Table 3.9 Estimated Monthly Runoff

Tabalong Kanan Sub-system
Catchment Area : 1075 km2

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1917	34.56	61.34	49.83	46.56	51.72	27.55	20.52	22.00	20.45	24.05	28.15	47.73	434.44
1918	63.42	35.97	56.62	27.37	25.73	22.92	17.01	14.37	12.63	15.78	15.16	23.49	330.48
1919	29.83	66.66	40.74	54.25	51.72	32.91	31.01	22.93	18.94	14.96	27.25	64.26	455.48
1920	54.68	60.71	63.29	40.09	26.33	28.49	22.74	22.55	20.74	20.26	29.71	28.67	418.26
1921	45.36	65.42	72.83	46.99	43.97	29.24	22.94	21.32	24.71	22.56	20.63	40.53	456.50
1922	31.19	31.17	45.79	26.55	54.36	27.08	20.94	17.68	12.60	17.16	30.94	26.93	342.37
1923	28.71	55.66	53.75	25.91	22.13	32.92	26.55	19.46	13.60	11.66	26.97	42.16	359.48
1924	58.56	35.30	92.25	51.32	78.59	44.24	25.63	28.23	18.83	87.93	81.67	95.19	697.74
1925	56.89	66.01	70.53	48.79	34.41	26.57	17.12	16.03	14.71	15.47	17.17	73.32	457.03
1926	49.18	65.70	62.22	58.91	38.09	29.46	24.79	21.67	26.34	21.80	25.27	48.02	471.44
1927	58.73	47.46	28.88	33.52	25.63	26.32	27.33	17.72	16.15	14.21	20.40	55.40	371.77
1928	101.20	68.36	53.33	40.36	29.20	25.43	24.41	23.85	20.84	19.12	32.91	56.83	495.86
1929	46.90	41.79	36.00	26.76	23.65	21.35	22.44	20.73	13.62	16.77	37.65	72.25	379.92
1930	93.64	77.42	48.15	65.98	83.44	35.71	25.12	23.25	20.05	19.13	22.34	60.18	574.40
1931	63.02	78.41	68.34	84.05	48.18	30.04	27.97	26.52	29.49	24.04	50.63	71.52	602.20
1932	70.73	66.46	58.69	67.76	45.82	54.90	29.51	24.64	22.05	17.84	21.88	29.92	510.20
1933	56.67	48.97	34.95	72.50	35.01	24.77	22.63	15.59	15.98	16.86	35.32	42.02	421.27
1934	55.73	50.22	63.95	64.04	28.39	39.91	25.13	21.14	16.07	17.40	35.18	87.73	504.90
1935	61.91	37.16	58.36	56.87	45.34	51.87	31.47	25.93	25.15	22.12	30.76	45.77	492.72
1936	51.32	55.96	75.55	67.56	45.72	30.50	24.90	25.19	21.05	22.78	59.18	54.79	534.50
1937	40.82	37.68	56.18	85.24	61.67	31.87	28.65	23.96	23.89	22.79	31.38	54.42	498.56
1938	60.08	29.50	104.63	47.69	29.12	24.74	26.38	25.93	20.65	21.96	21.37	44.86	456.92
1939	84.26	60.12	42.17	38.64	34.01	42.86	27.10	21.55	21.63	22.70	26.46	26.22	447.72
1940	33.73	52.39	66.57	55.30	75.92	33.86	24.65	19.32	16.52	16.30	19.59	43.16	457.30
1941	32.36	34.78	29.23	39.95	44.93	25.61	18.32	12.38	11.71	12.88	30.03	48.75	340.93
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951	51.93	67.99	46.59	39.02	28.18	27.98	25.42	20.66	20.04	17.43	29.86	74.80	449.89
1952	50.87	100.87	78.50	36.33	40.27	28.36	22.70	19.72	18.56	70.80	77.95	65.99	610.92
1953	109.61	50.73	55.54	70.85	33.77	25.51	24.72	23.42	21.03	20.88	31.38	49.73	517.15
1954	67.33	68.41	87.53	78.77	57.23	45.99	42.99	30.82	31.44	24.91	33.08	61.54	630.04
1955	132.23	111.30	79.04	57.80	33.56	44.67	30.99	58.01	32.09	64.06	79.16	68.24	791.15
1956	80.01	76.87	79.73	70.16	55.79	39.06	31.73	26.76	23.14	26.46	45.85	76.19	631.74
1957	90.91	92.78	89.47	78.83	60.50	40.07	62.29	30.63	24.56	25.43	30.72	89.54	715.74
1958	97.04	94.98	60.03	35.81	37.42	29.23	25.70	26.78	22.56	23.48	31.71	48.12	532.87
1959	37.72	38.03	60.53	55.54	53.40	29.86	25.56	21.69	16.09	16.78	39.95	74.36	469.51
1960	71.12	42.43	43.24	35.21	41.97	28.98	25.03	24.76	26.56	19.96	62.36	117.10	538.72
1961	68.86	51.12	57.42	37.93	28.15	23.01	22.67	15.50	16.59	18.95	18.12	45.94	404.27
1962	58.90	56.61	58.54	50.64	39.89	27.79	22.57	22.69	22.43	22.00	32.58	56.81	471.47
1963	47.84	42.00	40.99	34.90	27.70	21.89	20.73	19.31	17.82	15.43	19.82	33.97	342.40
1964	47.36	46.64	48.08	41.58	32.26	23.80	22.77	21.46	20.01	18.30	25.02	45.27	392.55
1965	69.00	48.75	34.53	30.91	23.80	16.36	12.66	11.81	13.04	19.03	17.40	89.94	387.21
1966	65.78	53.82	52.89	45.18	35.26	25.03	19.70	19.80	19.54	18.83	27.24	49.38	432.45
1967	45.39	40.82	40.18	34.25	26.79	20.86	19.74	18.36	16.93	14.59	19.11	33.88	330.89
1968	62.17	63.99	67.70	59.21	46.09	30.61	24.66	19.79	16.41	19.73	37.27	67.03	514.65
1969	56.61	49.20	48.80	41.86	32.65	24.43	23.23	21.88	20.29	18.47	24.61	44.17	406.20
1970	64.03	63.40	66.43	57.89	45.46	30.42	24.83	19.92	21.15	22.85	38.35	65.52	520.26
1971	79.20	68.90	50.26	52.31	25.36	19.28	15.38	18.15	18.27	18.13	35.65	28.67	429.55
1972	31.01	29.22	28.59	24.87	21.19	19.54	17.52	15.27	13.50	15.38	16.72	23.42	256.23
1973	48.63	52.39	55.82	48.16	37.73	25.40	20.37	20.56	20.37	20.11	30.98	55.50	436.02
1974	52.82	47.54	47.88	40.96	31.78	23.62	22.46	21.15	19.61	17.83	24.15	43.89	393.69
1975	67.26	75.47	86.39	78.95	77.49	41.45	80.41	55.23	53.98	69.98	94.34	108.98	889.93
1976	84.70	84.63	102.46	80.88	36.39	31.67	42.52	34.10	32.42	28.98	67.17	68.19	694.12
1977	66.30	78.76	44.20	40.60	48.20	48.63	30.55	26.63	26.35	22.59	26.03	40.90	499.73
1978	61.94	62.12	64.57	56.52	44.80	31.10	25.88	25.92	25.50	25.21	37.79	62.70	524.06
1979	57.60	51.56	51.41	44.44	34.98	26.63	25.44	23.98	22.39	20.46	26.66	46.28	431.84
1980	47.33	43.70	43.49	37.29	29.34	23.04	21.79	20.48	19.01	16.71	21.43	37.32	360.92
1981	44.15	42.29	42.57	36.57	28.45	21.99	20.88	19.53	18.12	15.98	20.83	37.34	348.69
1982	48.13	46.50	47.73	41.21	31.86	23.52	22.45	21.21	19.72	17.97	24.58	44.75	389.63
1983	60.11	58.67	60.88	52.89	41.52	27.91	22.85	23.04	22.66	22.51	35.02	60.18	488.24
1984	60.17	55.01	56.01	47.99	38.12	26.95	21.50	21.57	21.28	20.64	29.76	52.87	451.88
1985	43.74	37.99	36.68	30.82	25.56	23.56	21.21	18.78	16.83	19.14	21.25	32.14	327.70
1986	48.25	48.37	50.24	43.29	34.01	24.39	19.01	19.09	18.91	18.10	26.00	47.77	397.41
1987	51.16	47.43	48.15	41.48	32.08	23.70	22.60	21.33	19.81	18.05	24.64	44.80	395.24
Mean	59.53	56.81	57.19	49.43	40.03	29.80	25.79	22.80	20.77	22.98	33.27	54.47	472.86

Table 3.10 Estimated Monthly Runoff

Tabalong Sub-system
Catchment Area : 1196 km2

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1917	54.61	49.04	58.31	40.89	27.13	31.12	19.49	17.26	15.72	16.01	20.52	25.87	375.96
1918	46.00	32.69	47.78	55.00	30.49	19.74	15.32	12.52	13.07	13.14	14.27	35.44	335.47
1919	32.93	25.33	59.22	52.47	64.14	42.15	21.30	12.64	12.00	11.78	12.95	17.97	364.89
1920	56.46	45.30	31.55	47.82	23.21	26.88	19.22	37.25	25.67	24.84	26.66	46.77	411.62
1921	72.35	58.38	45.40	31.05	24.16	19.34	15.08	12.90	37.40	22.72	54.50	45.62	438.89
1922	30.10	44.88	91.73	47.71	23.62	19.66	15.60	14.37	13.59	14.94	14.12	31.24	361.56
1923	51.89	39.74	47.48	25.24	21.21	15.05	16.82	13.17	11.84	10.48	24.99	60.80	338.70
1924	65.67	54.91	93.67	106.24	88.79	37.51	23.63	42.32	43.44	64.35	105.01	106.84	832.36
1925	83.59	96.48	58.74	55.63	29.56	23.83	17.95	15.57	14.35	13.53	13.60	59.86	482.71
1926	52.65	53.09	53.20	22.72	31.05	21.79	15.92	12.75	12.71	34.43	39.90	60.46	410.67
1927	47.11	45.89	52.74	23.15	42.29	24.09	19.67	14.52	12.47	14.79	31.81	20.81	349.34
1928	84.29	169.96	185.75	83.85	47.23	31.28	21.96	17.64	15.64	15.90	27.62	40.47	741.59
1929	45.02	50.60	42.45	26.84	16.79	14.93	13.78	12.22	11.53	10.85	17.88	70.86	333.74
1930	67.64	79.57	69.34	125.74	94.86	43.47	22.60	15.09	15.71	17.92	17.67	89.51	659.10
1931	92.17	80.14	52.57	101.58	46.92	51.17	31.02	20.12	17.68	21.16	19.85	96.24	630.62
1932	103.10	72.42	65.48	82.25	50.99	44.00	24.72	21.87	26.14	18.10	34.25	72.09	615.40
1933	65.50	43.11	32.36	68.83	47.21	31.26	21.01	16.79	16.91	17.41	61.04	49.12	470.56
1934	47.56	35.70	58.25	88.05	38.79	33.23	22.41	16.40	15.17	16.00	24.35	78.32	474.24
1935	46.80	20.95	25.04	23.17	17.31	16.42	15.14	14.88	13.87	14.97	15.72	49.35	273.61
1936	42.99	22.64	50.87	75.22	38.72	30.95	16.31	14.21	13.69	14.79	37.11	45.77	403.28
1937	48.74	59.21	56.64	85.21	50.62	50.84	56.07	26.56	18.56	19.37	24.45	50.42	546.70
1938	80.75	40.66	90.15	43.94	40.89	32.80	28.74	30.94	19.01	16.65	42.40	71.44	538.37
1939	86.56	64.30	101.24	79.97	61.39	50.37	53.97	25.47	19.25	17.97	22.37	29.14	612.01
1940	37.84	81.85	108.01	52.60	46.36	32.28	19.76	17.48	14.63	13.82	14.69	32.59	471.92
1941	55.12	66.91	64.44	69.78	70.22	25.45	17.68	13.85	13.99	13.09	13.62	27.64	451.79
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951	85.74	52.88	35.08	23.98	18.50	16.33	15.29	22.02	16.64	15.71	17.63	108.49	428.29
1952	70.38	64.22	59.46	41.31	34.67	19.88	17.78	16.06	14.87	14.35	15.12	41.61	409.70
1953	37.96	33.31	19.61	16.08	14.07	12.08	11.42	11.57	10.35	9.63	9.41	11.43	196.94
1954	33.26	25.89	48.41	43.99	20.51	19.41	34.42	18.15	19.44	18.32	22.85	50.48	355.12
1955	76.75	54.66	53.01	39.94	48.00	23.83	17.10	18.08	35.45	41.36	76.76	41.11	526.06
1956	67.45	91.95	48.29	49.80	73.47	40.66	27.06	21.31	18.73	22.14	16.43	56.16	533.45
1957	64.80	61.97	52.25	51.26	30.25	22.81	16.95	17.36	16.64	14.25	39.83	69.98	458.35
1958	42.93	83.47	106.74	73.71	33.45	26.89	19.67	23.90	17.47	17.83	34.67	71.74	552.48
1959	38.50	23.33	38.58	53.75	49.40	43.80	20.13	15.81	15.24	13.80	17.55	54.66	384.55
1960	55.15	50.28	43.99	45.84	38.57	23.96	16.44	16.45	33.36	19.67	71.83	98.55	514.09
1961	70.38	41.07	70.70	55.57	52.78	27.76	17.21	14.42	13.42	12.44	15.16	51.97	442.89
1962	70.42	78.13	68.76	49.17	25.12	17.73	21.58	19.63	17.76	15.39	26.65	73.77	484.11
1963	37.83	69.35	65.28	32.05	24.22	16.55	14.95	13.20	12.47	13.80	12.86	23.97	336.52
1964	49.66	62.35	48.62	56.85	46.59	21.77	20.12	13.70	13.30	42.43	43.07	41.13	459.58
1965	76.53	91.56	48.11	41.58	50.03	26.15	17.19	14.54	12.66	11.92	11.38	22.54	424.21
1966	45.27	48.89	64.46	31.80	29.29	20.14	16.31	15.35	12.53	24.65	45.38	51.43	405.51
1967	42.32	44.15	24.61	16.44	19.58	19.91	14.17	13.17	13.55	12.43	12.20	52.12	284.64
1968	86.71	62.61	42.83	39.38	24.48	18.95	16.41	16.68	14.58	13.97	21.00	32.70	390.31
1969	19.22	23.23	20.11	14.05	14.85	11.81	10.10	9.45	8.88	10.49	20.65	39.34	202.17
1970	44.78	26.45	27.18	61.49	29.54	42.82	32.52	20.01	27.23	18.90	32.09	46.50	409.51
1971	63.40	64.57	84.91	49.09	27.42	31.55	34.03	21.46	18.53	16.37	19.56	49.91	480.79
1972	54.35	28.25	24.98	21.59	28.73	17.88	15.48	12.24	11.11	12.96	12.57	42.29	282.44
1973	46.62	41.30	79.00	74.64	65.01	39.34	24.82	29.01	25.50	20.27	26.04	55.44	527.00
1974	46.40	33.57	26.14	40.80	26.86	15.68	17.30	13.73	13.84	28.77	56.54	54.44	374.07
1975	42.06	43.86	50.32	24.68	36.59	19.40	27.33	22.45	18.94	44.27	56.36	37.92	424.16
1976	33.16	58.81	83.84	41.87	23.38	17.43	18.15	18.98	15.08	27.37	64.82	71.85	474.74
1977	45.63	50.90	61.74	37.70	24.55	27.96	17.52	17.34	14.93	15.51	13.89	36.66	364.33
1978	27.53	68.28	28.09	44.09	34.98	24.65	30.21	23.81	18.50	69.91	57.35	82.02	509.41
1979	92.09	74.48	36.49	25.19	18.58	19.83	17.06	15.52	12.72	12.01	11.88	34.46	370.31
1980	33.53	67.43	39.54	33.13	15.96	13.82	12.87	11.86	11.32	12.21	29.74	25.53	306.94
1981	21.21	26.83	26.22	17.28	13.68	13.14	11.92	11.34	11.64	9.76	12.36	72.69	248.07
1982	64.10	28.71	90.29	104.65	41.78	33.40	16.55	13.47	12.05	11.23	11.19	17.19	444.62
1983	21.14	36.92	16.50	18.59	15.12	24.69	14.69	12.49	57.32	31.09	122.39	183.83	554.78
1984	76.30	108.91	80.44	61.30	33.17	21.84	19.36	18.62	18.23	16.23	15.97	14.62	484.99
1985	20.05	16.78	18.81	15.20	17.73	15.44	13.95	10.87	11.74	9.50	10.57	15.59	176.24
1986	18.69	44.86	81.45	79.45	36.66	24.52	14.77	11.02	10.70	13.71	23.66	34.10	393.56
1987	58.94	32.12	23.46	16.01	21.75	14.85	11.74	11.67	11.97	13.50	19.22	55.02	290.25
Mean	54.49	54.03	56.14	49.33	36.02	26.10	20.32	17.35	17.46	19.31	29.97	52.22	432.75

Table 3.11 Estimated Monthly Runoff

Balangan Sub-system
Catchment Area : 2098 km2

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1917	100.54	97.93	81.76	62.51	59.24	52.46	42.73	38.50	40.46	33.94	52.57	86.56	749.22
1918	75.60	69.07	54.61	44.94	41.15	36.42	36.08	30.84	30.46	31.84	38.34	53.91	543.24
1919	77.14	80.66	67.89	50.87	48.36	43.76	34.38	30.77	32.99	36.58	50.76	76.41	630.57
1920	86.07	84.82	70.52	52.77	50.26	45.16	35.68	31.82	34.05	37.65	52.82	79.42	661.03
1921	88.86	87.00	72.38	54.06	51.55	45.94	36.40	32.52	34.73	38.32	54.26	81.49	677.49
1922	82.85	79.88	65.22	49.11	46.67	42.21	41.51	35.42	34.91	36.88	48.44	72.01	635.10
1923	79.04	77.69	63.46	48.19	45.58	41.19	40.57	34.51	34.03	35.85	46.94	69.95	617.01
1924	112.66	119.06	102.63	79.03	75.86	65.56	49.23	45.16	38.98	36.27	72.08	118.08	914.60
1925	93.81	83.86	67.88	51.54	48.79	44.10	43.22	36.96	36.30	38.15	49.40	72.44	666.46
1926	90.96	92.03	77.34	58.12	55.42	48.98	39.35	35.40	37.58	31.05	49.24	83.25	698.72
1927	85.89	82.55	67.91	50.94	48.30	43.97	34.46	30.72	32.84	36.32	49.44	74.41	637.75
1928	96.04	97.45	82.02	62.41	59.20	51.45	41.27	37.15	30.35	26.81	49.54	88.60	722.30
1929	85.01	80.18	65.41	49.29	46.85	42.39	41.52	35.47	35.01	36.84	48.41	71.70	638.08
1930	85.91	86.18	71.73	53.79	51.37	45.80	36.29	32.41	34.64	38.24	53.89	80.85	671.11
1931	99.84	100.26	84.05	64.36	60.77	52.67	42.22	38.00	31.30	27.83	51.57	91.47	744.32
1932	104.05	102.55	85.77	65.66	62.29	54.06	43.20	38.95	32.23	28.76	52.97	93.26	763.75
1933	104.07	101.69	85.15	65.01	61.59	53.53	43.05	38.79	32.05	28.56	52.26	92.13	757.87
1934	106.28	104.81	87.88	67.49	64.02	55.55	44.45	40.11	33.32	29.80	54.77	96.13	784.60
1935	85.25	79.01	63.70	49.07	46.16	41.59	40.83	34.83	34.35	36.14	46.19	68.18	625.31
1936	81.79	82.19	68.51	51.27	48.58	44.02	34.51	30.80	32.95	36.46	50.40	75.92	637.42
1937	99.65	101.59	85.60	65.42	62.06	53.78	42.86	38.71	32.07	28.66	53.41	94.15	757.97
1938	95.21	91.32	75.62	56.48	53.97	47.86	38.23	34.28	36.45	40.02	57.14	85.21	711.79
1939	86.00	82.43	67.69	51.06	48.29	43.83	34.24	30.62	32.64	36.03	48.91	73.41	635.13
1940	82.45	81.42	67.34	50.48	47.80	43.40	33.86	30.29	32.36	35.82	49.23	74.44	628.89
1941	65.42	59.74	47.26	38.94	35.03	30.40	30.34	25.48	25.18	26.60	32.45	45.36	462.20
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951	85.56	79.95	64.66	51.06	47.87	43.10	42.35	36.34	35.83	37.56	46.76	68.15	639.17
1952	98.04	101.77	86.22	66.38	63.08	54.89	44.05	39.81	33.09	29.62	53.82	94.51	765.28
1953	128.31	103.52	90.08	102.83	109.38	54.76	46.55	37.46	27.57	31.69	96.76	106.53	935.44
1954	93.94	92.61	75.85	71.93	75.30	82.00	55.93	49.56	48.54	46.50	58.82	113.97	864.95
1955	143.36	115.77	89.18	60.84	54.48	44.93	44.98	70.41	45.98	40.18	78.14	54.66	842.91
1956	72.61	116.30	53.51	62.65	79.65	55.57	38.43	31.21	31.53	35.41	44.00	68.17	689.04
1957	50.73	96.16	63.40	47.83	45.22	43.40	42.80	29.02	20.91	19.50	42.08	49.05	550.11
1958	41.76	73.39	91.73	65.82	38.80	29.38	22.79	28.82	33.56	28.02	29.80	53.93	537.80
1959	54.63	52.45	60.31	65.09	66.96	57.02	38.37	27.85	22.40	17.93	24.62	102.87	590.50
1960	85.95	113.21	52.31	42.08	70.30	43.82	87.94	40.58	43.16	34.92	78.32	132.64	825.23
1961	147.05	181.55	129.90	74.58	66.26	69.53	42.11	28.29	42.95	50.91	57.62	84.85	975.59
1962	151.08	111.75	86.96	66.92	46.60	40.64	35.62	32.74	29.12	32.96	77.04	113.84	825.26
1963	58.42	112.70	111.91	58.45	62.93	38.54	31.37	28.65	30.75	30.01	26.86	56.60	647.20
1964	127.90	65.63	60.92	55.08	46.87	34.52	33.18	30.15	26.51	32.89	40.41	38.92	592.96
1965	65.61	71.11	64.52	46.05	41.02	37.67	31.92	22.73	18.76	17.63	18.98	24.78	460.78
1966	39.32	90.95	108.44	47.12	61.80	37.93	32.02	38.55	24.22	25.63	32.03	71.72	609.72
1967	120.34	110.07	38.91	26.04	32.49	27.55	25.65	29.28	24.99	18.99	24.61	56.86	535.78
1968	114.88	70.25	68.56	41.14	98.14	129.13	56.50	47.47	38.91	34.65	57.49	94.67	851.78
1969	91.87	86.98	71.70	53.62	50.66	45.45	35.79	31.96	34.03	37.49	52.37	78.82	670.74
1970	56.58	41.86	55.32	42.14	45.52	150.28	99.48	40.18	100.17	74.67	51.32	89.33	846.85
1971	151.03	134.31	74.16	57.28	45.85	42.31	38.19	34.31	37.95	33.06	37.89	62.85	749.19
1972	74.21	48.64	47.97	40.26	75.21	37.53	24.18	19.18	20.46	26.90	32.57	76.31	523.43
1973	108.55	74.65	43.83	68.84	87.68	47.57	43.89	50.20	70.65	42.36	92.09	161.11	891.42
1974	68.90	68.12	62.99	63.15	58.92	45.51	39.28	38.02	34.22	34.05	82.89	95.34	691.40
1975	108.26	81.09	78.12	55.46	46.39	36.78	34.86	34.56	53.80	75.43	46.86	66.25	717.86
1976	104.02	67.33	55.44	48.72	35.90	31.32	27.08	21.02	19.83	28.54	116.21	158.30	713.72
1977	74.68	72.16	88.34	63.12	44.21	49.47	39.85	30.63	21.44	22.84	29.84	79.39	615.96
1978	121.62	164.37	89.17	69.95	60.10	53.15	105.80	57.50	60.23	50.65	126.43	106.49	1065.46
1979	111.74	95.51	55.42	48.99	62.44	47.93	40.26	26.42	24.34	22.46	38.96	132.85	707.32
1980	119.01	69.75	52.16	42.33	37.05	53.58	41.84	32.59	24.89	25.42	52.52	49.56	600.69
1981	39.46	57.02	64.35	49.75	39.90	32.79	34.54	21.73	25.35	31.23	55.26	80.73	533.11
1982	111.35	84.03	127.16	105.76	56.87	94.49	40.94	24.14	26.14	27.24	33.17	40.39	771.69
1983	83.87	48.01	33.37	24.44	49.33	134.46	157.93	86.38	51.47	117.58	370.38	340.08	1497.31
1984	183.36	286.48	277.57	216.62	120.71	75.32	62.70	60.87	59.47	45.86	59.56	87.54	1536.07
1985	125.29	113.16	123.43	64.66	53.56	132.48	62.83	47.56	45.02	36.90	40.96	42.22	888.06
1986	52.77	95.67	163.24	106.32	81.54	80.74	53.70	33.82	28.57	35.56	51.90	54.79	838.61
1987	131.50	73.93	57.57	84.99	115.68	47.80	33.73	36.26	36.45	33.34	36.42	95.36	783.01
Mean	94.32	92.38	78.19	60.50	57.96	53.76	44.35	36.21	35.41	35.74	57.45	85.21	731.51

