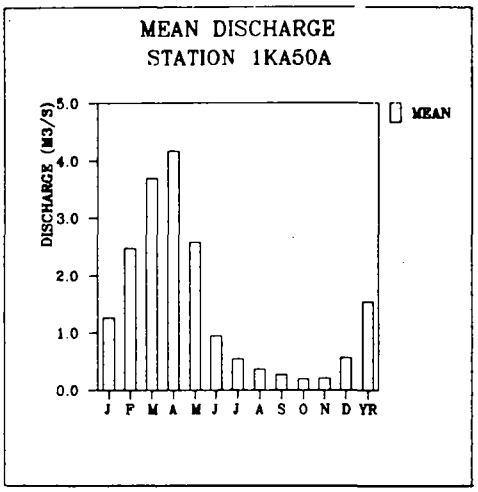
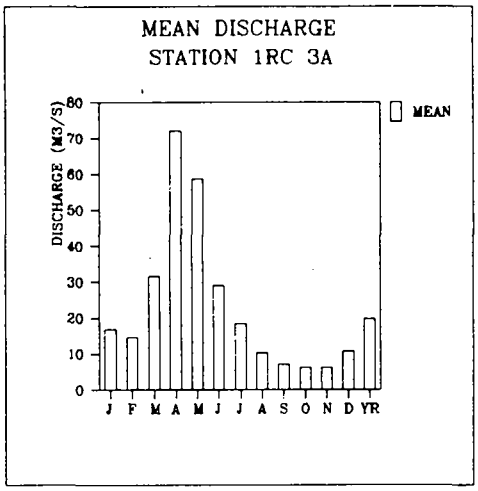
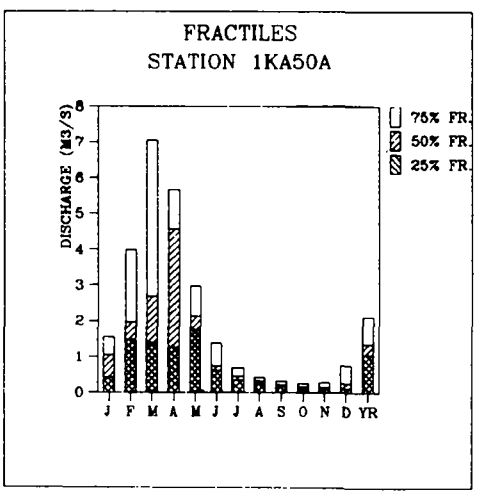


Figure 6.7 - Cont'd.







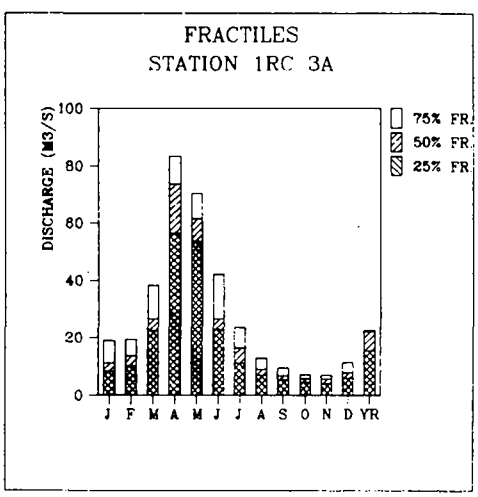
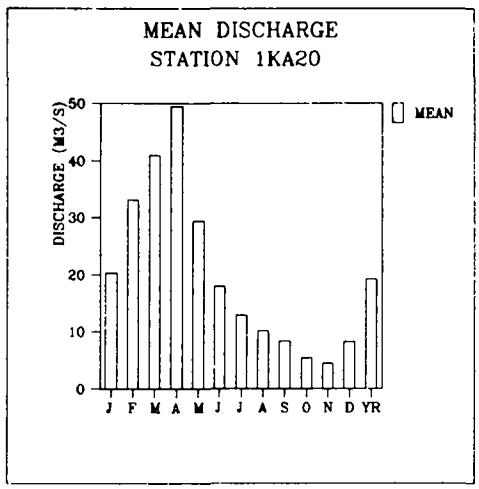
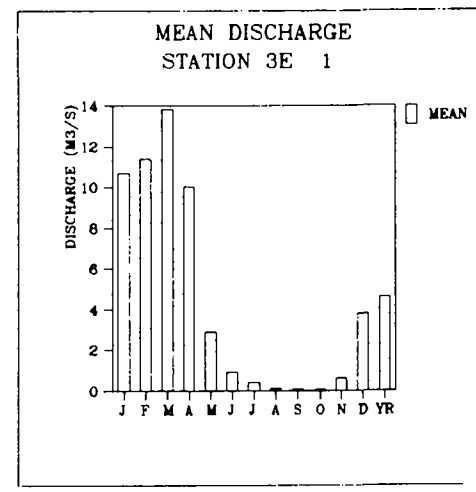
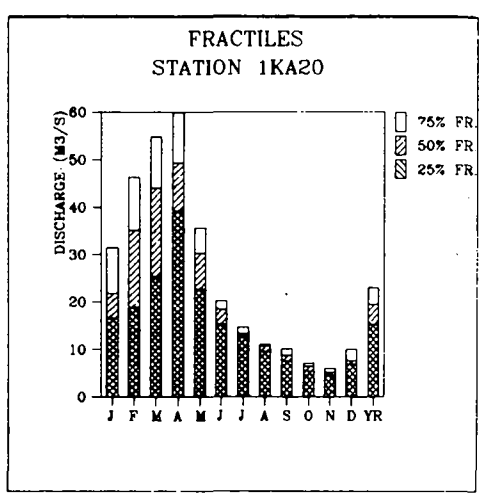
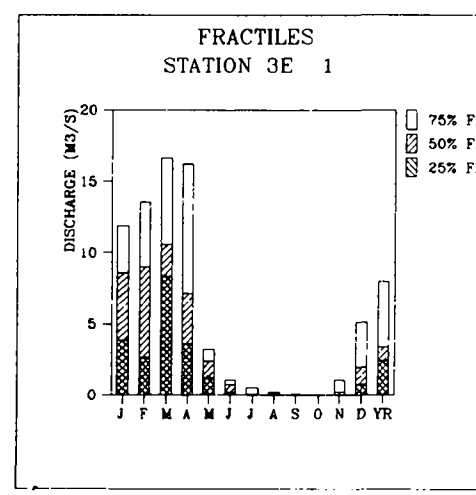


Figure 6.7 - Cont'd.









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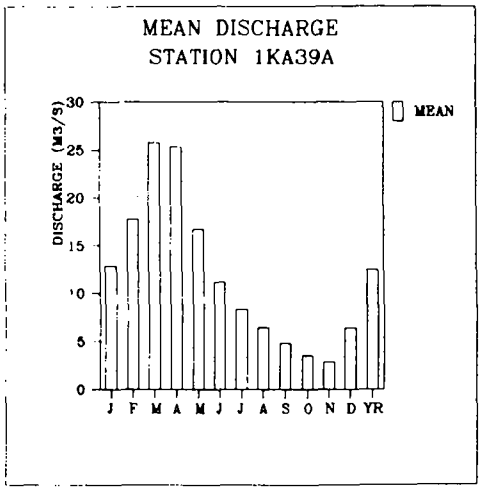

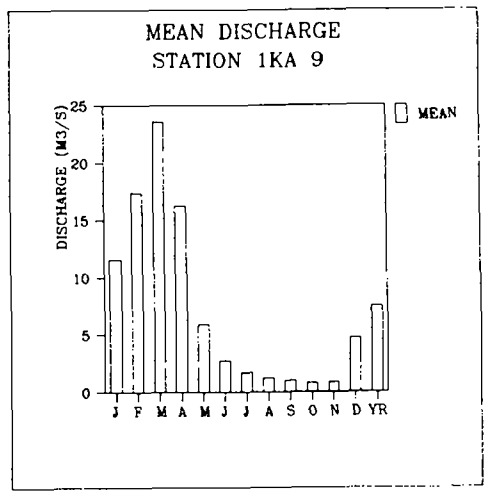

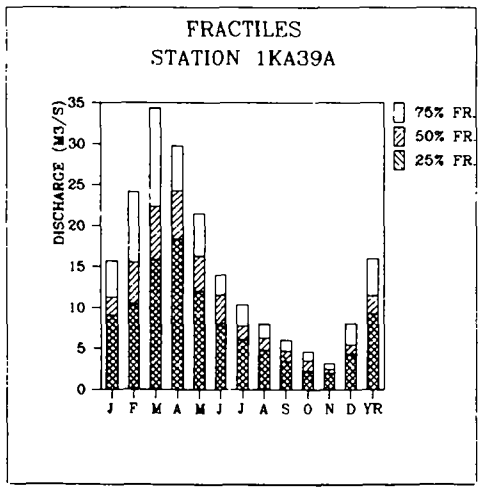

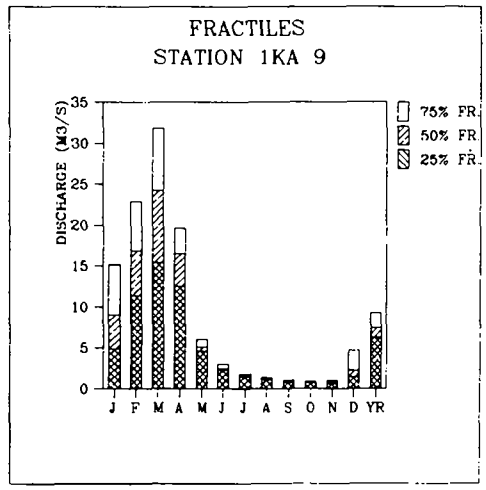

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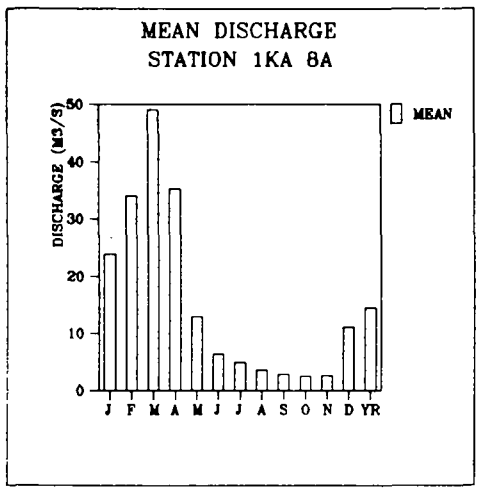

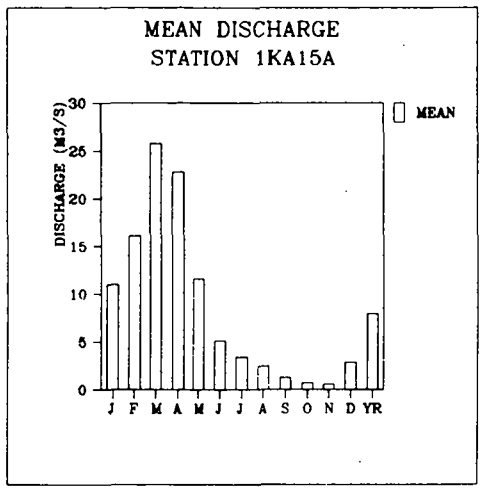

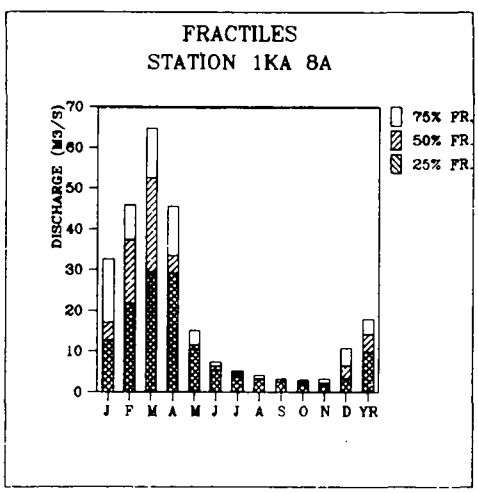

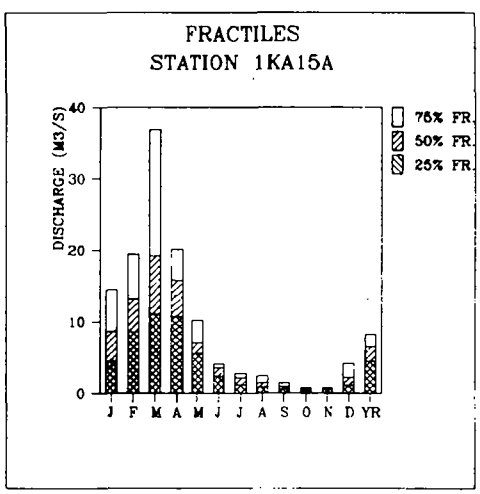

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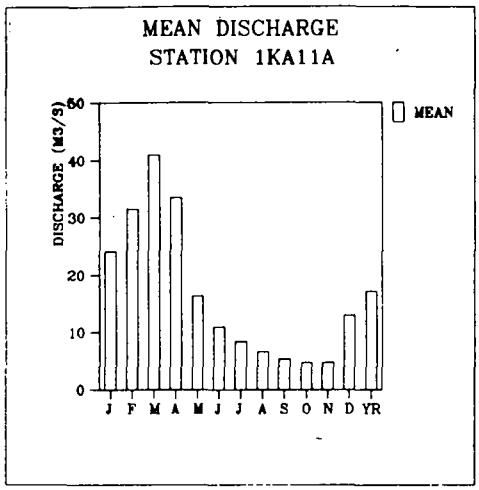

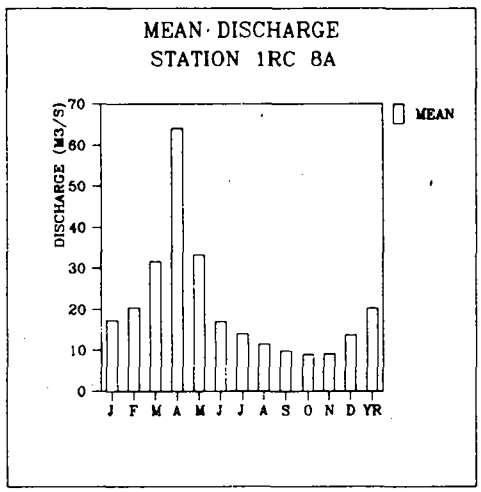

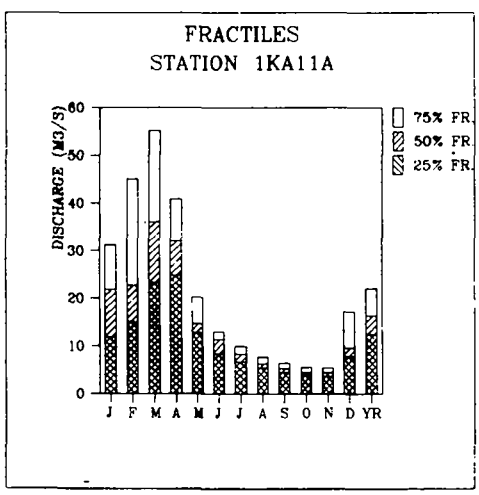

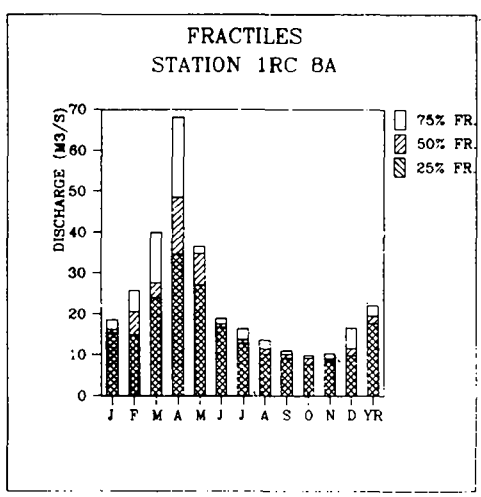

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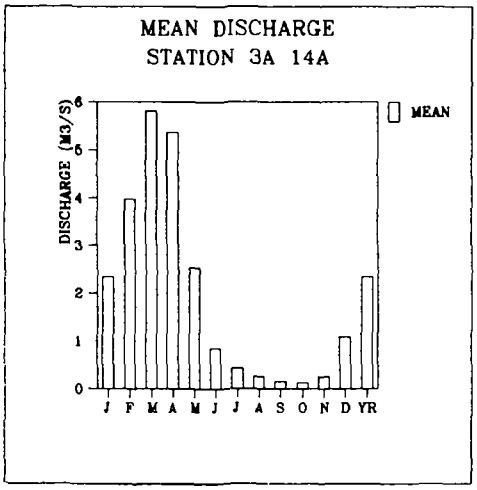

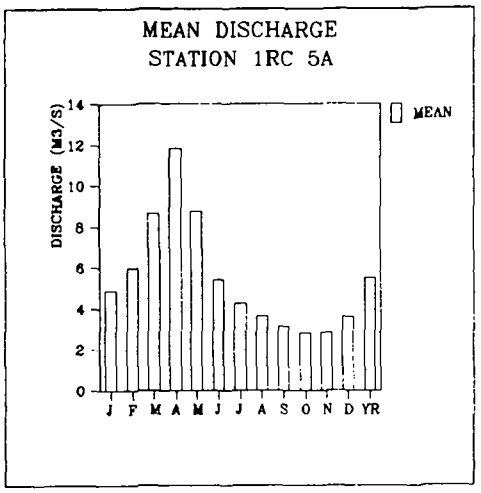

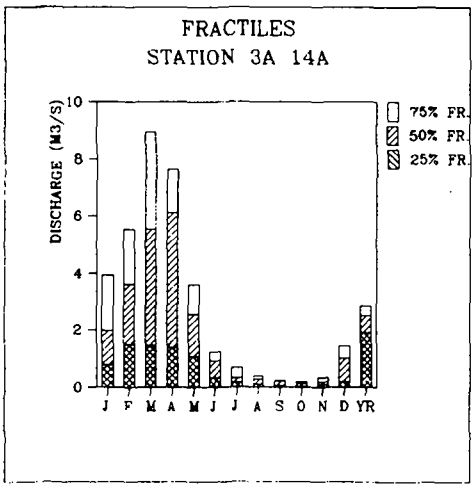

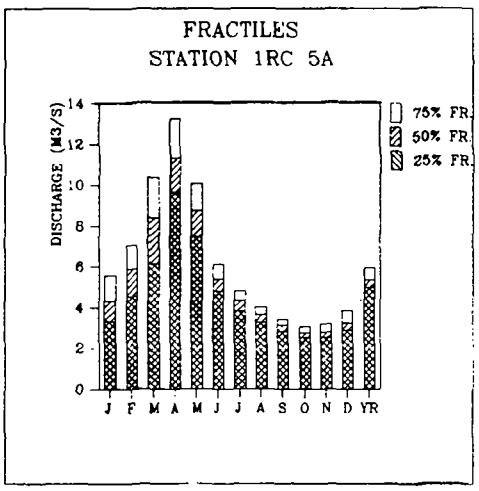

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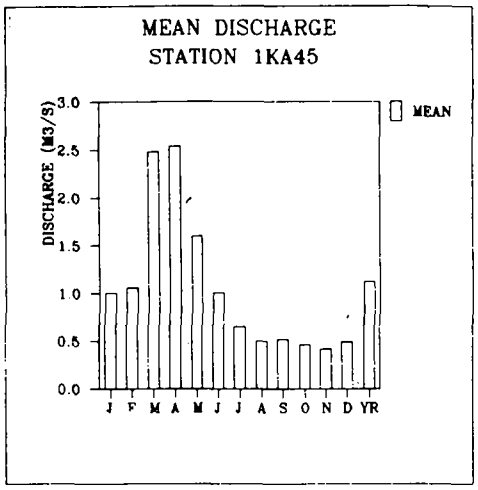

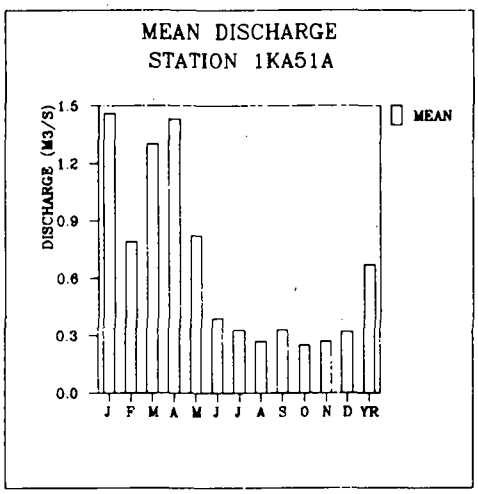

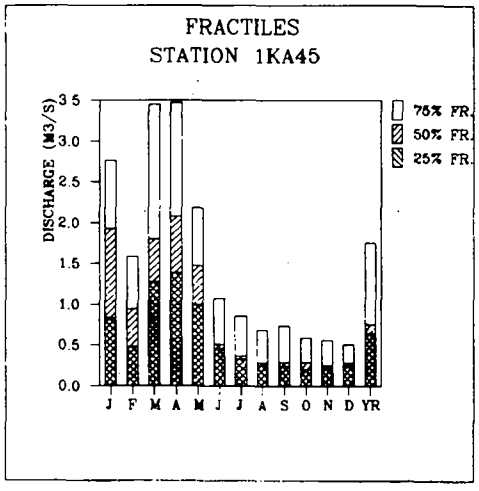

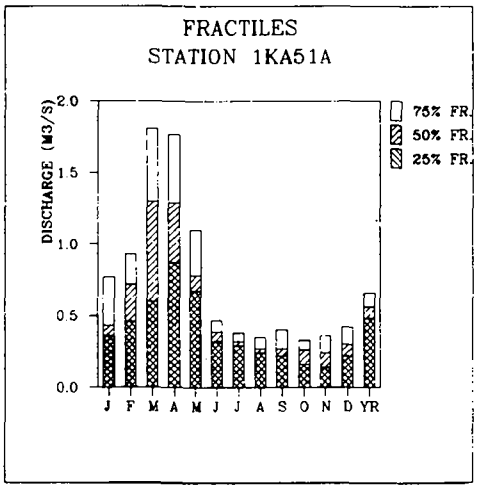

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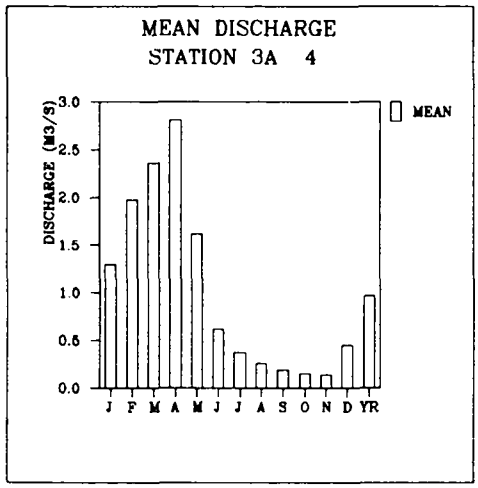

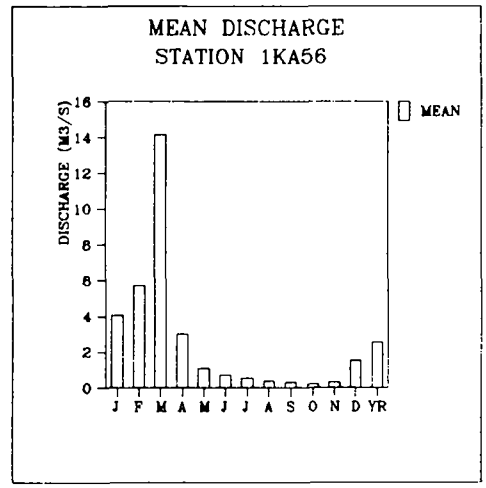

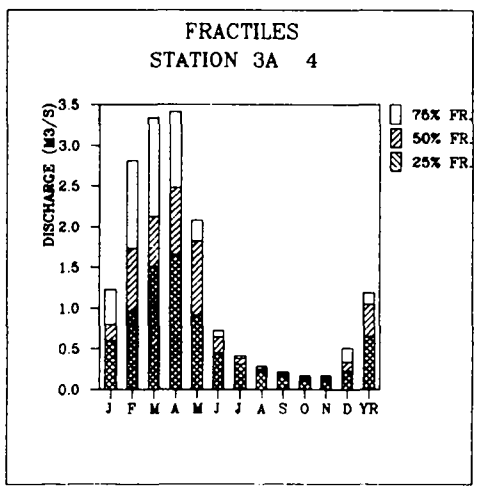

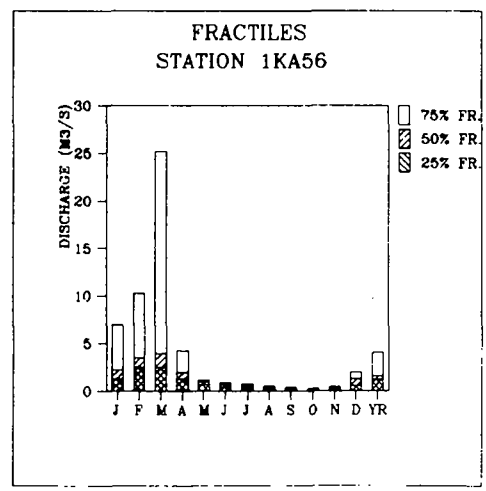

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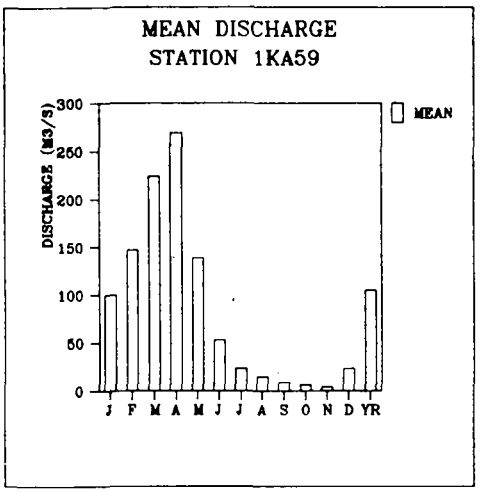

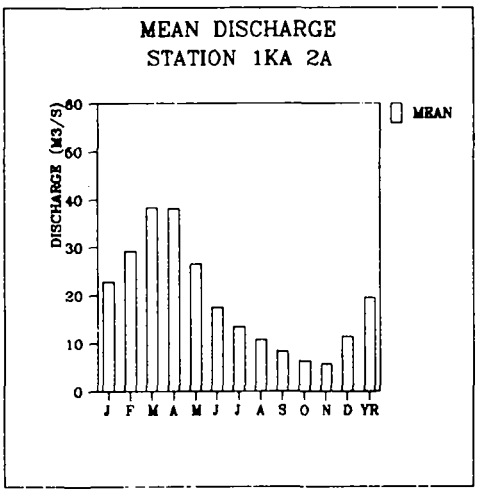

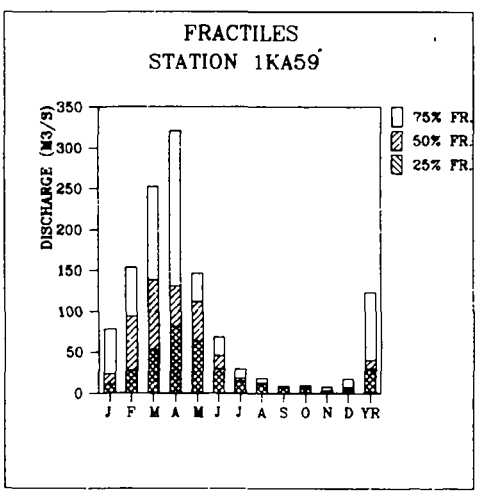

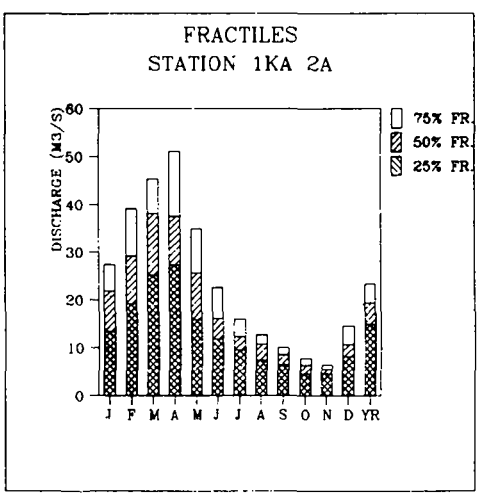

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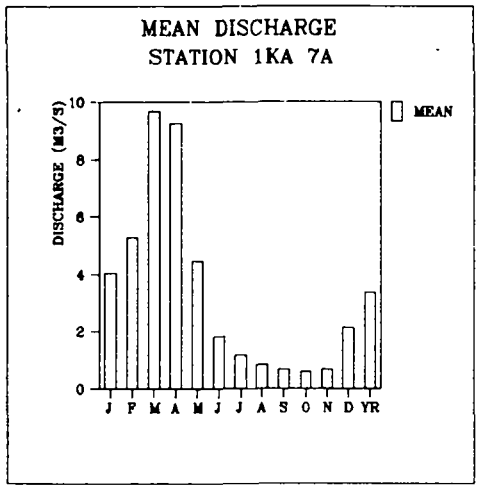

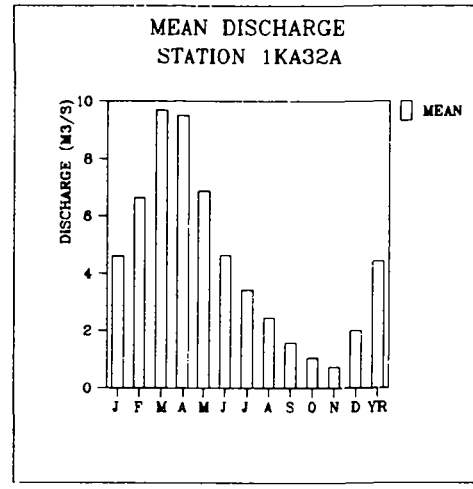

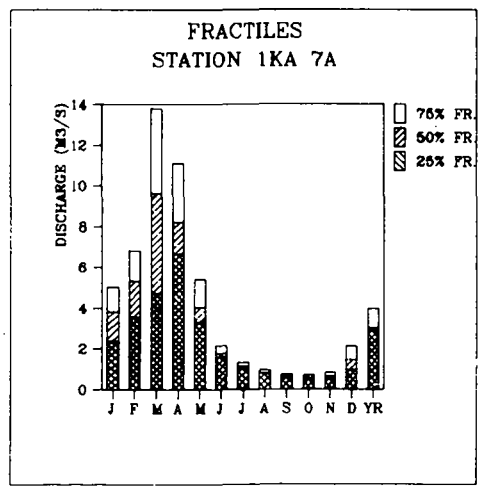

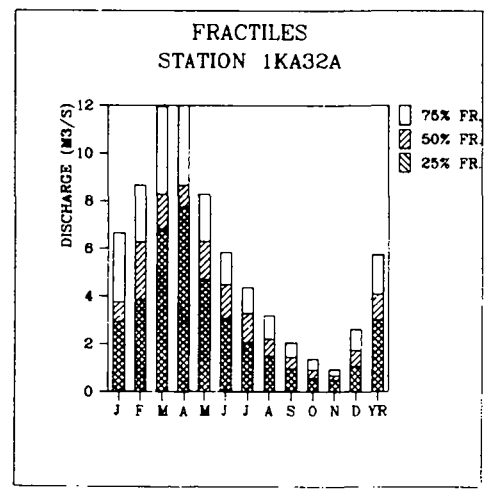

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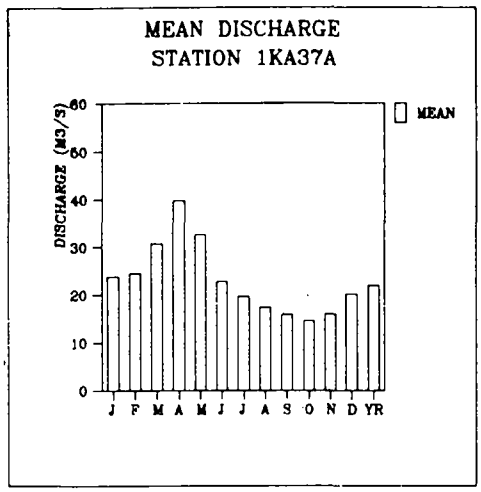

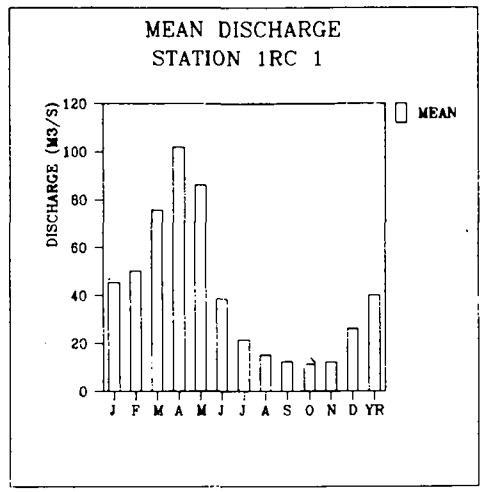

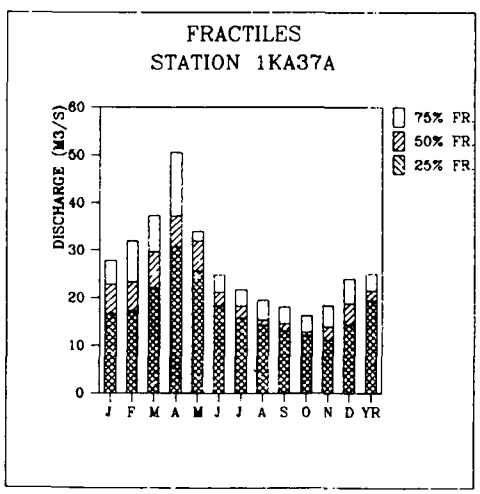

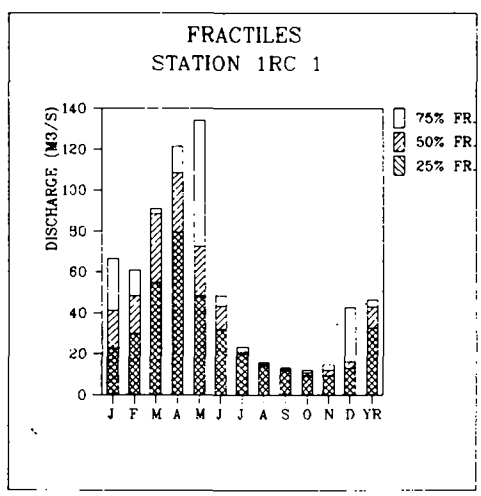

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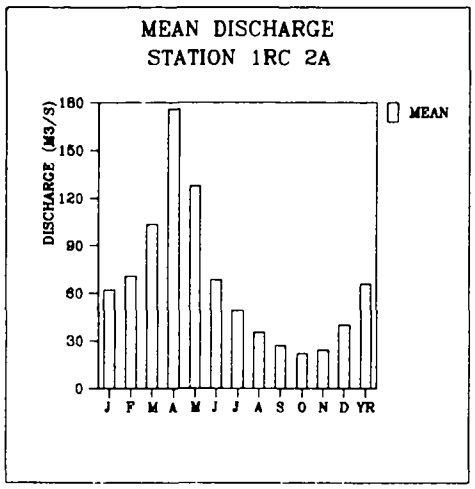

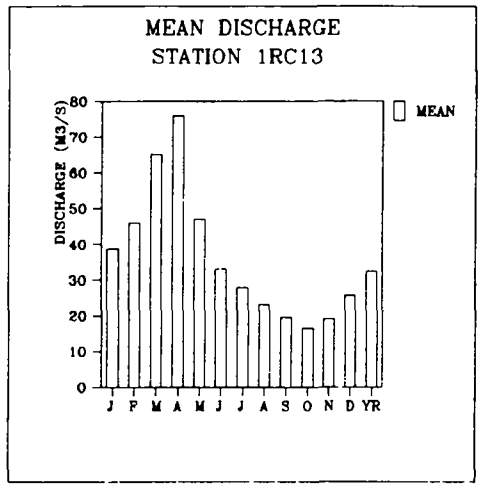

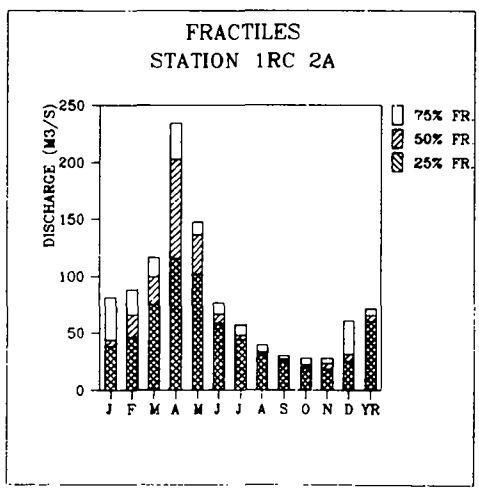

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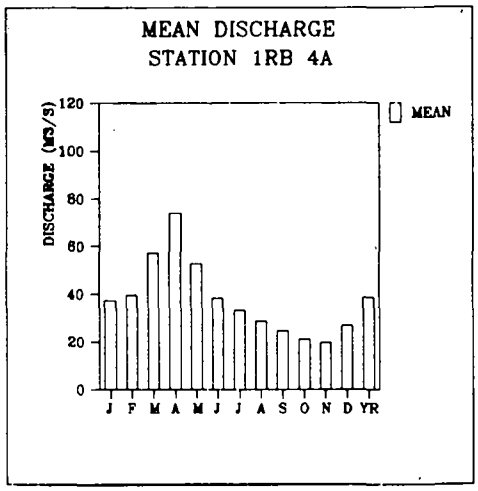

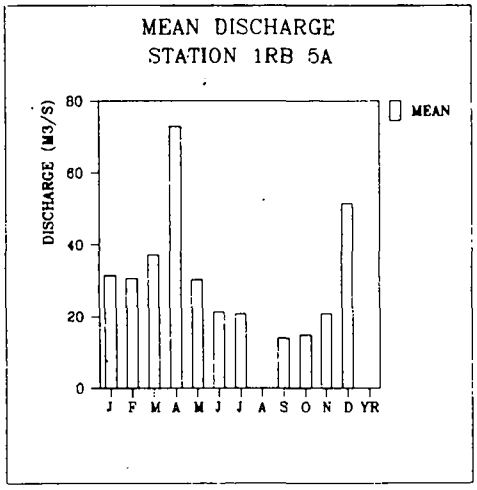

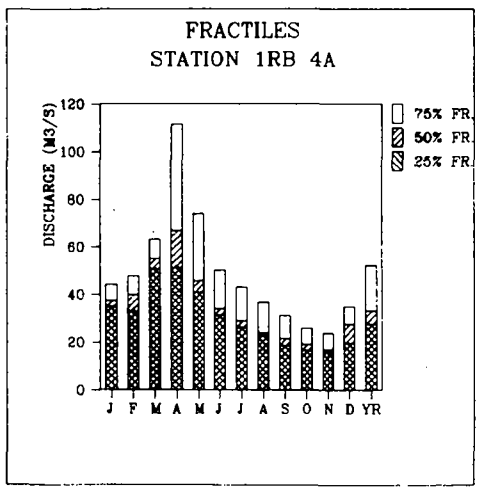

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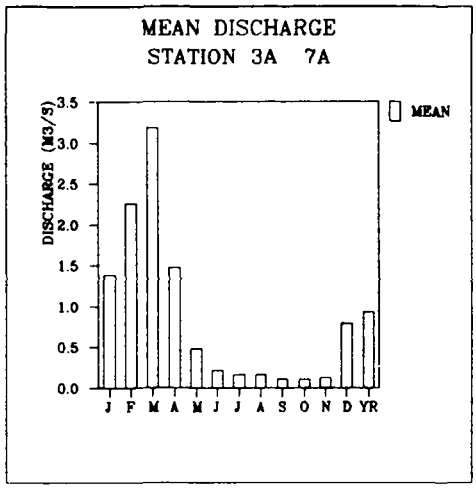

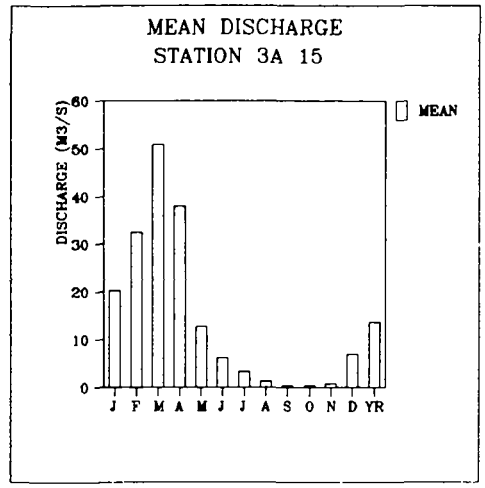

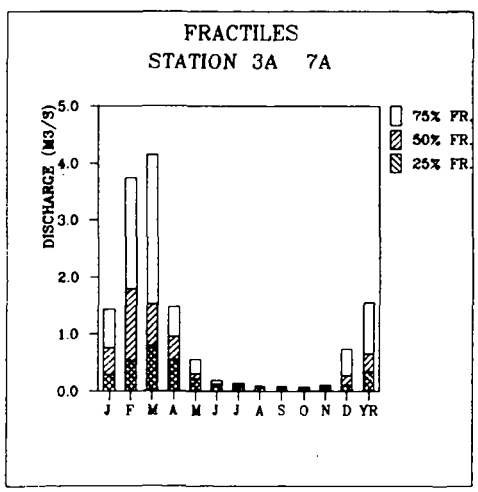

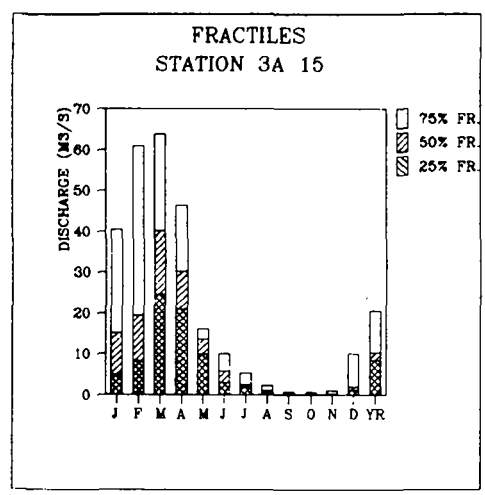

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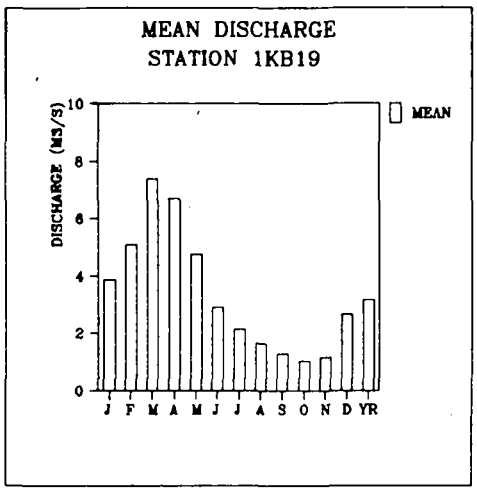

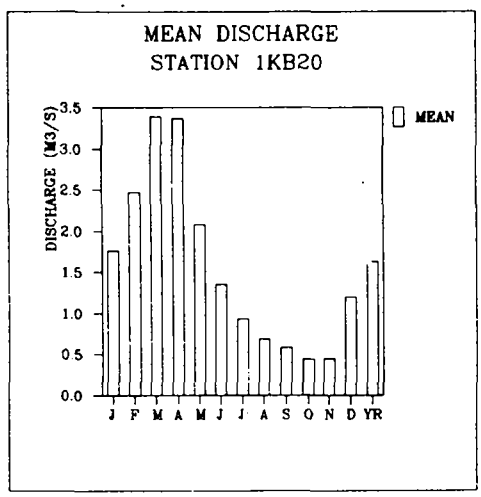

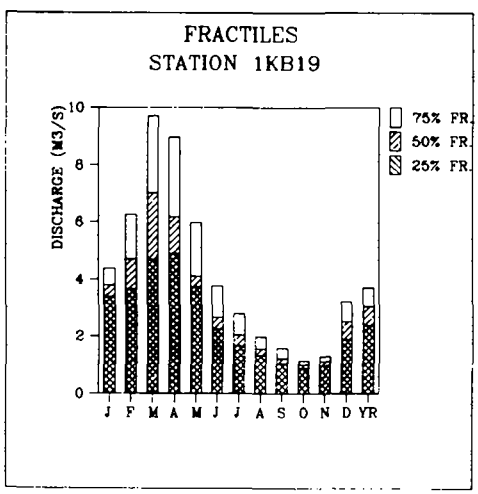

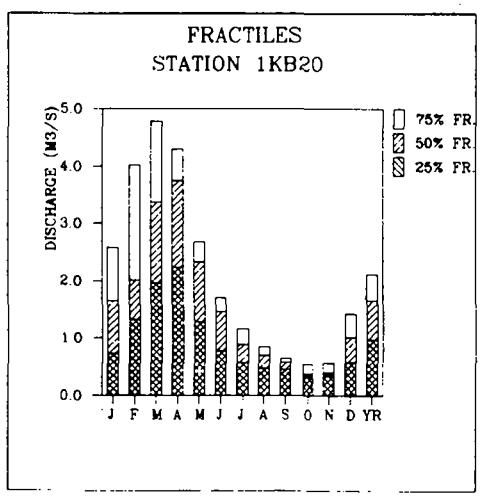

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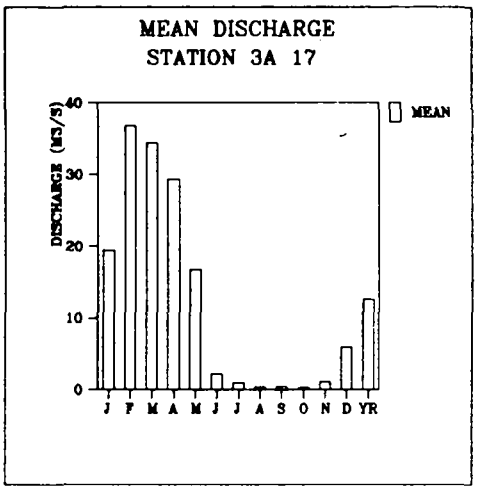

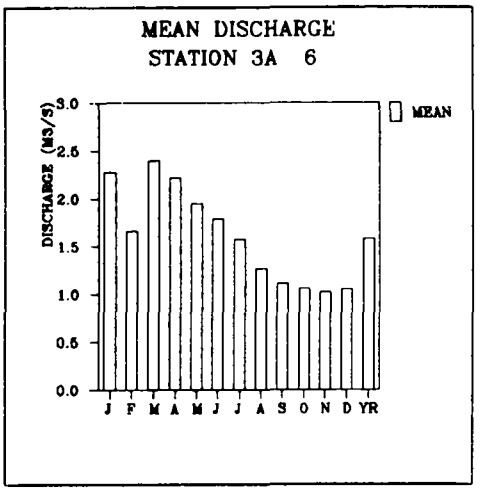

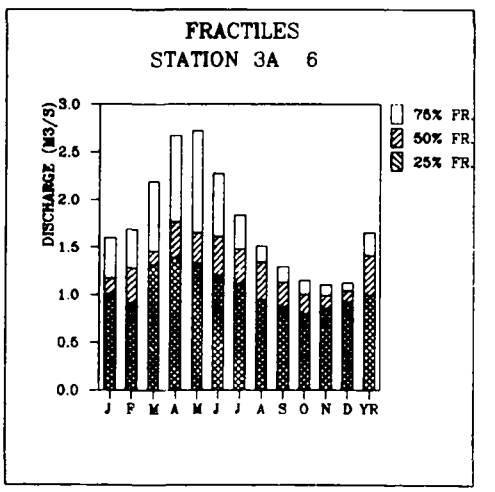

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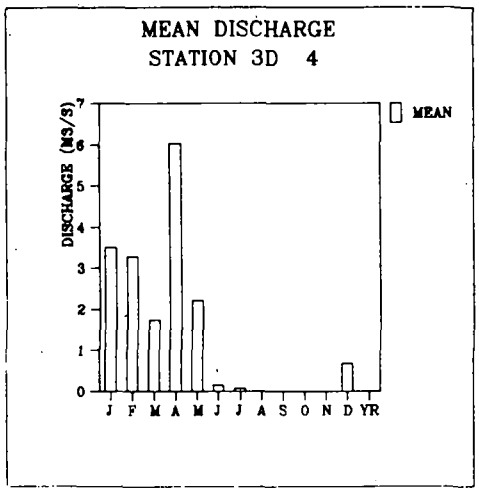

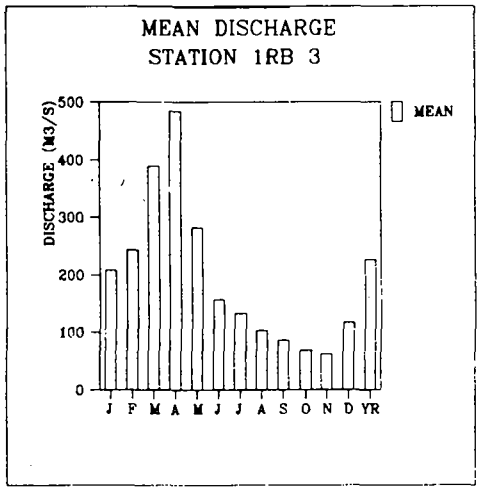

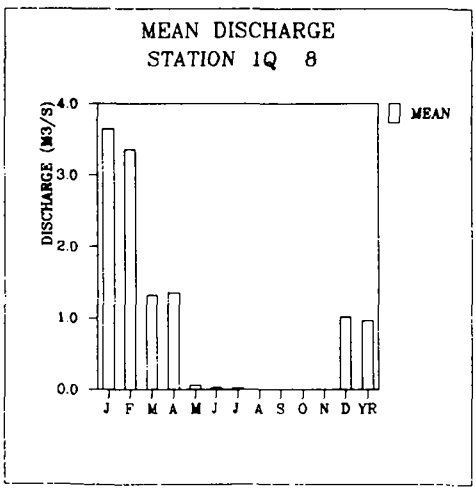

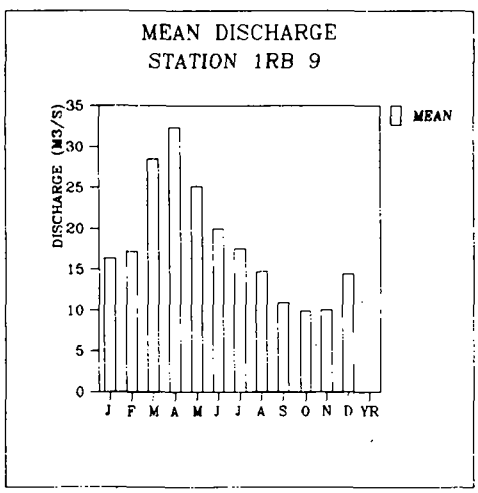

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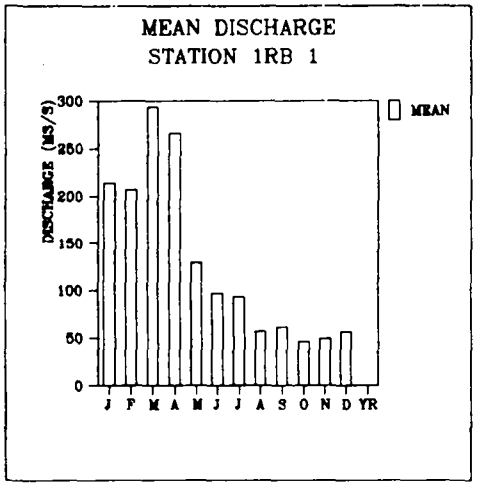