Table 3.12 Estimated Monthly Runoff

Batang Alai Sub-system
Catchment Area : 1,539 km2

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1917	127.93	134.67	114.81	91.09	75.01	77.14	54.49	48.71	37.58	38.02	34.59	68.13	902.17
1918	98.57	80.81	89.36	94.13	66.19	49.20	34.38	24.60	18.15	15.36	29.01	63.37	663.14
1919	136.99	92.76	101.87	92.06	88.75	67.20	51.86	33.03	24.80	19.24	21.91	60.51	790.98
1920	65.29	53.42	56.97	76.47	60.98	44.99	35.46	35.99	31.83	44.75	62.15	76.28	644.58
1921	82.55	103.19	89.16	77.12	58.19	46.82	49.83	35.87	31.98	38.66	33.20	47.82	694.39
1922	60.08	89.18	87.84	86.43	60.52	65.06	45.06	31.35	21.54	29.11	31.64	53.41	661.23
1923	85.87	119.72	95.20	88.11	69.16	49.41	46.04	40.90	27.60	21.04	51.05	61.50	755.58
1924	73.78	77.38	133.56	109.41	80.93	64.47	59.69	47.64	39.90	65.65	121.31	106.62	980.35
1925	83.50	89.18	100.77	88.84	91.64	72.18	57.13	40.63	28.86	16.47	14.31	83.91	767.44
1926	70.13	69.05	75.96	102.85	109.32	76.96	61.63	50.95	39.29	40.83	50.78	62.34	810.09
1927	92.47	82.53	89.33	83.25	66.98	73.30	51.72	36.25	30.72	27.89	48.99	79.99	763.42
1928	116.33	94.52	130.35	76.91	66.15	49.37	38.21	31.80	28.85	28.88	46.72	82.54	790.62
1929	96.04	81.24	114.49	83.43	59.50	50.93	39.62	29.71	22.74	17.80	22.84	93.08	711.41
1930	96.25	80.27	74.43	73.94	66.53	45.41	26.45	11.60	4.70	6.46	13.54	47.37	546.96
1931	63.10	52.84	41.43	68.73	64.54	70.65	55.19	38.87	32.10	49.29	53.96	139.31	730.02
1932	126.84	111.45	141.12	163.43	99.89	79.44	66.76	65.64	50.54	39.59	33.65	63.24	1041.59
1933	121.88	97.83	145.13	125.97	87.73	94.73	66.09	47.53	40.37	32.69	40.67	60.76	961.37
1934	67.90	65.92	70.26	81.21	64.25	52.85	57.37	46.92	35.27	44.02	80.82	78.09	744.87
1935	84.78	80.27	64.99	68.34	75.82	53.84	39.94	27.11	25.82	42.90	39.82	68.35	671.99
1936	120.17	71.85	72.04	71.64	60.93	69.78	48.47	35.50	23.85	20.88	40.92	47.19	683.21
1937	61.67	78.23	56.13	72.00	94.10	68.20	57.32	34.89	39.96	38.42	41.95	62.90	705.78
1938	73.17	65.66	84.53	60.33	52.10	42.99	38.25	34.63	31.13	29.85	41.89	57.62	612.15
1939	90.83	71.73	81.06	106.28	69.77	56.97	43.08	30.28	23.90	23.37	22.91	27.02	647.18
1940	40.22	64.27	77.72	55.43	58.09	43.79	37.36	29.65	18.21	15.64	19.12	30.57	490.07
1941	32.27	26.40	29.58	25.31	45.18	37.54	26.16	11.61	10.45	4.32	22.89	41.35	313.06
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951	83.05	85.27	61.49	45.99	34.17	25.18	21.26	21.14	23.14	21.51	21.94	44.51	488.64
1952	90.45	77.96	146.32	115.09	125.90	74.96	54.14	44.15	34.24	50.47	71.51	211.34	1096.52
1953	120.29	147.63	179.16	177.83	196.64	148.46	107.88	75.78	51.15	60.93	78.26	255.53	1599.54
1954	250.26	180.68	168.08	190.29	113.89	135.89	174.86	108.09	102.84	71.21	75.61	76.03	1647.73
1955	87.65	161.95	104.39	98.09	72.79	53.36	58.58	54.15	51.06	38.46	64.22	58.16	902.88
1956	69.69	57.55	62.39	65.25	97.07	72.85	53.96	49.00	37.81	32.65	33.80	49.44	681.46
1957	53.72	86.99	73.89	59.20	54.71	53.44	45.88	35.98	26.55	17.70	40.02	66.03	614.12
1958	63.31	125.23	100.71	70.74	57.77	43.41	34.54	38.62	32.88	33.37	44.18	77.61	722.38
1959	62.39	67.45	72.52	60.62	54.33	67.09	55.43	34.71	26.93	20.74	30.93	53.12	606.27
1960	107.46	128.31	91.38	77.29	76.80	52.35	55.61	43.17	37.07	26.14	57.02	57.46	810.04
1961	89.35	121.82	76.30	71.76	80.97	62.71	42.31	27.41	21.98	17.72	36.16	55.94	704.43
1962	81.60	83.22	73.79	69.54	56.79	42.81	33.50	28.01	25.21	20.22	24.22	27.72	566.63
1963	25.52	88.17	72.75	54.85	39.44	23.84	18.82	16.44	11.27	8.45	7.90	19.15	386.61
1964	44.18	81.74	76.45	74.57	65.89	49.99	41.56	34.61	30.42	25.36	48.58	57.18	630.50
1965	61.76	63.87	61.97	56.40	47.14	35.49	30.80	25.31	21.69	22.86	29.66	46.54	503.49
1966	109.95	117.10	93.76	74.47	54.49	41.15	36.53	28.62	17.67	20.68	39.20	32.50	666.10
1967	45.57	54.89	57.99	55.46	47.73	36.17	32.05	26.86	23.42	24.82	33.23	50.93	489.12
1968	63.85	67.32	47.52	50.44	43.86	39.91	40.81	37.69	29.99	24.29	73.66	117.44	636.79
1969	86.24	78.42	95.71	70.97	74.02	54.25	35.91	23.11	19.06	17.41	29.41	54.10	638.62
1970	85.99	102.19	104.54	94.81	85.27	68.11	62.56	47.78	41.26	38.41	30.70	69.96	831.58
1971	81.03	77.60	60.13	74.33	48.54	38.31	35.56	34.22	50.81	40.71	50.66	85.24	677.15
1972	60.45	50.91	45.24	50.58	55.84	41.00	31.56	22.66	14.23	14.23	17.29	89.50	493.49
1973	62.57	47.04	44.97	52.18	57.65	48.76	68.14	61.86	62.22	43.86	58.96	97.37	705.58
1974	59.83	71.57	57.64	43.14	84.89	61.69	46.01	40.99	53.76	66.19	146.51	183.87	916.09
1975	83.69	88.28	85.73	66.30	50.22	38.81	37.29	31.32	31.00	43.27	95.41	112.36	763.68
1976	77.23	62.42	72.20	63.84	55.26	41.20	38.29	24.04	19.95	17.71	96.44	109.11	677.69
1977	91.64	140.11	158.52	103.44	80.13	59.24	47.19	35.26	21.18	13.50	17.93	54.73	822.86
1978	54.52	90.06	126.00	77.75	68.35	53.00	40.30	48.57	36.42	62.48	72.76	76.00	806.21
1979	138.69	186.19	111.17	116.15	77.40	67.81	48.58	36.01	25.71	13.38	34.52	59.21	914.84
1980	58.74	64.88	70.33	74.92	79.90	55.94	35.13	28.72	18.32	12.04	11.20	26.60	536.71
1981	44.51	89.62	92.42	72.61	56.66	41.61	32.46	19.35	16.04	31.80	43.30	92.84	633.21
1982	180.77	118.95	132.27	111.33	85.98	68.46	45.77	32.82	23.18	14.20	19.63	60.26	893.63
1983	125.78	112.13	65.23	72.72	98.67	66.79	49.45	41.39	31.55	32.59	36.15	50.37	782.79
1984	41.69	65.25	86.12	120.66	74.60	51.66	46.75	41.75	32.12	25.03	41.47	60.12	687.23
1985	73.97	66.93	80.80	72.90	52.08	34.88	25.35	23.26	20.81	20.95	26.88	59.91	558.72
1986	108.25	138.76	159.05	179.95	93.90	67.82	56.99	36.34	29.57	35.06	55.74	60.66	1022.08
1987	150.47	117.19	89.60	80.13	52.63	43.21	28.54	16.12	8.64	4.64	15.05	66.35	672.59
Mean	86.20	90.32	89.94	83.70	71.69	57.50	47.39	36.73	30.34	29.62	44.04	72.39	739.87

Table 3.13 Estimated Monthly Runoff

Tapin Sub-system
Catchment Area : 1,714 km2

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1917	78.31	99.99	102.22	74.41	99.02	65.71	38.10	29.37	21.37	54.21	49.52	48.66	760.88
1918	66.58	51.15	31.40	49.53	40.30	22.41	16.49	15.76	14.90	14.02	13.26	44.44	380.25
1919	69.52	60.33	113.39	86.96	61.81	31.07	16.34	14.66	14.04	13.30	12.84	90.20	584.45
1920	89.82	41.14	84.81	71.30	31.81	20.04	14.46	18.20	27.06	30.79	13.83	30.98	474.24
1921	75.36	63.12	94.96	64.44	29.04	17.69	16.96	17.02	17.78	25.56	25.99	37.49	485.41
1922	71.96	71.93	68.57	53.00	46.36	24.24	15.11	14.63	14.01	13.41	29.12	25.75	448.10
1923	81.60	89.35	73.64	39.76	24.39	25.59	25.02	14.11	13.54	12.98	25.09	15.99	441.06
1924	79.66	75.23	102.15	101.65	51.55	28.22	15.83	14.58	14.20	13.75	26.39	65.77	588.97
1925	52.32	63.38	106.79	58.82	39.12	48.11	23.82	14.99	14.46	13.76	13.07	23.64	472.27
1926	68.70	66.62	90.18	66.51	86.88	49.56	20.16	14.74	14.41	14.01	30.43	65.97	588.16
1927	91.65	71.36	85.79	74.64	37.72	34.57	18.83	16.07	42.34	15.03	54.54	43.99	586.53
1928	75.94	82.90	111.54	90.93	43.18	59.63	25.09	17.08	16.11	15.58	39.80	60.30	638.09
1929	54.46	45.99	107.93	43.65	22.54	15.79	15.39	14.92	14.39	13.85	13.30	12.74	374.96
1930	16.89	11.97	11.60	11.26	18.43	13.73	10.71	10.30	9.60	8.25	11.26	40.70	174.69
1931	82.69	57.43	39.87	23.65	15.46	35.07	11.01	10.70	10.46	10.19	9.94	103.49	409.94
1932	106.78	105.52	71.29	83.93	67.51	29.32	20.23	14.14	17.21	17.15	18.03	34.05	585.16
1933	91.43	67.84	140.86	63.66	53.45	38.34	18.65	15.40	15.04	14.93	20.73	31.84	572.17
1934	111.72	59.22	88.17	101.89	45.99	88.89	74.01	32.35	20.09	31.96	52.74	74.92	781.95
1935	52.21	31.46	60.30	73.54	40.69	45.13	18.89	16.07	15.56	15.03	14.50	24.60	407.97
1936	65.90	65.73	37.95	46.05	32.33	17.73	14.33	13.80	13.16	16.53	12.27	29.94	365.70
1937	12.96	20.59	18.63	37.62	29.63	22.30	12.13	11.95	12.26	11.51	11.40	59.17	260.16
1938	93.18	45.28	69.33	27.49	25.50	13.15	12.92	12.64	12.24	16.97	11.68	22.90	363.28
1939	42.04	44.26	18.14	19.46	11.96	11.79	11.51	10.95	10.37	9.82	9.28	42.28	241.88
1940	75.94	114.24	166.71	79.27	65.01	34.88	19.42	13.68	13.23	12.62	12.01	53.25	660.26
1941	94.43	55.51	66.50	28.03	72.01	24.80	15.69	13.54	13.19	12.78	12.34	40.74	449.57
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951	68.98	63.15	69.45	52.61	36.45	23.42	16.11	14.50	14.13	13.73	19.06	42.44	434.01
1952	82.80	83.96	97.23	78.13	57.77	37.54	19.16	15.34	14.95	14.54	29.81	71.12	602.34
1953	92.57	86.70	96.43	76.40	56.22	36.88	19.02	16.05	15.58	15.10	27.53	66.89	605.37
1954	107.95	106.96	121.65	99.35	75.61	51.38	28.82	22.17	16.96	22.05	47.31	93.45	793.66
1955	124.26	118.70	132.37	108.11	82.77	57.34	33.09	25.84	18.84	24.94	53.46	101.11	880.82
1956	128.67	121.56	134.54	109.92	84.38	58.82	34.22	26.82	19.68	25.85	54.59	102.20	901.25
1957	107.69	95.58	102.04	80.65	59.70	39.95	21.97	18.77	18.13	17.48	29.62	68.55	660.14
1958	102.77	100.35	113.31	91.59	69.38	46.39	26.30	19.76	17.66	19.77	39.92	84.06	731.25
1959	88.59	77.93	83.48	64.33	45.94	30.58	22.33	17.07	16.60	16.11	24.96	54.57	542.48
1960	98.54	133.25	124.12	101.25	62.53	29.47	42.87	27.34	17.39	22.94	100.50	87.96	848.17
1961	106.39	108.91	78.93	94.42	69.88	49.04	21.61	18.16	17.44	16.75	16.12	75.64	673.28
1962	136.17	97.34	139.49	110.32	45.82	39.70	54.34	31.35	18.89	46.90	76.16	76.87	873.35
1963	87.35	101.08	132.48	89.27	53.28	24.72	46.85	28.61	18.04	17.34	20.73	101.63	721.41
1964	106.15	87.59	90.74	90.58	38.78	26.27	17.70	17.11	21.02	46.98	74.80	43.63	661.33
1965	111.64	68.65	89.79	59.28	32.78	21.86	16.84	16.23	15.49	14.83	14.14	63.95	525.49
1966	68.03	159.39	143.93	57.48	49.63	23.70	16.38	18.63	17.28	24.67	61.60	116.65	757.38
1967	130.58	84.20	45.87	54.70	39.92	24.62	19.15	16.51	17.93	18.01	48.95	138.46	638.89
1968	215.74	165.15	150.22	127.92	116.65	129.95	112.78	78.01	42.27	44.64	105.34	119.92	1408.59
1969	118.30	147.76	111.77	115.53	117.64	50.77	26.57	21.76	20.87	34.13	82.84	133.71	981.65
1970	131.70	143.94	226.33	185.72	131.95	123.11	84.94	44.25	41.21	62.19	59.01	107.98	1342.32
1971	106.75	114.89	78.05	52.03	45.23	51.10	29.69	30.65	35.73	62.36	116.06	74.37	796.92
1972	62.67	118.81	76.59	71.64	104.82	43.61	29.00	19.78	18.83	17.88	30.69	39.28	633.60
1973	80.58	42.63	60.16	68.13	46.93	32.75	19.03	18.82	16.07	21.41	57.94	84.39	548.85
1974	91.84	42.09	84.50	111.96	100.25	61.75	32.39	22.31	35.06	39.52	41.30	44.20	707.17
1975	87.56	50.47	125.66	56.30	41.39	21.41	17.25	16.69	28.91	50.14	73.36	79.78	648.91
1976	75.38	52.95	103.17	87.31	42.16	27.39	17.19	16.58	15.79	35.24	44.62	95.39	613.17
1977	84.72	120.37	84.64	55.15	31.65	31.09	16.66	16.09	15.26	14.41	13.65	19.45	503.15
1978	37.60	42.93	60.70	33.86	92.04	50.58	26.05	16.76	19.57	13.86	13.55	20.74	428.24
1979	49.09	76.60	72.75	91.43	54.46	47.86	21.87	14.98	14.64	14.16	17.70	93.50	569.04
1980	100.39	64.60	51.42	65.40	59.22	34.52	29.29	19.92	15.14	14.74	25.57	46.09	526.29
1981	24.30	70.06	48.60	74.36	63.38	28.86	20.44	14.86	14.37	22.24	51.89	109.53	542.88
1982	133.22	98.34	118.60	57.58	35.22	24.39	16.50	15.72	14.74	13.84	13.12	50.39	591.65
1983	29.54	28.77	77.76	65.42	49.83	34.63	17.67	16.28	13.69	13.36	36.30	57.41	440.66
1984	41.76	45.60	60.45	63.80	52.37	23.65	14.99	14.15	13.75	13.31	12.86	24.73	381.42
1985	65.17	69.70	54.22	40.41	21.70	16.80	13.47	13.18	12.81	12.35	11.91	20.34	352.06
1986	12.60	21.67	30.48	12.85	11.35	11.15	10.86	10.29	9.78	9.29	27.43	54.51	222.26
1987	124.09	184.33	157.99	77.78	54.99	34.69	17.06	14.55	14.18	19.84	13.56	64.73	777.78
Mean	84.26	79.98	90.20	71.04	53.64	37.41	24.70	18.99	17.90	21.53	34.38	62.15	596.18

Table 3.14 Estimated Monthly Runoff

Negara Sub-system
Catchment Area : 1,887 km2

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1917	53.61	51.39	60.21	36.46	33.42	28.61	17.66	17.07	16.38	15.69	15.04	16.83	362.35
1918	62.16	29.26	47.94	60.71	31.56	14.91	14.47	13.65	12.29	10.89	10.36	26.05	334.24
1919	37.20	52.98	81.65	56.84	60.12	23.25	12.81	12.38	11.93	11.51	11.15	18.01	389.84
1920	34.44	20.78	11.20	15.22	38.77	41.86	18.96	11.95	11.86	13.15	27.59	45.34	291.12
1921	84.40	49.29	61.82	41.11	22.40	13.81	13.56	13.10	12.60	12.10	17.93	23.28	365.42
1922	26.22	49.39	95.15	74.52	35.07	50.65	27.73	14.01	13.67	13.31	13.30	22.81	435.83
1923	62.94	54.98	67.58	49.72	59.01	26.07	34.34	14.59	14.23	13.83	17.55	49.96	464.81
1924	57.94	43.95	122.21	102.67	42.59	23.30	15.68	15.37	15.01	19.01	52.52	31.08	541.33
1925	59.63	71.46	83.70	64.70	36.95	16.03	15.60	14.89	13.90	12.34	18.27	80.35	487.82
1926	38.42	76.64	42.26	62.60	40.27	33.10	14.97	13.87	18.15	14.28	24.71	67.88	447.14
1927	45.89	37.46	57.39	27.52	14.87	14.25	13.99	13.56	12.97	12.34	20.94	63.74	334.93
1928	144.66	85.12	107.30	54.63	68.82	39.37	22.15	15.57	15.09	14.53	35.31	44.44	647.00
1929	51.10	66.35	105.76	71.25	25.23	18.72	15.48	18.33	14.70	14.23	18.67	108.10	527.92
1930	99.79	58.81	53.52	45.42	49.14	21.47	15.58	15.11	14.42	13.79	13.24	18.97	419.27
1931	44.99	80.22	55.95	93.36	42.96	35.75	14.76	14.39	13.92	13.40	16.89	47.83	474.41
1932	73.38	60.14	78.69	61.04	46.22	23.00	14.92	14.61	14.17	13.57	12.99	22.60	435.34
1933	23.23	23.65	21.17	12.63	12.24	20.91	12.02	11.84	11.58	11.30	23.79	36.62	220.97
1934	34.90	30.53	31.90	75.94	31.63	21.28	13.05	12.83	12.45	12.00	19.74	53.15	349.40
1935	37.58	19.82	12.24	26.72	29.24	17.70	12.36	11.99	11.53	11.06	35.08	70.70	296.04
1936	79.24	29.98	30.95	47.30	45.24	41.03	16.95	13.41	13.10	12.69	24.60	38.24	392.74
1937	67.16	46.07	85.02	106.66	87.86	46.51	43.83	24.39	15.57	15.23	14.82	19.37	572.49
1938	37.27	31.99	73.16	29.77	30.84	14.72	14.51	14.11	13.65	13.12	15.31	19.14	307.59
1939	46.15	48.40	35.79	69.69	29.48	23.68	13.70	13.37	12.92	12.50	12.08	11.72	329.48
1940	20.07	158.04	149.44	73.47	58.93	23.38	14.90	14.56	14.03	13.40	23.31	44.05	607.56
1941	55.16	19.92	26.84	16.75	80.86	25.99	13.86	13.49	12.94	12.13	11.44	21.47	310.83
1942													
1943													
1944													
1945													
1946													
1947													
1948													
1949													
1950													
1951	59.92	73.29	36.27	30.65	15.51	15.16	14.72	14.18	13.55	12.98	12.44	25.45	324.13
1952	49.57	81.00	106.31	44.72	36.85	17.50	14.22	13.96	13.59	13.13	12.67	13.03	416.53
1953	23.13	29.67	46.11	35.75	25.88	13.97	12.73	12.47	12.02	11.51	11.11	54.15	288.50
1954	109.99	54.91	23.40	31.80	14.06	17.70	13.38	12.76	16.24	18.77	52.89	82.56	448.46
1955	93.44	135.29	155.59	98.17	68.99	96.95	52.80	34.73	30.72	30.81	110.96	98.08	1006.52
1956	107.58	148.10	138.29	202.09	192.58	140.37	73.65	45.03	63.14	75.06	97.91	243.17	1526.97
1957	196.73	239.32	246.72	116.28	92.42	119.12	93.07	45.73	30.43	25.50	64.45	93.85	1363.61
1958	110.00	186.35	86.78	143.93	148.82	112.13	97.04	87.36	49.88	51.37	33.05	50.18	1156.90
1959	89.79	54.98	35.09	85.66	63.06	42.16	23.12	20.98	20.12	19.02	18.10	59.66	531.75
1960	67.80	95.06	74.32	54.04	61.18	25.36	23.06	17.66	24.33	16.82	17.49	59.42	536.54
1961	68.56	69.34	51.55	49.64	28.82	16.70	16.22	15.45	14.71	13.96	13.31	30.40	388.65
1962	65.22	87.01	85.67	81.73	36.13	38.44	26.23	19.29	18.48	17.93	14.60	50.21	540.94
1963	26.07	93.10	104.53	67.67	31.87	17.45	15.68	14.98	14.00	13.13	12.38	34.69	445.54
1964	49.00	44.38	78.76	55.90	25.85	14.42	13.53	13.20	12.78	12.34	12.97	12.53	345.64
1965	94.68	45.80	37.53	19.94	40.33	21.29	13.14	12.82	12.18	11.59	10.97	22.36	342.62
1966	50.31	63.91	73.33	62.35	46.20	26.92	13.31	13.03	12.81	12.51	21.06	51.78	447.51
1967	58.29	56.89	57.74	45.51	32.47	17.37	14.20	13.76	13.43	13.08	18.08	34.93	375.76
1968	84.70	97.60	108.09	93.81	73.18	44.73	26.78	18.15	15.76	15.36	34.92	82.99	696.08
1969	81.97	76.58	76.79	62.39	45.37	27.67	21.44	16.41	16.00	16.36	25.91	52.53	519.42
1970	55.07	59.95	61.01	53.84	45.59	34.59	22.85	15.93	15.57	15.19	14.85	32.57	426.99
1971	97.35	93.84	52.40	33.27	17.43	18.68	15.37	15.03	14.63	19.55	55.55	119.08	552.16
1972	84.30	45.55	39.05	24.77	57.73	18.19	15.61	14.94	14.25	13.55	13.00	45.52	386.46
1973	63.85	68.19	90.54	117.75	76.94	24.86	20.67	22.37	22.88	15.06	14.45	13.91	551.46
1974	13.62	20.41	47.37	20.51	30.25	14.27	13.10	12.78	12.33	11.82	11.42	18.50	226.38
1975	66.95	31.08	27.44	13.25	19.45	12.09	11.94	11.84	18.62	11.57	39.37	54.08	317.68
1976	57.74	56.76	78.75	38.16	26.72	14.36	13.80	13.43	13.01	13.77	68.79	95.83	491.11
1977	60.87	92.65	95.50	59.66	37.94	46.64	26.28	15.68	15.13	14.46	13.80	23.71	502.32
1978	25.21	25.26	77.35	34.24	66.05	55.67	30.03	19.68	47.20	59.30	82.05	51.69	573.72
1979	76.34	78.40	41.38	21.20	21.19	15.92	15.45	14.85	14.17	13.33	21.54	43.01	376.78
1980	64.42	83.33	61.82	54.47	25.83	27.61	14.83	14.19	13.76	13.32	24.03	36.30	433.90
1981	23.61	57.55	23.69	57.29	27.28	13.85	45.13	26.38	18.27	13.82	13.61	54.32	374.81
1982	159.50	83.15	119.13	91.91	53.85	41.70	21.26	16.70	16.10	15.48	15.35	15.34	649.47
1983	38.65	64.82	38.35	55.83	34.99	27.02	14.87	14.59	14.23	13.82	15.88	39.11	372.17
1984	35.80	57.28	59.32	77.35	55.57	35.21	50.96	20.51	24.44	14.96	41.24	60.50	533.13
1985	67.58	51.29	87.29	64.04	29.32	19.21	15.89	15.34	14.72	14.06	29.09	23.21	431.03
1986	31.60	67.85	87.41	81.26	46.36	26.33	15.17	14.72	14.14	13.55	13.07	24.21	435.67
1987	51.52	43.19	58.21	27.84	22.59	13.60	13.27	12.83	12.30	11.72	11.18	26.39	304.66
Mean	63.52	66.29	70.45	59.44	45.62	31.36	22.46	17.68	17.15	16.63	25.81	47.27	483.67

Table 4.1 Population by Tertio-system in 2018

Unit : 1000

		Kabupaten/ Kecamatan	Population in 2018	Sub basib																								
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Others	Total
1. Tapin	501	Binuang	53380																							53.38	53.38
	502	Tapin Selatan	37440																						37.4		37.44
	503	Tapin Tengah	31990																						23.6	8.44	31.99
	504	Tapin Utara	32770																					32.8			32.77
	505	Candi Laras Selatan	20630																			3.0		11.7	6.0		20.63
	506	Candi Laras Utara	23830																			9.0			4.1	10.78	23.83
	507	Piani	8250																				8.3				8.25
	508	Bakarangan	16690																					16.7			16.69
	509	Lokpa Ikat	12650																					12.7			12.65
	510	Bungur	14470																				14.5				14.47
2. H.S.Selatan	601	Sungai Raya	17110																					17.1			17.11
	602	Padang Batung	16360																		0.6		15.7				16.36
	603	Telaga Langsat	8750																		8.8						8.75
	604	Angkinang	16180																		14.4	1.8					16.18
	605	Kandangan	40850																		7.9			33.0			40.85
	606	Simpur	13890																					13.9			13.89
	607	Daha Selatan	36420																				21.0		8.1		7.34	36.42
	608	Daha Utara	27360															5.2				1.4	14.9				5.89	27.36
	609	Kalumpang	7380																						7.4			7.38
	610	Loksado	6850																		0.3			6.6				6.85
3. H.S.Tengah	701	Haruyan	20190																	15.1	5.0							20.19
	702	Batu Benawa	29150																1.9	27.3								29.15
	703	Labuan Amas Selatan	25940																	10.0		15.9						25.94
	704	Labuan Amas Utara	27720																		4.3	23.5						27.72
	705	Pandawan	28320														11.2			1.0		16.1						28.32
	706	Barabai	41490																	28.4		13.1						41.49
	707	Batang Alai Selatan	29410														0.9		22.0	4.6		1.9						29.41
	708	Batang Alai Utara	26700														20.9					5.8						26.70
4. H.S.Utara	801	Danau Panggang	21100															3.1					0.8				17.16	21.10
	802	Babirik	18400															9.2					9.2					18.40
	803	Sungai Pandan	40400															23.3									17.12	40.40
	804	Amuntai Selatan	20150															13.2									6.95	20.15
	805	Amuntai Tengah	51500														20.3	31.2										51.50
	806	Amuntai Utara	33710									21.5						12.3										33.71
	807	Lampihong	14320													1.7	7.7	5.0										14.32
	808	Batu Mandi	13810														13.8											13.81
	809	Awayan	17110												17.1													17.11
	810	Paringin	21230									2.1		7.7	1.4	9.0	1.0											21.23
	811	Juai	12540											12.5														12.54
	812	Halong	13000										7.6	5.4														13.00
5. Tabalong	901	Banua Lawas	16610									4.6						9.7									2.31	16.61
	902	Kelua	17700									13.1						4.6										17.70
	903	Tanta	13300									13.3																13.30
	904	Tanjung	24270								8.1	16.2																24.27
	905	Haruai	18590			7.2			11.4																			18.59
	906	Muara Uya	14560	5.6	2.4	0.4	1.0	0.3	1.1																		3.72	14.56
	907	Murung Pudak	20830							11.6	3.6	5.6																20.83
	908	Upau	5400						2.0	3.4																		5.40
	909	Jaro	9150				3.0	5.6	0.6																			9.15
	910	Harus	6110									6.1																6.11
	911	Pugaan	6330									6.3																6.33
6. Out of Basin											4.3	49.3													7.7			61.34
		Total Study Area	1102320	5.6	2.4	7.5	4.0	5.9	15.1	14.9	16.0	138.1	7.6	25.6	18.5	10.7	75.9	116.7	23.9	86.4	41.2	79.4	57.9	22.3	30.5	153.3	71.0	133.08	1163.63