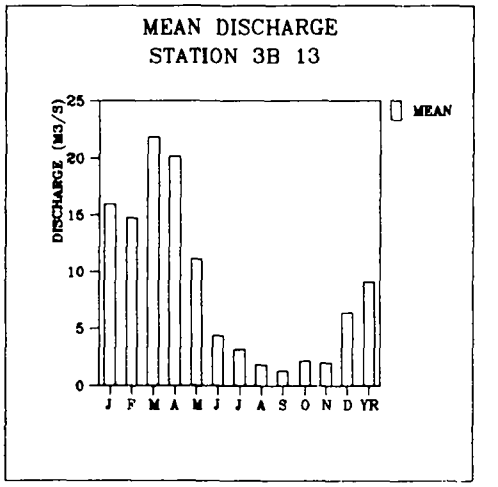

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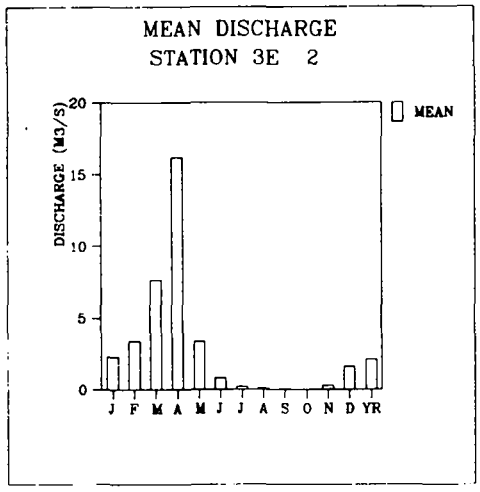

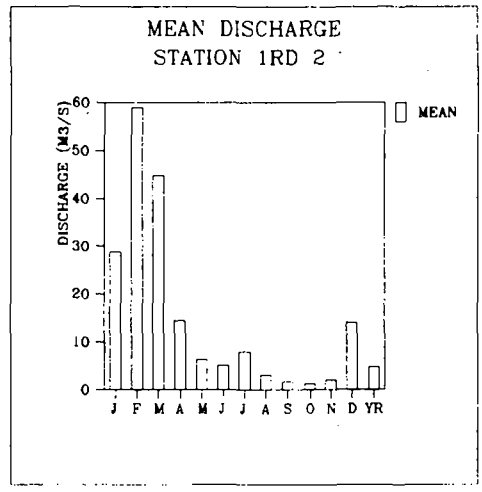

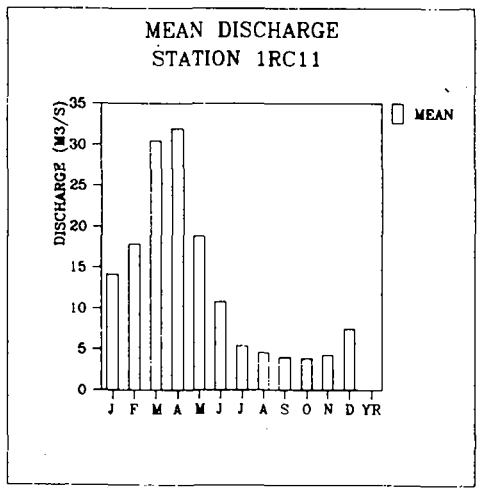

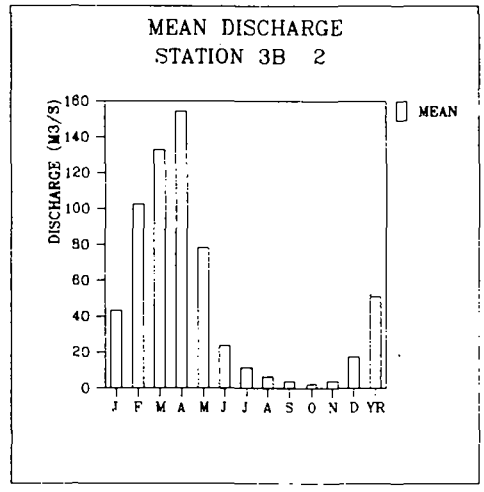

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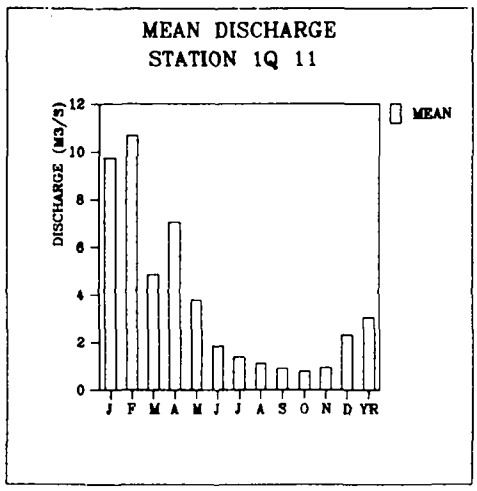

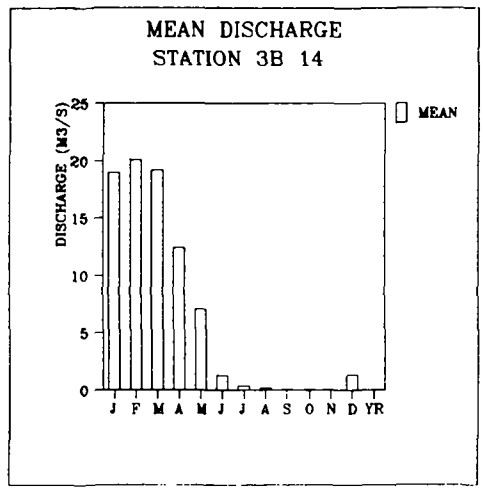

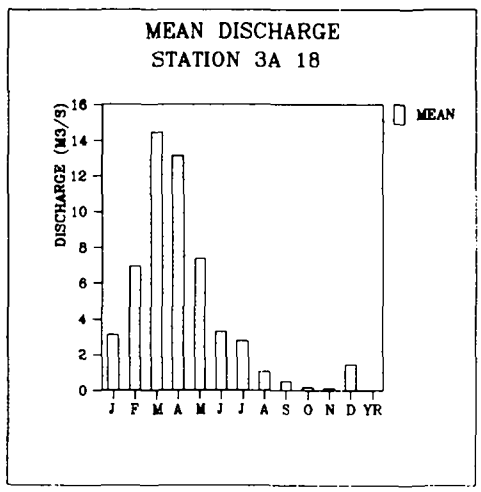

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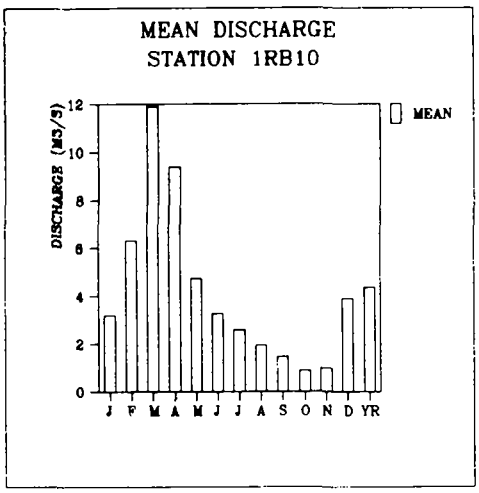

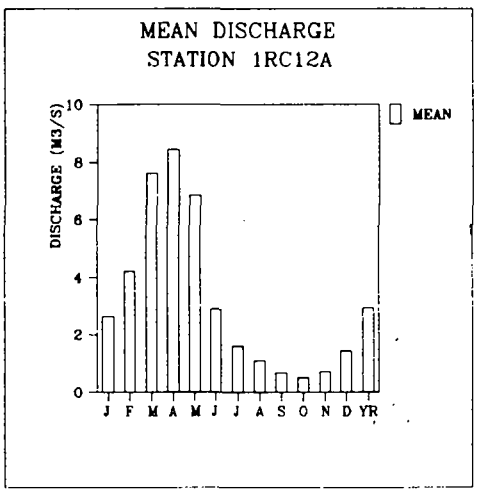

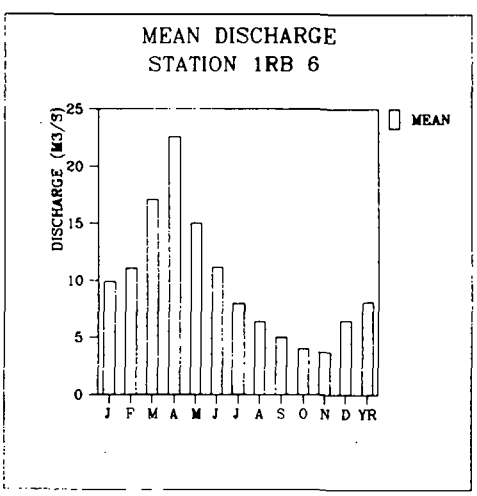

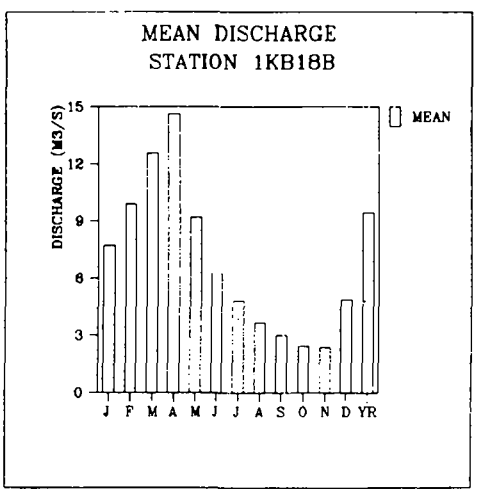

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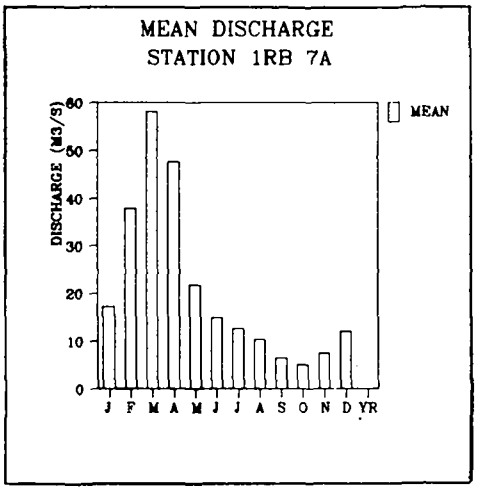

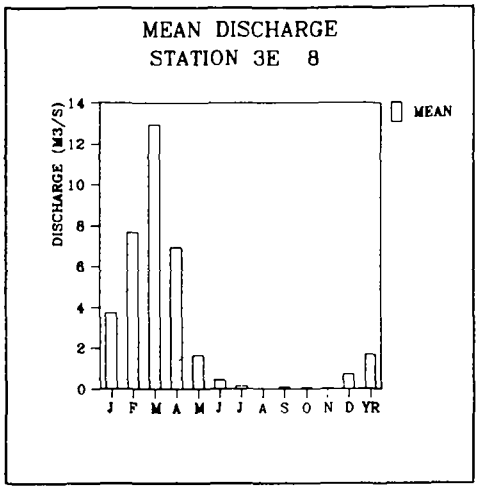

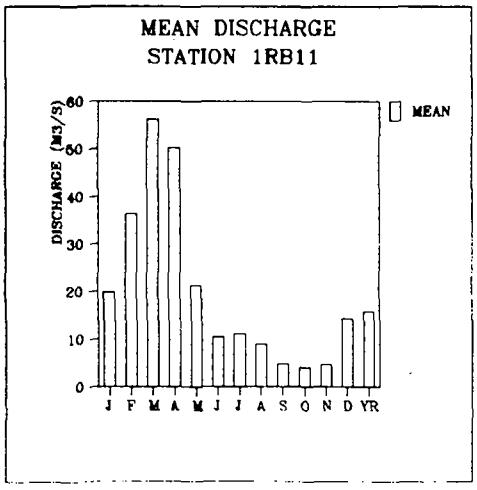

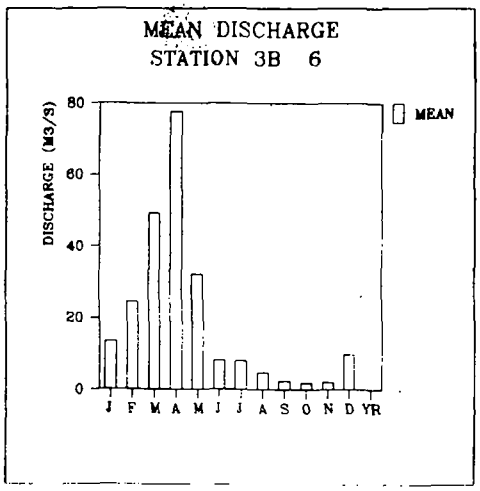

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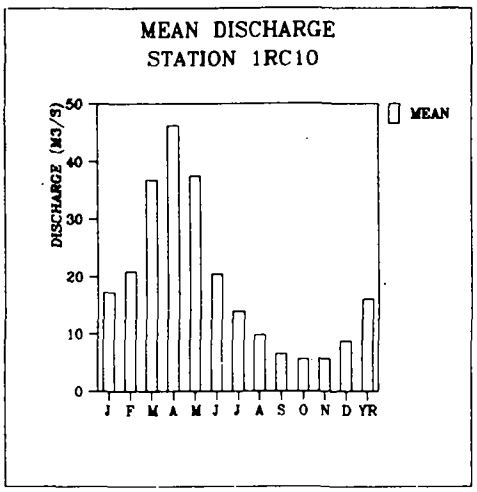
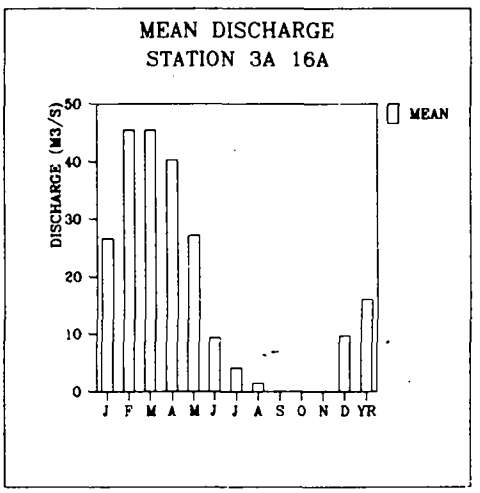
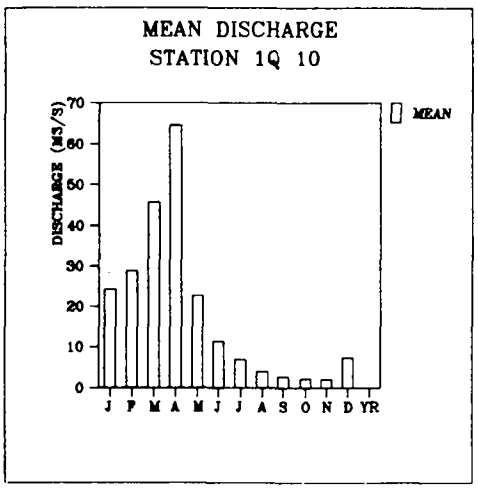
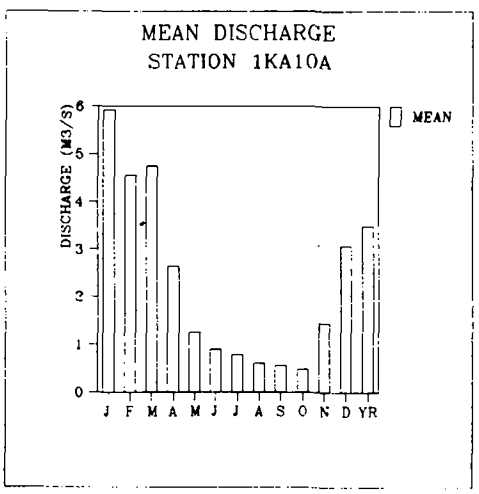








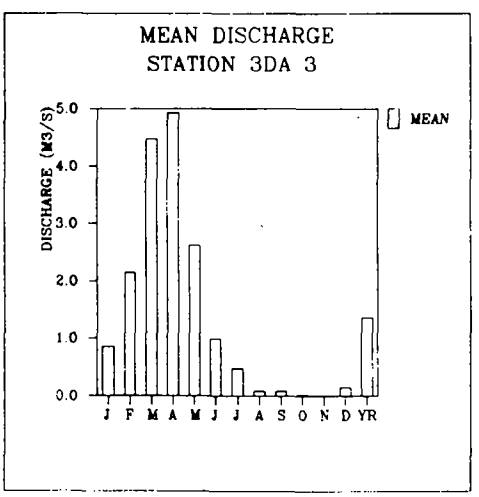
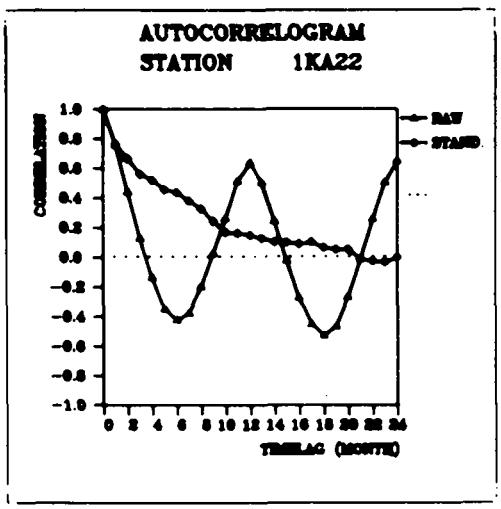
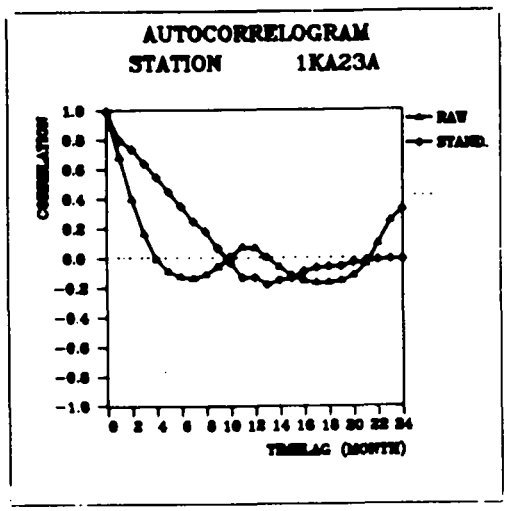
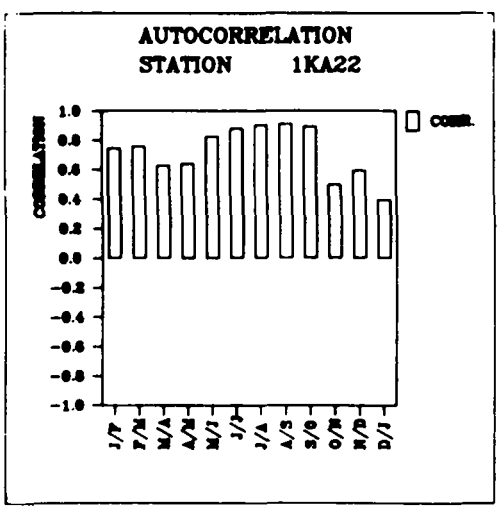


Figure 6.78 - Cont'd.







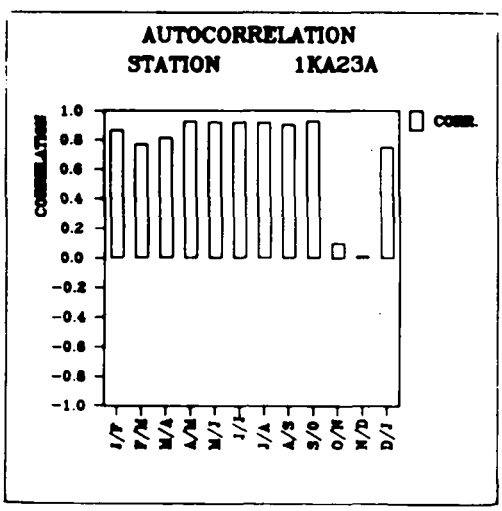
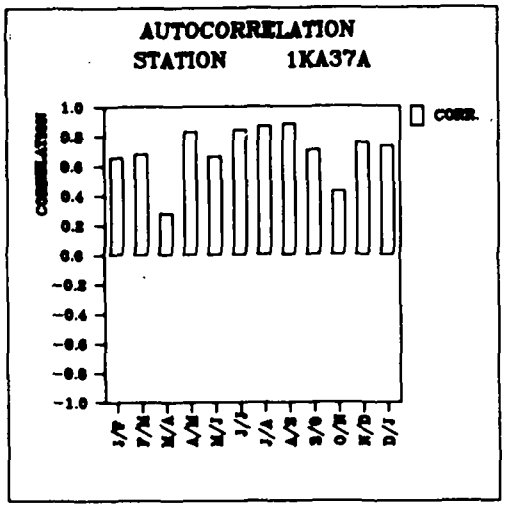
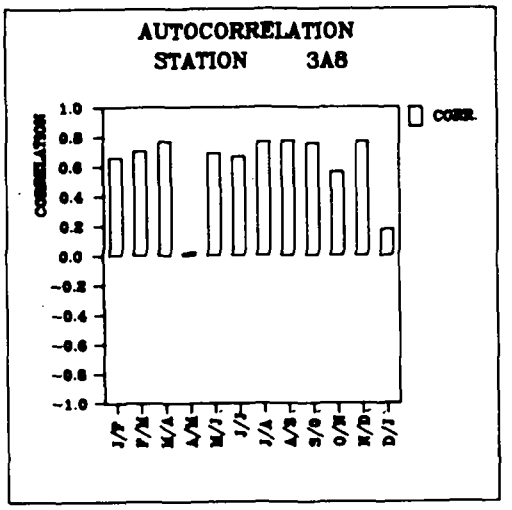
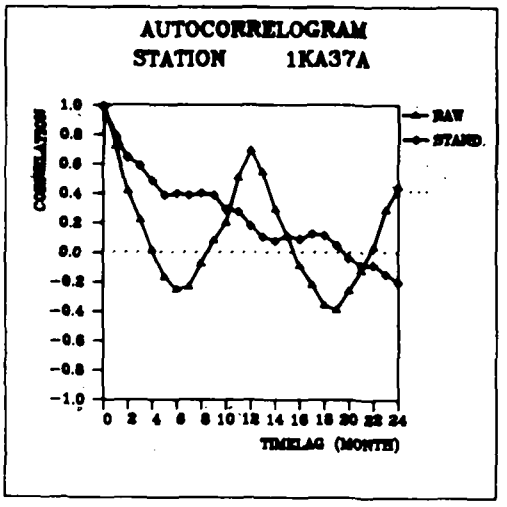


Figure 6.9[8] - Autocorrelograms for raw and standardized data together with the seasonal variation of the lag-1 autocorrelation coefficient of the raw data. For the priority stations.







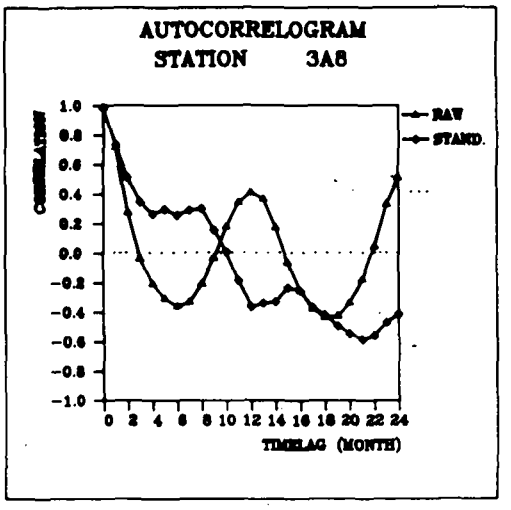
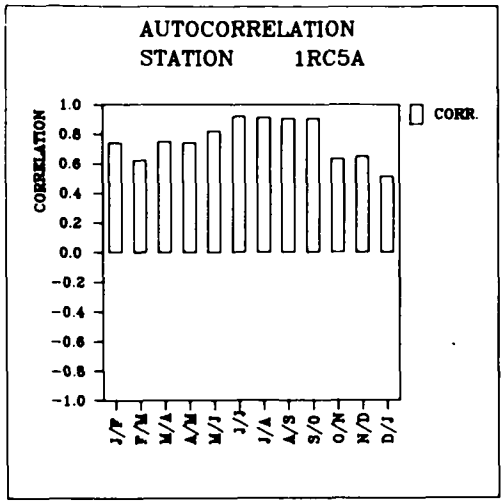
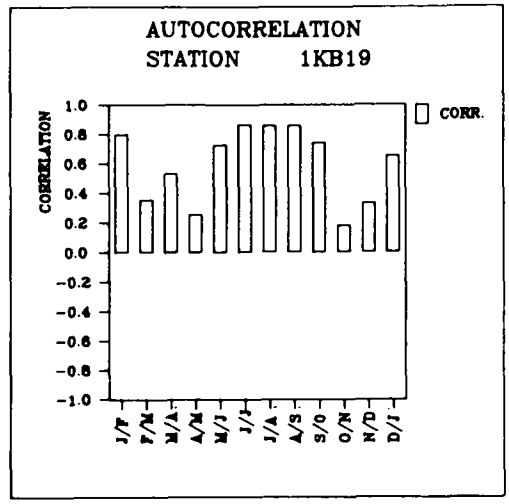
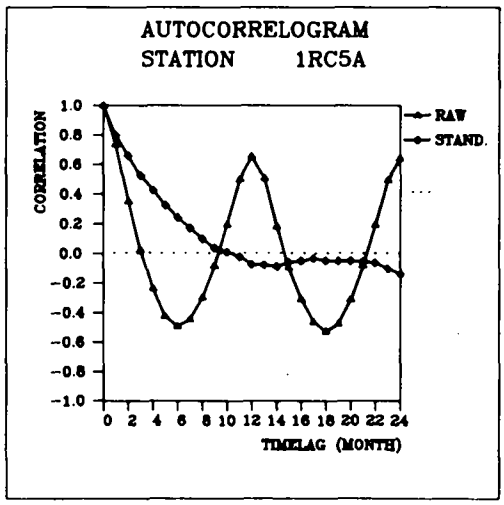


Figure 6.9[8] - Cont'd.