Table 4.2 Water Demand by Tertio-system by Purpose in 2018

Tertio-syste	Annual Water Demand			Monthly Water Demand
	Domestic	Livestck	Industry	
	MCM/Year	MCM/Year	MCM/Year	MCM/mon
1	0.0920	0.0061	0.014	0.0093
2	0.0394	0.0026	0.014	0.0047
3	0.1232	0.0082	0.014	0.0121
4	0.0657	0.0044	0.014	0.0070
5	0.0969	0.0065	0.014	0.0098
6	0.2480	0.0165	0.014	0.0232
7	0.2447	0.0163	0.014	0.0229
8	0.2628	0.0175	0.014	0.0245
9	2.2683	0.1512	0.014	0.2028
10	0.1248	0.0105	0.026	0.0134
11	0.4205	0.0355	0.026	0.0402
12	0.3039	0.0257	0.026	0.0296
13	0.1757	0.0148	0.026	0.0180
14	1.2467	0.1053	0.104	0.1213
15	1.9168	0.1619	0.026	0.1754
16	0.3926	0.0366	0.081	0.0425
17	1.4191	0.1325	0.237	0.1490
18	0.6767	0.0406	0.006	0.0603
19	1.3041	0.1217	0.081	0.1256
20	0.9510	0.0951	0.005	0.0876
21	0.3663	0.0220	0.006	0.0329
22	0.5010	0.0501	0.005	0.0463
23	2.5180	0.1511	0.006	0.2229
24	1.1662	0.1166	0.005	0.1073
Total	16.9243	1.3494	0.792	1.5888

Table 4.3 Water Demand by Livestock by Kabupaten in 1985

	Livestock	Human Populatio (1985)	Livestock Population (1985)	Livestock Population per 100 person	Water Consumption per head	Water Consumption per person
				(Head)	(litre/day)	(litre/day)
(1) Tabalong		134706				
	Cattle		5547	4.118	40	1.6471
	Buffalo		45	0.033	40	0.0134
	Goat		6662	4.946	5	0.2473
	Sheep		652	0.484	5	0.0242
	Pig		5518	4.096	6	0.2458
	Chicken (traditional)		321400	238.594	0.3	0.7158
	Chicken (improved)		14500	10.764	0.3	0.0323
	Duck		55100	40.904	0.3	0.1227
	Total					3.0486
(2) Hulu Sungai Utara		247095				
	Cattle		2480	1.004	40	0.4015
	Buffalo		9891	4.003	40	1.6012
	Goat		7200	2.914	5	0.1457
	Sheep		4558	1.845	5	0.0922
	Pig		1670	0.676	6	0.0406
	Chicken (traditional)		513100	207.653	0.3	0.623
	Chicken (improved)		42600	17.240	0.3	0.0517
	Duck		690400	279.407	0.3	0.8382
	Total					3.7941
(3) Hulu Sungai Tengah		205353				
	Cattle		4698	2.288	40	0.9151
	Buffalo		4324	2.106	40	0.8423
	Goat		12873	6.269	5	0.3134
	Sheep		5609	2.731	5	0.1366
	Pig		1670	0.813	6	0.0488
	Chicken (traditional)		888400	432.621	0.3	1.2979
	Chicken (improved)		37200	18.115	0.3	0.0543
	Duck		391600	190.696	0.3	0.5721
	Total					4.1805
(4) Hulu Sungai Selatan		182669				
	Cattle		2639	1.445	40	0.5779
	Buffalo		1909	1.045	40	0.418
	Goat		3643	1.994	5	0.0997
	Sheep		1955	1.070	5	0.0535
	Pig		202	0.111	6	0.0066
	Chicken (traditional)		458500	251.000	0.3	0.753
	Chicken (improved)		14000	7.664	0.3	0.023
	Duck		453900	248.482	0.3	0.7454
	Total					2.6771
(5) Tapin		120406				
	Cattle		9109	7.565	40	3.0261
	Buffalo		508	0.422	40	0.1688
	Goat		4546	3.776	5	0.1888
	Sheep		191	0.159	5	0.0079
	Pig		36	0.030	6	0.0018
	Chicken (traditional)		355100	294.919	0.3	0.8848
	Chicken (improved)		14000	11.627	0.3	0.0349
	Duck		63400	52.655	0.3	0.158
	Total					4.4711

Table 4.4 Existing Rubber Factory & Estimated Water Demand

Factory Name	Location	(A) Processing Capacity	(B) Nos. of Tertio-system	Tertio-system Number
47 small scale facilitis	Tapin	705	3	20,22,24
57 small scale facilitis	HSS	855	3	18,21,23
P.T. Dharma Kalimantan Jaya	HST, Barabai	3,600	1	17
P.T. Hevea Kalimantan	HST, Barabai	3,600	1	17
748 small scale facilitis	HST	11,220	3	16,17,19
P.T. Kartas Tabing Kencan	HSU, Amuntai	3,600	1	14
486 small scale facilitis	HSU	7,290	6	10,11,12,13,14,15
P.T. Swarga Rubert	Tabalong, Hayup	n.a		
402 small scale facilitis	Tabalong	6,030	9	1,2,3,4,5,6,7,8,9

Factory Name	(C)=(A)/(B) Capacity per Tertio-system	(D) Unit Water Demand	(C)*(D)*120% Water Demand
	ton/year	m3/ton	MCM/year
47 small scale facilitis	235	18	0.00508
57 small scale facilitis	285	18	0.00616
P.T. Dharma Kalimantan Jaya	3,600	18	0.07776
P.T. Hevea Kalimantan	3,600	18	0.07776
748 small scale facilitis	3,740	18	0.08078
P.T. Karias Tabing Kencan	3,600	18	0.07776
486 small scale facilitis	1,215	18	0.02624
P.T. Swarga Rubert		18	
402 small scale facilitis	670	18	0.01447

Source : DINUS Estate Crops, Kal Sel

Table 4.5 Monthly Irrigation Water Demand by Tertio-system in 2018

Unit : MCM

Tertio-system No.	Irrigation Area Wet (ha)	Irrigation Area Dry (ha)	Jan	Feb	Mar	Apr	May	Jun
1	-	-	0.000	0.000	0.000	0.000	0.000	0.000
2	-	-	0.000	0.000	0.000	0.000	0.000	0.000
3	-	-	0.000	0.000	0.000	0.000	0.000	0.000
4	-	-	0.000	0.000	0.000	0.000	0.000	0.000
5	1169	484	1.284	0.481	0.689	0.000	0.363	0.790
6	836	773	0.918	0.344	0.493	0.000	0.580	1.262
7	643	643	0.706	0.264	0.379	0.000	0.482	1.050
8	-	-	0.000	0.000	0.000	0.000	0.000	0.000
9	1004	1004	1.103	0.413	0.592	0.000	0.753	1.639
10	2172	2172	2.385	0.893	1.280	0.000	1.629	3.547
11	188	188	0.206	0.077	0.111	0.000	0.141	0.307
12	4757	5388	5.224	1.956	2.803	0.000	4.041	8.798
13	-	-	0.000	0.000	0.000	0.000	0.000	0.000
14	677	647	0.743	0.278	0.399	0.000	0.485	1.057
15	-	-	0.000	0.000	0.000	0.000	0.000	0.000
16	7227	8042	7.936	2.972	4.259	0.000	6.031	13.132
17	6632	5817	7.283	2.727	3.908	0.000	4.362	9.499
18	2059	691	2.261	0.847	1.213	0.000	0.518	1.128
19	-	-	0.000	0.000	0.000	0.000	0.000	0.000
20	-	-	0.000	0.000	0.000	0.000	0.000	0.000
21	7221	5449	7.930	2.970	4.255	0.000	4.086	8.898
22	6610	3977	7.259	2.718	3.895	0.000	2.983	6.494
23	1227	454	1.347	0.505	0.723	0.000	0.340	0.741
24	1874	714	2.058	0.771	1.104	0.000	0.535	1.166
Total	44296	36443	48.643	18.217	26.101	0.000	27.330	59.510

Unit : MCM

Tertio-system No.	Irrigation Area Wet (ha)	Irrigation Area Dry (ha)	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	0.000	0.000	0.000	0.000	0.000	0.000
2	-	-	0.000	0.000	0.000	0.000	0.000	0.000
3	-	-	0.000	0.000	0.000	0.000	0.000	0.000
4	-	-	0.000	0.000	0.000	0.000	0.000	0.000
5	1169	484	1.076	1.115	1.061	0.000	0.606	1.190
6	836	773	1.718	1.781	0.758	0.000	0.433	0.851
7	643	643	1.429	1.481	0.583	0.000	0.333	0.654
8	-	-	0.000	0.000	0.000	0.000	0.000	0.000
9	1004	1004	2.232	2.313	0.911	0.000	0.520	1.022
10	2172	2172	4.829	5.003	1.970	0.000	1.126	2.211
11	188	188	0.418	0.433	0.171	0.000	0.097	0.191
12	4757	5388	11.978	12.411	4.316	0.000	2.466	4.842
13	-	-	0.000	0.000	0.000	0.000	0.000	0.000
14	677	647	1.438	1.490	0.614	0.000	0.351	0.689
15	-	-	0.000	0.000	0.000	0.000	0.000	0.000
16	7227	8042	17.878	18.524	6.556	0.000	3.746	7.356
17	6632	5817	12.932	13.399	6.017	0.000	3.438	6.750
18	2059	691	1.536	1.592	1.868	0.000	1.067	2.096
19	-	-	0.000	0.000	0.000	0.000	0.000	0.000
20	-	-	0.000	0.000	0.000	0.000	0.000	0.000
21	7221	5449	12.114	12.551	6.551	0.000	3.743	7.349
22	6610	3977	8.841	9.161	5.997	0.000	3.427	6.728
23	1227	454	1.009	1.046	1.113	0.000	0.636	1.249
24	1874	714	1.587	1.645	1.700	0.000	0.971	1.907
Total	44296	36443	81.015	83.944	40.185	0.000	22.963	45.084

Table 4.6 Water Balance by Tertio-system in 2018

Tertio-system	OCT					NOV					DEC					JAN				
	Demand	Runoff	Inflow	Total In	Balance	Demand	Runoff	Inflow	Total In	Balance	Demand	Runoff	Inflow	Total In	Balance	Demand	Runoff	Inflow	Total In	Balance
1	0.023	39.218		39.218	39.195	0.023	54.944		54.944	54.920	0.023	93.970		93.970	93.946	0.023	101.595		101.595	101.572
2	0.023	18.149		18.149	18.126	0.023	25.436		25.436	25.414	0.023	43.024		43.024	43.001	0.023	47.016		47.016	46.993
3	0.025	18.951	57.321	76.272	76.247	0.025	26.549	80.324	106.873	106.849	0.025	44.934	135.947	180.881	180.857	0.025	49.092	148.565	197.657	197.632
4	0.203	17.348		17.348	17.145	0.203	24.304		24.304	24.101	0.203	41.134		41.134	40.931	0.203	44.939		44.939	44.736
5	0.912	20.210		20.210	20.198	0.616	28.314		28.314	27.698	1.202	47.910		47.910	46.708	1.296	52.355		52.355	51.059
6	0.013	23.949	37.345	61.293	61.292	0.473	33.604	51.796	85.400	84.932	0.890	56.868	87.629	144.496	143.606	0.957	62.144	95.795	157.939	156.981
7	0.029	12.846		12.846	12.854	0.362	18.354		18.354	18.992	0.683	34.852		34.852	34.169	0.735	36.367		36.367	35.633
8	0.017	6.097	137.560	143.657	143.620	0.017	9.157	191.780	200.938	200.921	0.017	16.490	324.453	340.943	340.926	0.017	17.307	354.613	371.921	371.904
9	0.114	32.734	156.477	189.212	189.098	0.634	49.155	219.943	269.098	268.463	1.135	88.534	375.095	463.629	462.494	1.215	92.383	407.436	499.819	498.605
10	0.175	21.355		21.355	21.179	1.301	33.220		33.220	31.918	2.386	50.912		50.912	48.526	2.581	56.354		56.354	53.794
11	0.038	33.447	21.179	54.626	54.588	0.135	52.000	31.918	83.949	83.813	0.239	79.740	48.526	128.265	128.026	0.244	88.264	53.794	142.058	141.814
12	0.131	18.480		18.480	18.349	2.597	26.743		26.743	26.150	4.973	44.058		44.058	39.085	5.555	44.768		44.768	43.413
13	0.062	2.641	72.937	75.578	75.522	0.062	4.117	109.964	114.081	114.019	0.062	6.310	167.121	173.431	173.369	0.062	6.984	185.227	192.211	192.149
14	0.122	19.803	75.522	95.325	95.197	0.478	30.806	114.019	144.825	144.347	0.817	47.213	171.369	220.582	219.765	0.871	52.260	192.149	244.409	243.538
15	0.089	10.453	284.295	297.748	297.659	0.089	20.207	412.790	432.997	432.907	0.089	38.247	682.259	720.506	720.417	0.089	51.391	742.141	793.532	793.443
16	0.039	16.390		16.390	16.351	3.756	-23.589		23.589	19.804	7.395	40.065		40.065	32.671	7.975	47.706		47.706	39.731
17	0.066	34.431		34.431	34.365	3.304	55.161		55.161	51.858	6.816	59.720		59.720	52.905	7.349	71.113		71.113	63.764
18	0.221	15.102		15.102	14.879	1.290	21.735		21.735	20.445	3.519	36.916		36.916	34.557	3.844	43.958		43.958	41.474
19	0.114	23.800	55.595	78.965	78.852	0.114	33.678	71.906	105.584	105.470	0.114	57.300	120.175	177.373	177.259	0.114	68.112	144.971	213.083	212.969
20	0.000	17.536	376.541	394.077	394.077	0.000	26.340	538.378	564.718	564.717	0.000	49.856	597.675	947.532	947.531	0.000	66.989	1006.412	1073.401	1073.401
21	1.411	16.519		16.519	15.108	5.154	25.525		25.525	20.370	8.760	47.687		47.687	38.927	9.341	64.650		64.650	55.310
22	0.000	12.852		12.852	12.852	3.427	19.858		19.858	16.431	6.728	37.101		37.101	30.373	7.259	50.294		50.294	43.035
23	0.001	28.295	27.960	56.255	56.254	0.837	43.719	35.802	80.521	79.684	1.249	91.680	69.399	150.979	149.730	1.348	110.735	98.349	209.084	207.736
24	0.000	13.547	450.331	463.878	463.878	0.972	20.349	644.602	664.950	663.978	1.908	38.516	1077.281	1115.775	1113.869	2.058	31.752	1281.136	1312.888	1310.830

Tertio-system	FEB					MAR					APR					MAY				
	Demand	Runoff	Inflow	Total In	Balance	Demand	Runoff	Inflow	Total In	Balance	Demand	Runoff	Inflow	Total In	Balance	Demand	Runoff	Inflow	Total In	Balance
1	0.023	87.567		87.567	87.544	0.023	97.610		97.610	97.587	0.023	61.645		61.645	61.622	0.023	68.324		68.324	68.301
2	0.023	40.524		40.524	40.501	0.023	45.171		45.171	45.149	0.023	37.783		37.783	37.760	0.023	31.419		31.419	31.396
3	0.025	42.313	128.045	170.358	170.334	0.025	47.166	142.736	189.902	189.878	0.025	39.452	119.383	158.835	158.810	0.025	33.015	99.897	132.912	132.887
4	0.203	38.734		38.734	38.531	0.203	43.177		43.177	42.974	0.203	36.115		36.115	35.912	0.203	30.222		30.222	30.019
5	0.691	45.126		45.126	44.435	0.701	50.301		50.301	49.600	0.013	42.074		42.074	42.062	0.375	35.209		35.209	34.834
6	0.543	53.565	83.164	136.727	136.184	0.537	59.706	92.574	152.280	151.744	0.039	99.941	77.974	177.915	177.875	0.619	41.792	64.853	106.644	106.025
7	0.291	32.570		32.570	32.277	0.606	37.466		37.466	37.068	0.029	31.857		31.857	31.828	0.581	34.039		34.039	33.458
8	0.017	15.411	306.677	322.088	322.071	0.017	17.727	341.826	359.553	359.536	0.017	15.079	286.686	301.759	301.742	0.017	11.374	238.914	250.288	250.271
9	0.921	62.737	354.348	417.085	416.559	0.705	95.173	396.194	491.367	490.662	0.114	80.925	333.570	414.496	414.382	0.667	61.066	273.800	334.865	334.199
10	1.069	46.853		46.853	44.784	1.451	46.719		46.719	45.268	0.175	34.982		34.982	34.807	1.804	34.632		34.632	32.828
11	0.115	78.082	48.784	126.866	126.751	0.149	73.173	45.263	118.436	118.287	0.038	54.790	34.807	89.597	89.559	0.179	54.342	32.818	87.049	86.870
12	2.088	43.143		43.143	41.054	2.933	40.430		40.430	37.495	0.131	30.273		30.273	30.141	6.172	29.970		29.970	23.798
13	0.062	6.178	167.805	173.984	173.922	0.062	5.730	155.782	161.512	161.450	0.062	4.535	119.700	124.235	124.173	0.062	4.292	112.648	116.940	116.878
14	0.406	46.231	173.922	220.153	219.747	0.526	43.525	161.510	205.035	204.509	0.127	32.441	123.973	156.414	156.286	0.653	32.116	116.918	149.034	148.381
15	0.089	48.440	656.306	704.746	704.656	0.049	56.995	695.171	752.166	752.077	0.089	48.540	570.668	617.208	617.119	0.049	36.908	482.430	519.338	519.289
16	3.011	45.150		45.150	42.139	4.298	49.778		49.778	45.481	0.039	44.627		44.627	44.588	6.070	39.474		39.474	33.404
17	2.193	67.299		67.299	64.506	5.974	74.196		74.196	70.224	0.066	66.818		66.818	66.752	4.428	59.137		59.137	54.709
18	1.070	41.601		41.601	40.531	1.436	45.865		45.865	44.429	0.223	41.303		41.303	41.080	0.741	36.555		36.555	35.814
19	0.114	64.469	147.176	211.645	211.532	0.114	71.081	160.154	231.201	231.088	0.114	63.995	152.621	216.616	216.502	0.114	56.642	134.127	190.768	190.655
20	0.000	63.142	916.178	979.319	979.319	0.000	74.294	983.164	1057.458	1057.458	0.000	60.665	833.634	894.299	894.299	0.000	48.110	699.893	748.003	748.002
21	4.381	55.425		55.425	51.044	5.668	69.211		69.211	63.545	1.411	52.748		52.748	51.337	5.497	41.157		41.157	35.660
22	2.719	43.120		43.120	40.402	3.895	53.846		53.846	49.951	0.000	41.038		41.038	41.038	2.983	32.020		32.020	29.037
23	0.505	94.933	91.446	186.378	185.873	0.726	118.546	113.496	232.042	231.316	0.001	90.348	92.375	182.723	182.722	0.141	70.495	64.697	135.193	135.052
24	0.721	48.780	1165.192	1213.972	1213.201	1.105	97.395	1248.776	1346.171	1345.066	0.000	46.866	1077.011	1123.878	1123.877	0.534	37.157	882.654	920.021	919.485

Tertio-system	JUN					JUL					AUG					SEP				
	Demand	Runoff	Inflow	Total In	Balance	Demand	Runoff	Inflow	Total In	Balance	Demand	Runoff	Inflow	Total In	Balance	Demand	Runoff	Inflow	Total In	Balance
1	0.023	49.215		49.215	49.192	0.023	44.011		44.011	43.987	0.023	38.916		38.916	38.893	0.023	34.297		34.297	34.274
2	0.023	22.775		22.775	22.752	0.023	20.387		20.387	20.364	0.023	18.009		18.009	17.987	0.023	15.872		15.872	15.849
3	0.025	23.781	71.944	95.725	95.701	0.025	21.266	64.331	85.596	85.571	0.025	18.805	56.880	75.684	75.660	0.025	16.573	50.123	66.696	66.671
4	0.203	21.770		21.770	21.567	0.203	19.467		19.467	19.265	0.203	17.214		17.214	17.011	0.203	15.171		15.171	14.968
5	0.908	25.342		25.342	24.559	1.068	22.680		22.680	21.591	1.127	20.055		20.055	18.927	1.053	17.674		17.674	16.621
6	1.301	30.104	46.126	76.229	74.928	1.758	26.930	40.856	67.776	66.018	1.820	23.804	35.933	59.743	57.923	0.798	20.979	31.569	52.548	51.751
7	1.079	16.857		16.857	15.778	1.458	13.560		13.560	12.102	1.510	11.577		11.577	10.067	0.819	11.278		11.278	10.460
8	0.017	7.976	170.629	178.605	178.588	0.017	6.416	151.592	158.008	157.991	0.017	5.478	133.583	139.061	139.044	0.017	5.316	118.632	123.948	123.931
9	1.753	42.821	194.566	237.387	235.634	2.146	34.466	170.093	204.559	202.413	2.426	29.408	149.111	178.519	176.092	1.025	28.641	134.407	163.048	162.023
10	3.722	31.086		31.086	27.364	5.004	26.499		26.499	21.496	5.176	21.632		21.632	16.454	2.146	20.475		20.475	18.329
11	0.345	48.648	27.364	76.053	75.708	0.456	41.568	21.496	63.000	62.544	0.471	33.841	16.454	50.334	49.863	0.268	32.068	18.329	50.397	50.131
12	6.930	26.902		26.902	17.972	12.109	22.932		22.932	10.823	12.542	18.720		18.720	6.178	4.447	17.719		17.719	13.272
13	0.062	3.853	93.679	97.532	97.470	0.062	3.291	73.361	76.651	76.589	0.062	2.691	56.041	58.732	58.669	0.062	2.537	43.460	45.996	45.934
14	1.184	29.628	97.470	126.298	125.114	1.566	24.574	76.589	101.164	99.598	1.618	20.060	58.669	78.730	77.102	0.742	18.597	45.934	64.533	63.792
15	0.049	24.556	360.548	385.104	385.055	0.049	18.173	301.791	319.964	319.915	0.049	14.304	253.195	267.499	267.450	0.049	13.424	246.213	259.637	259.587
16	13.171	30.794		30.794	17.623	17.917	26.225		26.225	8.308	18.563	20.325		20.325	1.762	6.595	16.251		16.251	9.656
17	9.565	45.901		45.901	36.336	12.957	39.090		39.090	26.092	13.465	30.296		30.296	16.831	6.083	24.224		24.224	18.141
18	1.351	28.373		28.373	27.022	1.759	24.163		24.163	22.404	1.815	18.727		18.727	16.912	2.051	14.974		14.974	12.923
19	0.114	43.964	80.991	124.956	124.842	0.114	37.440	54.604	94.244	94.130	0.114	29.013	35.505	64.519	64.405	0.116	21.302	40.640	61.942	61.826
20	0.000	32.010	509.847	541.856	541.856	0.000	23.619	414.005	437.624	437.624	0.000	18.646	331.819	350.465	350.465	0.000	17.438	323.315	340.814	340.813
21	10.309	27.778		27.778	17.469	13.524	18.953		18.953	5.429	13.962	14.572		14.572	0.610	7.962	13.290		13.290	5.328
22	6.495	21.611		21.611	15.117	8.842	14.746		14.746	5.904	9.161	11.337		11.337	2.176	5.997	10.339		10.339	4.343
23	0.742	47.579	32.516	80.165	79.423	1.010	32.464	11.333	43.797	42.787	1.046	34.980	2.765	37.745	36.700	1.114	22.743	9.670	32.413	31.299
24	1.166	34.729	631.279	666.007	664.841	1.548	18.365	480.481	498.781	497.234	1.645	14.466	377.165	391.570	389.925	1.701	13.518	372.132	385.651	383.950