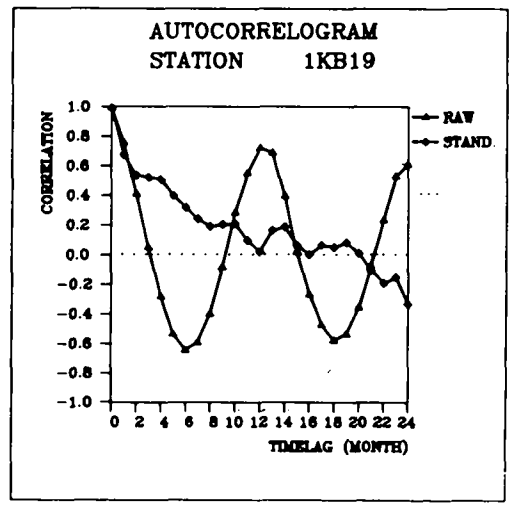
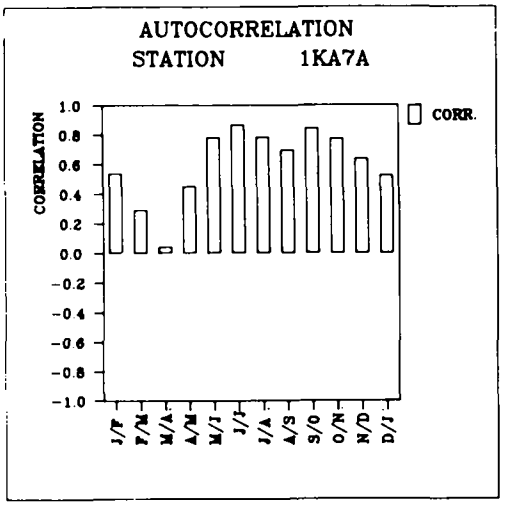
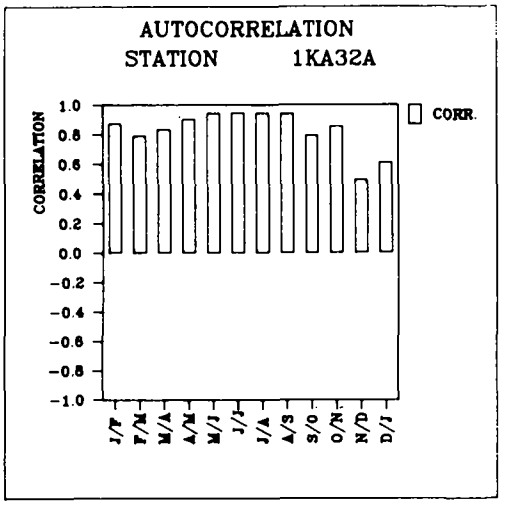
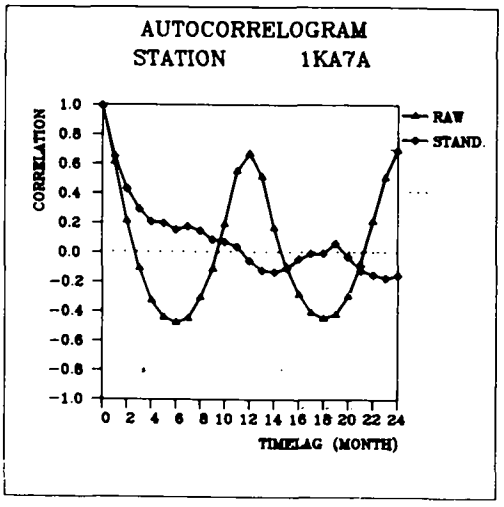
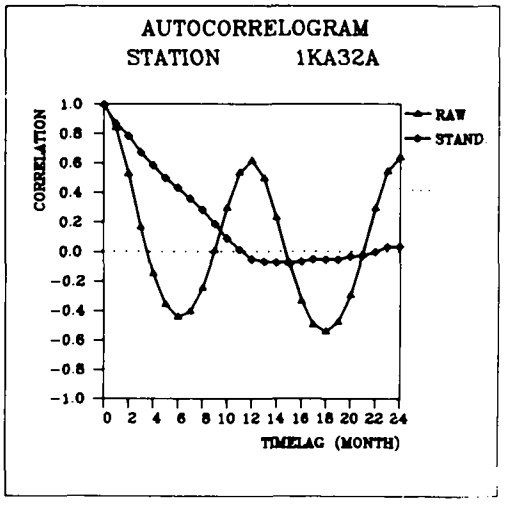


Figure 6.9[8] - Cont'd.









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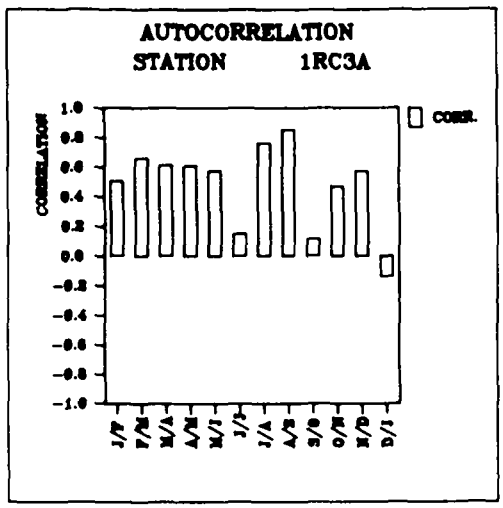

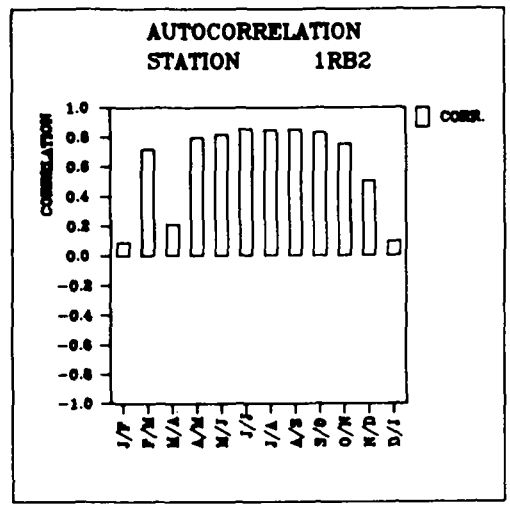

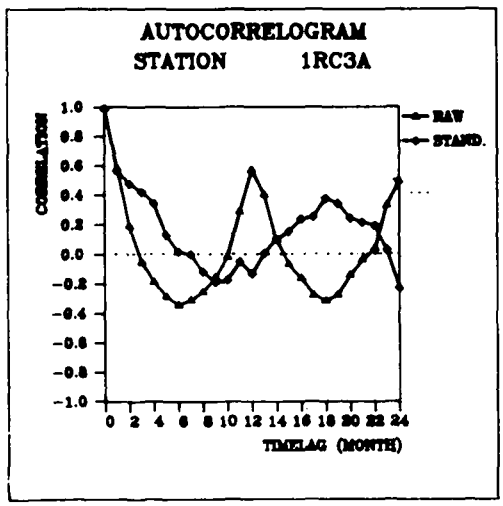

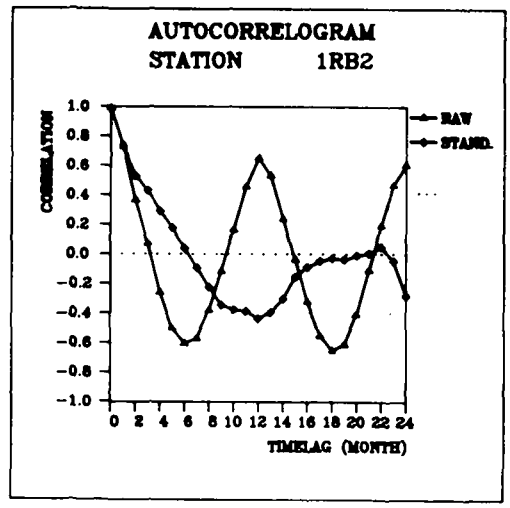

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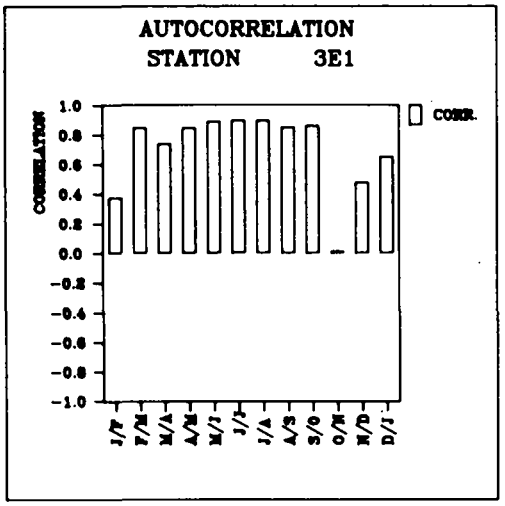

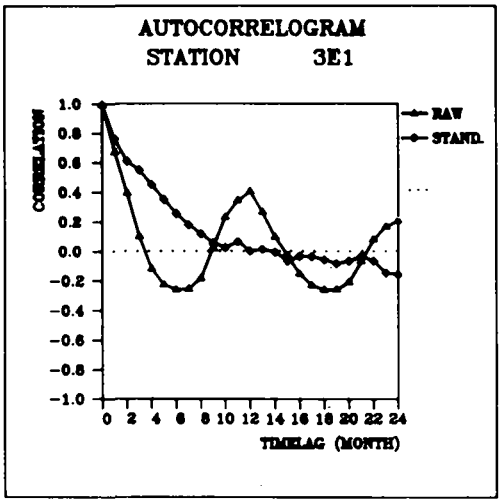

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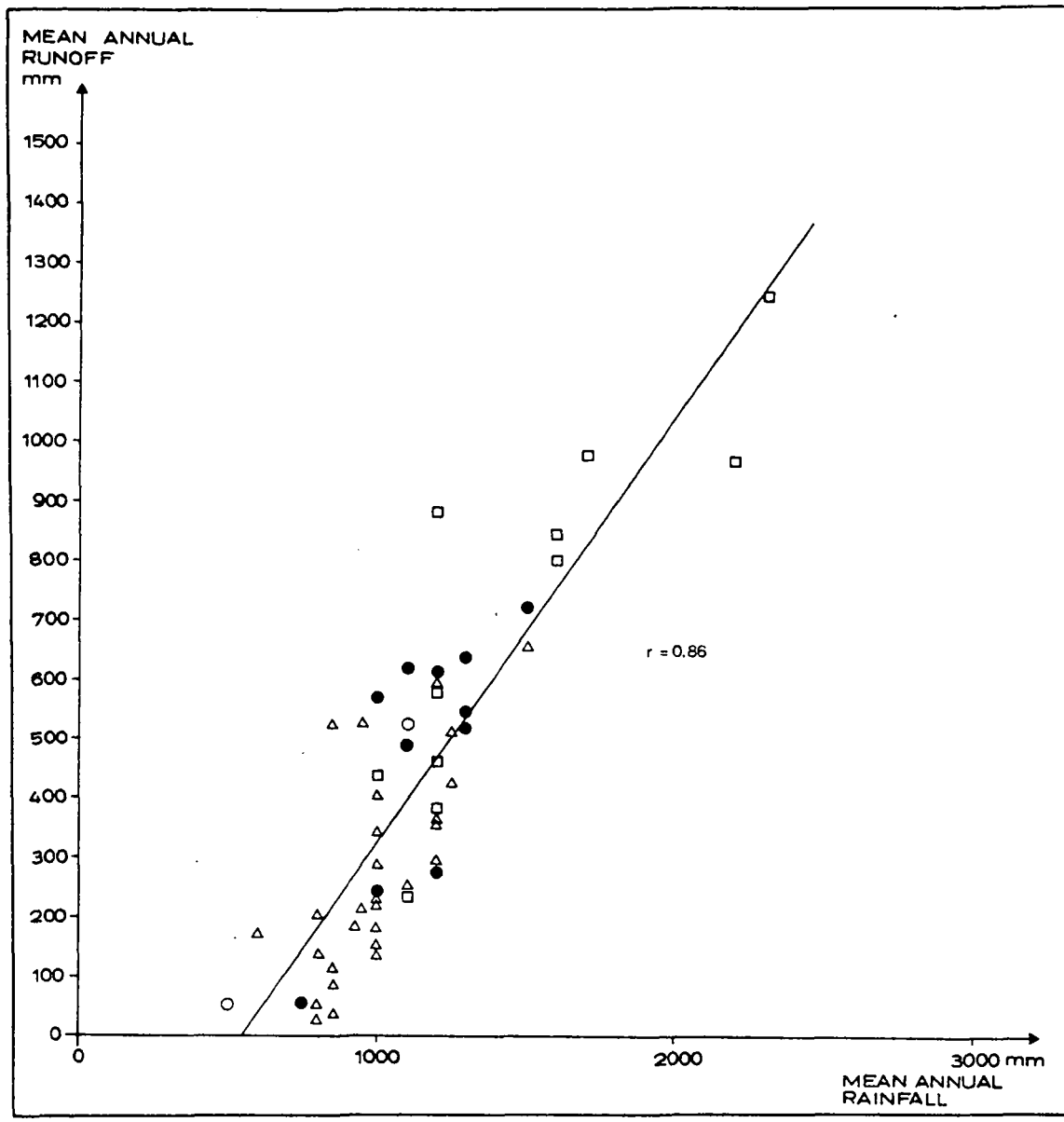

Figure 6.18[8] - Mean annual runoff plottet against mean annual rainfall for selected catchments.

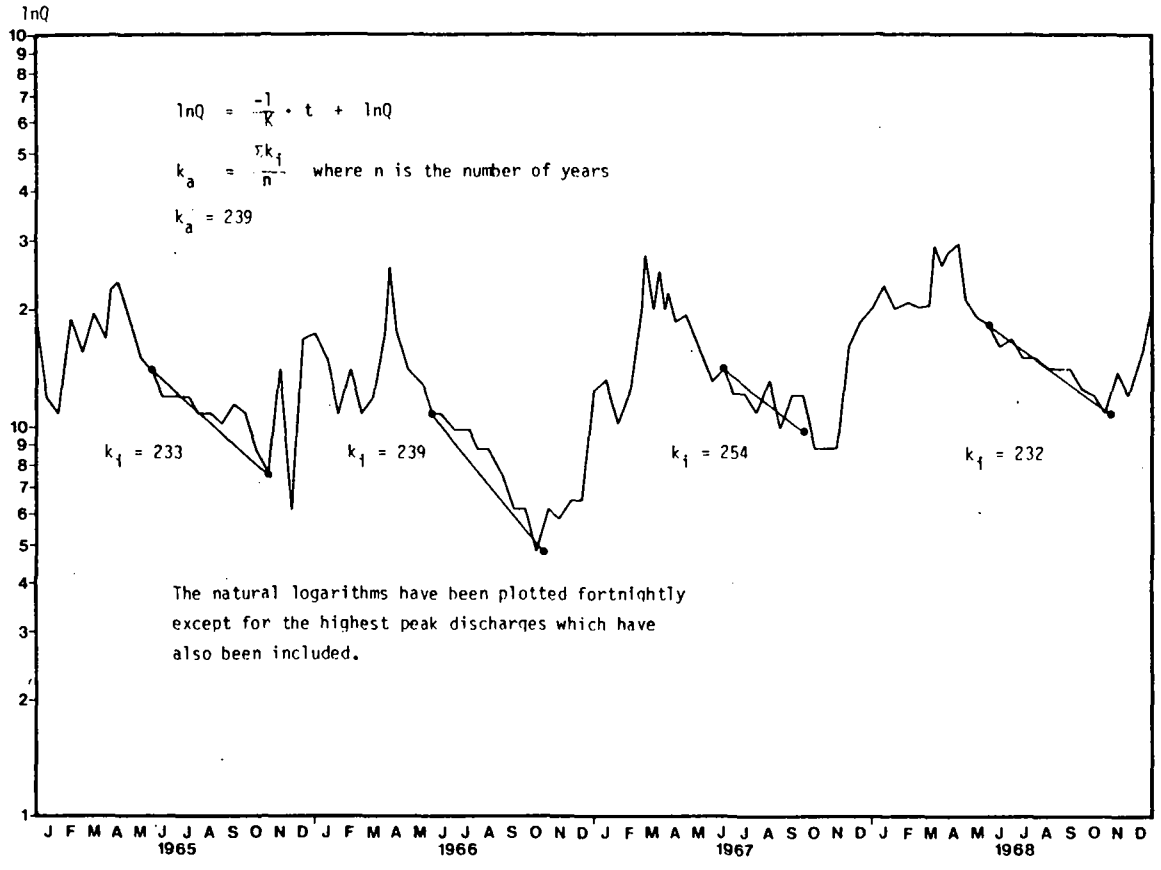

Figure 6.23[8]. Plot illustrates the applicability of the exponential baseflow recession. K_i being the recession constant of the individual year and K_a the average recession constant for the four year period.

Perennial rivers

National station code	Region	River	Location	Average recession constant k[day^{-1}]	Range of average recession constants k [day^{-1}]
1KA21A	Iringa	Little Ruaha	Ihimbu	0.009	0.007-0.011
1KA22	Iringa	Mtitu	Mtitu	0.005	0.005-0.006
1KA37A	Iringa	Lukosi	Mtandika	0.004	0.003-0.004
1RC8A	Mbeya	Kiwira	Natural Brigde	0.004	0.002-0.005
1KA2A	Iringa	Little Ruaha	Ndiuka	0.008	0.006-0.009
3A8	Mbeya	Myovisi	G.N. Road	0.008	0.007-0.008
1RC5A	Mbeya	Kiwira	Kiwira Village	0.004	0.003-0.005
1KB19	Iringa	Hagafiro	Hagafiro	0.008	0.007-0.009
1KA7A	Mbeya	Chimala	Chitekelo	0.010	0.009-0.011
1RC3A	Mbeya	Mbaka	Mwaya	0.010	0.005-0.013
3A2A	Mbeya	Songwe	Iwe	0.007	0.003-0.010
1RB2	Ruvuma	Ruhuhu	Masigira	0.005	0.004-0.005

Intermittent rivers

National station code	Region	River	Location	Average recession constant k [day^{-1}]	Range of average recession constant k [day^{-1}]
3A15	Mbeya	Lupa	Itigi Road	0.039	0.026-0.051
3B8	Mbeya	Mpemba	G.N. Road	0.029	0.022-0.040
1KA10A	Mbeya	Mlomboji	G.N. Road	0.031	0.013-0.053

Ephemeral rivers

National station code	Region	River	Location	Average recession constant k [day^{-1}]	Range of average recession constant k [day^{-1}]
1KA23A	Iringa	Huhuni	Iyayi	0.077	0.048-0.144
3DA3	Mbeya	Piti	Itigi Road Br.	0.051	0.044-0.055
3E1	Mbeya	Luika	Gua Road Br.	0.077	0.069-0.085

Table 6.1[8] Baseflow recession constants and their approximate range.

TABLE 6.28 EXTREME FLOW ANALYSIS

MINIMUM FLOW

NATIONAL STATION CODE: 1KA22

DURATION DAYS	RETURN PERIOD YEARS	EVENT $M^3/SEC.$	STANDARD DEVIATION $M^3/SEC.$
1	2	1.50	0.12
	5	1.21	0.07
	10	1.13	0.10
	20	1.08	0.13
	50	1.05	0.16
30	2	1.78	0.12
	5	1.44	0.08
	10	1.32	0.09
	20	1.24	0.12
	50	1.19	0.16
120	2	2.25	0.14
	5	1.82	0.10
	10	1.66	0.10
	20	1.55	0.13
	50	1.46	0.17

TABLE 6.3.8 EXTREME FLOW ANALYSIS

MINIMUM FLOW

NATIONAL STATION CODE: 1KA37A

DURATION DAYS	RETURN PERIOD YEARS	EVENT $M^3/SEC.$	STANDARD DEVIATION $M^3/SEC.$
1	2	10.87	1.04
	5	8.70	0.58
	10	8.09	0.95
	20	7.79	1.29
	50	7.61	1.58
30	2	12.26	1.02
	5	10.29	0.61
	10	9.79	1.07
	20	9.55	1.41
	50	9.41	1.68
120	2	14.05	0.65
	5	12.16	0.51
	10	11.39	0.51
	20	10.89	0.62
	50	10.46	0.83

TABLE 6.48 EXTREME FLOW ANALYSIS

MINIMUM FLOW

NATIONAL STATION CODE: 3A8

DURATION DAYS	RETURN PERIOD YEARS	EVENT $M^3/SEC.$	STANDARD DEVIATION $M^3/SEC.$
1	2	0.34	0.03
	5	0.27	0.02
	10	0.24	0.02
	20	0.23	0.03
	50	0.22	0.04
30	2	0.42	0.03
	5	0.32	0.03
	10	0.27	0.03
	20	0.24	0.04
	50	0.21	0.05
120	2	0.55	0.04
	5	0.44	0.04
	10	0.39	0.04
	20	0.35	0.04
	50	0.32	0.05

TABLE 6.58 EXTREME FLOW ANALYSIS

MINIMUM FLOW

NATIONAL STATION CODE: 1RC5A

DURATION DAYS	RETURN PERIOD YEARS	EVENT $M^3/SEC.$	STANDARD DEVIATION $M^3/SEC.$
1	2	2.42	0.07
	5	2.17	0.07
	10	2.06	0.07
	20	1.98	0.08
	50	1.90	0.10
30	2	2.59	0.08
	5	2.33	0.07
	10	2.21	0.07
	20	2.12	0.08
	50	2.05	0.11
120	2	2.93	0.10
	5	2.62	0.08
	10	2.49	0.08
	20	2.40	0.10
	50	2.32	0.13

TABLE 6.6[8] EXTREME FLOW ANALYSIS

MINIMUM FLOW

NATIONAL STATION CODE: 1KB19

DURATION DAYS	RETURN PERIOD YEARS	EVENT $M^3/SEC.$	STANDARD DEVIATION $M^3/SEC.$
1	2	0.69	0.03
	5	0.59	0.03
	10	0.54	0.03
	20	0.51	0.04
	50	0.48	0.05
30	2	0.83	0.04
	5	0.71	0.03
	10	0.67	0.03
	20	0.64	0.04
	50	0.61	0.06
120	2	1.14	0.06
	5	0.99	0.04
	10	0.93	0.04
	20	0.90	0.06
	50	0.87	0.08

TABLE 6.78 EXTREME FLOW ANALYSIS

MINIMUM FLOW

NATIONAL STATION CODE: 1KA7A

DURATION DAYS	RETURN PERIOD YEARS	EVENT $M^3/SEC.$	STANDARD DEVIATION $M^3/SEC.$
1	2	0.37	0.06
	5	0.23	0.04
	10	0.17	0.04
	20	0.14	0.05
	50	0.11	0.07
30	2	0.54	0.05
	5	0.40	0.05
	10	0.32	0.06
	20	0.26	0.07
	50	0.20	0.09
120	2	0.66	0.04
	5	0.52	0.05
	10	0.45	0.06
	20	0.39	0.07
	50	0.33	0.09

TABLE 6.8[8] EXTREME FLOW ANALYSIS

MINIMUM FLOW

NATIONAL STATION CODE: 1KA32A

DURATION DAYS	RETURN PERIOD YEARS	EVENT $M^3/SEC.$	STANDARD DEVIATION $M^3/SEC.$
1	2	0.46	0.08
	5	0.28	0.04
	10	0.23	0.07
	20	0.20	0.09
	50	0.19	0.10
30	2	0.57	0.09
	5	0.36	0.05
	10	0.29	0.07
	20	0.26	0.10
	50	0.23	0.13
120	2	1.06	0.14
	5	0.67	0.09
	10	0.53	0.10
	20	0.45	0.13
	50	0.39	0.18

TABLE 6.98 EXTREME FLOW ANALYSIS

MINIMUM FLOW

NATIONAL STATION CODE: 1RC3A

DURATION DAYS	RETURN PERIOD YEARS	EVENT $M^3/SEC.$	STANDARD DEVIATION $M^3/SEC.$
1	2	4.44	0.36
	5	3.24	0.45
	10	2.54	0.54
	20	1.94	0.69
	50	1.23	0.98
30	2	5.20	0.43
	5	3.79	0.53
	10	2.97	0.63
	20	2.27	0.80
	50	1.47	1.13
120	2	7.05	0.76
	5	5.50	0.49
	10	4.96	0.54
	20	4.64	0.73
	50	4.39	0.97

TABLE 6.10[8] EXTREME FLOW ANALYSIS

MINIMUM FLOW

NATIONAL STATION CODE: 1RB2

DURATION DAYS	RETURN PERIOD YEARS	EVENT $M^3/SEC.$	STANDARD DEVIATION $M^3/SEC.$
1	2	18.32	1.55
	5	15.75	1.00
	10	14.83	1.10
	20	14.29	1.50
	50	13.88	1.97
30	2	20.69	1.57
	5	18.00	1.06
	10	17.02	1.12
	20	16.43	1.47
	50	15.96	1.97
120	2	25.66	2.02
	5	22.09	1.59
	10	20.64	1.60
	20	19.68	1.94
	50	18.86	2.57

National Station Code	River	Geomorph. Zone	Area km^2	Mean Annual rainfall mm/year	Mean Annual runoff $l/s/km^2$	10 year min. runoff $l/s/km^2$	75% fractile of monthly runoff $l/s/km^2$	25% fractile of monthly runoff $l/s/km^2$	ratio Q_{75}/Q_{25}
1KA22	Mtitu	A	445	1000	9.1	2.5	11.5	5.9	1.95
1KA5	Gt. Ruaha	M	67950	500	1.7	0.01	2.4	0.18	13.33
1KA37A	Lukosi	G	2890	1000	7.6	2.8	9.0	5.3	1.70
1RC8A	Kiwira	R	655	1700	31.0	8.3	39.2	15.8	2.48
1KA2A	Lt. Ruaha	A	2920	950	6.7	0.6	9.1	2.8	3.25
3A8	Myovisi	A	152	1250	16.1	1.6	22.0	4.5	4.89
1RC5A	Kiwira	R	217	1600	25.2	9.5	33.0	15.0	2.20
1KB19	Hagafiro	A	153	1500	20.7	3.5	30.0	10.0	3.00
1KA7A	Chimala	G	167	1300	20.1	1.0	30.0	5.0	6.00
1KA23A	Muhuni	A	803	800	1.6	0	1.36	0.01	136.0
1KA32A	Lt. Ruaha	A	759	1000	5.8	0.3	8.7	1.9	4.58
1KA51A	Mswiswi	R	55	1200	12.2	-	13.6	5.0	2.72
1RC3A	Mbaka	R	645	2200	30.5	3.9	42.6	12.3	3.46
3B15	Mtembwa	A	8000	1000	4.3	0.01	4.9	0.3	16.33
1RB2	Ruhuhu	G	2220	1100	19.7	6.7	24.2	13.3	1.82
1RB3	Ruhuhu	M	13490	1100	16.8	-	25.1	6.9	3.64
1RC11	Rumakali	R	414	1600	-	only 1 years data	-	-	-
3DA3	Piti	G	800	750	1.7	0	2.9	0.05	58.00
1RC2A	Kiwira	R	1660	2300	39.5	5.4	51.3	16.7	3.07
3E1	Luika	A	1700	850	2.5	0	4.1	0.01	4.10

A = African/Post African G = Gondwana/Post Gondwana R = Rungwe Volcanics M = More than one broad type

Table 6.11[8] - Selected stations and hydrological variables used in regional studies.