Table 4.7 Water Utilization Ratio by Tertio-system in 2018

Tertio-system	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.02%	0.03%	0.02%	0.03%	0.03%	0.05%	0.05%	0.06%	0.07%	0.06%	0.04%	0.02%
2	0.05%	0.06%	0.05%	0.06%	0.07%	0.10%	0.11%	0.13%	0.14%	0.13%	0.09%	0.05%
3	0.01%	0.01%	0.01%	0.02%	0.02%	0.03%	0.03%	0.03%	0.04%	0.03%	0.02%	0.01%
4	0.45%	0.52%	0.47%	0.56%	0.67%	0.93%	1.04%	1.18%	1.34%	1.17%	0.83%	0.49%
5	2.48%	1.09%	1.39%	0.03%	1.07%	3.17%	4.80%	5.62%	6.07%	0.06%	2.18%	2.51%
6	0.61%	0.28%	0.35%	0.03%	0.58%	1.71%	2.59%	3.05%	1.52%	0.06%	0.55%	0.62%
7	2.02%	0.90%	1.09%	0.09%	2.13%	6.40%	10.75%	13.04%	5.43%	0.22%	1.87%	1.96%
8	0.00%	0.01%	0.00%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%
9	0.24%	0.12%	0.14%	0.03%	0.26%	0.74%	1.15%	1.36%	0.63%	0.06%	0.24%	0.24%
10	4.54%	2.14%	3.11%	0.50%	5.21%	11.97%	18.88%	23.94%	10.48%	0.82%	3.92%	4.69%
11	0.17%	0.09%	0.13%	0.04%	0.21%	0.45%	0.72%	0.94%	0.41%	0.07%	0.16%	0.18%
12	10.98%	4.84%	7.26%	0.43%	13.92%	33.19%	52.80%	67.00%	25.10%	0.71%	9.04%	11.29%
13	0.03%	0.04%	0.04%	0.05%	0.05%	0.06%	0.08%	0.11%	0.09%	0.08%	0.05%	0.04%
14	0.36%	0.18%	0.26%	0.08%	0.41%	0.94%	1.55%	2.06%	0.87%	0.13%	0.33%	0.37%
15	0.01%	0.01%	0.01%	0.01%	0.02%	0.02%	0.03%	0.03%	0.03%	0.03%	0.02%	0.01%
16	16.72%	6.67%	8.63%	0.09%	15.30%	42.77%	68.32%	91.33%	40.58%	0.24%	16.05%	18.46%
17	10.33%	4.15%	5.36%	0.10%	7.49%	20.84%	33.25%	44.44%	25.11%	0.27%	9.96%	11.41%
18	5.65%	2.57%	3.13%	0.54%	2.03%	4.76%	7.28%	9.69%	13.96%	1.48%	5.94%	6.28%
19	0.05%	0.05%	0.05%	0.05%	0.06%	0.09%	0.12%	0.18%	0.18%	0.14%	0.11%	0.06%
20	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
21	14.45%	7.90%	8.19%	2.67%	13.36%	37.11%	71.36%	95.81%	59.91%	8.54%	20.19%	18.37%
22	14.43%	6.31%	7.23%	0.00%	9.32%	30.05%	59.96%	80.80%	58.00%	0.00%	17.26%	18.13%
23	0.64%	0.27%	0.31%	0.00%	0.25%	0.93%	2.31%	3.77%	3.43%	0.00%	0.79%	0.83%
24	0.15%	0.06%	0.08%	0.00%	0.06%	0.18%	0.32%	0.42%	0.44%	0.00%	0.15%	0.17%

Table 5.1 Daily Maximun Rainfall

Unit : mm

	Rainfall Station													
Year	299	300	301	302	302a	303	303a	305	305a	305b	306	306a	Mean	Max
1917	73	107	86	90		69		90			103		88	107
1918	70	72	80	110		82		91			68		82	110
1919	140	83	125	120		98		100	600		83		169	600
1920	89	55	63	89		102		85	126		124		92	126
1921	92	119	111	99		89		100	80	83	105	138	102	138
1922	80	92	72	63		100		112	120	87	130	68	92	130
1923		112	95	125		156		101	118	115	102	102	114	156
1924	115		150	154		93		116	106	96	105	126	118	154
1925	104	80	105	122		114		104	112	180	129	202	125	202
1926	75	117	89	110		106		138	120	93	81	77	101	138
1927	88		68	135		168		110	92	151	128	105	116	168
1928	147	135	125	102		105		107	95	110	116	85	113	147
1929	115	107	123	101		109		68	208	130	99	88	115	208
1930	132	120	217					88	78	212		69	131	217
1931	96	85	200			117		159	140	163	152	120	137	200
1932	97	126	101	108		67		119	108	100	116	99	104	126
1933	88	126	122	125		67		130	182	250	327	106	152	327
1934	87	100	117	158		60		90	120		172	98	111	172
1935	154	170	99	110		80		131	169	180	96	96	129	180
1936	129	92	80	92		73		78	114	75	175	76	98	175
1937	107	104	142	79		206		138	110	92	93	95	117	206
1938	111	117	145	68		130		76	115	125	101	110	110	145
1939	125	91	138	58		62		100	121	110	56	55	92	138
1940	89	115	90	71		105		96	78	75	168	99	99	168
1941	63	140	76	53		79		136	87	50	128	113	93	140
1951	106	107	150	75		55		100	130	85			101	150
1952	112	192	84	82				135	128	69			115	192
1953	126	231	42	78		88		133	97	41			105	231
1954	67	87	95	94		140	60	133	85	72			93	140
1955	113	134	109	104		150	103	130	154	150			127	154
1956			121	140	90	179		115	88				122	179
1957	94			106	115	139	121	111	94	87			108	139
1958	83		113	105	98	145	111	99	142				112	145
1959	79			112	93	99	103	94	66				92	112
1960	127		125	127	103	102	296	119	86	135	125		135	296
1961	64		125	126	98	78	144	122		79	113		105	144
1962			135	139	109	140		75	160	79	106		118	160
1963			85	131	77	97		120		70	126		101	131
1964			135	124	110	100		97		49	89		101	135
1965	81		135		89	131				50	196		114	196
1966			83		131			140		47	126		105	140
1967			79		90		79				125		93	125
1968			76				119	102			130		107	130
1969														
1970			113				185	65		49	145		111	185
1971	62		89			65	110	68	85	49	125		82	125

Table 5.2 Storm Rainfall Records

Series No.	Station No.	Station Name	Date	Total Rainfall
	ARR Station			
1	1	Miyawa	02-May-83	136
2	2	Lumpangi kiri	21-Oct-76	129
3	2	Lumpangi kiri	12-Mar-77	131
4	2	Lumpangi kiri	14-Oct-82	109
5	4	Muara Halong	15-Feb-79	167
6	4	Muara Halong	21-May-79	102
7	4	Muara Halong	28-Nov-79	147
8	4	Muara Halong	25-Feb-82	141
9	4	Muara Halong	10-Oct-82	105
10	4	Muara Halong	27-Sep-84	115
11	5	Batu Tangga	28-Nov-77	109
12	6	Bihara	03-Dec-78	124
13	6	Bihara	30-Oct-80	140
14	6	Bihara	11-Jun-82	108
15	7	Limau Manis	28-Feb-80	109
16	8	Teratau	04-Jan-80	56
17	13	Mantuyan	22-Jan-84	126
18	14	Sei Batung	14-Mar-82	110
19	14	Sei Batung	30-Mar-85	114
20	31	Telaga Langsat	12-Jan-85	152
21	31	Telaga Langsat	20-Nov-86	120
22	31	Telaga Langsat	20-May-87	108
	Meteoro-station			
23	1	Sei Malang Amuntai	12-Mar-77	144
24	1	Sei Malang Amuntai	02-May-78	111
25	1	Sei Malang Amuntai	18-Dec-79	135
26	1	Sei Malang Amuntai	20-Jan-83	121
27	1	Sei Malang Amuntai	20-Mar-85	160
28	1	Sei Malang Amuntai	30-Nov-85	109
29	1	Sei Malang Amuntai	11-Apr-86	176
30	2	Tatakan	10-May-77	108
31	2	Tatakan	18-Feb-78	120
32	2	Tatakan	14-Nov-79	117
33	2	Tatakan	08-May-81	104
34	2	Tatakan	21-Mar-86	113
35	12	Batu Mandi	25-Apr-82	118
36	12	Batu Mandi	27-Dec-86	124

Tabel 5.3 Storage Function of Tertio-system

Tertio-system Number	Basin Area (km2)	Length (km)	Slope (1/n)	K	P	TL	Base Flow (m3/sec)
1	685	71	400	19.72	0.72	3	14
2	317	65	100	29.89	0.52	2	6
3	331	48	1550	13.14	0.98	2	7
4	303	57	320	21.09	0.68	2	6
5	353	29	150	26.47	0.57	1	7
6	419	40	90	30.85	0.5	1	8
7	298	36	150	26.47	0.57	1	6
8	141	29	2910	10.87	1.14	1	3
9	757	41	8200	7.97	1.45	1	15
10	468	31	100	29.89	0.52	1	9
11	733	69	200	24.28	0.61	3	15
12	405	65	100	29.89	0.52	2	8
13	58	16	800	16.02	0.84	1	1
14	434	39	300	21.5	0.67	1	9
15	570	58	8200	7.97	1.45	2	11
16	318	39	100	29.89	0.52	1	6
17	474	53	100	29.89	0.52	2	9
18	293	33	700	16.67	0.82	1	6
19	454	57	1200	14.18	0.93	2	9
20	743	54	50000	4.63	2.23	2	15
21	491	66	100	29.89	0.52	3	10
22	382	94	100	29.89	0.52	4	8
23	841	18	1500	13.27	0.98	1	17
24	574	62	900	15.46	0.87	2	11

Table 5.4 Estimated Flood Peak Discharge

Return Period — Unit : m3

Tertio-syst	1000	500	200	100	50	10
1	740	660	530	450	350	270
2	320	280	220	190	160	110
3	363	327	275	235	186	130
4	330	290	230	190	160	120
5	370	330	290	220	190	140
6	417	358	284	249	214	148
7	461	398	331	282	227	139
8	202	184	160	142	121	62
9	981	903	799	715	624	325
10	1100	940	760	620	510	260
11	1900	1480	1210	1010	830	420
12	950	820	660	540	440	220
13	126	112	95	82	69	38
14	1000	870	720	610	500	260
15	900	828	726	652	568	338
16	1010	890	700	570	450	220
17	1500	1320	1040	850	670	330
18	830	730	610	520	430	240
19	1200	1090	910	780	660	370
20	831	789	732	664	597	415
21	1280	1090	880	730	590	300
22	1000	850	690	560	460	240
23	1845	1659	1419	1238	1070	645
24	1330	1190	1010	870	740	430

Table S.1 Water Quality in the Study Area

No. in Fig. 1.11	Date	Location	Sampling Depth	TURB (ppm)	PH	DO (%)	DO (ppm)	TEMP (°C)	COND (μ mho)	SAL (ppm)
1	22 Jan. 86	S. Danau Panggang - Danau Panggang	1	38	6.8	75	5.9	27	95	61
			2	39	6.8	80	6.3	27	93	60
			0.1	52	6.8	80	6.3	27	89	57
2	23 Jan. 86	S. Hanyar - Desa. S. Hanyar	1.5	95	7.8	65	5.27	25	125	80
			3	100	7.7	65	5.27	25	125	80
			0.1	95	7.8	65	5.27	25	120	77
3	23 Jan. 86	S. Tabalong - Tanjung	0.6	120	7.2	60	4.83	25.5	140	90
			1.2	120	7.2	60	4.83	25.5	140	90
			0.1	120	7.2	60	4.83	25.5	135	86
4	23 Jan. 86	S. Balangan - Halong	0.25	55	8.1	60	4.79	26	130	83
			0.5	60	8.1	60	4.79	26	130	83
			0.1	56	8.2	60	4.79	26	130	83
5	23 Jan. 86	S. Balangan - Balang	0.5	80	7.2	55	4.39	26	180	115
			1	100	7.2	60	4.79	26	180	115
			0.1	100	7.3	60	4.79	26	180	115
6	23 Jan. 86	S. Balangan - Lampihong	0.75	70	7.4	65	5.12	27	120	77
			2	80	7.5	65	5.12	27	140	90
			0.1	70	7.6	65	5.12	27	125	80
7	20 Feb. 86	S. Barito - Desa S. Lirik	1	46	6.4	137	11.1	25	85	54
			3	65	6.5	122	9.89	25	85	54
			4	100	6.5	110	8.92	25	85	54
8	20 Feb. 86	S. Negara - Marabahan 500 m	0.5	40	6.7	54	4.28	26.5	60	38
			1	38	6.6	52	4.12	26.5	75	48
9	20 Feb. 86	S. Barito - KP. Tengah Marabahan	0.5	45	6.5	85	6.84	25.5	25	16
			1.5	35	6.5	85	6.84	25.5	25	16
			3	50	6.5	85	6.84	25.5	30	19
10	20 Feb. 86	S. Paminggir - Paminggir	2	90	6.7	65	5.19	26	40	26
			3.5	90	6.5	70	5.59	26	40	26
			5.5	85	6.6	70	5.59	26	45	29
11	20 Feb. 86	S. Barito - Kuripan			6.5					
12	20 Feb. 86	S. Barito - Kuripan Hilir 5 Km			6.5					
13	20 Feb. 86	S. Barito - Kuripan Hilir 10 Km			6.8					
14	22 Mar. 86	S. Batang Alai - Mantaas	3	70	6.3	60	4.62	28.5	45	29
			2	75	6.2	70	5.39	28.5	45	29
			0.5	75	6.2	70	5.39	28.5	45	29
15	22 Mar. 86	S. Pitap - Bihara	0.5	30	8.1	88	7.03	26	110	70
			0.1	25	8.1	80	6.39	26	115	74
16	23 Mar. 86	S. Tabalong Kanan - Batu Pulut	1.25	40	7.7	76	6.12	25.5	150	96
			0.75	70	7.7	76	6.12	25.5	150	96
			0.25	40	7.8	71	5.72	25.5	155	99
17	23 Mar. 86	S. Uya - Teratau	0.2	60	7.9	75	6.04	25.5	165	106
			0.8	58	8	79	6.36	25.5	160	102
18	24 Mar. 86	S. Ayu - KP Licin	1.1	55	7.6	77	6.3	24.5	145	93
			0.9	55	7.6	75	6.08	25	135	86
			0.25	50	7.6	66	5.35	25	135	86
19	25 Mar. 86	S. Tabalong Kiri - Mahe	1.5	90	7.3	85	6.95	24.5	50	32
			1	90	7.3	85	6.95	24.5	50	32
			0.1	85	7.3	88	7.2	24.5	70	45
20	28 Nop. 85	S. Balimau - Muara Tabirai	1	140	6.3	70	5.47	27.5	140	90
			2	140	6.3	75	5.86	27.5	140	90
21	28 Nop. 85	S. Negara - Negara	1.5	90	7.1	80	6.39	26	125	80
			3	80	7	90	7.19	26	130	83
22	28 Nop. 85	S. Amandit - Lungau (Kandangan)	0.5	90	7.7	80	6.49	25	120	77
			1	70	7.7	80	6.49	25	120	77
23	27 Nop. 85	S. Tapin - Kuranji (Rantau)	0.75	100	7.6	80	6.3	27	120	77
			1.25	85	7.7	82	6.45	27	120	77
24	27 Nop. 85	S. Tapin - Linuh (Rantau)	0.5	95	7.8	65	5.12	27	120	77
			0.8	85	7.7	64	5.04	27	120	77
25	27 Nop. 85	S. Amandit - Jambu Hulu (Kandangan)	0.25	60	7.6	66	5.27	26	120	77
			0.75	60	7.8	58	4.63	26	115	74

No. in Fig. 1.11	Date	Location	Sampling Depth	TURB (ppm)	PH	DO (%)	DO (ppm)	TEMP (°C)	COND (µ mho)	SAL (ppm)
26	27 Nop. 85	S. Tapin - Pabaungan (Margasari)	1	50	6.6	90	7.14	26.5	140	90
			2	25	6.3	92	7.3	26.5	150	96
			3	32	6.4	92	7.3	26.5	150	96
27	26 Des. 85	S. Barabai - Baruh Batong	0.2	50	8.4	82	6.6	25.5	85	54
			0.35	50	8.4	80	6.44	25.5	85	54
			0.1	50	8.4	80	6.44	25.5	90	58
28	26 Des. 85	S. Batang Alai - Sei Buluh	0.3	75	7.2	80	6.3	27	125	80
			0.75	70	7.2	80	6.25	27.5	125	80
			0.1	65	7.2	75	5.86	27.5	130	83
29	26 Des. 85	S. Pinang Habang - Pinang Habang	0.5	95	6.7	65	5.04	28	100	64
			1	95	6.7	65	5.08	27.5	110	70
			0.1	100	6.7	68	5.23	28.5	110	70
30	26 Des. 85	S. Negara - Amuntai	1	90	7.6	70	5.64	25.5	110	70
			2	85	7.6	70	5.64	25.5	100	64
			0.1	85	7.6	73	5.88	25.5	105	67
31	26 Des. 85	S. Barabai - Kasarangan	0.5	55	7.1	65	5.15	26.5	120	77
			1	60	7.1	65	5.15	26.5	120	77
			0.1	95	7.1	65	5.19	26	120	77
32	26 Des. 85	S. Batang Alai - BT. Tangga	0.25	32	7.9	75	6.19	24	150	96
			0.5	35	7.8	70	5.78	24	155	99
			0.1	35	7.9	70	5.78	24	150	96
33	4 Des. 85	S. Tapin - Pabaungan	1.5	40	6.2	80	6.3	27	145	93
			3	40	6.2	80	6.3	27	145	93
			4.5	45	6.2	82	6.45	27	145	93
34	4 Des. 85	S. Barito - Marabahan Hulu 1 Km	1	75	6.2	90	7.08	27	130	83
			2	75	6.1	87	6.85	27	130	83
35	4 Des. 85	S. Barito - Marabahan Hilir 1 Km	1	70	5.8	95	7.53	26.5	120	77
			2.5	95	5.9	90	7.14	26.5	120	77
36	4 Des. 85	S. Negara - Margasari (Dermaga)	2	78	6.2	80	6.25	27.5	145	93
37	4 Des. 85	S. Negara - Margasari Hulu	2	80	6.6	65	5.08	27.5	150	96
			4	45	6.5	65	5.08	27.5	140	90
			2.5	25	6.6	70	5.47	27.5	140	90
			5	45	6.3	75	5.86	27.5	140	90
38	21 Sept.86	S. Barito - Sinar Arja (Marabahan)	1	45		80	6.49	25	60	38
39	9 Sept.86	S. Danau Bangkau - Bangkau	0.5	75	7.0	12	0.9	30.5	150	96
40	9 Sept.86	S. Negara - Negara (AWLR)	1	12	7.2	80	6.07	29.5	175	112
41	9 Sept.86	S. Negara - Ds. Tambangan	1	12	7.9	80	6.07	29.5	180	115
42	9 Sept.86	S. Pasungkan - Pasungkan	1	60	7.5	44	3.31	30	175	112
43	9 Sept.86	S. Negara - Pasungkan	1	35	7.4	50	3.79	29.5	180	115
44	9 Sept.86	S. Pandansari - Negara	0.5	82	7.2	15	1.13	30	180	115
45	9 Sept.86	S. Batang Alai - Negara	1	30	7.2	20	1.52	29.5	180	115
46	9 Sept.86	S. Amandit - Lungau (AWLR)	0.75	25	7.9	60	4.65	28	115	74
47	10 Sept.86	S. Negara - Amuntai (AWLR)	1	40	7.5	80	6.25	27.5	225	144
48	10 Sept.86	S. Negara - Alabio (Down)	0.5	55	7.5	70	5.39	28.5	220	141
49	10 Sept.86	S. Danau Panggang - Danau Panggang (AWLR).	0.5	100	7.5	34	2.53	31	250	160
50	10 Sept.86	S. Negara - Alabio (Up)	0.5	35	7.6	85	6.45	29.5	230	147
51	11 Sept.86	S. Balangan - Amuntai	0.5	35	7.8	82	6.45	27	175	112
52	11 Sept.86	S. Tabalong - Amuntai	0.5	45	7.5	78	6	28.5	230	147
53	11 Sept.86	S. Batang Alai - S. Buluh (AWLR)	0.5	80	7.3	94	6.98	31	180	115

Table 8.2 Water Quality Criteria

Group A: For drinking without prior treatment

	Parameter		Unit	Maximum Suggestion	Maximum Allowance	Remarks
1.	Physics					
	Temperature		℃	normal water temperature	normal water temperature	
	Color		Unit.	5	50	
	Smell		-	no smell	no smell	
	Taste		-	no taste	no taste	
	Turbidity		mg/t. SiO2	5	25	
	Dissolved residue		mg/l	500	1,500	
2.	Chemistry					
	pH		-	6.5 - 8.5	6.5 - 8.5	
	Calcium	(Ca)	mg/l	75	200	
	Magnesium	(Mg)	mg/l	30	150	
	Barium	(Ba)	mg/l	nil	0.05	
	Iron	(Fe)	mg/l	0.1	1	
	Manganese	(Mn)	mg/l	0.05	0.5	
	Copper	(Cu)	mg/l	nil	1	
	Zinc	(Zn)	mg/l	1	15	
	Chromium	(Cr)	mg/l	nil	0.05	
	Cadmium	(Cd)	mg/l	nil	0.01	
	Mercury	(Hg)	mg/l	0.0005	0.001	
	Lead	(Pb)	mg/l	0.05	0.1	
	Aresemic	(As)	mg/l	nil	0.05	
	Selenium	(Se)	mg/l	nil	0.01	
	Cyanide	(CN)	mg/l	nil	0.05	
	Sulfur	(S)	mg/l	nil	nil	
	Fluorine	(F)	mg/l	-	1.5	minimum 0.5
	Chlorine	(Cl)	mg/l	200	600	
	Sulfate	(SO4)	mg/l	200	400	
	Ammonia	(NH3-N)	mg/l	nil	nil	
	Nitrate	(NO3-N)	mg/l	5	10	
	Nitrate	(NO2-N)	mg/l	nil	nil	
	Permangnate	(KMnO4)	mg/l	nil	10	
	Blue methyl active compound		mg/l	nil	0.5	
	Phenol		mg/l	0.001	0.002	
	Oil and Grease		mg/l	nil	nil	
	Extract Chloroform Carbon		mg/l	0.04	0.5	
	PCB		mg/l	nil	nil	
3.	Bacteriology					
	Coliform group		MPN/100 ml	nil	nil	
	Parasitic Bacteria			nil	nil	
	Pathogenic Bacteria			nil	nil	
4.	Radioactivity					
	Total Beta activity		pCi/l	-	100	
	Strontium 90		pCi/l	-	2	
	Radium 226		pCi/l	-	1	
	Pestiside		mg/l	nil	nil	

Table 8.2 Water Quality Criteria

Group B: For drinking and domestic use but not applicable for Group A

	Parameter		Unit	Maximum Suggestion	Maximum Allowance	Remarks
1.	Physics					
	Temperature		℃	normal water temperature	normal water temperature	
	Dissolved residue		mg/l	500	1,500	
2.	Chemistry					
	pH		-	5 - 9	5 - 9	
	Barium	(Ba)	mg/l	nil	1	
	Iron	(Fe)	mg/l	1	5	
	Manganese	(Mn)	mg/l	0.05	0.5	
	Copper	(Cu)	mg/l	nil	1	
	Zinc	(Zn)	mg/l	1	15	
	Chromium	(Cr)	mg/l	nil	0.05	
	Cadmium	(Cd)	mg/l	nil	0.01	
	Mercury	(Hg)	mg/l	0.0005	0.001	
	Lead	(Pb)	mg/l	0.05	0.1	
	Arsenic	(As)	mg/l	nil	0.05	
	Selenium	(Se)	mg/l	nil	0.01	
	Cyanide	(CN)	mg/l	nil	0.05	
	Sulfur	(S)	mg/l	nil	nil	
	Fluorine	(F)	mg/l	-	1.5	minimum 0.5
	Chlorine	(Cl)	mg/l	200	600	
	Sulfate	(SO4)	mg/l	200	400	
	Ammonia	(NH3-N)	mg/l	0.01	nil	
	Nitrate	(NO3-N)	mg/l	5	10	
	Nitrate	(NO2-N)	mg/l	nil	nil	
	Dissolved Oxygen	(DO)	mg/l			1/
	BOD		mg/l	6	-	
	COD		mg/l	10	-	
3.	Bacteriology					
	Coliform group		MPN/100 ml	10,000	-	
	Feces			2,000	-	
4.	Radioactivity					
	Total Beta activity		pCi/l	-	100	
	Strontium 90		pCi/l	-	2	
	Radium 226		pCi/l	-	1	
5.	Pestiside					
	Aldrin		mg/l	nil	0.017	
	Chlordane		mg/l	nil	0.003	
	DOT		mg/l	nil	0.042	
	Dieldrin		mg/l	nil	0.017	
	Endrin		mg/l	nil	0.001	
	Heptachlor		mg/l	nil	0.018	
	Heptachlor epoxide		mg/l	nil	0.018	
	Lindane		mg/l	nil	0.056	
	Methexy chlor		mg/l	nil	0.035	
	Organic phophate & carbonate		mg/l	nil	0.1	
	Toxaphane		mg/l	nil	0.005	

1/ To be ≥6 for surface water

Table 8.2 Water Quality Criteria

Group C: Good for fishery & livestock as well as other purpose but not belong to Group A and B Requirement

	Parameter		Unit	Maximum Value	Remarks
1.	Physics				
	Temperature		℃	normal water temperature ±4℃	
	Dissolved residue		mg/l	2,000	
2.	Chemistry				
	pH		-	6 - 9	
	Copper	(Cu)	mg/l	0.02	
	Zinc	(Zn)	mg/l	0.02	
	Chromium	(Cr)	mg/l	0.05	
	Cadmium	(Cd)	mg/l	0.01	
	Mercury	(Hg)	mg/l	0.002	
	Lead	(Pb)	mg/l	0.03	
	Aresemic	(As)	mg/l	1	
	Selenium	(Se)	mg/l	0.05	
	Cyanide	(CN)	mg/l	0.02	
	Sulfur	(S)	mg/l	0.002	
	Fluorine	(F)	mg/l	1.5	
	Ammonia	(NH3-N)	mg/l	0.016	
	Nitrate	(NO2-N)	mg/l	0.06	
	Chloride	(Cl2)	mg/l	0.003	
	Dissolved Oxygen		mg/l	-	1/
	Blue methyl active compound		mg/l	0.2	
	Phenol		mg/l	0.001	
	Oil and Grease		mg/l	1	
3.	Radioactivity				
	Total Beta activity		pCi/l	1,000	2/
	Strontium 90		pCi/l	10	
	Radium 226		pCi/l	3	
4.	Pestiside				
	DDT		mg/l	0.002	
	Endrin		mg/l	0.004	
	BHC		mg/l	0.21	
	Methyl Parathion		mg/l	0.1	
	Malathion		mg/l	0.16	

1/ to be >3 and allowance DO=3, maximum 8 hours/day
2/ activities without Sr-90 and Ra-226

Table 8.2 Water Quality Criteria

Group D: Good for agriculture, industry, hydropower and navigation etc. but can not be used for Group A, B & C

	Parameter		Unit	Maximum Value		Remarks
1.	Physics					
	Temperature		℃	normal water temperature	1/	
	Dissolved residue		mg/l	1,000 - 2,000		
	Electric conductivity		μΩ/cm (25°C)	1,750 - 2,250	2/	
2.	Chemistry					
	pH		-	5 - 9		
	Manganese	(Mn)	mg/l	2		
	Copper	(Cu)	mg/l	0.2		
	Zinc	(Zn)	mg/l	2		
	Chromium	(Cr)	mg/l	1		
	Cadmium	(Cd)	mg/l	0		
	Mercury	(Hg)	mg/l	0.005		
	Lead	(Pb)	mg/l	1		
	Aresemic	(As)	mg/l	1		
	Selenium	(Se)	mg/l	0.005		
	Nichel	(Ni)	mg/l	0.5		
	Cobalt	(Co)	mg/l	0.2		
	Boron	(B)	mg/l	1		
	Sodium	(Na)	%	60		
	Sodium Absorption Ratio			10 - 18	3/	
	Residual Sodium Carbonate			1.25 - 2.5	4/	
3.	Radioactivity					
	Total Beta activity		pCi/l	1,000	5/	
	Strontium 90		pCi/l	10		
	Radium 226		pCi/l	3		

1/ According to local condition
2/ 1,750 for sensitive plant
2,250 for medium sensitive plant
3/ maximum 10 for sensitive plant
maximum 18 for low sensitive plant
4/ maximum 1.25 for sensitive plant
maximum 2.5 for low sensitive plant
5/ activities without Sr-90 and Ra-226

Table 8.3 Water Quality in the Balangan River

Parameter		Unit	Sungai Balangan - Tabuan		Sungai Balangan - Muara Halung		Sungai Balangan - Balang		Sungai Balangan - Lampihong	
			18-4-1983	14-10-1983	18-4-1983	14-10-1983	14-4-1983	12-10-1983	12-4-1983	13-10-1983
1 Sampling Location No. in Fig. 1.11			1	1	2	2	3	3	4	4
2 Physics										
Temperature		°C	26	28	27	29	28	30	27	30
Color		Unit/PtCo	-	-	-	-	-	-	-	-
Smell		-	-	-	-	-	-	-	-	-
Taste		-	-	-	-	-	-	-	-	-
Turbidity		mgA. SiO2	12.5	13	15	14	10	-	10	-
Dissolved residue		mg/l	125	130	130	128	150	160	88	140
DHL		umho/cm	183	185	197	198	191	240	160	210
3 Chemistry										
pH		-	7.6	7.7	7.8	7.7	7.6	8.0	7.5	7.9
Calcium	(Ca)	mg/l	24	23	28	29	27	24	23	19.9
Magnesium	(Mg)	mg/l	5.1	5.5	4.9	5	4.7	6.8	2.9	6.8
		-	-	-	-	-	6	-	-	-
Sodium	(Na)	mg/l	5.1	5.6	4.9	5.1	1.3	51	1.5	19
Potassium	(K)	mg/l	1.5	1.6	1.3	1.4	0.1	6.0	1.5	10
Nichel	(Ni)	mg/l	0.09	0.04	0.07	0.06	0.21	nil	0.08	nil
Iron	(Fe)	mg/l	0.2	0.5	0.19	0.15	0.03	0.24	0.63	0.4
Manganese	(Mn)	mg/l	0.01	0.01	0.02	0.01	0.03	0.01	0.09	0.02
Copper	(Cu)	mg/l	nil	nil	nil	nil	0.27	nil	0.01	nil
Zinc	(Zn)	mg/l	0.21	0.19	0.22	0.19	nil	0.05	0.25	0.12
Chromium	(Cr)	mg/l	nil	nil	nil	nil	nil	nil	nil	nil
Cadmium	(Cd)	mg/l	nil	nil	nil	nil	nil	nil	nil	nil
Mercury	(Hg)	mg/l	nil	nil	nil	nil	nil	nil	nil	nil
Lead	(Pb)	mg/l	nil	nil	nil	nil	nil	nil	nil	nil
Cyanide	(CN)	mg/l	nil	nil	nil	nil	nil	nil	nil	nil
Sulfur	(S)	mg/l	nil	nil	nil	nil	nil	nil	nil	nil
Fluorine	(F)	mg/l	nil	nil	nil	nil	nil	nil	nil	nil
Chlorine	(Cl)	mg/l	4.3	4.2	4.2	4.5	3.5	3.6	4.4	2.3
Sulfate	(SO4)	mg/l	3.1	3.0	2.6	2.7	1	0.5	2	0.3
Ammonium	(NH4)	mg/l	nil	nil	nil	nil	nil	0.28	nil	0.3
Nitrate	(NO3)	mg/l	nil	nil	nil	nil	nil	0.4	nil	0.6
Nitrate	(NO2)	mg/l	0.001	0.001	0.001	0.002	0.02	nil	0.003	0.03
Calcium Carbonate	(CaCO3)	mg/l	83	82	92	90	94	99	74	76
Carbon Dioxide	(CO2)	mg/l	4.1	4	3.7	3.5	4.9	12.1	3.7	12.9
Phenol		mg/l	nil	nil	nil	nil	nil	nil	nil	nil
Dissolved Oxygen	(DO)	mg/l	7.2	7.0	7.1	7.0	7.1	7.1	7.2	6.1
Boron	(B)	mg/l	nil	nil	nil	nil	0.1	0.05	0.01	0.14
Permangnate	(KMnO4)	mg/l	6.4	6.3	5.7	5.6	9.7	5.1	12	2.5
4 Bacteriology										
Coliform group		MPN/100 ml	1.1x10 hundred	1.5x10 hundred	1.1x10 hundred	1.5x10 hundred	7x1 hundred	7.3x1 hundred	2.4x10 thousand	
BOD					0.6	0.6	0.8	1.4	0.6	0.72
COD					9.3	9.0	70	17	1.2	18

Parameter		Unit	Sungai Balangan - Rihara/Awayan		Sungai Balangan - Muara Pitap		Sungai Balangan - Kepayang	
			15-4-1983	12-10-1983	16-4-1983	12-10-1983	18-4-1983	14-10-84
1 Sampling Location No. in Fig. 1.11			5	5	6	6	7	7
2 Physics								
Temperature		°C	27	30	27	30	26	27
Color		Unit/PtCo	-	-	-	-	-	-
Smell		-	-	-	-	-	-	-
Taste		-	-	-	-	-	-	-
Turbidity		mgA. SiO2	10	-	12.5	-	10	11
Dissolved residue		mg/l	79	130	82	125	116	118
DHL		umho/cm	156	200	150	190	187	188
3 Chemistry								
pH		-	7.9	7.6	7.8	7.6	7.7	7.6
Calcium	(Ca)	mg/l	18	18.2	18	18.2	24	23
Magnesium	(Mg)	mg/l	5.4	7.9	5.4	7.9	5	4
		-	-	-	-	-	-	-
Sodium	(Na)	mg/l	5.8	51	5.9	51	6.6	6.7
Potassium	(K)	mg/l	1.1	6.2	1.1	6.2	1.1	1.2
Nichel	(Ni)	mg/l	0.1	nil	0.11	nil	0.06	0.04
Iron	(Fe)	mg/l	0.13	2.9	0.29	2.9	0.22	0.2
Manganese	(Mn)	mg/l	0.01	0.02	0.01	0.02	0.02	0.01
Copper	(Cu)	mg/l	0.01	nil	0.01	nil	nil	nil
Zinc	(Zn)	mg/l	0.43	0.07	0.19	0.07	0.23	0.21
Chromium	(Cr)	mg/l	nil	nil	nil	nil	nil	nil
Cadmium	(Cd)	mg/l	nil	nil	nil	nil	nil	nil
Mercury	(Hg)	mg/l	0.02	nil	nil	nil	nil	nil
Lead	(Pb)	mg/l	nil	nil	nil	nil	nil	nil
Cyanide	(CN)	mg/l	nil	nil	nil	nil	nil	nil
Sulfur	(S)	mg/l	nil	nil	nil	nil	nil	nil
Fluorine	(F)	mg/l	nil	nil	nil	nil	nil	nil
Chlorine	(Cl)	mg/l	2.7	3.1	3.5	3.1	4.3	4.4
Sulfate	(SO4)	mg/l	1	0.5	2.0	0.5	1.5	1.6
Ammonium	(NH4)	mg/l	nil	0.3	nil	0.3	nil	nil
Nitrate	(NO3)	mg/l	nil	0.5	nil	0.5	nil	nil
Nitrate	(NO2)	mg/l	0-.003	0.003	0.002	0.003	0.002	0.003
Calcium Carbonate	(CaCO3)	mg/l	75	79	73	79	85	84
Carbon Dioxide	(CO2)	mg/l	1.6	6.9	7.9	6.9	3.3	3.2
Phenol		mg/l	nil	nil	nil	nil	tr	nil
Dissolved Oxygen	(DO)	mg/l	7	6.6	7	6.6	7.3	7.4
Boron	(B)	mg/l	nil	0.06	nil	0.06	tr	nil
Permangnate	(KMnO4)	mg/l	6.4	3.4	5.8	3.4	7.1	7.4
4 Bacteriology								
Coliform group		MPN/100 ml	4.3x10 hundred	3.6x10 hundred	7x1 hundred	8.6x1 hundred	2.1x1 hundred	2.9x1 hundred
BOD			0.6	0.71	0.55	0.98	0.65	0.7
COD			4.1	12	7.3	15	11.4	11.2

FIGURES

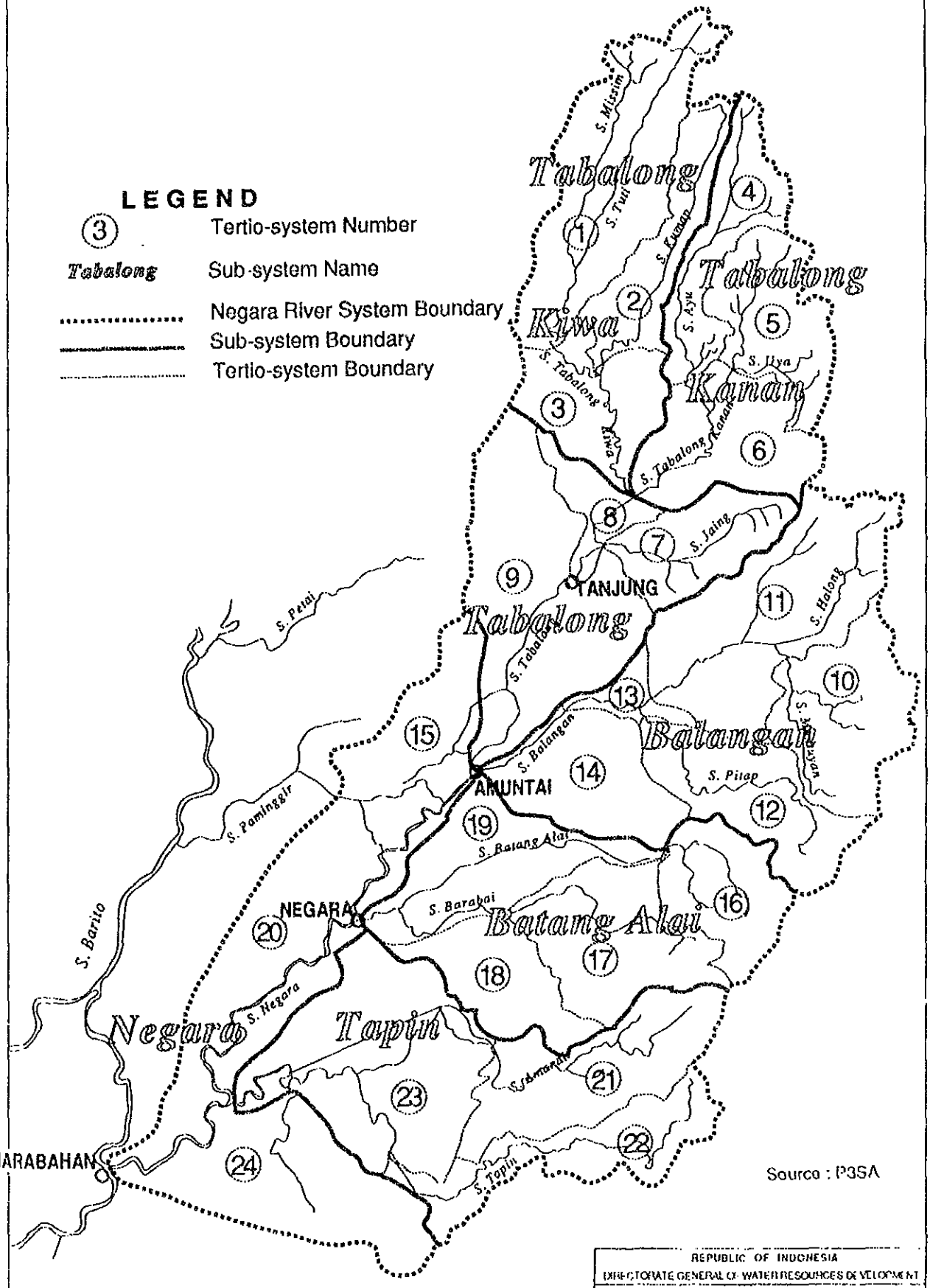

Figure 1.1 Negara River System

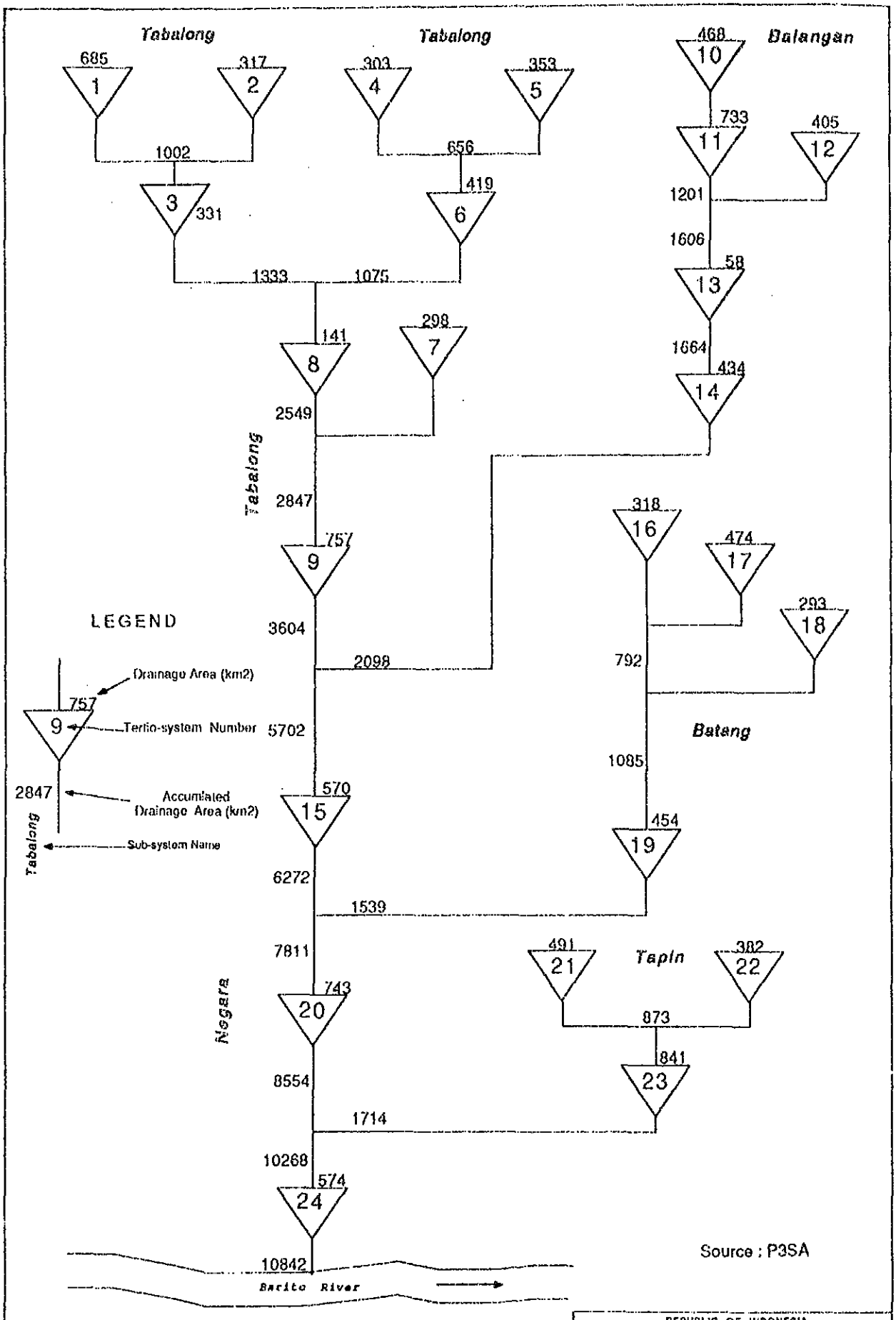

Figure 1.2 Configuration of the Negara River System

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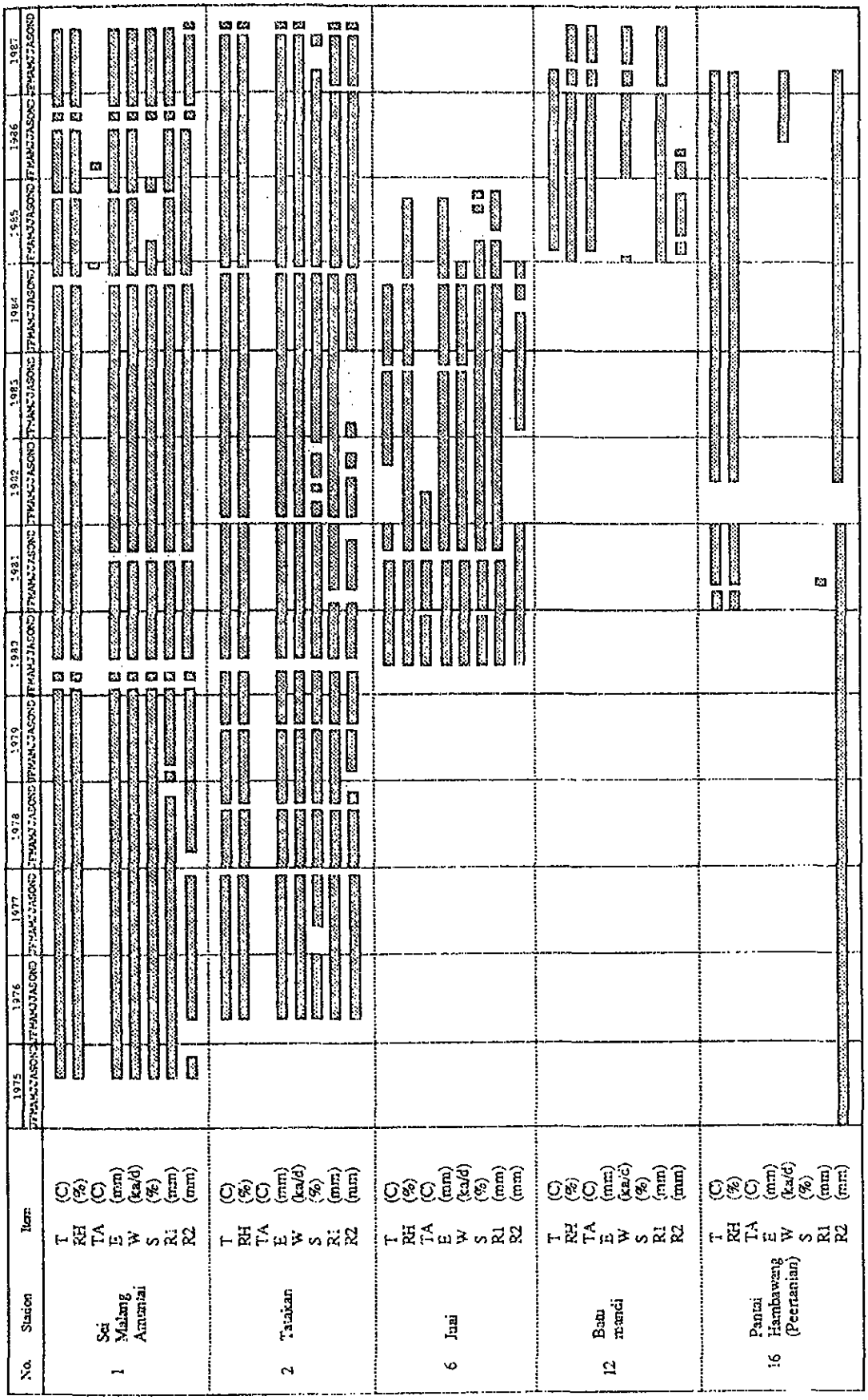

Source : P3SA

Figure 1.3 Available Meteorological Data

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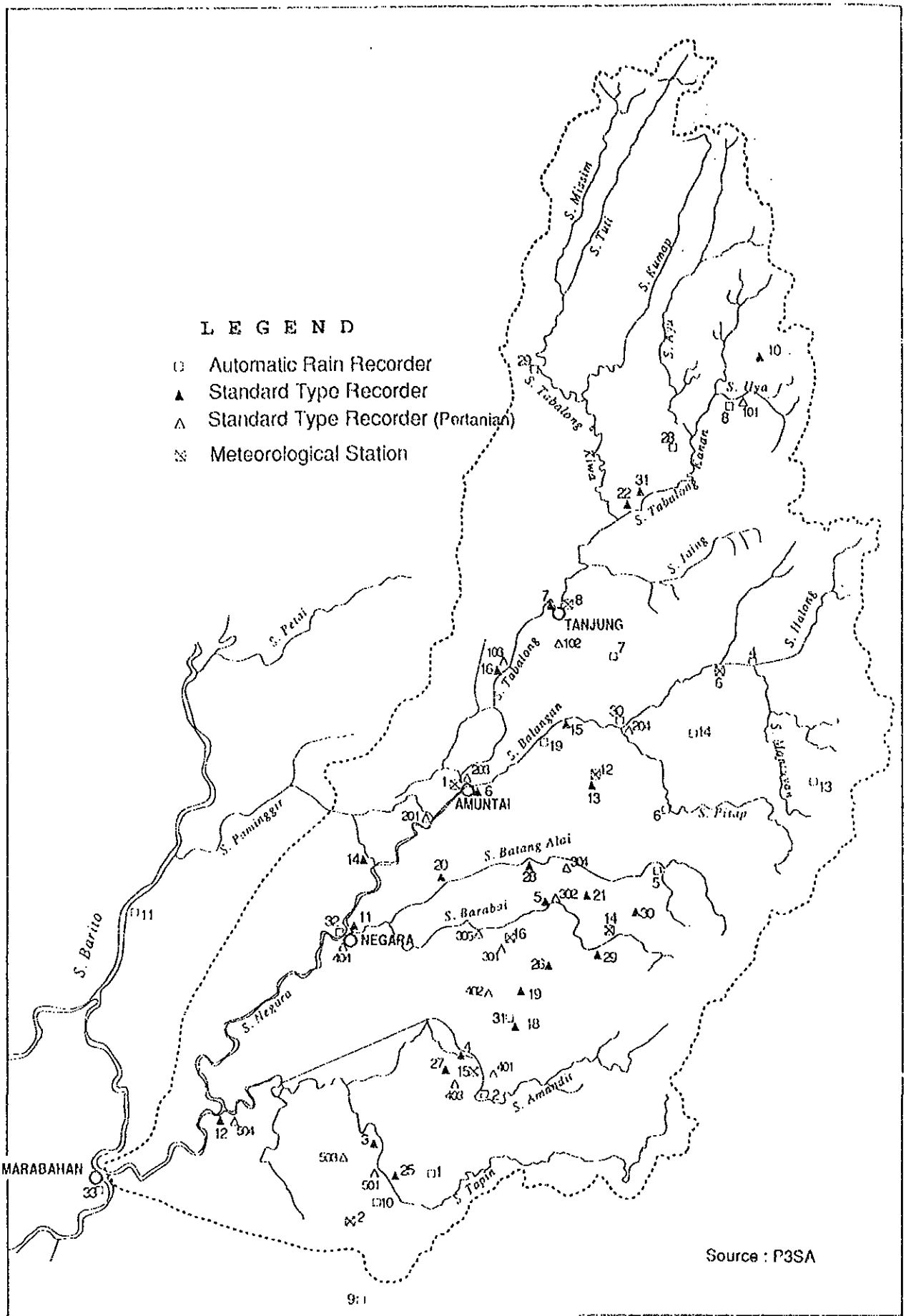

Figure 1.4 Location Map of Meteorological and Rainfall Station

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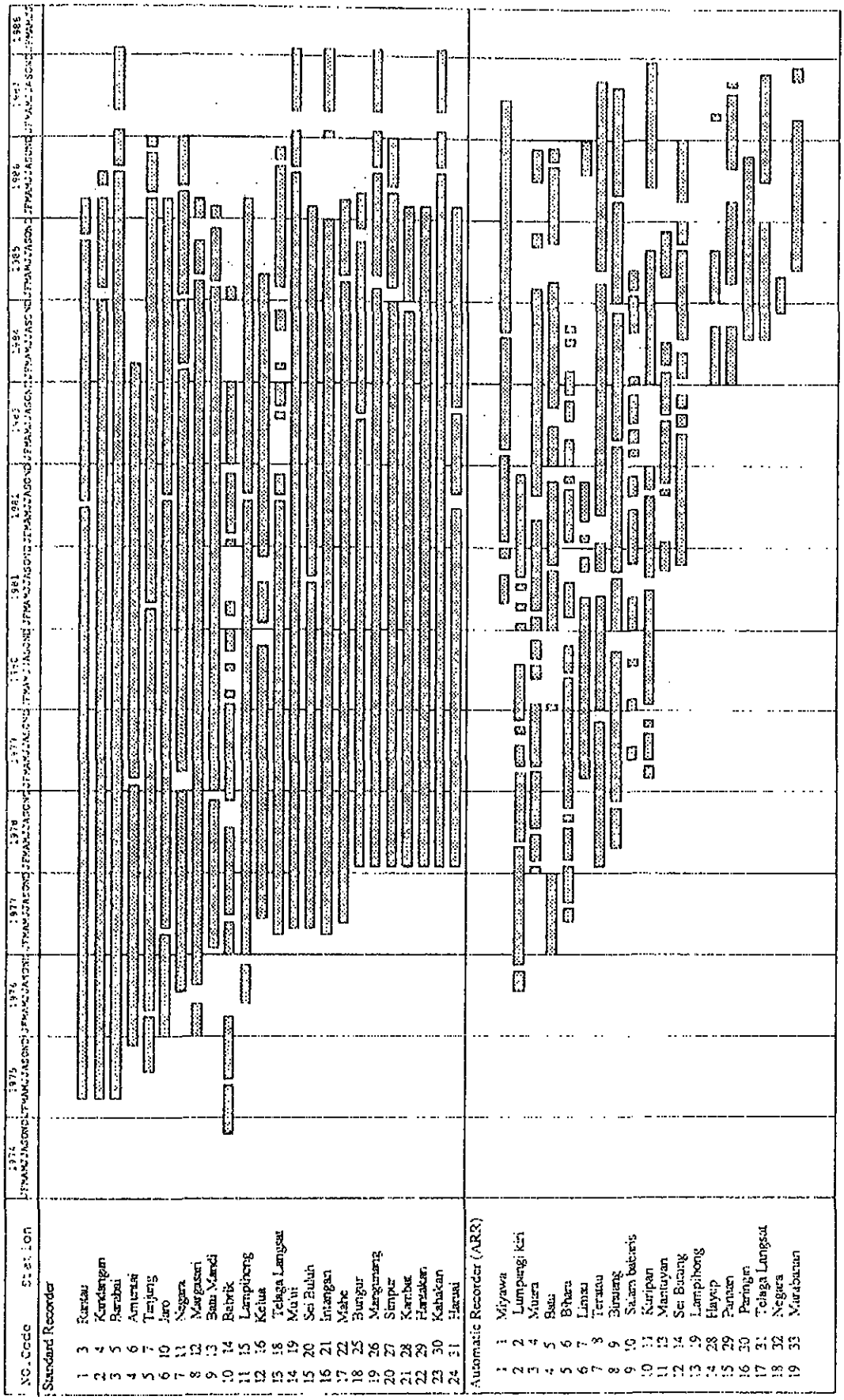