National Station code	Catchment area km^2	Mean Annual discharge m^3/sec	Mean Annual Runoff mm/year	Mean Annual Rainfall mm/year	Geomorpholo-gic grouping
1KA21A	2480	17.2	219	1000	A
1KA22	445	4.0	286	1000	A
1KA39A	1740	12.5	226	1000	A
1KA9	448	7.5	528	950	A
1KA11A	1600	17.2	340	1000	A
1KA5	67950	114.0	53	500	M
1KA37A	2890	22.0	240	1000	G
1RC8A	655	20.3	977	1700	R
1KA8A	795	14.5	574	1000	G
1KA15A	1360	7.9	184	925	A
1KA59	24620	105.0	134	800	A
1KA2A	2920	19.6	211	950	A
3A4	131	1.0	234	1100	R
3A8	152	2.5	509	1250	A
1KA33A	2190	11.8	170	600	A
3B8	65	0.6	296	1200	A
1KA56	151	2.5	528	850	A
3A14A	176	2.4	421	1250	A
1RC5A	217	5.5	800	1600	R
1KB19	153	3.2	654	1500	A
1KB20	95	1.6	541	1300	G
1KA7A	167	3.4	635	1300	G
1KA12	470	3.0	201	800	A
1KA16	77	1.5	611	1200	G
1KA23A	803	1.3	50	800	A
1KA27	19941	50.0	32	800	A
1KA31	5193	19.2	116	850	A
1KA32A	759	4.4	184	1000	A
1KA45	40	1.1	883	1200	R
1KA51A	55	0.7	384	1200	R
1KA50A	104	1.5	467	1200	R
1RC3A	645	19.7	963	2200	R
3A2A	763	6.7	279	1200	G

Table 6.12[8] - Selected stations and hydrological variables used in retional studies.

National Station code	Catchment area km^2	Mean Annual discharge m^3/sec	Mean Annual Runoff mm/year	Mean Annual Rainfall mm/year	Geomorphologic grouping
3A7A	50	0.9	587	1200	G,R
3B15	8000	35.1	138	1000	A
3A16A	1250	16.1	407	1000	A
1RB2	2220	43.8	622	1100	G
1RB3	13490	226.0	529	1100	M
1RB4A	2480	38.5	490	1100	G
1RB10	544	4.4	252	1100	A,C
1RC12A	109	2.9	847	1600	R
1RC2A	1660	65.6	1246	2300	R
3E1	1700	4.6	86	850	A
1RC13	1414	32.4	724	1500	G
1RD2	292	4.8	519	1300	G
3DA3	800	1.4	54	750	G
3E2	2080	2.1	32	850	A
3A17	2587	12.6	153	1000	A
1KB18B	500	9.5	596	1200	A
1RB6	688	8.1	372	1200	A
1RB11	1400	15.8	356	1200	A
3A6	144	1.6	437	1000	R

Geomorphological Groupings:

A = African surface

G = Gondwana surface

R = Rungwe volcanics

C = Congo surface

M = more than one group

Table 6.12[8] - Cont'd.

Appendix 5
Refers to Volume 7, Chapter 7.

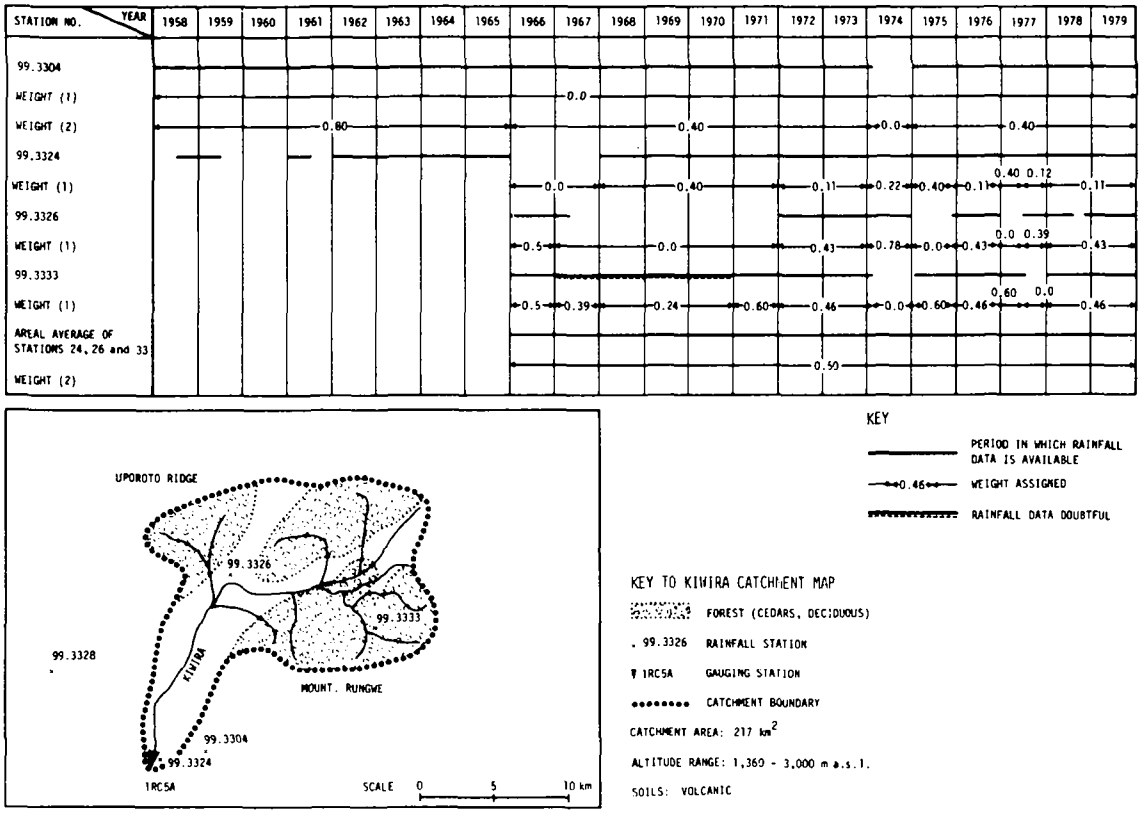

Figure 7.6[8] - Areal weight factors assigned to the rainfall stations at the Kiwira index catchment.

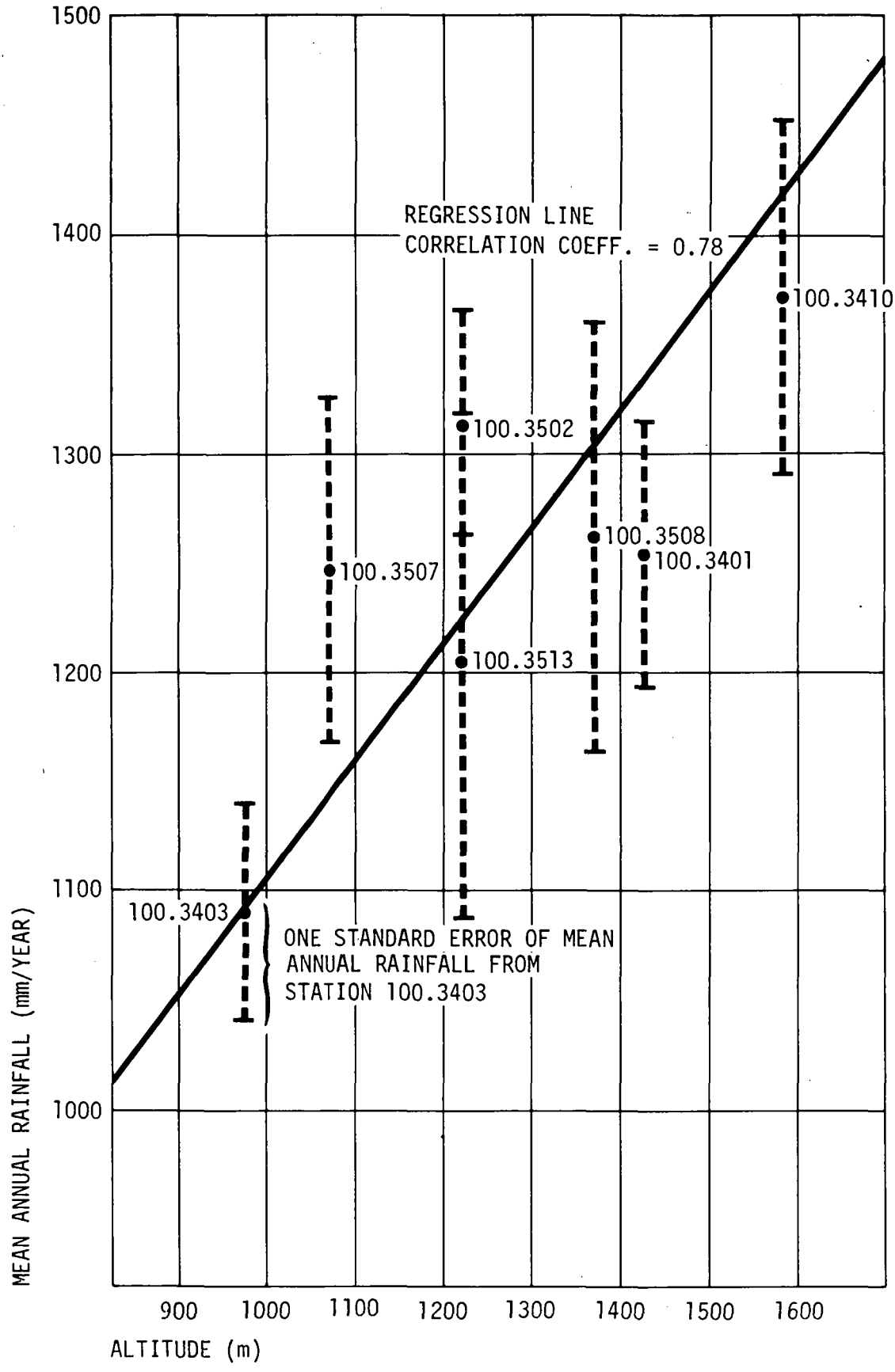

Figure 7.9[8] - Relationship between mean annual rainfall and altitude in the Mngaka area.

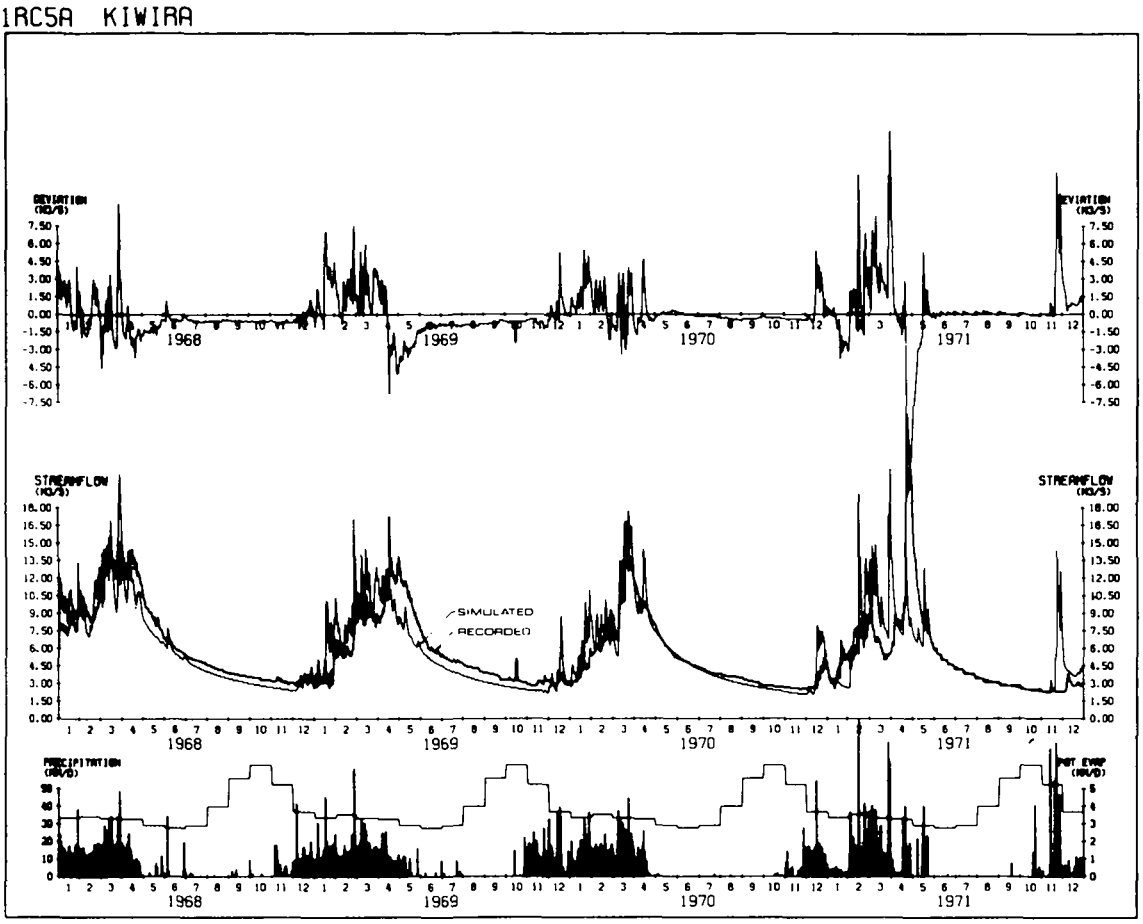

Figure 7.12[8] - Test run, Kiwira catchment at 1RC5A.

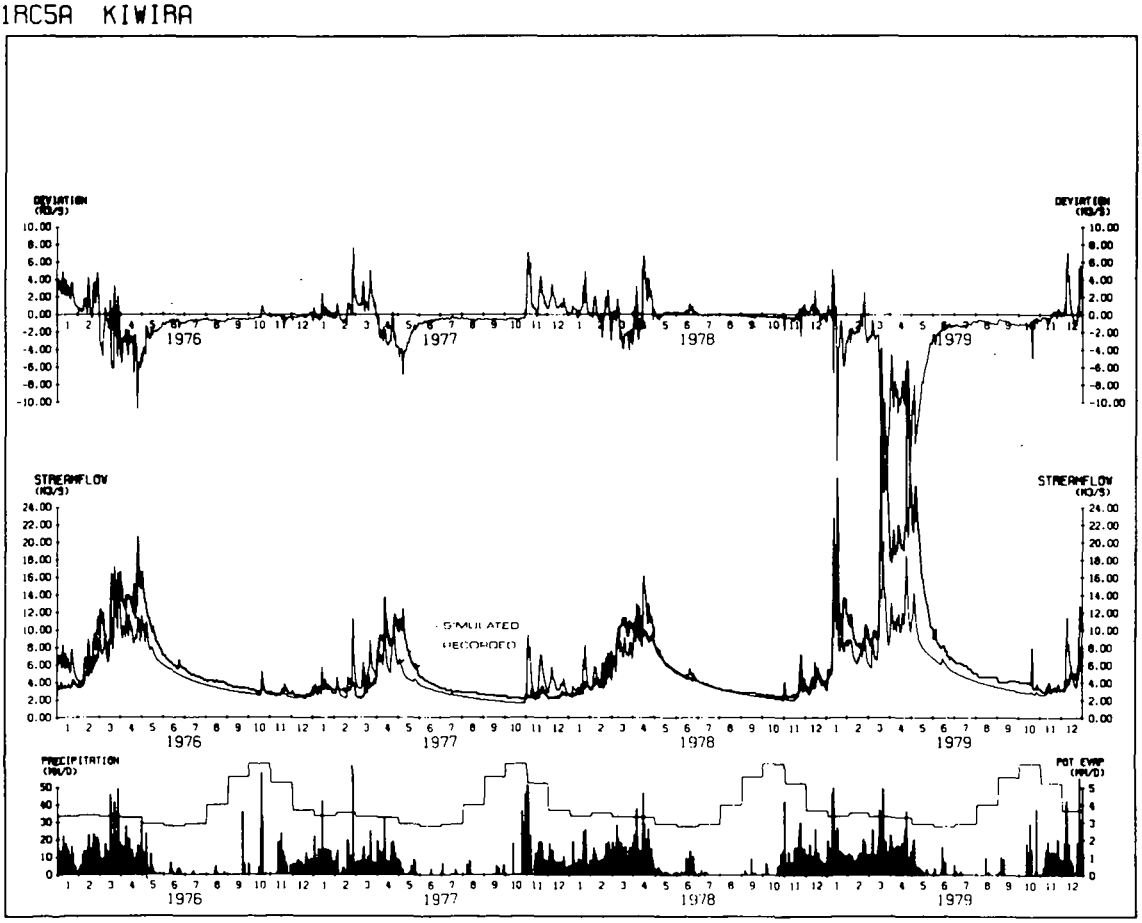

Figure 7.13[8] - Test run, Kiwira catchment at 1RC5A.

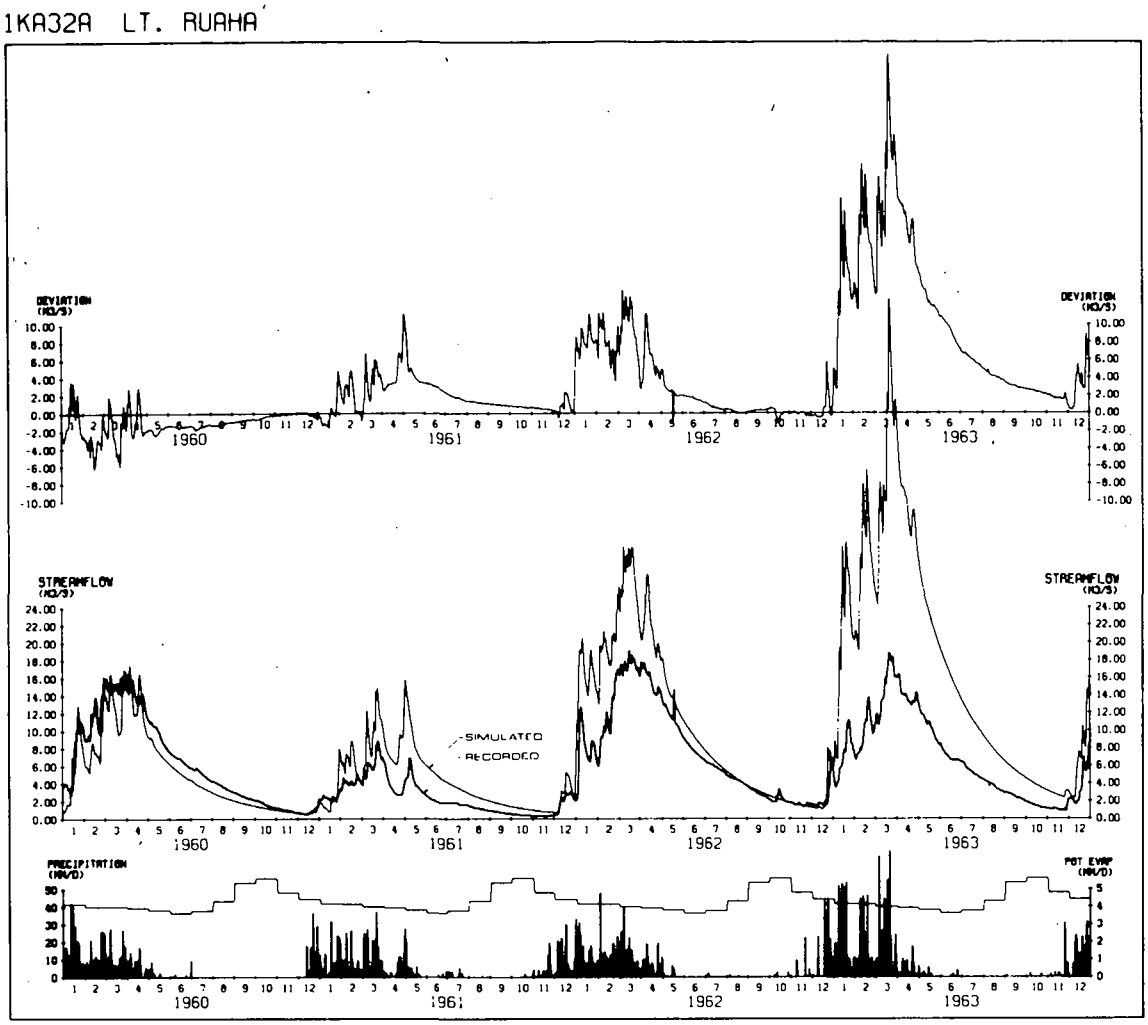

Figure 7.15[8] - Test run, Lt. Ruaha catchment at 1KA32A.

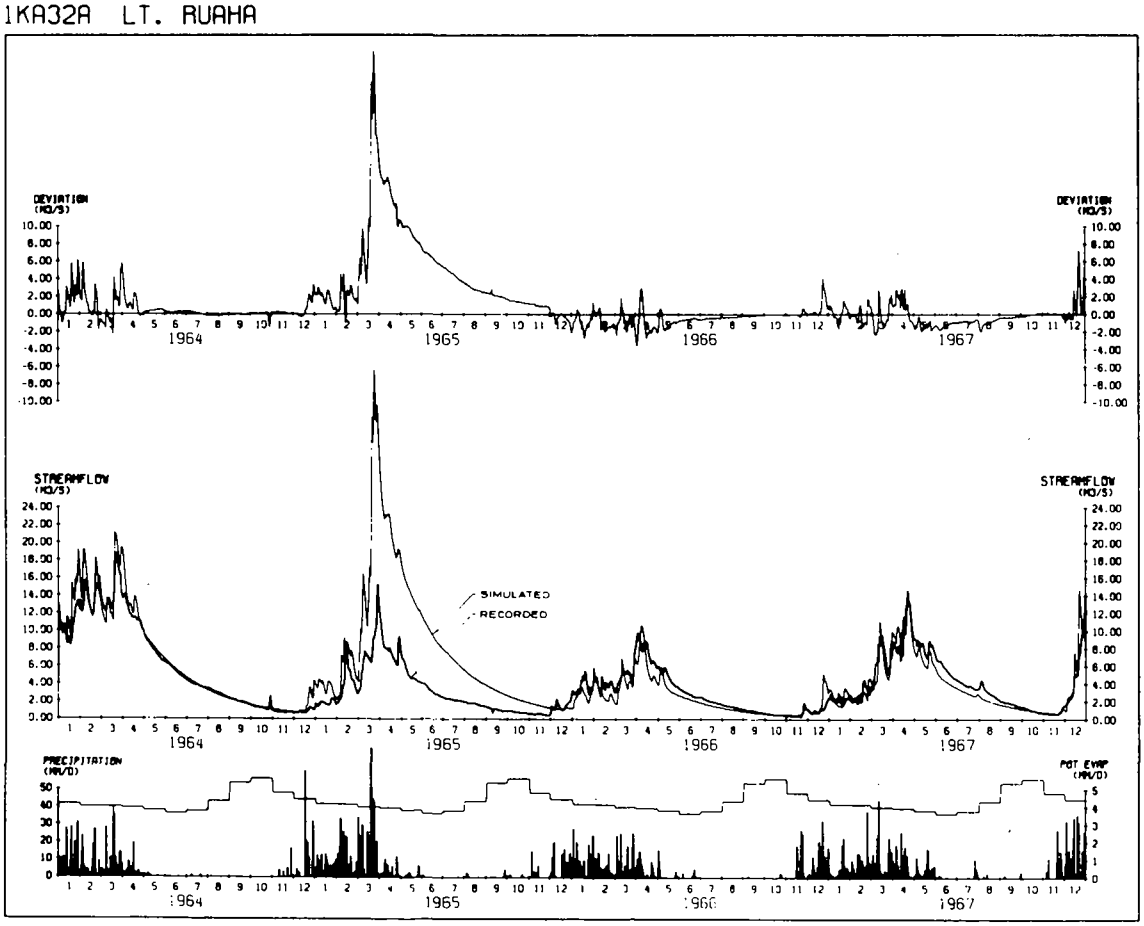

Figure 7.16[8] - Test run, Lt. Ruaha catchment at 1KA32A.

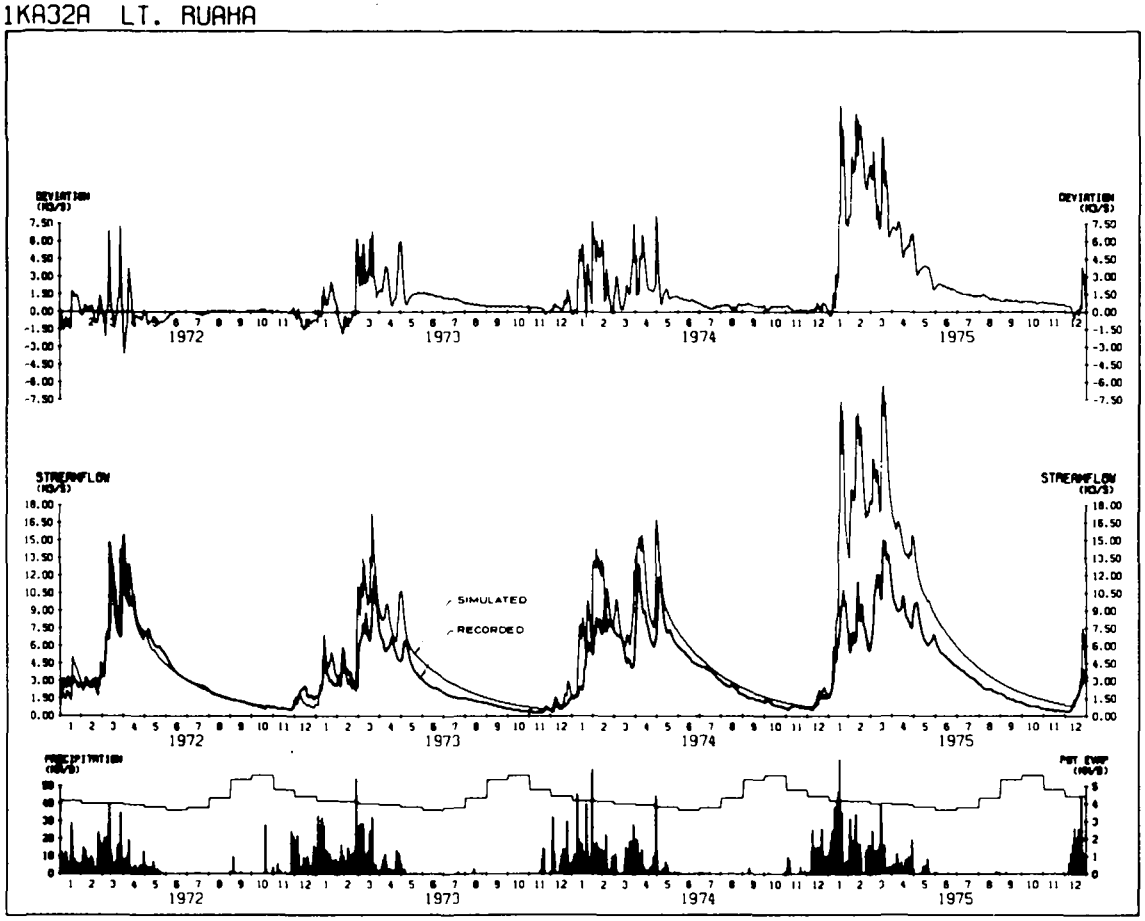

Figure 7.17[8] - Test run, Lt Ruaha catchment at 1KA32A.