Source : P3SA

Figure 1.5 Available Daily Rainfall Data

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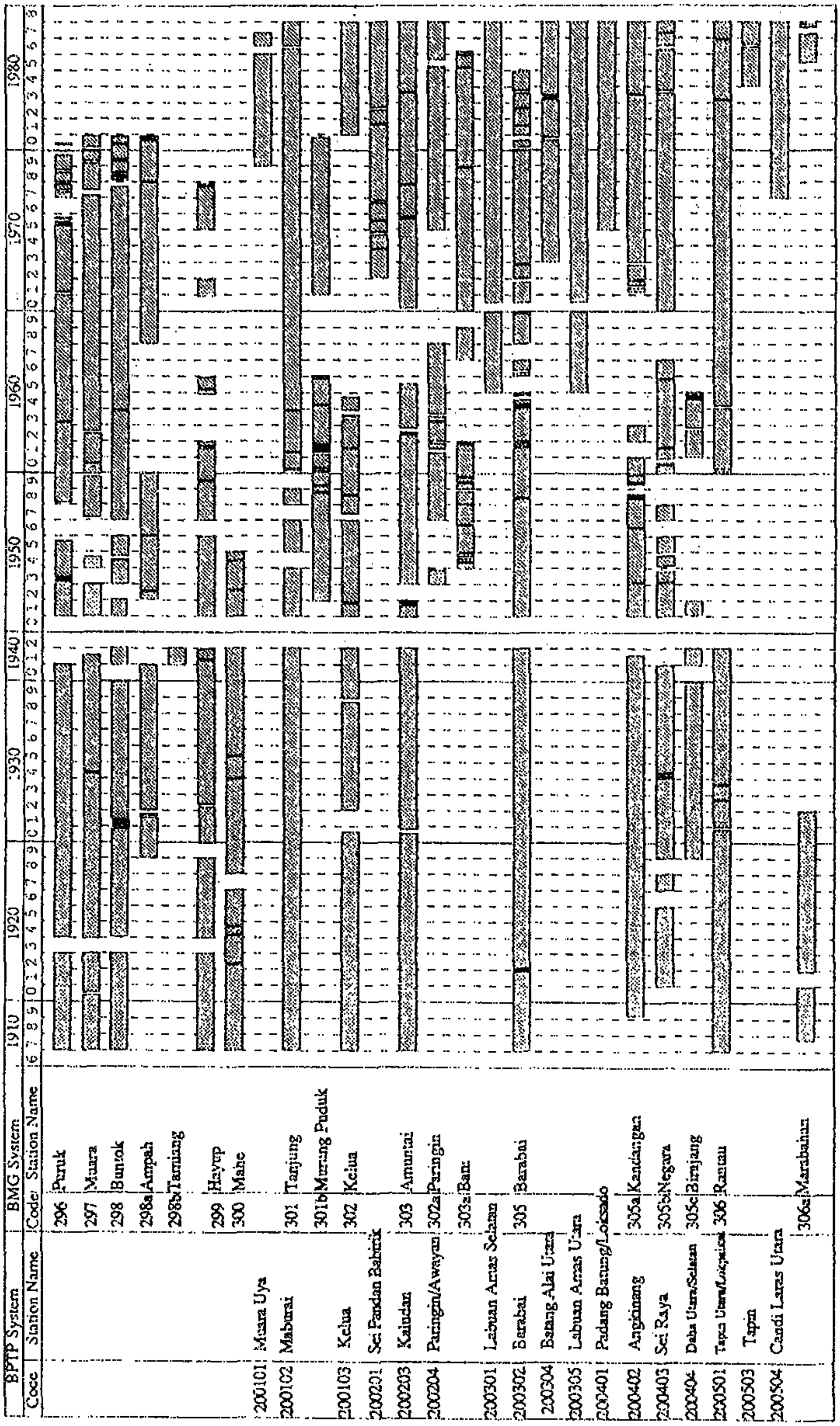

Source : P3SA

Figure 1.6 Available Monthly Rainfall Data

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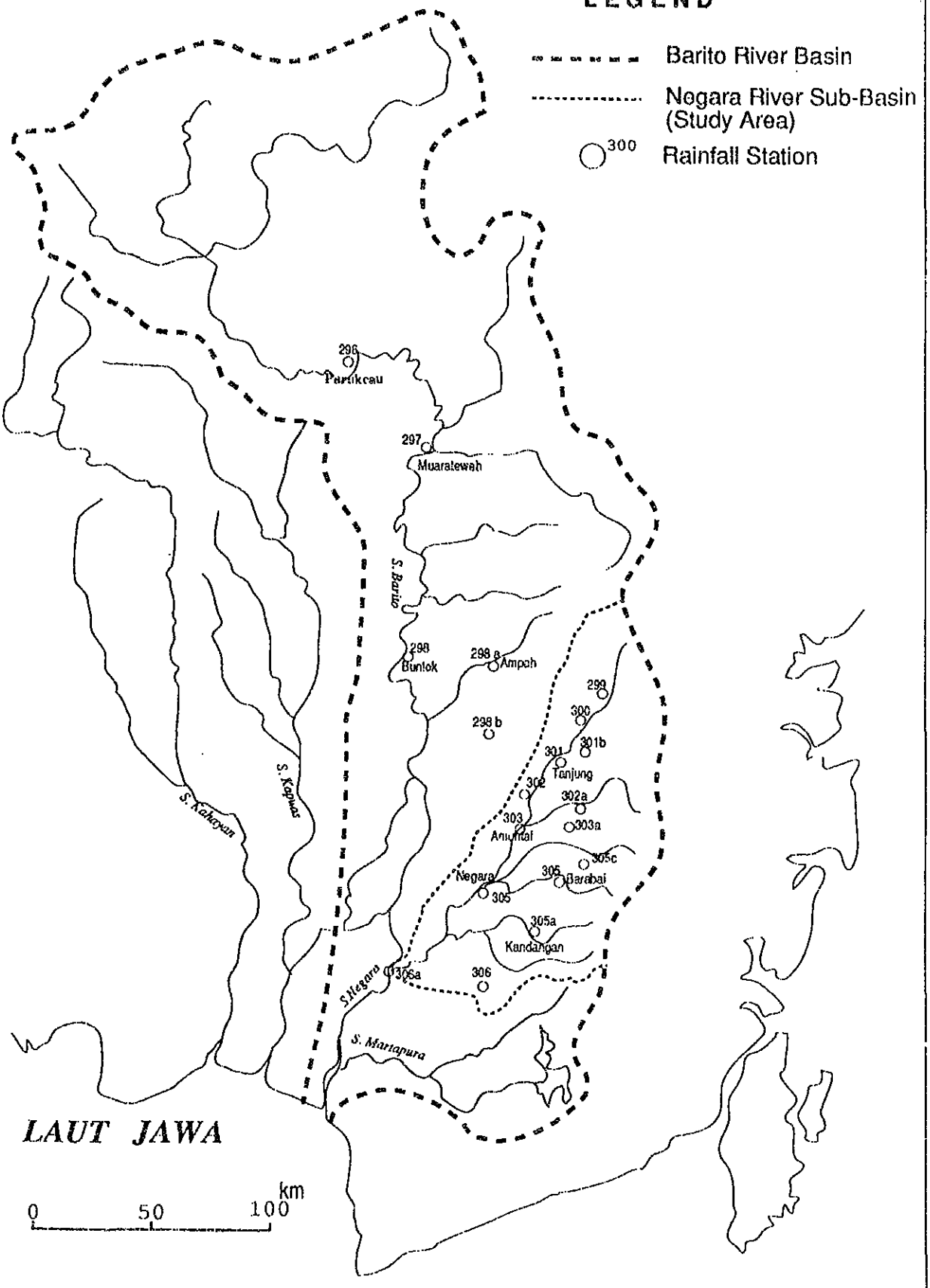

Figure 1.7 Location Map of Rainfall Station

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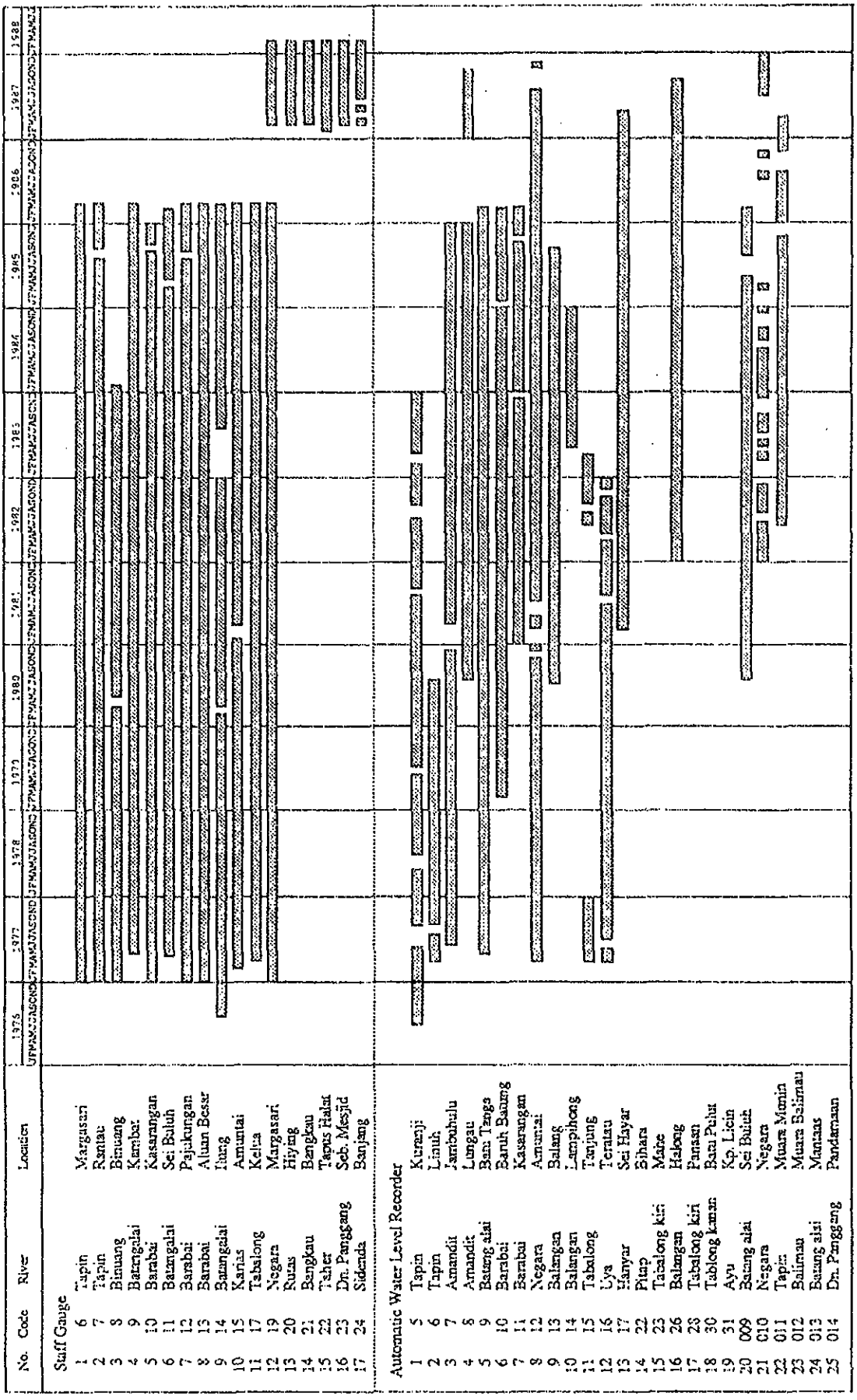

Source : P3SA

Figure 1.8 Available Water Level Records

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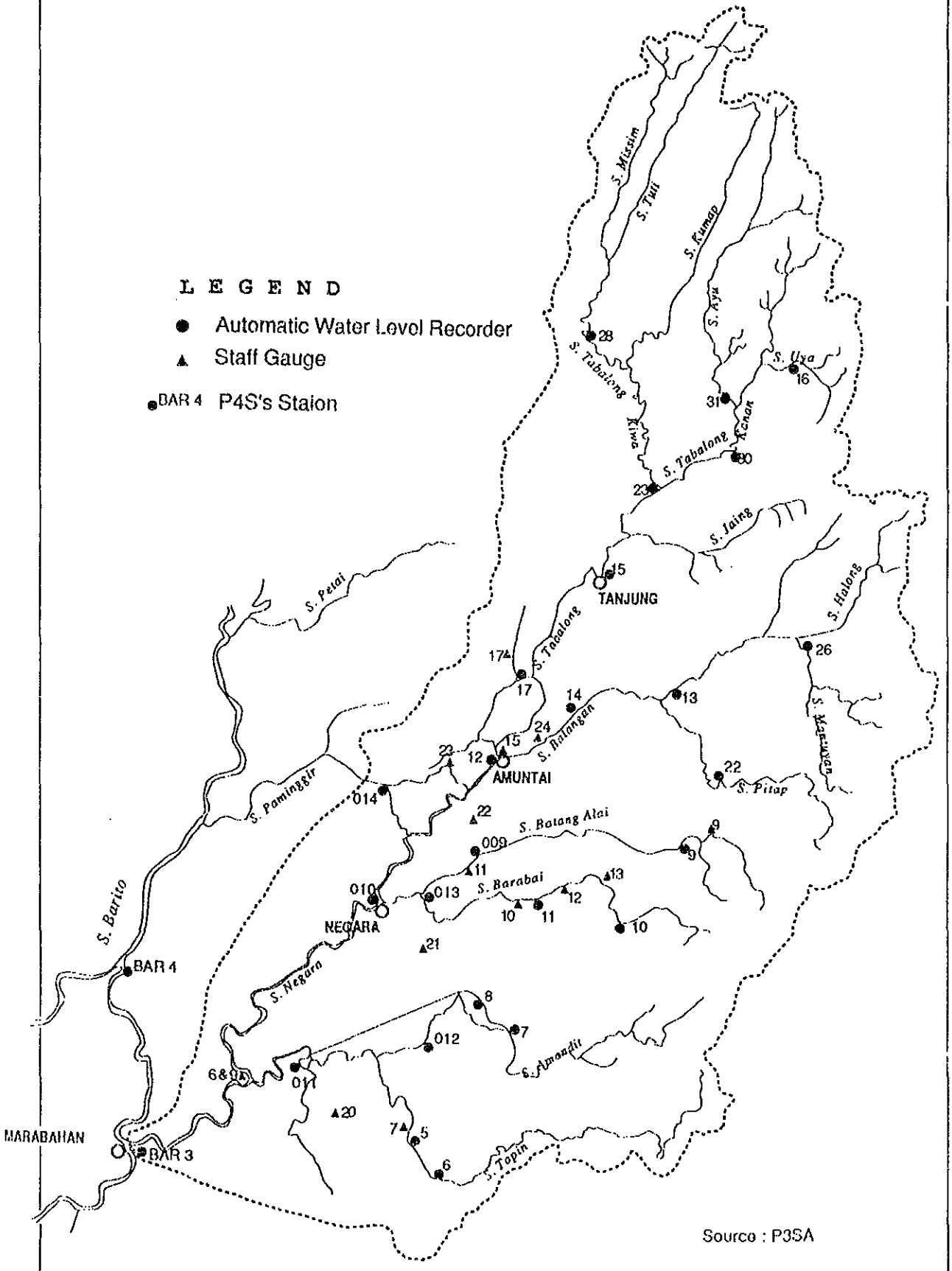

Figure 1.9 Location Map of Water Level Gauging Station

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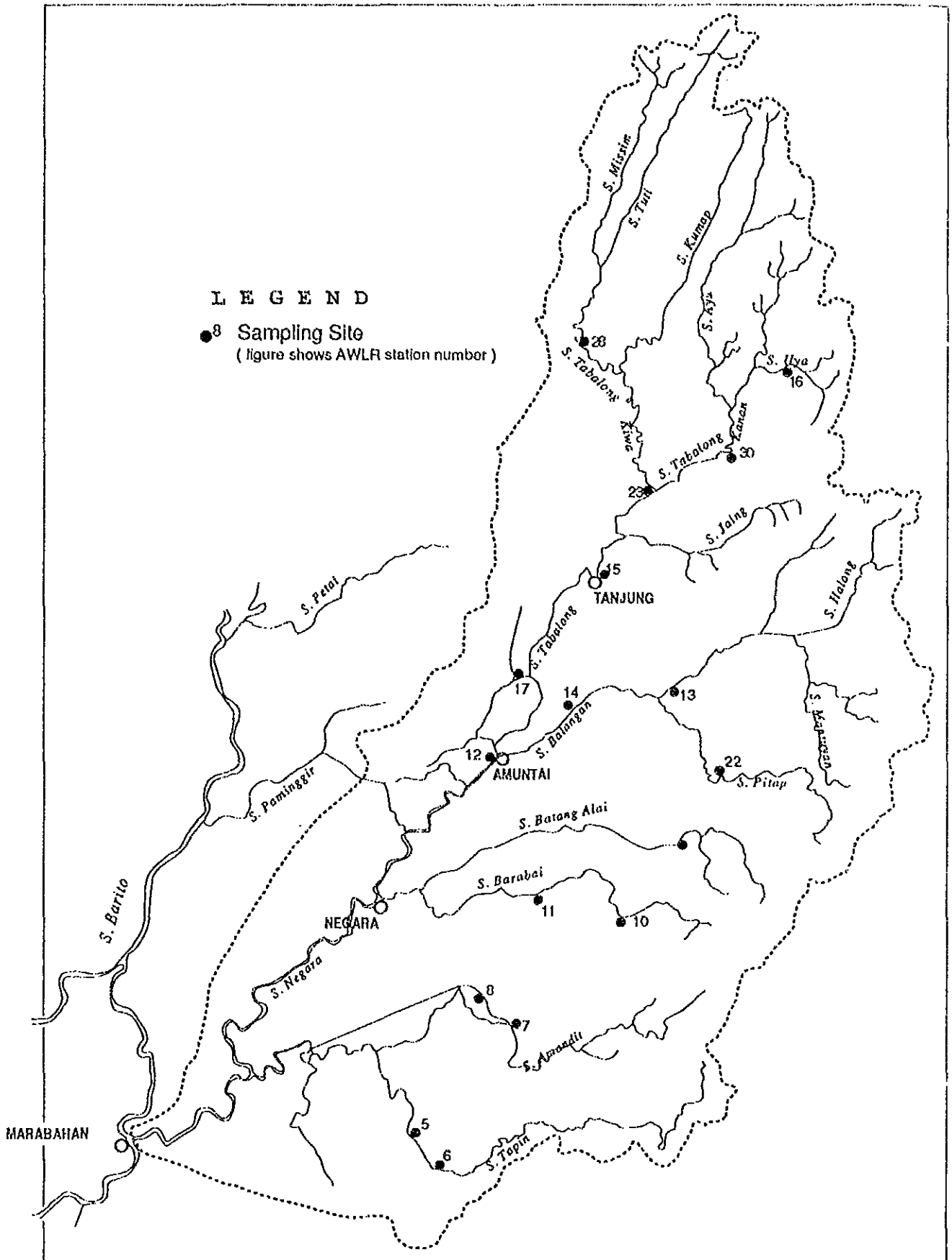

Source : Ref. B-18~B-23

Figure 1.10 Location Map of Sediment Sampling

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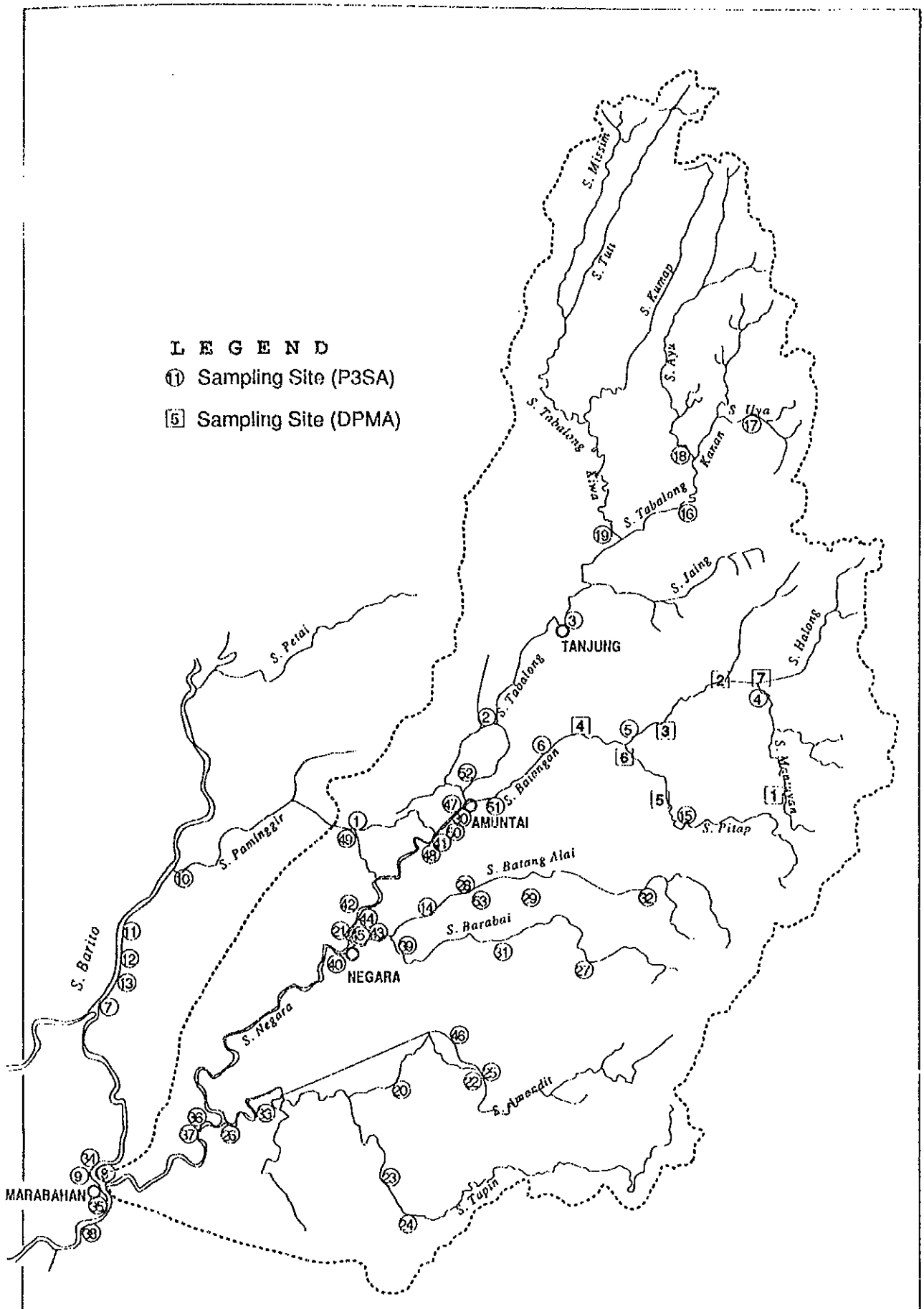

Source : Ref. B-15, P3SA

Figure 1.11 Location Map of Water Quality Sampling

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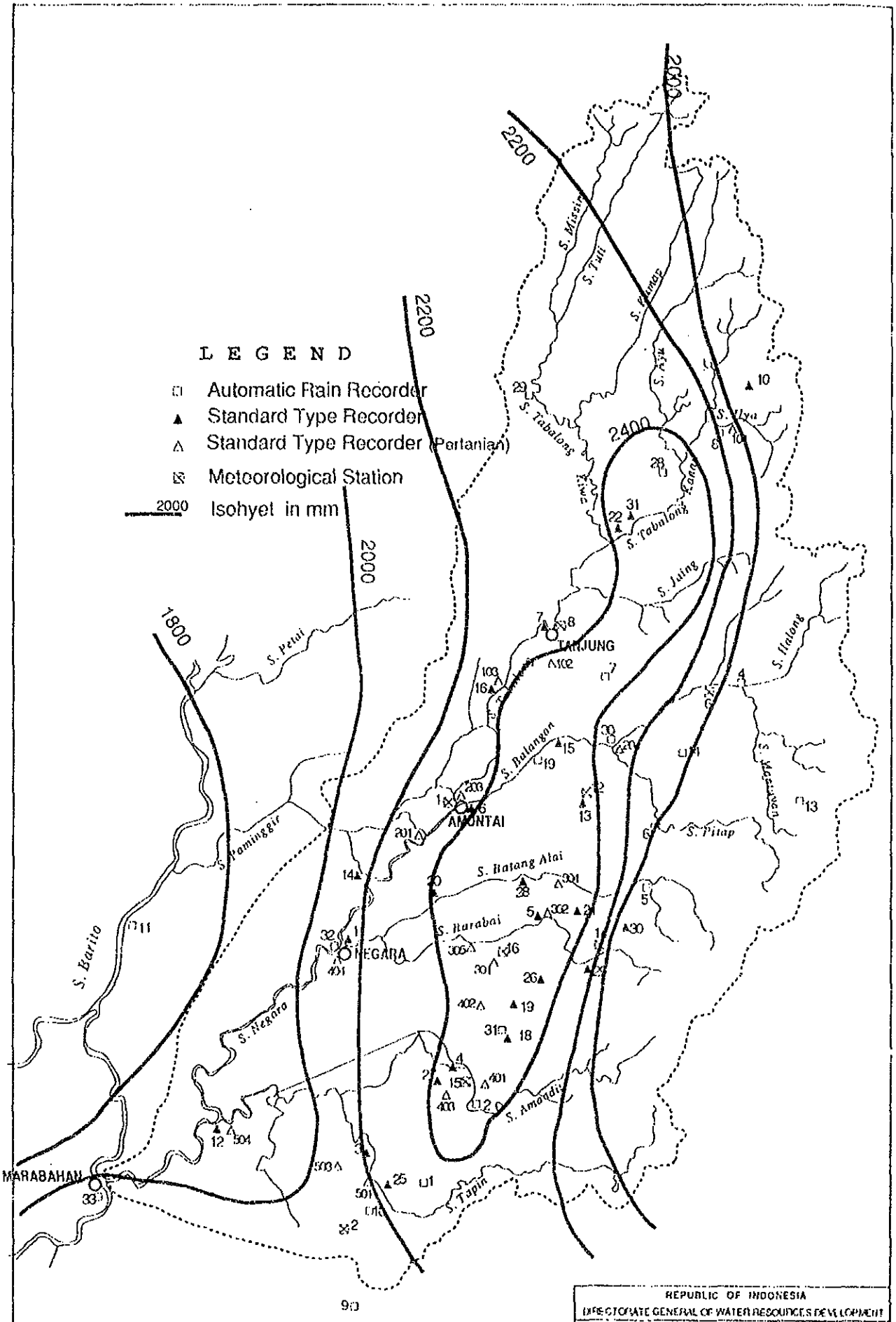