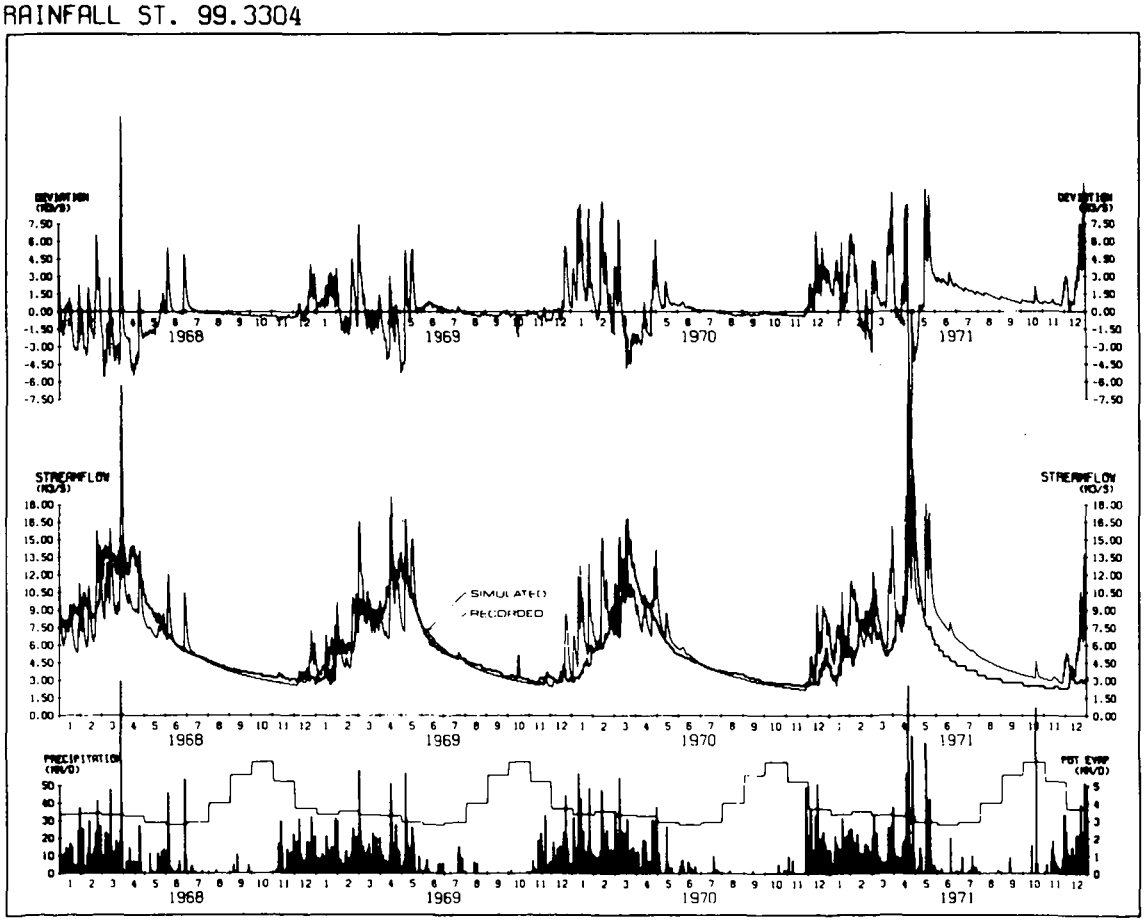

Figure 7.19[8] - NAM simulation of the 1RC5A Kiwira catchment with the rainfall input alone from station 99.3304.

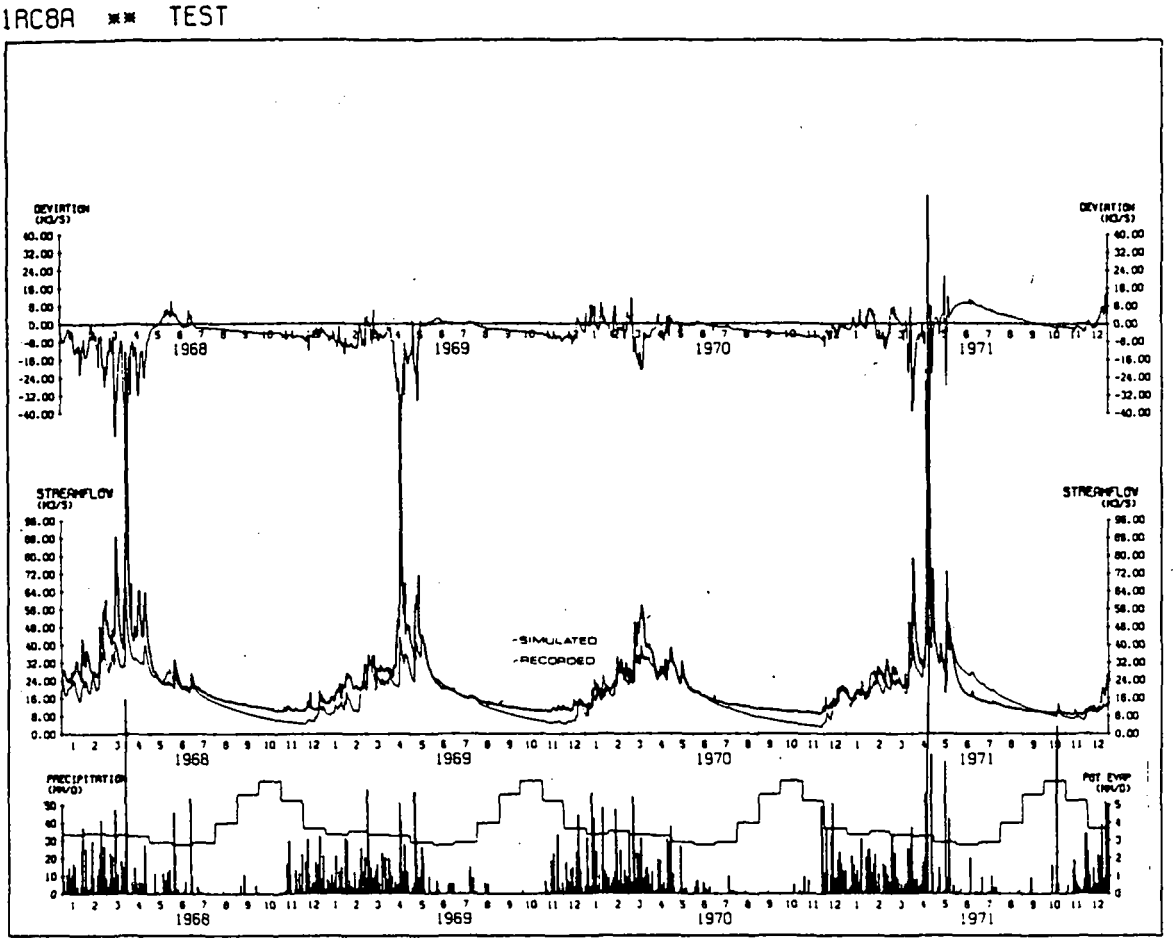

Figure 7.23[8] - NAM simulations of runoff from the Kiwira catchment at 1RC8A, using the "standard" parameter values.

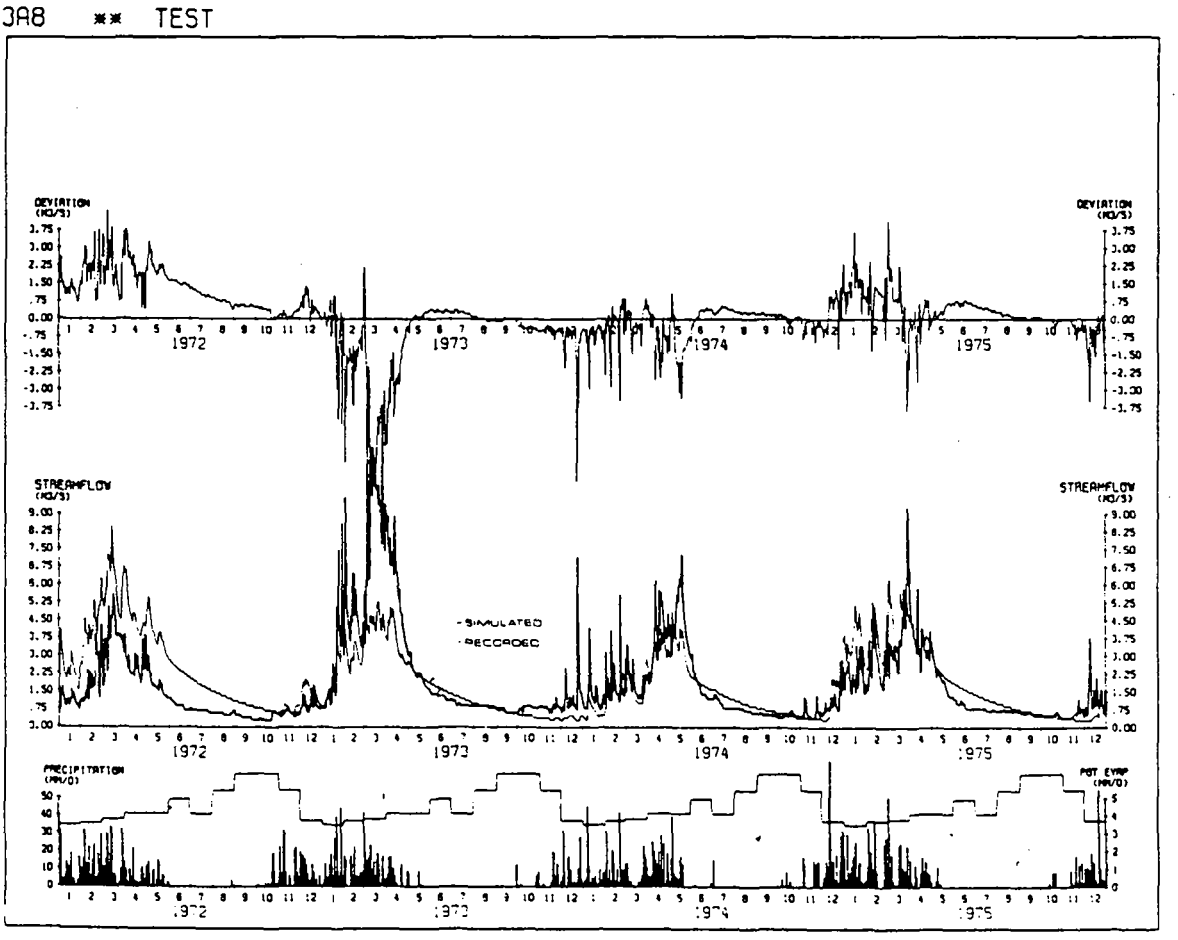

Figure 7.24[8] - NAM simulations of runoff from the Myovisi catchment at 3A8, using the "standard" parameter values.

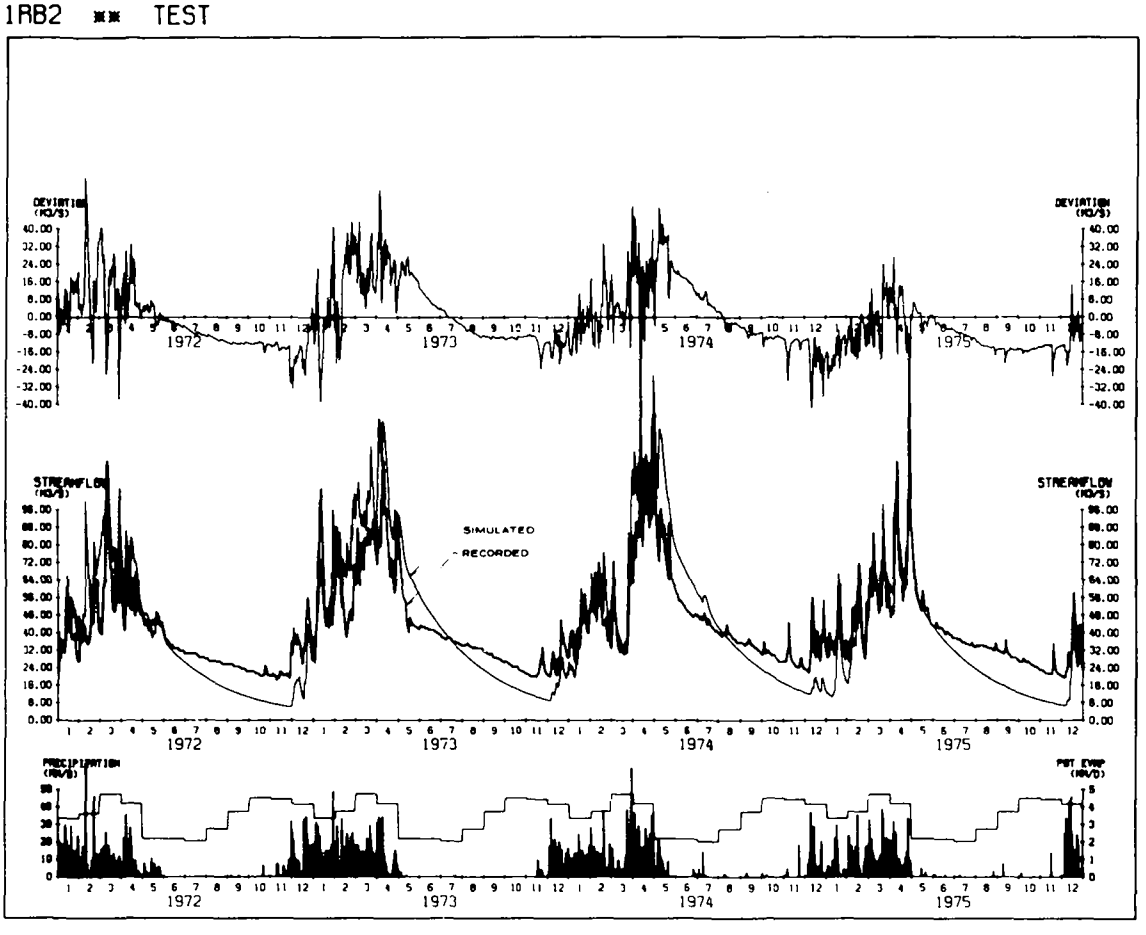

Figure 7.25[8] - NAM simulations of runoff from the Ruhuhu catchment at 1RB2, using the "standard" parameter values.

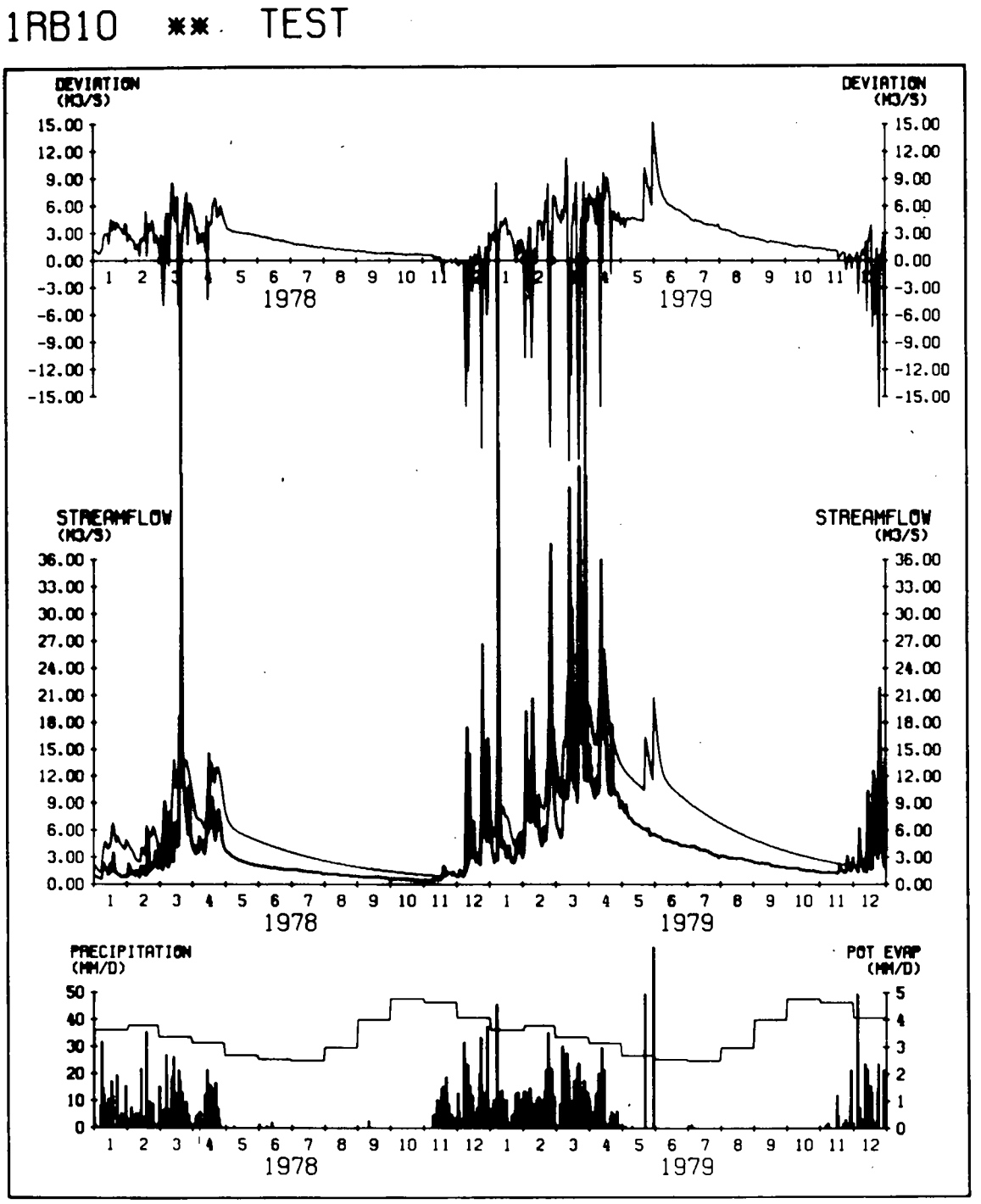

Figure 7.26[8] - NAM simulations of runoff from the Mwinamaji catchment at 1RB10, using the "standard" parameter values.

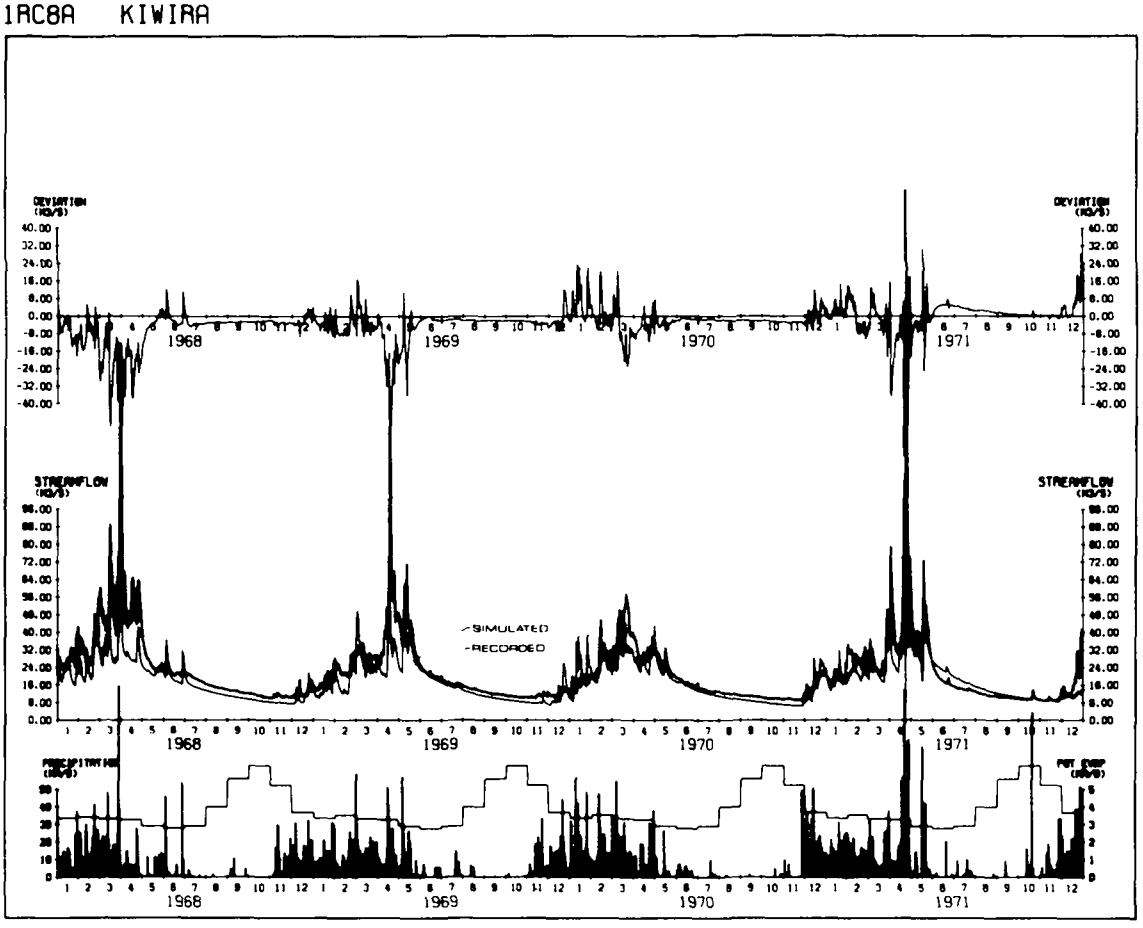

Figure 7.27[8] - 1RC8A simulated with the parameters from the subcatchment 1RC5A (index catchment).

Station	98.3509	98.3521	98.3535	98.3538	98.3540
98.3509	1.0 (23)	0.72 (23)	0.53 (12)	0.34 (23)	0.77 (9)
98.3521		1.0 (23)	0.31 (12)	0.47 (23)	0.32 (9)
98.3535			1.0 (12)	0.73 (12)	- (1)
98.3538				1.0 (26)	-0.33 (8)
98.3540					1.0 (9)

Table 7.2[8] Correlation coefficients between annual rainfall values for station in or close to the Lt. Ruaha catchment. The figures in () are the number of values (years) on which the correlation coefficients are based. In cases where the record gaps indicated in Figure 7.7 are in month with usually no rainfall, the gap has been filled with zero rainfall and the year has been included in the above correlation analysis.

Station / Day no. since 1-1-1960	98.3509	98.3521	98.3535	98.3538	98.3540
0-1461	0.13	0.03	0.84	0.00	0.00
1462-2922	0.13	0.03	0.84	0.00	0.00
2923-3804	0.13	0.00	0.41	0.46	0.00
3805-3957	0.13	0.03	0.84	0.00	0.00
3958-4383	0.13	0.03	0.00	0.00	0.84
4384-5844	0.13	0.03	0.00	0.00	0.84
5845-7305	0.13	0.00	0.00	0.46	0.41

Table 7.3[8] Weight coefficient for the rainfall stations in the mean areal rainfall calculations for the period 1960-1979.

Station	100.3401	100.3403	100.3410	100.3502	100.3508	100.3513
100.3401	1.0 (20)	0.05 (18)	0.28 (6)	0.69 (12)	-0.08 (10)	0.18 (8)
100.3403		1.0 (19)	0.65 (6)	0.38 (11)	0.27 (7)	0.61 (8)
100.3410			1.0 (6)	0.71 (4)	- (2)	0.84 (3)
100.3502				1.0 (12)	0.51 (7)	0.53 (6)
100.3508					1.0 (10)	- (1)
100.3513						1.0 (8)

Table 7.4[8] Correlation coefficients between annual rainfall values for stations in or close to the Mngaka catchment. The figures in () are the number of values (year) on which the correlation coefficients are based.

Year	Areal rainfall (mm)	Recorded runoff (mm)
1960	954	271
1961	1063	100
1962	1228	315
1963	1601	281
1964	858	257
1965	1036	129
1966	899	118
1967	1125	178
1968	1018	359
1969	798	160
1970	732	169
1971	726	96
1972	882	146
1973	893	114
1974	987	169
1975	1129	197
1976	770	212
1977	857	61
1978	924	151
1979	1064	188

Table 7.5[8] Relation between mean annual rainfall and recorded runoff for the 1KA32A Lt. Ruaha catchment.

Catchment	1RC8A Kiwira	3A8 Myovisi	1RB2 Ruhuhu	1RB10 Mwinamaji
Area (km^2)	650	150	2200	540
Period	1968-71	1972-75	1972-75	1978-79
Geomorphological zone	Rungwe Volcanics	African	African	Mixed zones
Rainfall stations applied	99.3304 x 0.85	99.3208 99.3315	99.3424 99.3508	Mngaka rainfall x 0.85
Evaporation data applied	Mbeya Airfield	Mbeya Airfield Galula	Madaba	Songea Airfield
$\overline{P}$ (mm/year)	1820	1290	1430	1200
$\overline{E}_p$ (mm/year)	1460	1690	1280	1280

Table 7.8[8] The four catchments which have been applied for test of the NAM streamflow simulations from ungauged catchments using "standard" parameter values.

Appendix 6
Refers to Volume 7, Chapter 8.