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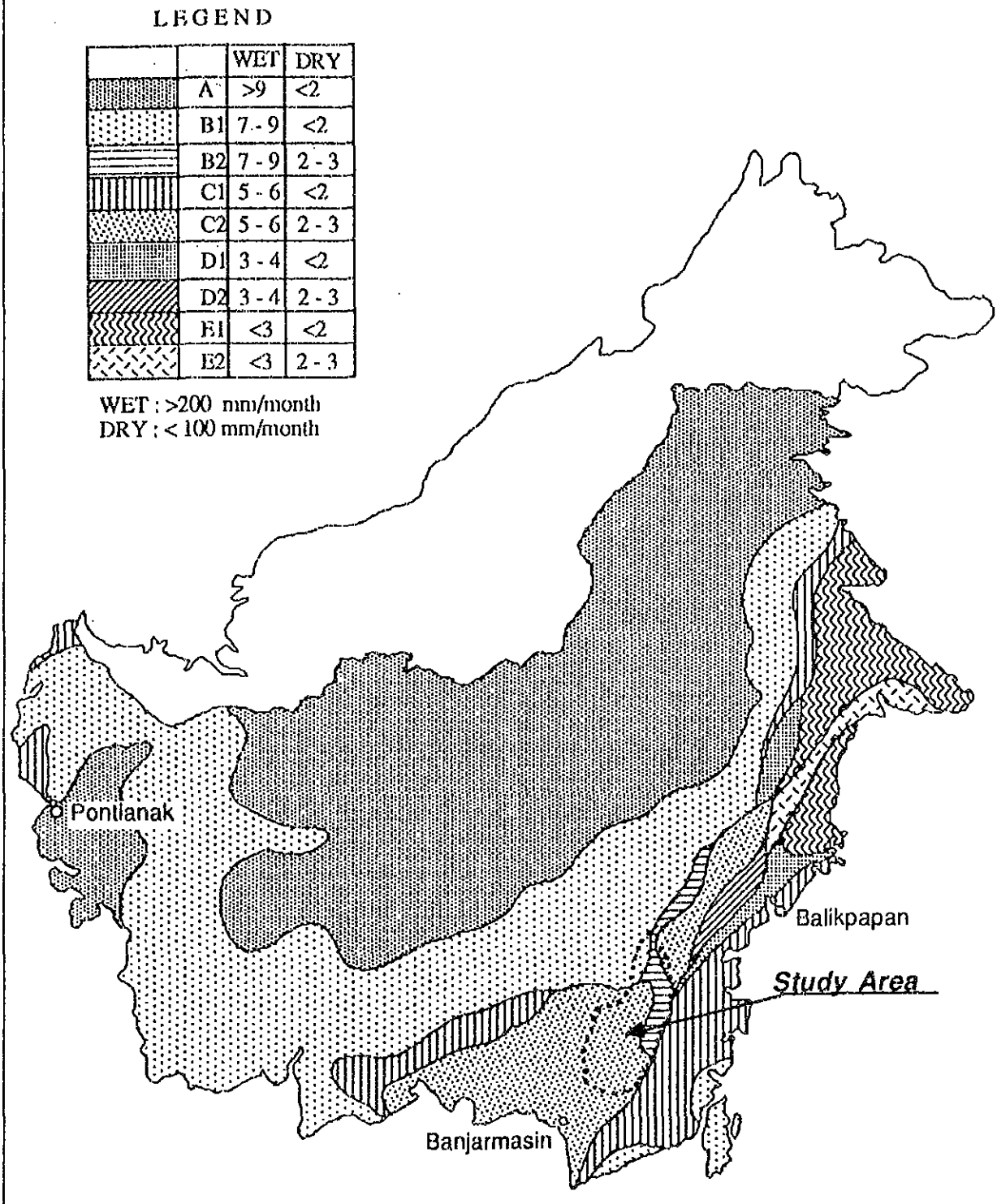
Figure 2.1 Isohyetal Map in the Study Area



Source : Ref. B-23

Figure 2.2 Agroclimatic Zones in Kalimantan

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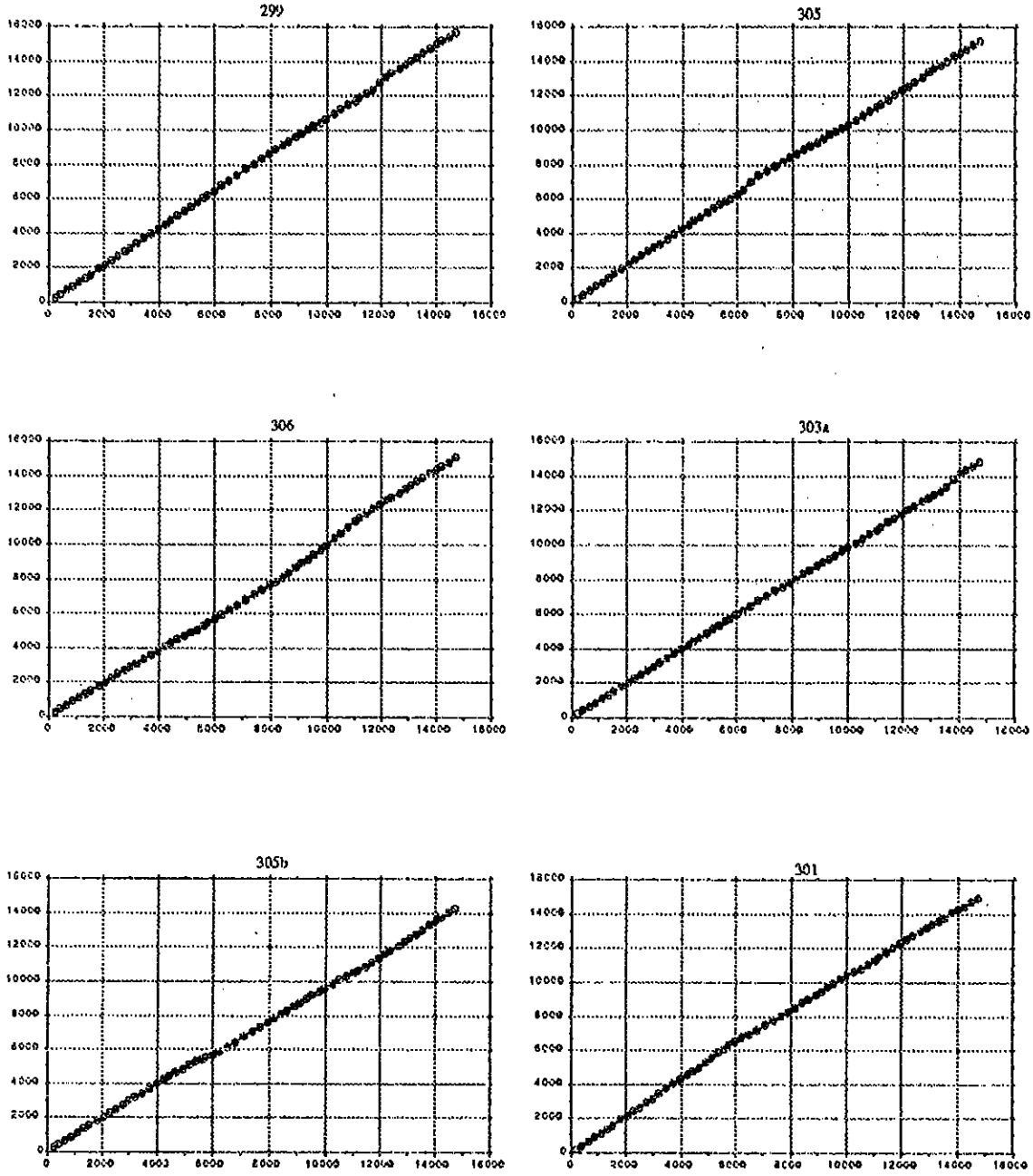

Figure 3.3 Double Mass Curve of Synthetic Monthly Rainfall

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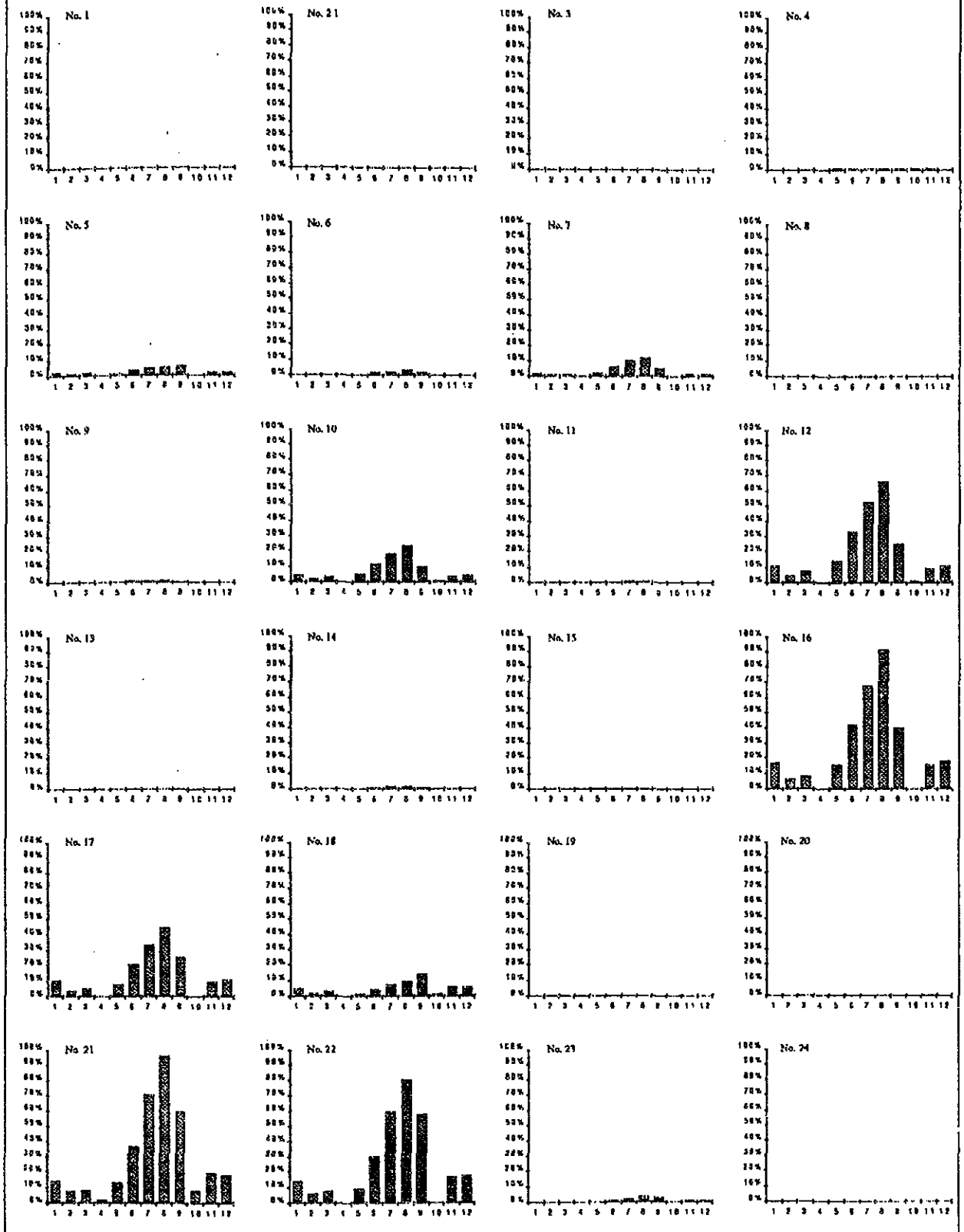

LEGEND

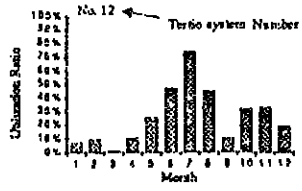

Figure 4.1 Monthly Water Utilization Ratio by Tertio-system in 2018

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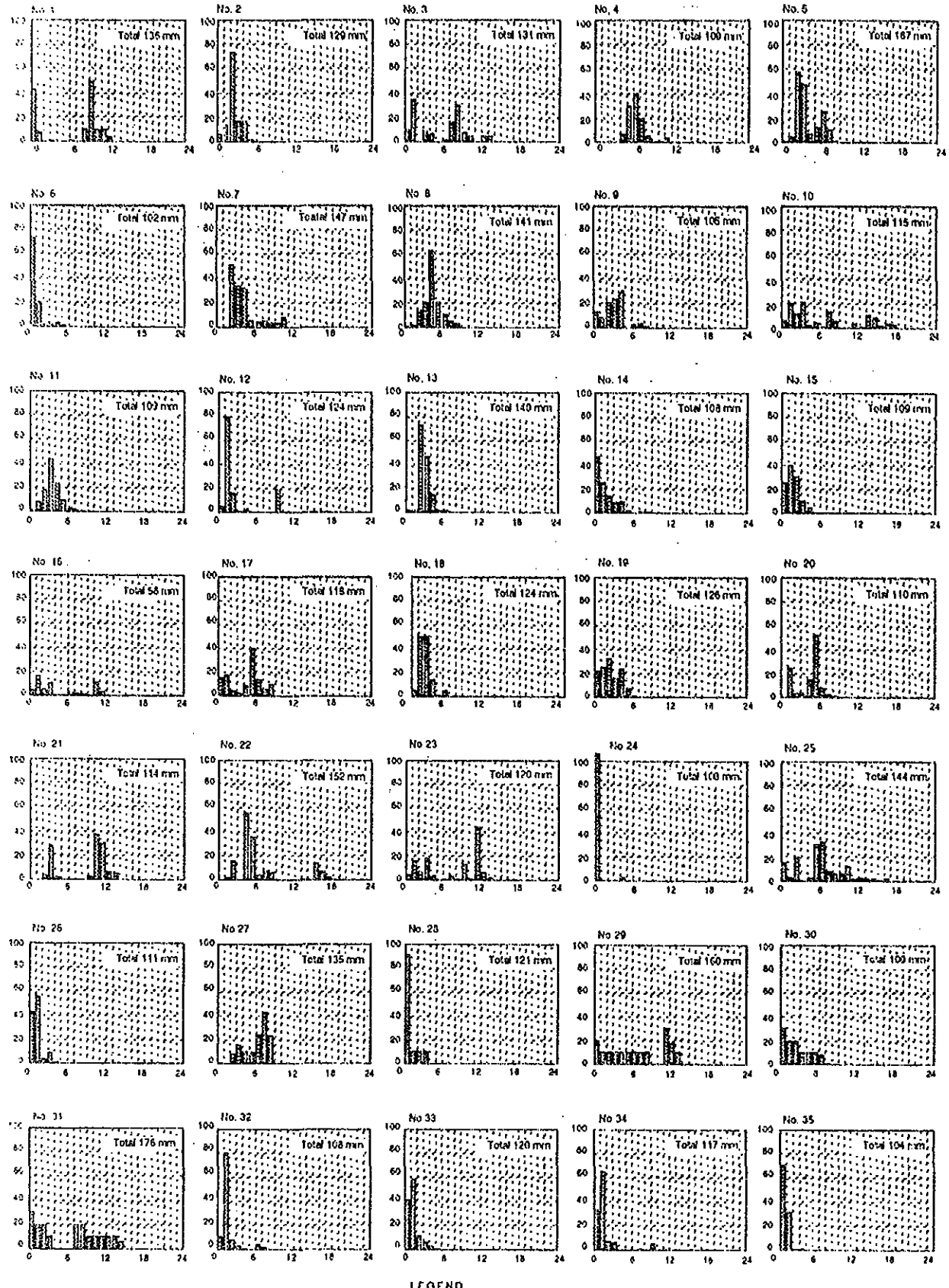

Figure 5.2 Rainfall Pattern

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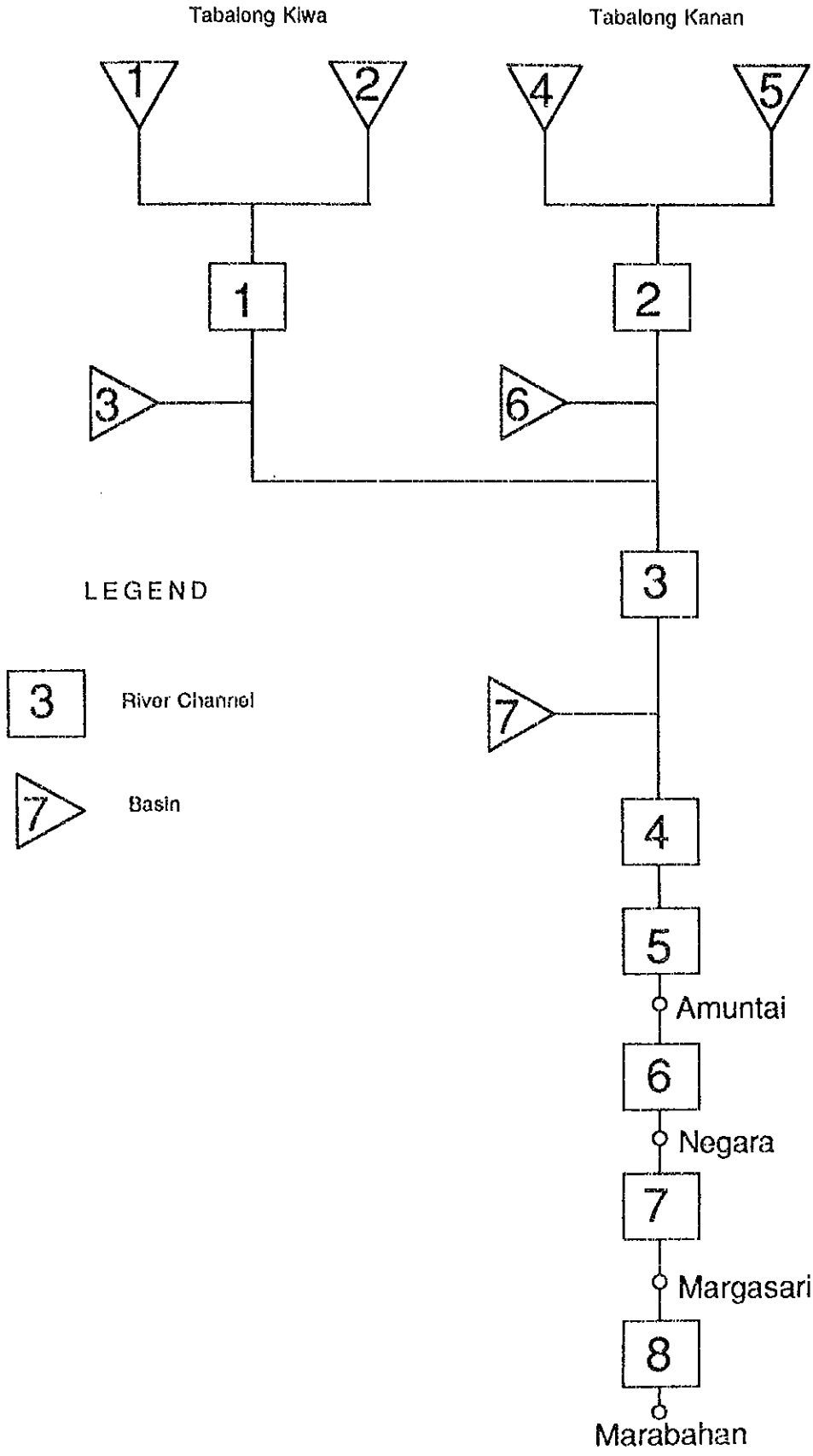

Figure 5.7 Negara River System

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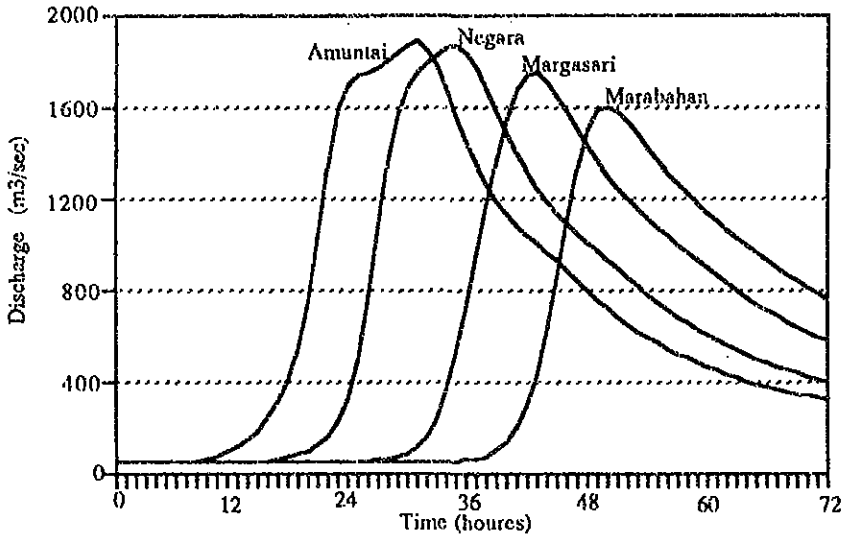

Figure 5.8 Flood Hydrograph (100 years probability)

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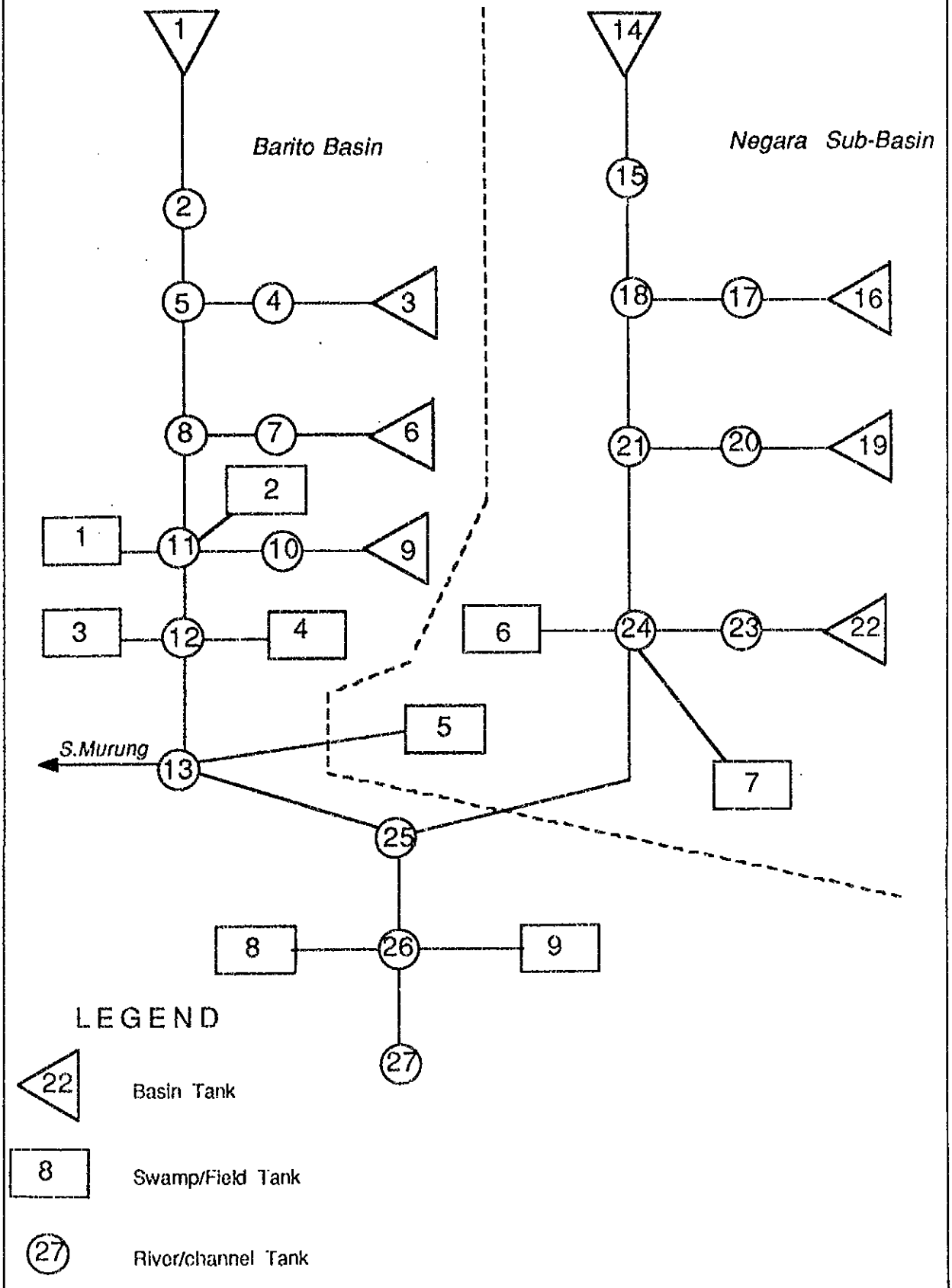