1KA32 Lt. Ruaha index catchment

Month	Rainfall P	Pot. Evap. E_p	Act. Evap. E_e	Recharge G	Sim. Discharge Q
1977 dry year (all values in mm)					
1	179	129	127	8	5
2	93	116	101	2	6
3	152	124	116	14	13
4	91	118	90	7	11
5	39	118	61	0	5
6	0	109	17	0	3
7	0	117	8	0	2
8	5	134	9	0	2
9	1	161	3	0	1
10	9	174	10	0	1
11	121	144	99	2	2
12	165	137	102	12	4
Year	855	1581	743	45	55
1960 medium year (all values in mm)					
1	252	129	119	52	21
2	196	116	114	43	26
3	194	124	123	48	47
4	131	118	114	26	45
5	36	118	83	0	27
6	15	109	41	0	18
7	0	117	23	0	13
8	0	134	9	0	9
9	0	161	4	0	6
10	0	174	2	0	4
11	0	144	0	0	3
12	131	137	83	4	3
Year	955	1581	716	173	222
1962 wet year (all values in mm)					
1	286	129	129	103	57
2	268	116	116	105	64
3	235	124	124	103	97
4	150	118	116	26	74
5	25	118	89	0	49
6	0	109	38	0	32
7	4	117	23	0	23
8	4	134	13	0	16
9	0	161	4	0	11
10	10	174	11	0	8
11	41	144	38	0	5
12	206	137	89	28	11
Year	1229	1581	790	365	447

Table 8.3[8] - Monthly totals of the different water balance elements for the Lt. Ruaha index catchment in a dry year, a medium year and a wet year.

1RB6 Mngaka index catchment

Month	Rainfall P	Pot. Evap. E_p	Act. Evap. E_a	Recharge G	Sim. Discharge Q
1969 dry year (all values in mm)					
1	167	112	111	11	19
2	191	106	102	34	26
3	228	104	104	60	50
4	200	94	94	58	60
5	1	83	68	0	31
6	0	76	41	0	21
7	0	77	28	0	17
8	0	92	22	0	14
9	0	120	17	0	10
10	0	148	11	0	8
11	46	139	41	0	6
12	144	126	101	1	8
Year	977	1277	740	164	270
1975 medium year (all values in mm)					
1	233	112	112	31	27
2	205	106	101	44	28
3	301	104	104	126	78
4	246	94	94	98	80
5	13	83	75	0	53
6	1	76	48	0	37
7	2	77	34	0	30
8	1	92	27	0	23
9	2	120	22	0	18
10	4	148	16	0	14
11	30	130	35	0	11
12	148	126	118	0	11
Year	1186	1277	786	299	407
1979 wet year (all values in mm)					
1	191	112	112	35	49
2	319	106	106	134	71
3	324	104	104	170	109
4	190	94	94	85	109
5	140	83	77	60	80
6	0	76	62	0	71
7	4	77	44	0	52
8	0	92	34	0	41
9	0	120	26	0	31
10	0	148	16	0	25
11	66	139	51	0	19
12	276	126	126	31	34
Year	1510	1277	852	515	691

Table 8.4[8] - Monthly totals of the different water balance elements for the Mngaka index catchment in a dry year, a medium year and a wet year.

1RC5A Kiwira index catchment

Month	Rainfall P	Pot. Evap. E_p	Act. Evap. E_a	Recharge G	Sim. Discharge Q
1977 dry year (all values in mm)					
1	189	104	104	28	41
2	173	99	94	52	43
3	190	103	103	65	60
4	255	98	98	131	86
5	59	90	85	7	58
6	4	83	49	0	39
7	13	90	36	0	32
8	16	124	32	0	27
9	21	168	30	0	22
10	129	197	58	2	21
11	314	157	155	80	56
12	147	114	114	23	44
Year	1520	1427	958	388	529
1971 medium year (all values in mm)					
1	47	104	96	0	37
2	416	99	98	219	96
3	383	103	103	229	134
4	148	98	97	47	110
5	123	90	87	39	90
6	2	83	55	0	60
7	3	90	32	0	49
8	0	124	19	0	40
9	8	168	16	0	33
10	71	197	52	0	30
11	343	157	103	108	58
12	108	114	110	5	50
Year	1652	1427	869	648	789
1979 wet year (all values in mm)					
1	397	104	104	239	115
2	169	99	99	67	84
3	351	103	103	192	122
4	320	98	98	182	139
5	87	90	84	39	109
6	44	83	64	2	72
7	7	90	41	0	57
8	12	124	33	0	46
9	22	168	32	0	38
10	134	197	98	0	35
11	208	157	139	9	36
12	350	114	114	151	79
Year	2101	1427	1009	881	932

Table 8.5[8] - Monthly totals of the different water balance elements for the Kiwira index catchments in a dry year, a medium year and a wet year

Iringa region	P	E_p	Q	$P-E_p$	E_a	E_a/E_p	Q/P
Lt. Ruaha average	970	1581	230	-611	740	0.47	0.24
dry	855	1581	55	-726	743	0.47	0.06
medium	955	1581	222	-626	716	0.45	0.23
wet	1229	1581	447	-352	790	0.50	0.36
Catchment 1.7	1100	1500	350	-400	750	0.50	0.32
Iringa	1000	1500	350	-500	650	0.43	0.23

Ruvuma Region	P	E_p	Q	$P-E_p$	E_a	E_a/E_p	Q/P
Mngaka average	1190	1277	410	-87	780	0.61	0.34
dry	977	1277	270	-300	740	0.76	0.28
medium	1186	1277	407	-91	786	0.62	0.34
wet	1510	1277	691	233	852	0.67	0.46
Catchment 1.14	1100	1300	450	-200	650	0.50	0.41
Ruvuma	1175	1400	405	-225	770	0.55	0.34

Mbeya region	P	E_p	Q	$P-E_p$	E_a	E_a/E_p	Q/P
Kiwira average	1680	1427	780	253	900	0.63	0.46
dry	1520	1427	529	93	958	0.67	0.35
medium	1652	1427	789	225	869	0.61	0.48
wet	2101	1427	932	674	1009	0.71	0.44
Catchment 1.11	1900	1200	800	700	1100	0.92	0.42
Northern Mbeya	815	1800	200	-985	615	0.34	0.25
Southern Mbeya	1120	1300	430	-180	690	0.53	0.38

Table 8.6[8] - Comparison of hydrological characteristics between index areas and broader regions.

average - mean over a number of years.
dry - characteristic dry year (10-year event).
medium - characteristic average year.
wet - characteristic wet year (10-year event).

NUMERICAL INDEX AND REGISTER OF WATER RIGHT APPLICATION

AS KNOWN AT WATER OFFICE DAR-ES-SALAAM

(IRINGA) ..... REGION

WATER RIGHT NUMBER	AMOUNT		PURPOSES	SOURCE	GRANTEE
	G.P.D.	CUSECS			
1008	2,000		Domestic & Industrial	Lufumbo River	Ndungu Sisal Estate
2479	3,240,000		Power	Rupari River	Luponde Tea Estate Ltd.
1946	2,750		Domestic	Madopi River	J. B. Christophersol
1027	500		-do-	Trib. of Madopi River	Knud Matzon
1654	3,400		Domestic & Industrial	Trib. of Rugalawa R.	Agriculture Dept.
1110	Full Flow		-do-	Well	R. C. Mission Luilo
1113	15,000		-do-	Lukongoti River	R. C. Mission Iringa
1843	2,000		-do-	Unnamed Stream	Agric. & Co-operation
1108	1,100		-do-	Lumbira River	R. C. Mission Uwemba
1941	540,000		Irrigation	Unnamed Stream	S. K. Walji & S. J. Shivji
2228	15,400		Domestic & Industrial	Tandara Stream	Diocese of Iringa
2441	640		Power	Ikonda River	Consolata Fathers
1010	3,000		Domestic	Makombe River	Ndungu Sisal Estate Ltd.
2043	2,000		Domestic & Industrial	-do-	-do-
3	2,880		-do-	Ukanyange River	A. C. Maher
4	17,000		Power	-do-	-do-
1099	2,450		Domestic & Industrial	Mahangi Stream	-do-
1112	Whole Flow		-do-	Well	R. C. Mission Matola
1111	1,100		-do-	Unnamed Spring	N. C. Mission Sunji
2326	7,000		-do-	-do-	Behediltina Mission Matola
1004	10,000		-do-	Ruaha River	Tanganyika Wattle Co. Ltd.
998	2,000		-do-	Unnamed Stream	-do-
1000	2,000		Domestic & Industrial	Unnamed Spring	Tanganyika Wattle Co. Ltd.
1030	300		Domestic	-do-	N. C. Pany
1028	300		-do-	-do-	S. A. Dharmsi
2	98,000		Domestic & Industrial	Lyagosa River	Tanganyika Wattle Co. Ltd.
997	2,000		-do-	Unnamed Stream	-do-
999	2,000		-do-	-do-	-do-
1001	2,000		-do-	-do-	-do-
1002	5,000		-do-	Lilogosa Swamp	-do-
1003	1,500		-do-	-do-	-do-
1005	52,500		-do-	Lilagose River	-do-
2072	2,000		-do-	-do-	-do-
2054	2,500		-do-	Ruhudji River	R. H. Haris (major)
1561	54,000		-do-	-do-	Comworks
1821	25,000		-do-	Unnamed Stream	Diocese of Iringa
1844	38,300		Irrigation & Domestic	Unnamed Spring	Agriculture Dept.
2027	500,000		Irrigation	Dindimoyo River	Lupembe Estate
2031	1,080,000		-do-	Upuru River	-do-
2256	Whole Flow		-do-	Mweruchi River	Uwemba Tea Estate Ltd.
1515	5,000		-do-	Unnamed Spring	-do-
1906	22,600		-do-	Hagafiro River	Agriculture
1011	540		Domestic	Unnamed Stream	Eric Rowland
2260	270,000		Irrigation	Hagafiro River	-do-
2045	55,000		-do-	Bingu River	Highlands Tea Co. Ltd.
1645	2,000		Domestic	Bingu River	Highlands Tea Co. Ltd.
1009	10,000		Domestic & Irrigation	Hagafiro River	Ndungu Sisal Est. Ltd.
1106	10,800		Domestic & Industrial	-do-	R. C. Mission Uwemba
1107	10,800		-do-	-do-	-do-
1006	1,500		-do-	-do-	William Brown
1015	2,000		Irrigation	-do-	C. M. Stockley
1100	20,790,000		Power	-do-	Nuldin Bandari
1109	10,800		Domestic & Industrial	Unnamed Spring	R. C. Mission Kifanya
2479		6.0	Industrial	Rupari River	Luponde Tea Estate
2517	60,000		Domestic	Trib. of Hofwi River	Njombe District Council
2718	60,000		-do-	Trib. of Kiyaga River	-do-
2519	60,000		-do-	Trib. of Ruaha River	-do-
2523	4,000		-do-	Nyachera River	Regional Trustee Diocese of Iringa
2563		65.0	Industrial	Rumakali River	Bulongwa Hsp. (E.L.C.T.)
2648	32,000		Domestic	Lwamalala River	-do-

Table 8.7[8] - Present water Appropriation in Iringa, Ruvuma and Mbeya.

NUMERICAL INDEX AND REGISTER OF WATER RIGHT APPLICATION

AS KNOWN AT WATER OFFICE DAR-ES-SALAAM

(IRINGA) REGION

WATER RIGHT NUMBER	AMOUNT		PURPOSES	SOURCE	GRANTEE
	G.P.D.	CUSECS			
2608		2.0	Domestic & Irrigation	Igoli River	Director of Agriculture
2651		1.0	Irrigation	Lihogoza Swamp	Tanganyika Wattle Co. Ltd.
4180	1,300,000		Domestic, Livestock & Irrigation	Mbikwa River	D. D. D.
4197	5,000		Domestic	Kifanya Spring	-do-
4251	7,000		-do-	Matika Spring	-do-
4252	6,000		-do-	Lake Nyasa	-do-
4253	27,000		Dom. & Fish Farming	Kitete River	-do-
4254	329,500 l/d		Domestic & Livestock	Itamba River	D. D. D.
4247	30,000		Domestic	Mwalailala River	Bulongula Hosp. (E.L.C.T.)
4255	5,000		Domestic	Magoda Stream	D. D. D.
4298	60,000		Fish Farming	Ruhudji River	District Natural Resource
4331	6,000		Domestic & Irrigation	Spring	Diocese of Njombe
4332	8,000		-do-	Three Springs	-do-
4333	4,500		-do-	Lumbila River	-do-
4334		1.0	Power	-do-	-do-
4335	4,000		Domestic & Irrigation	Spring	-do-
4336	4,000		-do-	Two wells	-do-
4337	2,800		-do-	Nyamabingwa Spring	-do-
4402	2,500		Irrigation	Lumbila River	-do-
2421	108,000	0.2	Irrigation	Waso River	Mufindi Tea Co. Ltd.
2422	270,000	0.5	-do-	Fikiri River	-do-
2542	7,800		Domestic	Tufezu Spring	Reg. Trustee Diocese of Iringa
4004		0.7	Irrigation	Luisenga River	Brooke Bond Liebig Ltd.
4037	18,000		-do-	Kitendege River	P.W.J. Mothers
4050	55,000		Domestic	Nyamalala River	D. D. D.
4143	20,000		Dom. & Fish Farming	Lake Nsiwi	-do-
4144		0.5	Irrigation	Lugoda A Stream	Brooke Bond Liebig Ltd.
4145		0.5	-do-	Lugoda D Stream	-do-
4146		0.6	-do-	Luisenga River	-do-
4147		0.5	-do-	Chambinga Stream	-do-
4148		0.5	Irrigation	Homani River	Brooke Bond Liebig Ltd.
4149		0.3	-do-	Inaso River	-do-
4215	115,000 l/d		Domestic	Sao Hills Spring	Regional Forest Officer
4220		13,000 m^3/d	Irrigation	Caldacara River	Brooke Bond Liebig (T) Ltd.
4221	600		Domestic & Irrigation	Makungu-Mgololo Stream	Regional Trustee Diocese of Iringa
4223	203,000 l/d		Domestic	Ruaha River	D. D. D.
4288	405,000		Irrigation	Fikiri River	Mufindi Tea Co. Ltd.
4296	225,000		-do-	Mwaani Stream	Reg. Agri. Dev. Officer
4376		0.2	-do-	Mzanza River	Brooke Bond Liebig (T) Ltd.
4377		0.2	-do-	Timbwi River	-do-
4378		0.24	-do-	Kinoga Stream	-do-
4379		0.3	-do-	Nakimunga River	-do-
4380		0.4	-do-	Kidofi River	-do-
4381		0.18	-do-	Luhanga River	-do-
4403	3,000		Domestic	Nyamifwa Spring	Diocese of Iringa
4415	115,000 l/d		-do-	Little Ruaha River	Regional Prisons Officer
4607		86,320 m^3/d	Domestic & Industrial	Kigogo Ruaha River	N. D. C.
4613		8,000 m^3/d	-do-	Little Ruaha River	Sao Hills Saw Mills
IR. 1		2.5	H. E. P.	Luawadinda Stream	Anglican Mission
IR. 2	20,000		Irrigation	Shallow Well	Headmaster Mkwawa Sec. School
IR. 3	6,000		Domestic	Kidulego Stream	Ikonda Hosp. Consolata Father

Table 8.7^8 - Cont'd.

NUMERICAL INDEX AND REGISTER OF WATER RIGHT APPLICATION

AS KNOWN AT WATER OFFICE DAR-ES-SALAAM

(IRINGA) ..... REGION

WATER RIGHT NUMBER	AMOUNT		PURPOSES	SOURCE	GRANTEE
	G.P.D.	CUSECS			
4o95		o.5	Mixed	Unnamed Spring	Manji Mendi Thawer
1163	½ Flow		Irrigation	Unnamed Stream	-do-
1431	½ Flow		Domestic & Irrigation	-do-	-do-
1857		o.5	Irrigation	Ndembera River	B. A. Jivraji
1824	6,ooo		Domestic	Mfukulemba Stream	Diocese of Iringa
3636	1o,ooo		Mixed	Libena River	A. Manji
1164		o.4	Irrigation	Changazi River	Meral Shivji Athman
1165		o.4	Irrigation	Kitewozi River	Meral Shivji Athman
1425	Full Flow		Domestic & Irrigation	Springs	Marion Lady Chesham
2291	1o,ooo		Domestic	Spring	Tanganyika Educ. Trust Fund
1122	1,5oo		-do-	Spring	B. A. Sachedina
674		o.75	Domestic & Irrigation	Ndembera River	N. C. Mission Sadansi
645		o.85	-do-	-do-	-do-
1545		3.o	Irrigation	-do-	Yusuf W. J. Ismail
3639	Whole Flow		Domestic	Maguena River	Costas Soubaris
1166		1.o	Domestic & Irrigation	Mkewe River	Mrs. V. M. McDonald
1o98	15o		Domestic	-do-	A. M. Water Mayer
1749	4oo		-do-	Unnamed Stream	R. Th. Seal
1o69	1,ooo		Domestic & Stock	Ngwdzi Lake	Tanganyika Tea Co. Ltd.
1o92	1o,ooo		Irrigation	-do-	-do-
2135	1o,ooo		Domestic & Stock	-do-	-do-
2178	4,ooo		Pulping Coffee	-do-	-do-
2139	15,ooo		Domestic	Unnamed tributary	-do-
1o77	22,ooo		Domestic & Factory	-do-	-do-
2249	1,ooo		Domestic	-do-	-do-
187o	15,ooo		Urban	Fefezu River	Comworks
3643	Whole Flow		Mixed	Lumandi River	J. K. Sanders
3644	5o% of Flow		Mixed	-do-	-do-
3645	5o% of Flow		Mixed	Rufunu River	-do-
3646	5o% of Flow		Mixed	Mikauli River	-do-
3647	3o% of Flow		Mixed	Tefezu River	J. K. Sanders
3621	5,ooo		Mixed	Trib. of Little Ruaha	J. E. Macartney-Snake
3622	15,ooo		Mixed	Rumande River	-do-
1979		2.o	Domestic & Irrigation	Tuferu River	-do-
2372	3,5oo		Domestic	Unnamed Stream	Diocese of Iringa
1575		o.5	Domestic & Irrigation	Maguiro Stream	Mrs. E. M. Berryman
16o5		o.5	Irrigation	-do-	H. W. & F. J. Halo
16o6		o.5	Mixed	Laheta Stream	-do-
673	7oo,ooo		Domestic & Irrigation	Mafinga Stream	Prefecture Apostolic of Iringa
1694	5,ooo		Domestic & Factory	Unnamed Stream	Stone Valley Tea Co. Ltd.
1693	29,ooo		Domestic & Irrigation	-do-	-do-
2283	5o,ooo		Irrigation	-do-	-do-
2285	6o,ooo		-do-	Kidofi River	-do-
2282	6o,ooo		-do-	Unnamed Stream	-do-
2127	3,ooo		-do-	Pangaumbwe River	Tanganyika Tea Co. Ltd.
2137	2,ooo		Domestic	Trib. of Kidofi River	-do-
1124	Whole Flow		-do-	Unnamed Stream	Mufindi Tea Co. Ltd.
2243	36o,ooo		Irrigation	Walihanga River	-do-
3633		1.o	Mixed	Little Ruaha River	C. Zannetos
1992	4oo,ooo		Irrigation	-do-	G. D. M. Palmer
17oo		1.o	Domestic & Irrigation	Ifwenga River	J. Nolandes
3699	Whole Flow		Generation of Power	Ifwenga River	I.N. Boddy
5o9		o.4	Domestic & Irrigation	Lohambiri River	Pommern Mission
3635	Whole Flow		Mixed	Lohambiri River	S. C. Baker
5o2	2oo		Domestic	Lupala/Makalala Spring	C. L. Towne
5o3	1,5oo		Domestic	Ngwongwa Spring	-do-
5o4	6,ooo		Domestic & Irrigation	Ngongwa Dam	-do-
5o6		o.5	Irrigation	Kigoma River	-do-
3592		1.5	Irrigation & Power	-do-	Towne's Farm Ltd.
3593	Whole Flow		Domestic	Halalima Stream	-do-
3594		1.5	Irrigation	Kigoma River	-do-
3624		o..	-do-	Mtoga R..	H. Clarsen

Table 8.7[8] - Cont'd.

NUMERICAL INDEX AND REGISTER OF WATER RIGHT APPLICATION

AS KNOWN AT WATER OFFICE DAR-ES-SALAAM

(IRINGA) ..... REGION

WATER RIGHT NUMBER	AMOUNT		PURPOSES	SOURCE	GRANTEE
	G.P.D.	CUSECS			
1586		3.5	Electric Power	Mtitu Power	Iringa Diaries Ltd.
2287		1.o	Generation of Power	-do-	Diocese of Iringa
1736		1.o	Mixed	-do-	-do-
979		1.o1	Domestic & Irrigation	-do-	Alfred Mansfield
2o48	2oo,ooo		Irrigation	Little Ruaha River	T. H. Constantinides
1427		o.33	Domestic & Irrigation	-do-	D. H. Papadometrion
98o	273,ooo		Irrigation & Domestic	-do-	A. Sarikas
5o1	9,9oo		Domestic & Irrigation	-do-	M. H. Shivji
1867	1,5oo		-do-	-do-	Dr. P. D. Lilia
977		2.o	-do-	Kibofu River	J. J. & A. E. Baldwin
363o	8o% of Flow		Mixed	Mtabuke River	K. B. A. Sachedina
2117	54,ooo		Diary & Irrigation	Little Ruaha River	Agriculture Dept.
1868		2.o	Urban	-do-	Comworks
3642	1" Pipe		Irrigation	-do-	B. Kazakedi
2239	12,ooo		Irrigation	Ilole Swamp	Diocese of Iringa
1476	38,34o	o.o71	-do-	Little Ruaha River	H. K. Von Freeder
577	1o,ooo		-do-	-do-	K. Anastasiu
1o67		o.5	-do-	-do-	Lalji Kassam Juma
1o68	Whole Flow		Domestic	Unnamed Spring	J. E. Gale
1436	25o		Mining	Unnamed Well	Enzo Albertelle
1121		1.o	Mixed	Kipolwi River	Sardina Farms
1859		o.5	Domestic Irrigation	-do-	Diocese of Iringa
2223	1o,ooo		Irrigation	Lupelema River	-do-
2242	9,ooo		-do-	Lulenga River	M/s Patel Farmers
2o69	35,ooo		Domestic & Irrigation	Kinyagana River	Diocese of Iringa
675		14o	Generation of Power	Little Ruaha River	TANESCO
1858		o.25	Domestic	-do-	Diocese of Iringa
3475		2.o	Irrigation	-do-	-do-
1559		1o.o	-do-	-do-	Iringa District Council
2238	½ Flow		Domestic	Mezu Swamp	Diocese of Iringa
978		o.75	Irrigation	Little Ruaha River	M. C. Van Guiethaysen
3626		o.5	Mixed	Mlowa River	D. Zouro's
3627		o.5	-do-	-do-	M. Mitsingas
3628		o.5	-do-	-do-	A. H. Ghani
3629		o.5	Irrigation	-do-	A. Angeletos
1827	3o,ooo		Domestic & Irrigation	Itale Cancel	Diocese of Iringa
3265	8o% of Flow		Mixed	Mtaguke River	J. I. & A. E. Baldwin
1o66	2o% of Flow		Irrigation	Mtaguke River	E. A. Golby
3396	5,ooo		Domestic	Well	Tosamaganga Mission
2119		1.5	Irrigation	Tungamalenga River	G. V. Pasette
2118		1.5	-do-	-do-	H. Maver
2o7o	7,ooo		Domestic & Irrigation	Mapogoro River	Diocese of Iringa
1869	12,ooo		Urban	Borehole	Comworks
156o		o.o33	Mixed	Natural Drainage	John Camboulocculoc
1823	1o,ooo		Domestic	Unnamed Stream	Diocese of Iringa
1828	7,7oo		-do-	Well	-do-
3634	8oo		-do-	Kibula Stream	Comworks
3632	Whole Flow		Domestic & Irrigation	Well	N. Panayotopoleus
981	8oc		-do-	Mutuwa River	Drosisciotis
1825	7,5oo		Domestic	Nyakipambo River	Diocese of Iringa
2179	15o		-do-	Unnamed Stream	Mrs. M. K. Patterson
1822	1o,5oo		Domestic & Stock	Kilindi Stream	Diocese of Iringa
1o72	5,ooo		Domestic & Irrigation	fwage River	Tanganyika Tea Co. Ltd.
2134	3o,ooo		Irrigation	-do-	-do-
2135	1,ooo		Domestic	Unnamed tributary	-do-
2149	3,ooo		-do-	-do-	-do-
2154	3,ooo		-do-	-do-	-do-
1o74	4oo		-do-	-do-	-do-
1o14	54o		-do-	-do-	J. H. Dathan
2o44	6o,65o		Domestic & Industrial	Ilande River	Highlands Tea Co. Ltd.

Table 8.7[8] - Cont'd.

NUMERICAL INDEX AND REGISTER OF WATER RIGHT APPLICATION

AS KNOWN AT WATER OFFICE DAR-ES-SALAAM

..(IRINGA) REGION

WATER RIGHT NUMBER	AMOUNT		PURPOSES	SOURCE	GRANTEE
	G.P.D.	CUSECS			
2157	2,000		Domestic	Unnamed tributary	Tanganyika Tea Co. Ltd.
1073	4,000		-do-	Kigogo River	-do-
1075	400		-do-	Unnamed tributary	-do-
2248	1,000		-do-	Trib. of Kigogo	-do-
2148	3,000		-do-	Nyamanyoki River	-do-
2150	3,000		-do-	Unnamed tributary	-do-
2247	1,000		-do-	Sabina River	-do-
2122	3,000		-do-	Ruiga River	-do-
2123	30,000		-do-	Ruiga River	-do-
2136	400		-do-	Unnamed tributary	-do-
1076	1,600		Domestic & Irrigation	Trib. of Ruiga River	-do-
1080	200		Domestic	Luisenga River	-do-
1057	2,600		Domestic & Irrigation	Trib. of Luisenga R.	-do-
1075	14,000		Domestic	Homani River	-do
1079	1,000		Domestic	-do-	-do-
2125	3,000		Domestic	-do-	-do-
2132	12,000		Domestic	-do-	-do-
2140	8,000		Domestic	-do-	-do-
1435	2,000		Domestic & Irrigation	Homani River	Tanganyika Tea Co. Ltd.
2152	3,000		Domestic	Trib. of Gwazo River	-do-
2129	10,000		Irrigation	Sirzo River	-do-
1426	540,000		Domestic & Irrigation	Idetero River	Mufindi Tea Co. Ltd.
1090	200		Domestic	Nyamarara River	Tanganyika Tea Co. Ltd.
2133	3,000		-do-	-do-	-do-
1071	1,500		Stock & Irrigation	Unnamed tributary	-do-
2144	16,000		Irrigation	Trib. of Nyamagongoro R.	-do-
2141	3,000		Domestic	Kifyanyi River	-do-
1070	5,000		Domestic & Irrigation	Unnamed tributary	-do-
1091	5,200		Domestic & Irrigation	-do-	-do-
2386	2,000		Irrigation	Ibumila River	Yeramia Kiwerage
2459	20,000		Domestic & Irrigation	Lihama River	Masoni Abiyudi
2458	28,000		Irrigation	Ifinda River	Daudi Maulaga
2469	15,000		Domestic & Irrigation	Luhosi River	Diocese of Iringa
2413	15,000		Irrigation	Luhosi River	Mr. Daudi Kayanda
2478	32,000		Irrigation	Lihima River	Anania Abiyudi Mbilinyi
2487	10,000		Cattle Dips	Mloa River	Reg. Vetinary officer
2500	8,640		Domestic & Irrigation	Bwabwa Stream	Regional Trustees of Iringa
2520	20,000		Public Supply	Trib. of Ruaha River	Iringa District Council
2543	480,000		Domestic & Stock	Mgeid River	-do-
2565	1,000		Domestic	Tanangozi Stream	Masjid-Tag-Waa
2609	83,000		Domestic & Irrigation	Kibuzelo River	Selestino P. Firawo
2660	18,000		Domestic	Muhiliwa River	(ELCT) Southern Synod
4320	500		Irrigation	Little Ruaha River	District Natural Resources Officer
4321	300		Irrigation	-do-	-do-
4428	50,000		Domestic, Livestock & Irrigation	-do-	D.D.D.
4605	105,308 l/d		Building	Great Ruaha River	Mr. J. W. Ladwa
4590	90,800 l/d		Irrigation	Lukosi River	Daudi Kayanda
4207	84,600 l/d		Domestic	Lukosi River	D.D.D.
4208	90,800		-do-	Magulilwa Stream	D.D.D.
4016	225,000 l/d		-do-	Kinyi Stream	T.P.D.F.
4039	12,000		Domestic & Irrigation	Lukosi River	Mr. Edgar J. Kiwawula
4042		4.0	Dom., Irri. & Fish Farming	-do-	D.D.D.
4043		20.0 rainy season 6.0 dry season	Irrigation	Idodi River	D.D.D.
4049	5,000		Domestic	Mbinga River	D.D.D.
4187		[illegible]	Generation of Power	Great Ruaha River	TANESCO
4222	20,000		Irrigation	Little Ruaha River	Reg. Agri. Dev. Officer
4285	7,500		Domestic & Stock	Stream	D.D.D.
4289	10,237		Irrigation	Little Ruaha River	Headmaster Ruaha P/School

Table 8.7[8] - Cont'd.

NUMERICAL INDEX AND REGISTER OF WATER RIGHT APPLICATION

AS KNOWN AT WATER OFFICE DAR-ES-SALAAM

(IRINGA)
..... REGION

WATER RIGHT NUMBER	AMOUNT		PURPOSES	SOURCE	GRANTEE
	G.P.D.	CUSECS			
IR. 4	23o,ooo l/d		Domestic & Industrial	Ngale River	Tanganyika Extract Co.
IR. 5	2,7oo		Domestic & Irrigation	Unnamed Spring	R. C. Diocese of Njombe/ Malengali
IR. 6	1,225,ooo l/d		Irrigation	Wasc River	Mufindi Tea Co. Ltd.
IR. 7	1,225,ooo l/d		-do-	-do-	-do-
IR. 8	1,225,ooo l/d		-do-	Kidofi River	Stone Valley Tea Co. Ltd.
IR. 9		o.5	-do-	-do-	-do-
IR. 1o	72,ooo		Nyakepambo U/V W/Supply	Nolimba River	D. D. D. Mufindi
IR. 12	1o,ooo		Irrigation	Uhansinyi Stream	Markus M. Kibisa
IR. 16	2,ooo		Domestic	Luhanga River	Director Brooke Bond
IR. 18	Whole Flow		H. E. P.	Ntoo Stream	R. C. Kipengere
IR. 19	2o,ooo		Irrigation	Unnamed Spring	C. J. Fliacos
IR. 2o	Whole Flow		Domestic	Ngowo Stream	R. D. D.
IR. 21	2o,ooo		Irrigation	Pool	Nicos Macheras
IR. 22	1,ooo l/d		H. E. P.	Lupali River	ST. Gertrud Convent Imiliwaha
IR. 25	4o,ooo		Domestic	Unegabihi Stream	Ukumbi Ujamaa Village
IR. 27	1o mi/gl per Annum		Irrigation	Walihanga River	Stone Valley Tea Co. Ltd.
IR. 28	3o,882 l/d		Domestic	Kisato River	R. D. D.
IR. 31		o.54	-do-	Ididiga Stream	-do-
IR. 26		1.84	-do-	Kitwiru Stream	Town Director Iringa

Table 8.7[8] - Cont'd.

NUMERICAL INDEX AND REGISTER OF WATER RIGHT APPLICATION

AS KNOWN AT WATER OFFICE DAR-ES-SALAAM

RUVUMA.... REGION

WATER RIGHT NUMBER	AMOUNT		PURPOSES	SOURCE	GRANTEE
	C.P.D.	CUSECS			
1260		0.25	Tobacco Factory	Bomba Mbili Stream	Ngoni-Matengo Coop. Marketing Union
2629	4,200		Domestic use	Luwere River	Commissioner for Village Settlement
992		0.5	Domestic use	Matogoro Stream	P.W.D.
852	3,000		- do -	Ruvuma River	P.W.D.
708	6,000		- do -	Matarauli Stream	P.W.D.
709		1.5	Irrigation use	Ruvuma River	Kitai Farm
710		1.5	Irrigation	Likuyu River	- do -
599	20,000		Domestic	Ruvuma River	P.W.D.
488		2.0	Irrigation	Namaguga River	Albert Schreckeriboefer
489		2.0	- do -	Namaguga/Hanga River	- do -
4487	34,400 1/d		Domestic	Matetereka Spring	D.D.D. - Songea
4485	552,000 1/d		- do -	Liweta Spring	D.D.D. - Songea
4442	51,600 1/d		- do -	Njoka Spring	- do -
2805	2,400		- do -	Lihira River	- do -
2348	5,760		Domestic and Irrigation	Nambeha Spring	Benedictine Mission Peramiho
4473	192,000 1/d		Domestic	Ligunga Spring	D.D.D. - Tunduru
4474	20,000		- do -	Makapanya Spring	- do -
4475	32,000		- do -	Mkoma River	- do -
4476	194,845		Domestic	Mlingoti Stream	D.D.D. - Tunduru
4477	30,000		- do -	Ligoma Stream	- do -
4478	345,600 1/d		- do -	Mahalela Stream	- do -
4479	345,600 1/d		Domestic	Malasi River	D.D.D. - Tunduru
4480	345,600 1/d		- do -	Ndenyemba River	- do -
4481	192,000 1/d		- do -	Mtina Spring	- do -
2557	49,060		- do -	Namasakata Springs	- do -
4512	40,000		- do -	Lake Nyasa	D.D.D. - Mbinga
4513	100,000		- do -	Luhuhu River	- do -
2561	190,620		- do -	Lake Nyasa	- do -
2559	48,060		- do -	Gumbiro Spring	D.D.D. - Songea
4130	15,000		- do -	Luwengu River	- do -
4131	12,000		- do -	Well	- do -
4132	9,000		- do -	Makagula Stream	- do -
4133	8,000		- do -	Well	- do -
4134	8,000		- do -	Ligera Stream	- do -
4502	15,000		- do -	Lizaboni Stream	Principal Secretary, Defence
2717	15,000		- do -	Lwika River	D.D.D. - Mbinga
4455	2,500		- do -	Lutonyo River	D.D.D. - Songea
4451	11,000		Domestic & Fish Farming	Naikese River	- do -
4452	8,000		- do -	Ngembambili River	- do -
4453	8,000		- do -	Liluli River	- do -
4454	2,500		Domestic	Lutonyo River	- do -
4430		100.0 m^3/d	- do -	Mahanje River	Mahanje Parish
4444	10,000		Irrigation	Ruwawazi River	Paramiho Mission
4565	170,000 1/d		Domestic	Well	Peramiho Mission
4489	10,000		- do -	Njoomlole Spring	D.D.D. - Songea
R.1	20,000 1/d		Domestic	Local Spring - Tributary of Mbinga River	C. O. Milinga
R.2	400,000 1/d		Irrigation & Fish Farming	Nanjoka Stream	Kanisa la Biblia Tunduru
R.3	14,500		Domestic, Irrigation and Fish Farming	Likonde River	Diocese of Songea
R.4		40 m^3/d	Domestic and Irrigation	Wells	- do -
R.5	51,000		- do -	Well	- do -
R.7	37,500 1/d		Domestic	Namaniola Springs	D.D.D. - Tunduru

Table 8.7[8] - Cont'd.

NUMERICAL INDEX AND REGISTER OF WATER RIGHT APPLICATION
AS KNOWN AT WATER OFFICE DAR-ES-SALAAM

.MBEYA... REGION

WATER RIGHT NUMBER	AMOUNT		PURPOSES	SOURCE	GRANTEE
	G.P.D.	CUSECS			
3618	Unspecified		Irrigation	Mambi River	Sub-Chief of Chosi (Usangu)
3654		5.0	- do -	Mfwisimu River	Jumbe Mwanambu
3663	Whole flow		All purposes	Mgona River	A.J. De Villiers
3676	4,320	¾	Irrigation and Factory	Matengo River	J. Ambrose
3677	10,000	¼	Irrigation and Factory	Matengo River	P.K. Hobson
3681	16,000		Domestic, Factory, Irrigation	Hanseketwa River	P.K. Hobson
3682	Unspecified		Domestic and Irrigation	Ihanda River	- do -
3683	30% of flow		- do -	Little Ihanda River	- do -
3684	Unspecified		Irrigation	Marouje Stream	E.K. Clarke
3685		1/10	Mining Purposes	Lupa River	New Ntumesi Reefs
3695		2	Irrigation and Domestic	Mbarali River	Mulla A. Pirmohammedi
3696		2	- do -	- do -	Mulla M.S. and Haji Osman Shakar
4142	40,000		Domestic	Mdembera River	Mbeya District Council
4184		1.5	Irrigation	Matengo River	NAFCO - Mbeya
4216	6,000		Fish Farming & Irrigation	Matula River	Mrs. Margritt Stanle
4217	6,000		- do -	- do -	- do -
4447	2,370 m^3		Domestic and Irrigation	Ihombo River	Nordic Tanz. Agr. Project.(ARTI)
4582		1.5	Irrigation	Mdembera River	NAFCO
4594	232,600 l/d		Domestic	Songwe River	D.D.D.
4595	135,000 l/d		Domestic	Kimani River	D.D.D.
4606	20,000 l/d		Domestic and Industrial	Songwe River	Mbeya Cement Co. Ltd.
4079		0.057	Irrigation	Mata River	D.D.D.
3224	12,000		Domestic, Irrigation and Industrial	Vwawa River	W.G. Smeed
3478	15,000		All purposes	Mbombesi River	E.A. Clowes
645		0.85	Domestic and Irrigation	Mdembera River	R.C. Prefectuse Apostolic
3664	Whole output		All purposes	Wells	G.C. Gray
3665	15,000		Domestic	Msofwe River	White Fathers
3666		1.5	All purposes	Mwaya River	Mrs. K.M. Coster
3667	5% of flow of furrow		- do -	Imeta River	Lamsck Mwaka Mgondya
3668	- do -		- do -	- do -	Kasimbaya Nsasha
3669	Whole flow		- do -	Chumba River	Mrs. Thelma Penny
3670	- do -		- do -	Spring	S.K. Kachra
3672	1,000		Domestic	Spring	Mbozi Club
3673	300,000		Domestic, Irrigation and Industry	Vwawa R. and Mbinga Stream	N.A. Allan
3674		0.5	Irrigation	Vwawa River	Papat and Sons
3675	Whole flow		Domestic and Irrigation	Zinsa River	Land Bank of Tangayika
281		1.5	- do -	Imeta River	National Service
2259	Not Specified		- do -	Mwambalisi and Mlowo R.	D.D.D. Mbeya
2316		1.0	Irrigation	Mbalizi River	- do -
2581	1,200		Domestic	Chimala River	- do -
2646	20,000		- do -	Kisindo Stream	- do -
2650	30,000		- do -	Mwambalizi River	- do -
2683		25.0	Irrigation	Mwiswi River	- do -
287	5,000		Domestic and Irrigation	Nandugu River	N.G. Newton
286	50,000		- do -	Nahara River	- do -
285		10.0	Mining	Songwe River	Mbeya Exploration Co. Ltd.
284		0.25	Irrigation	Imeta River	Mrs. Agnes Stead
607		0.4	Irrigation and Industry	Ruanda River	Z. Edward Kingdon
606		0.5	Domestic and Irrigation	Imeta River	Mbeya Joint Native Treasury
787		0.45	Domestic and Irrigation	Mchewa River	H.R. Wildbolz
740		2.0	All purposes	Msumbi River	W. Totman
739		0.02	Domestic and Irrigation	Kaualula River	Vwawa Minor Settlement
742		4.0	Irrigation	Brandt Furrown from (Chimala R.)	E.L. Echols
4649		2.0	Irrigation & Fish Farming	Songwe River	Magereza Songwe
4630		7.0	Irrigation	Mbarali River	D.D.D. Mbeya
4600		2.0	Domestic & Industrial	Songwe River	Mbeya Cement Co. Ltd.
4666	1,801,000 l/d		Domestic	Mambwe R. Trib. of Mbaka R.	R.D.D. Mbeya
2545	150,000		Domestic and Irrigation	Humba River	Director of Agriculture
1303		50.0	H. E. P.	Nzouwe River	TANESCO

Table 8.7[8] - Cont'd.

NUMERICAL INDEX AND REGISTER OF WATER RIGHT APPLICATION

AS KNOWN AT WATER OFFICE DAR-ES-SALAAM

MBEYA..... REGION

WATER RIGHT NUMBER	AMOUNT		PURPOSES	SOURCE	GRANTEE
	G.P.D.	CUSECS			
2181	1,000		Domestic	Kiwira River	Principal Secretary, Ministry of Land, Forest and Wildlife
2182	30,000		Irrigation	- do -	- do -
2203	1,000		Domestic	Luwalisi River	Messrs. Musekera Estate Ltd.
2240	20,000		Irrigation	- do -	Musekera Tea Estate Ltd.
2376		5.9	Irrigation and H. E. P.	Nyamesi River	Jivanjee Estate Ltd.
2381	120,000		Irrigation	Mbaka Masawe River	- do -
2382	150,000		Irrigation	Ngoyo River	Eugin Schneider (Jivanjee)
2383		5.9	Irrigation and H. E. P.	Nyamesi River	Jivanjee Estate Ltd.
2384	206,000		Domestic and Irrigation	Kisararuswa River	- do -
2391	180,000		Coffee Pulpery	Kiwira River	Kiwira Coffee Co. Society
2394	720,000		Irrigation	Luwalisi River	Musekera Estate Ltd.
2395	50,000		- do -	Kiganga River	- do -
2564	500,000		- do -	Maseba River	Jivanjee Estate Ltd.
2690	1,700		Domestic	Masukulu Springs	D.D.D. - Rungwe
2723	6,500		Irrigation	Njungile River	Director of Agriculture
2686					
2746	2,000		Domestic	Ipinda River	D.D.D.
2747	9,000		- do -	Mbaka River	D.D.D.
2748	40,000		- do -	Kapondero River	D.D.D.
2813	400,000		Irrigation	Ngunga River	Tanzania Tea Authority
4032	2,000		Domestic	Luwalisi River	D.D.D.
4242	80,000		Livestock purposes	Owiri River	National Agri. Co. Ltd.
4245	206,000		Domestic	Malonja River	- do -
4243	61,500		Domestic	Mbiriri River	- do -
4349	50,000 l/d		- do -	Kangolo River	D.D.D.
4382	2,250		- do -	Meta River	Assemblies of God Mission
4438		114 m^3/d	Domestic and Industrial	Chimala River	TAZARA
4439		559 m^3/d	- do -	Nzovwa River	TAZARA
3584		2.5	Irrigation	Nzofwa River	Headman of Itende
3473	Whole flow		Domestic	Sisimba & Hospital R.	Director of Public Works
3393	8,000		Domestic	Nzofwa River	- do -
3220	50,000		All purposes	Mtengo River	J. Caims
3192	Whole flow		- do -	Dagu River	E.S. Thomson
3181	Whole flow		- do -	Olaudadabu River	Karl Rahde
1489	This File Belongs to Morogoro Region				
3173	½ of the flow		Domestic and Factory	Two Springs	Mrs. H.R. Collyer
3174	75% of the flow		All purposes	Ishera River	D.St.J. Clowers
3175	40% of the flow		- do -	- do -	- do -
3176		¼	- do -	Ipogoro River	- do -
2971	Unspecified		Irrigation	Mswiswi River	D.D.D.
2969		2.5	- do -	Kapio River	Mbeya District Council
643	4,000		Domestic and Factory	Kiganga River	The Manager, Kiganga Estate
794	10,000		Domestic	Nyibuka Spring	Rungwe District Council (D.D.D.)
2918		4.0	Public Supply	Nzovwe River	H.D.D. Mbeya
2970	Unspecified		Irrigation	Msiswi River	D.D.D. Mbeya
2161	3.5 Million gall.		Domestic	Chiwanda River	White Fathers
2093		1.0	Irrigation	Ihanda River	H. Col. E.J. Newau
2039	5,500		Irrigation	Unnamed Stream	Binamu Kinza
2010	5,000		Domestic	Momba River	White Fathers, Kemsamba Mission
2004	1,000 Dom.	0.33 Irr.	Domestic and Irrigation	Meta River	Moosa Esso Mia
1980	7 Million gall.		Irrigation	Itinga Stream	N.A. Allan
1968	40% of the flow		All purposes	Issera River	R.W. Towers
1969	75% of the flow		All purposes	Issera River	R.W. Towers
1970		¼	- do -	Ipogoro River	- do -
1943	15,000		Domestic and Irrigation	Chimala River	Registered Trustees Diocese of Iringa
1882		0.5	All purposes	Mbarali River	- do -
1881	Full flow		Irrigation	Sara River	K.C. Ohlson
1854	50,000		Domestic	Nzofwe River	Engineering Chief - P.W.D.
1852	24,000		Domestic and Irrigation	Mfisimu River	Moravian Mission
1751	10,000		Domestic and Irrigation	Kawatira River	District Forest Officer
1744	100,000		- do -	Unnamed tributary	S.K. Kachra
3615	Unspecified		Irrigation	Chimala River	Sub-Chief of Chosi
3616	Unspecified		- do -	- do -	- do -
3617	Unspecified		- do -	Mimbi River	- do - (Usangu)

Table 8.7^{8} - Cont'd.

NUMERICAL INDEX AND REGISTER OF WATER RIGHT APPLICATION

AS KNOWN AT WATER OFFICE DAR-ES-SALAAM

..MBEYA... REGION

WATER RIGHT NUMBER	AMOUNT G.P.D.	AMOUNT CUSECS	PURPOSES	SOURCE	GRANTEE
4127	90,800 l/d		Domestic	(Borehole at) Kiwira River	D.D.D.
4128	90,800 l/d		Domestic	Unnamed Spring	D.D.D.
4129	20,000		- do -	Kiwira River	D.D.D.
604	50% of the flow	25	Domestic and Irrigation	Zinza River	W.R. Horne
605	90,000	0.17	Irrigation	Itemesa River	G.C. Gray
607	6,000		Domestic and Irrigation	Ruanda River	Z. Edward Kingdom
614		2/20	Factory and Irrigation	Itemba River	Chidlow Vigne
617	125,000		Irrigation	Ihande River	E.J. Newall
1748	400	0.40	Domestic and Irrigation	Ishera River	Rajabali Sachedina Hadur
2011		1.5	Irrigation	Mnyarisi River	D.D.D.
2251	12,000	¼	Irrigation, Domestic and Factory	Vwawa River	M/s. Popat and Sons
2330	540,000		- do -	Vwawa River	Mr. A.N. Allan
2346	15,000	0.52	Domestic, Irrigation and Coffee Factory	Mbimba River	Director of Agriculture
2347	50,000		Coffee Pulpery	Vwawa River	Vwawa Cooperative Society
2541	3,000		Domestic, Fish Pond Irrigation	Mlowo River	Catholic Mission Mlowo
2357		½	Domestic, Irrigation, Coffee Pulpery	Vwawa River	Messrs. Popat and Sons
2822	1,500		Domestic	Momba River	D.D.D.
2823	1,500		- do -	- do -	D.D.D.
2824	2,000		Domestic	Momba River	D.D.D.
2825	1,500		- do -	Nkana River	D.D.D.
2992	232,760		Domestic and Irrigation	Mimba River	Mimba Farm
4351	45,050		Domestic	Hanseletwa River	D.D.D.
4614	600		- do -	Ruanda River	D.D.D.
4617	5,702,600 l/d		Irrigation	Msimbizi River	D.D.D.
4618	5,702,600 l/d		- do -	- do -	D.D.D.
4619	4,320,000 l/d		- do -	- do -	D.D.D.
4620	4,406,400 l/d		- do -	Nyorisi River	D.D.D.
4621	221,325 l/d		- do -	Sademu Spring	D.D.D.
4622	325,145 l/d		- do -	Iwezye River	D.D.D.
4623	603,865 l/d		- do -	Shindima Spring	D.D.D.
1114	30,000		Domestic	Chunya & 2 boreholes	Director Public Works
1192	24,000		Mining	Lupa River	Ntumbi Reef Mines
2503	2,000		Domestic	Spring	Gua Catholic Parish
2569	1,000		Domestic	Songwe River	Galula Catholic Parish
2575	30,000		- do -	Lurka Spring	D.D.D.
2671	10,000		- do -	Lombo River	D.D.D.
2807	20,000		- do -	Spring	Diocese of Mbeya
3661	Unspecified		All purposes	Tributary of Luiya R.	H. Reinstorf
3685		1/10th	All mining purposes	Lupa River	New Ntimei Reefs
924	2,500		Domestic	Malipesa	Manager, Kiganga Tea Estate
939	Whole flow		Domestic and Irrigation	Mwela Stream	Busokalo Rural Council
1143	15,000		Forest Nursery	Tributary of Kiwira R.	Forest Officer Mbeya
1150		1/540	Domestic Supply	Mbaka River	Department of Agriculture
1160	7,000		Irrigation	Kijunjwe	Rev. Father Jean Fowny
1193		0.05	Domestic use	Magubwa Stream	Finnish Missionary Society
1571	4,000		Domestic	Ndeligwe River	Kiganga Estate
1609	16,000		Public Supply	Boreholes	Rungwe African District Council
1738	7,000		Domestic	Mwatesi River	Finnish Luth. Mission Mwakaleli
1752	10,000		Domestic and Irrigation	Kiwira River	District Forest Officer
1784	1,100		- do -	Ndala River	Department of Agriculture
1789	6,000		Domestic	Luwalisi River	Kiganga Estate Ltd.
1846	2,000		- do -	Kiganga River	Museckera Estate Ltd.
1847	1,500		Domestic	Ndunguwisi River	- do -
1850	1,600		- do -	Kiganga River	- do -
1855		1	Public Supply	Mwarezi River	Chief of Engineer Public Works Department
1922	8,000		Domestic	Kala River	Rungwe Monravian Mission
1945	2,000		- do -	Isaka River	Catholic Mission Igonge
1955	4,500		Domestic and Factory	Lusangaye River	Rungwe Tea Estate
1981	100,000		Domestic and Irrigation	Kilasi River	Rungwe Monravian Mission
1982	2,000		Domestic	Spring	- do -
2102	250,000		Irrigation	Kiranga River	Kiganga Estate Ltd.

Table 8.7[8] - Cont'd.

NUMERICAL INDEX AND REGISTER OF WATER RIGHT APPLICATION

AS KNOWN AT WATER OFFICE DAR-ES-SALAAM

.MBEYA... REGION

WATER RIGHT NUMBER	AMOUNT		PURPOSES	SOURCE	GRANTEE
	G.P.D.	CUSECS			
963		1.75	Irrigation and Domestic	Mchewe Stream	D.M. Stewart
927		0.2	Irrigation	Matula River	Hans Staub
928		0.06	Domestic, Irrigation and Coffee Processing	Mkera River	Francis R.H. Nicholls
948		0.01	Domestic	Well	Dr. Hope Traut
949		0.05	Domestic and Irrigation	Mbalizi River	L. Lehner
1576		0.3	All purposes	Mambi River	A. Mahmood Baluch
1607		0.5	Irrigation	Nyikuku Stream	E.A. Clowes
1623	168,000		Irrigation	Nsufwe River	Utengule Tea and Coffee Plantation
1624	175,000		Irrigation	Ilunga River	- do -
1625	46,400		Irrigation and Coffee Pulping	Msalisi River	- do -
1626	18,450		Domestic and Irrigation	Mfisimu River	- do -
1708		10.0	Irrigation	Mbarali River	NAFCO, Mbarali State Farm
1706	500		Domestic	Msalisi River	Mrs. Ursula E. Egan
1705		1.0	Domestic and Irrigation	Nkungulu River	- do -
1720	Whole flow		Construction works	Sisimba River	Moosa Essop Mia
1723	60% of the River		All purposes	Ishera River	E.G. Kroussos
1745	180,300		Domestic and Irrigation	Springs	A. Pitcairn
1304		0.75	Domestic and Irrigation	Mlowo River	E.A. Clowes
283	1,000	0.33	Domestic and Irrigation	Unnamed Spring near Meta River	Karim Bux Abdallah
288		1.0	Irrigation	Mlowa River	N.G. Newton
554		1.5	Domestic and Irrigation	Imeta River	C.G. Carson Houry
3576		6.0	- do -	Chimala River	Africans
1119		1.0	- do -	Chosi River	E.L. Echols & G.V. Caskey
308		0.75	Irrigation	Mbilisi River	Gulamhusein M. Daya
1778		0.75	All purposes	Myomba River	F.K. Ahmed
3367		0.25	- do -	Komera River	S.M. Gilbert

Table 8.7[8] - Cont'd.