Figure 6.1 Barito River System

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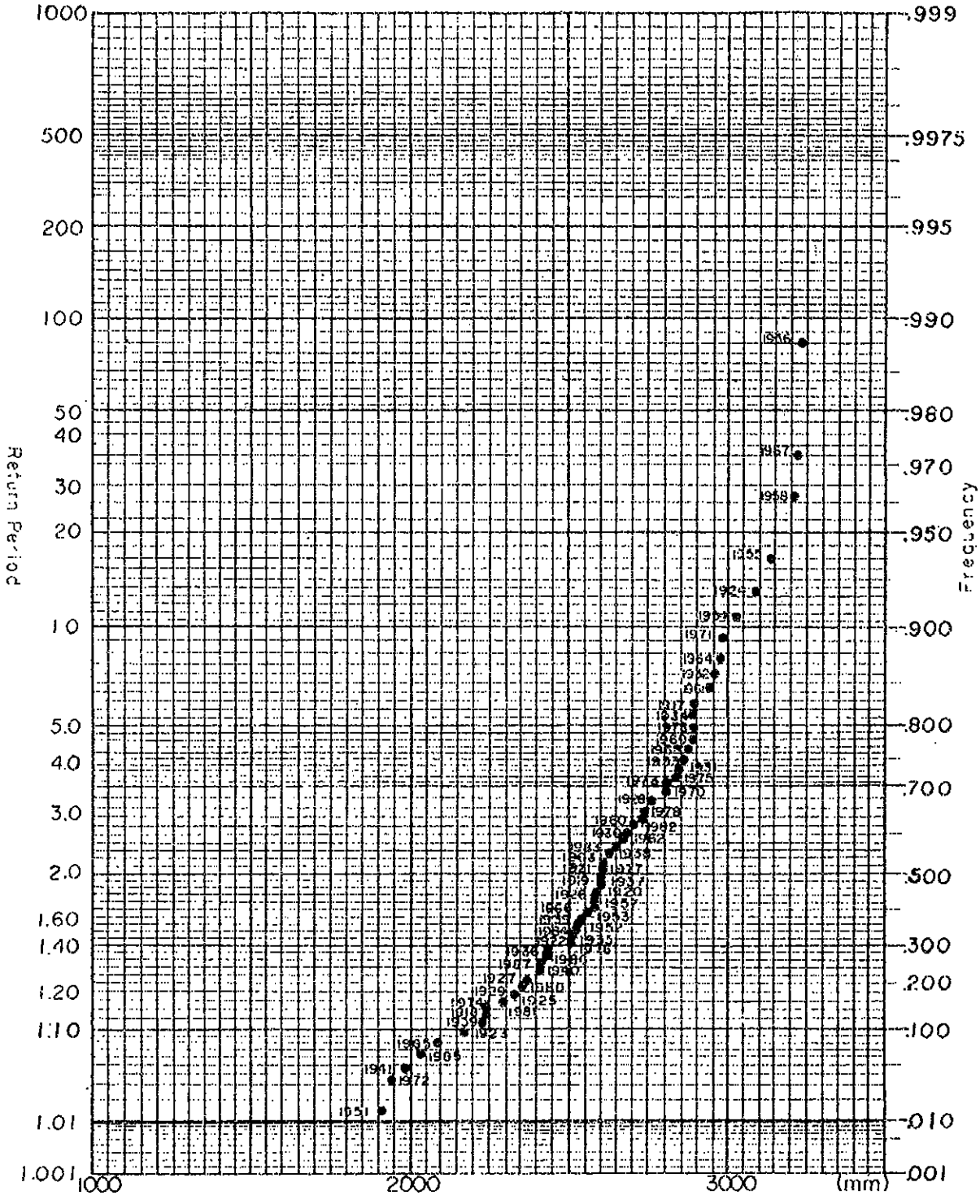

Figure 6.2 Probability of Annual Mean Rainfall

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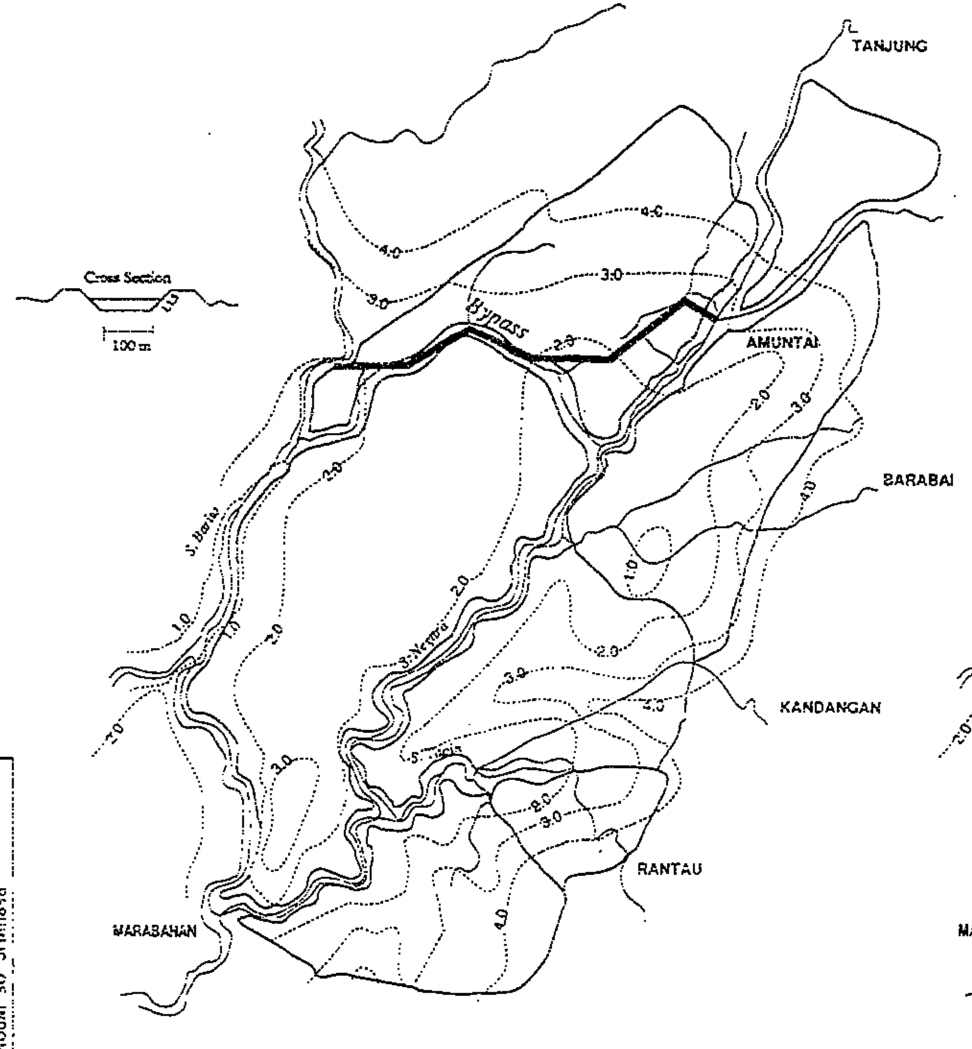
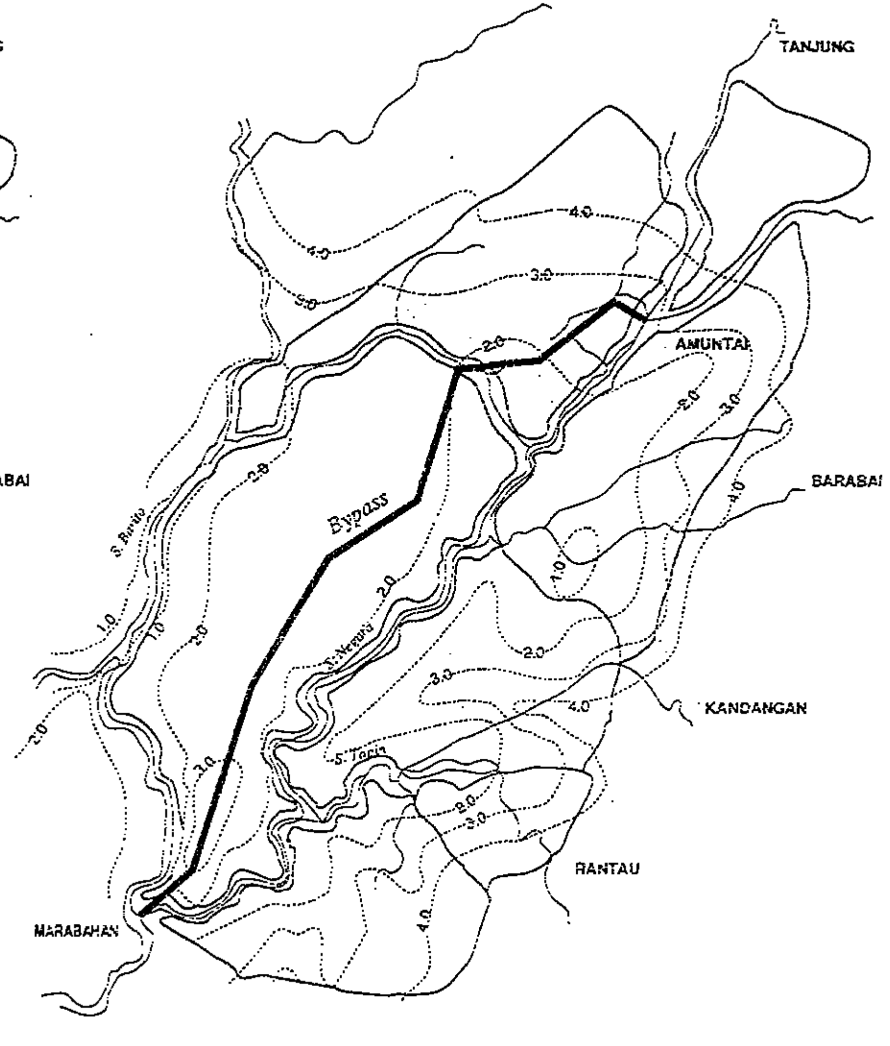


Fgure 6.3 Location of Bypass Channel Case 2



Fgure 6.4 Location of Bypass Channel Case 3

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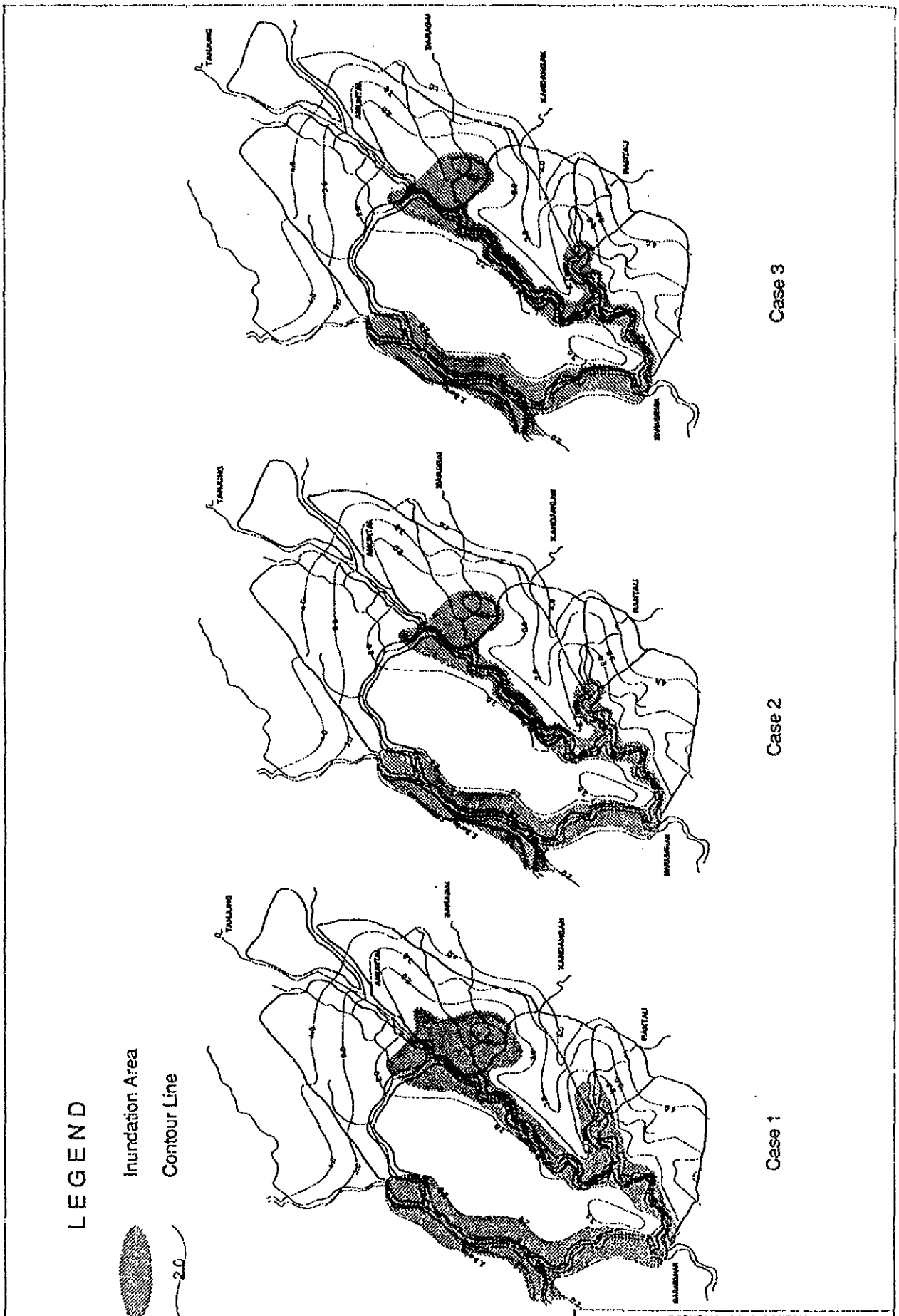
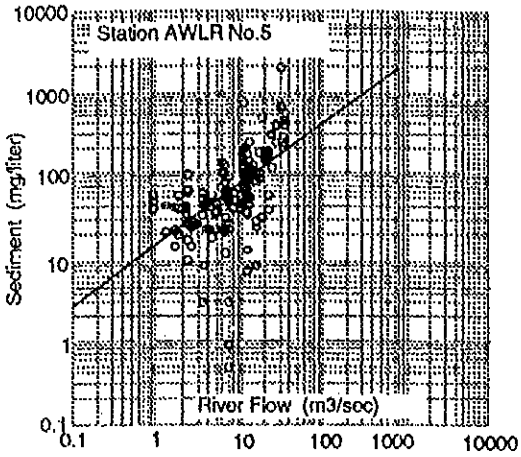
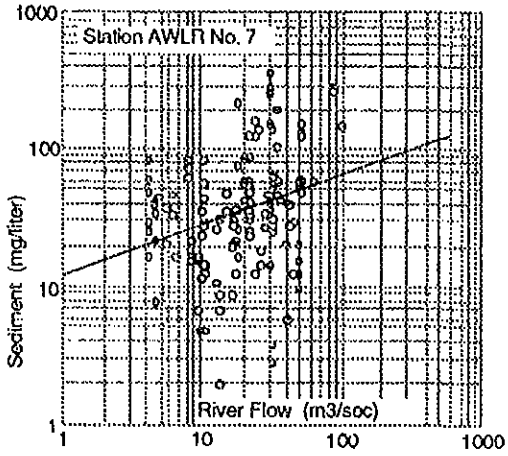
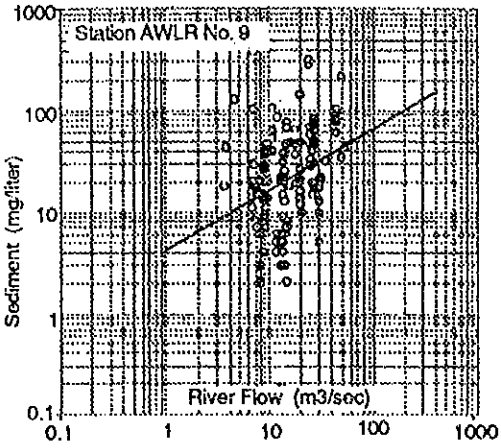
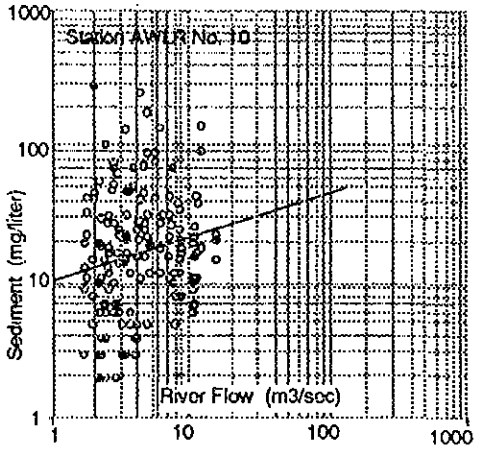


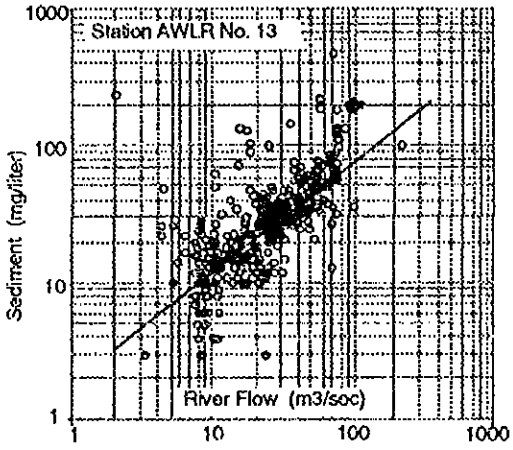
Figure 6.5 Estimated Inundation Area under Three Cases

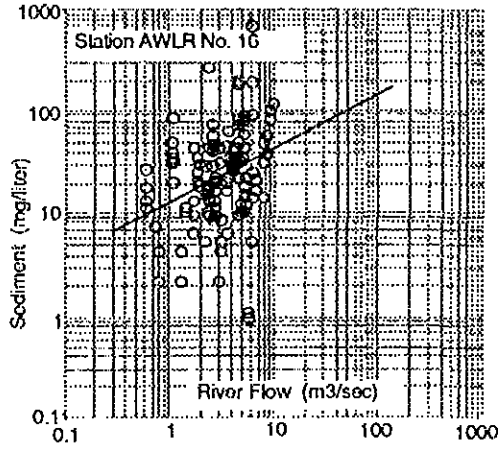












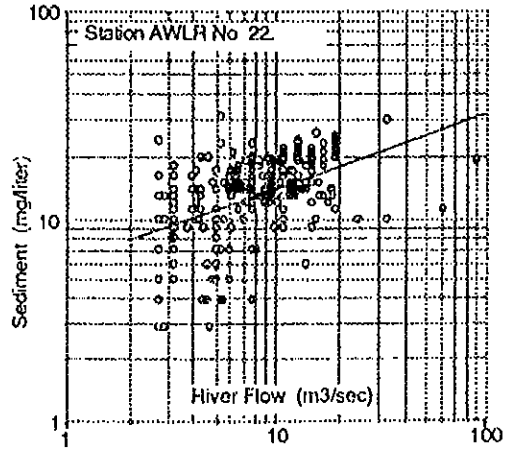


Figure 7.1 Sediment Rating Curve

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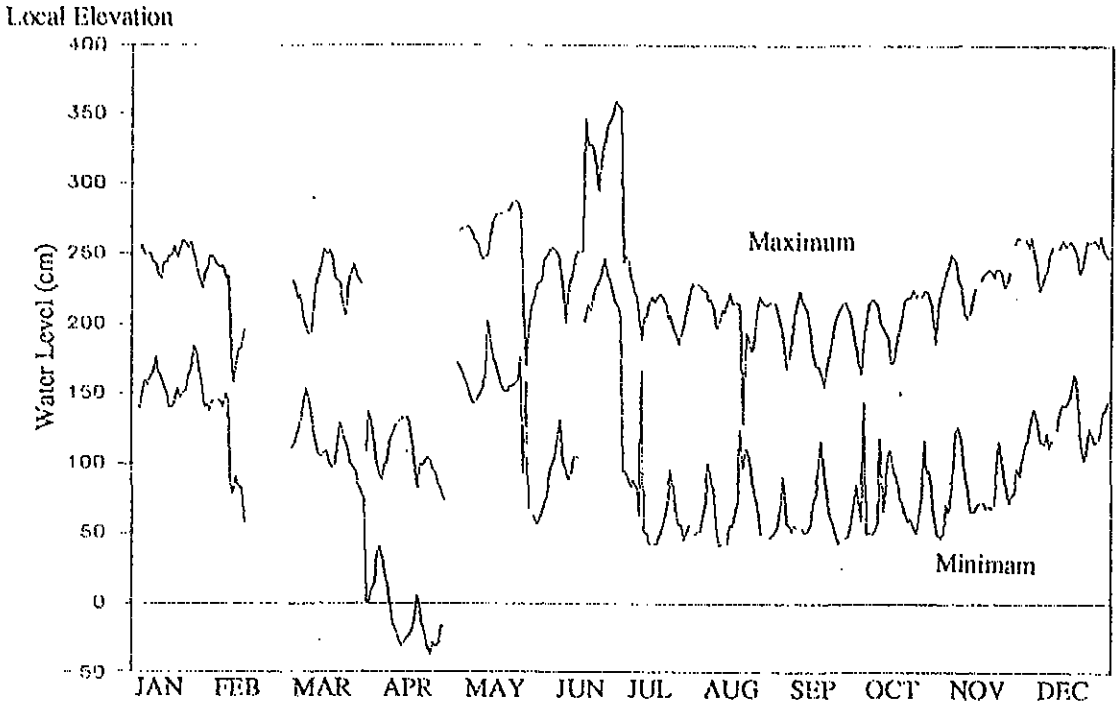

Figure 8.1 Daily Maximum and Minimum Water Level at Marabahan in 1980

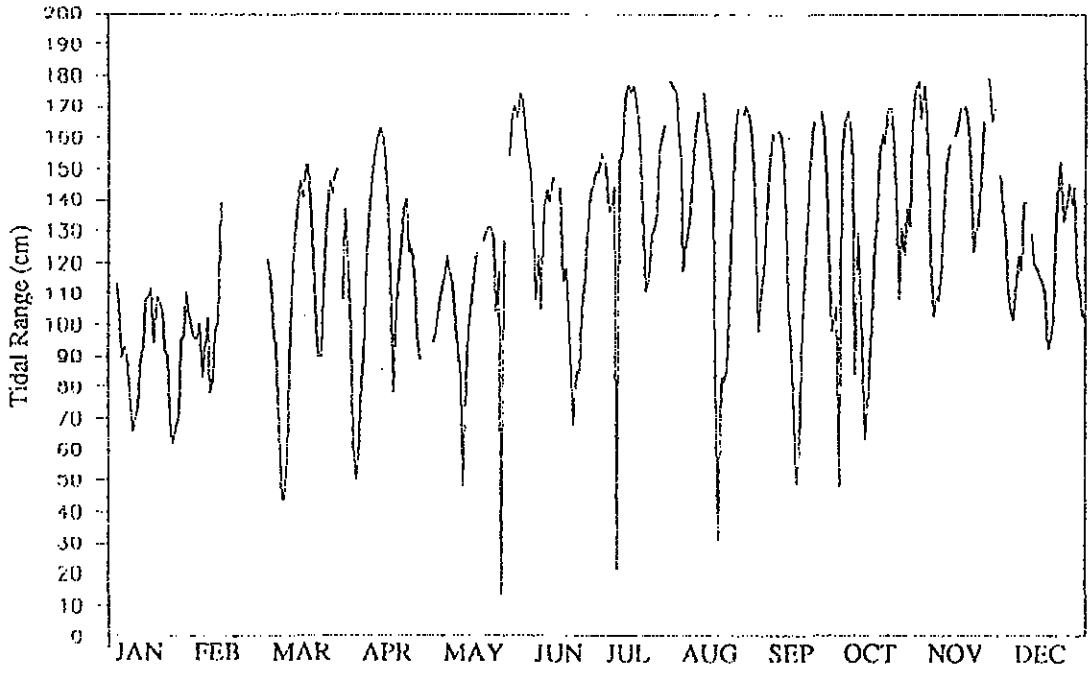

Figure 8.2 Daily Tidal Range at Marabahan in 1980

Source: P4S

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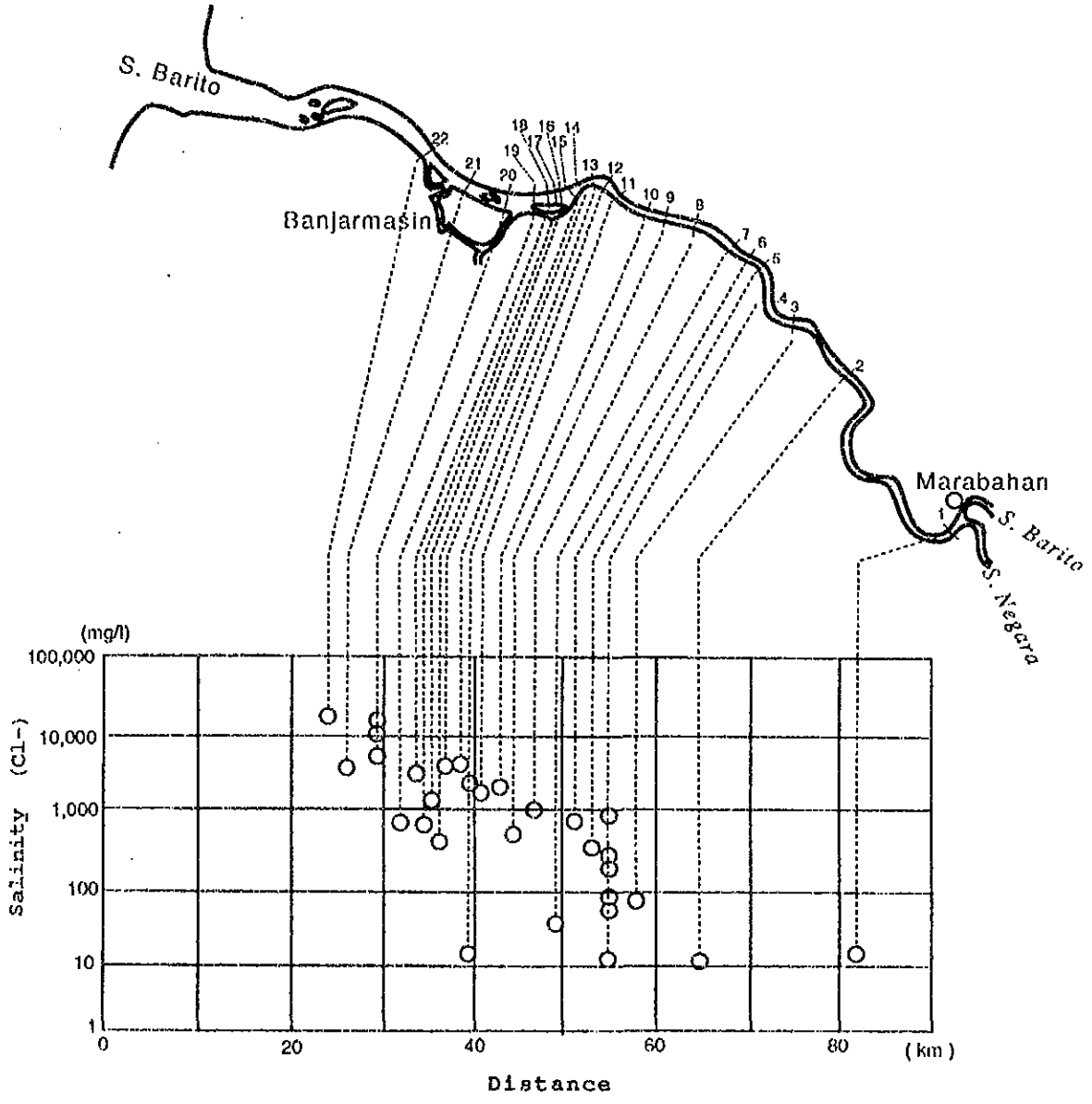

Source : Ref. B-13

Figure 8.3 Profile of Salinity Condition along the Barito River

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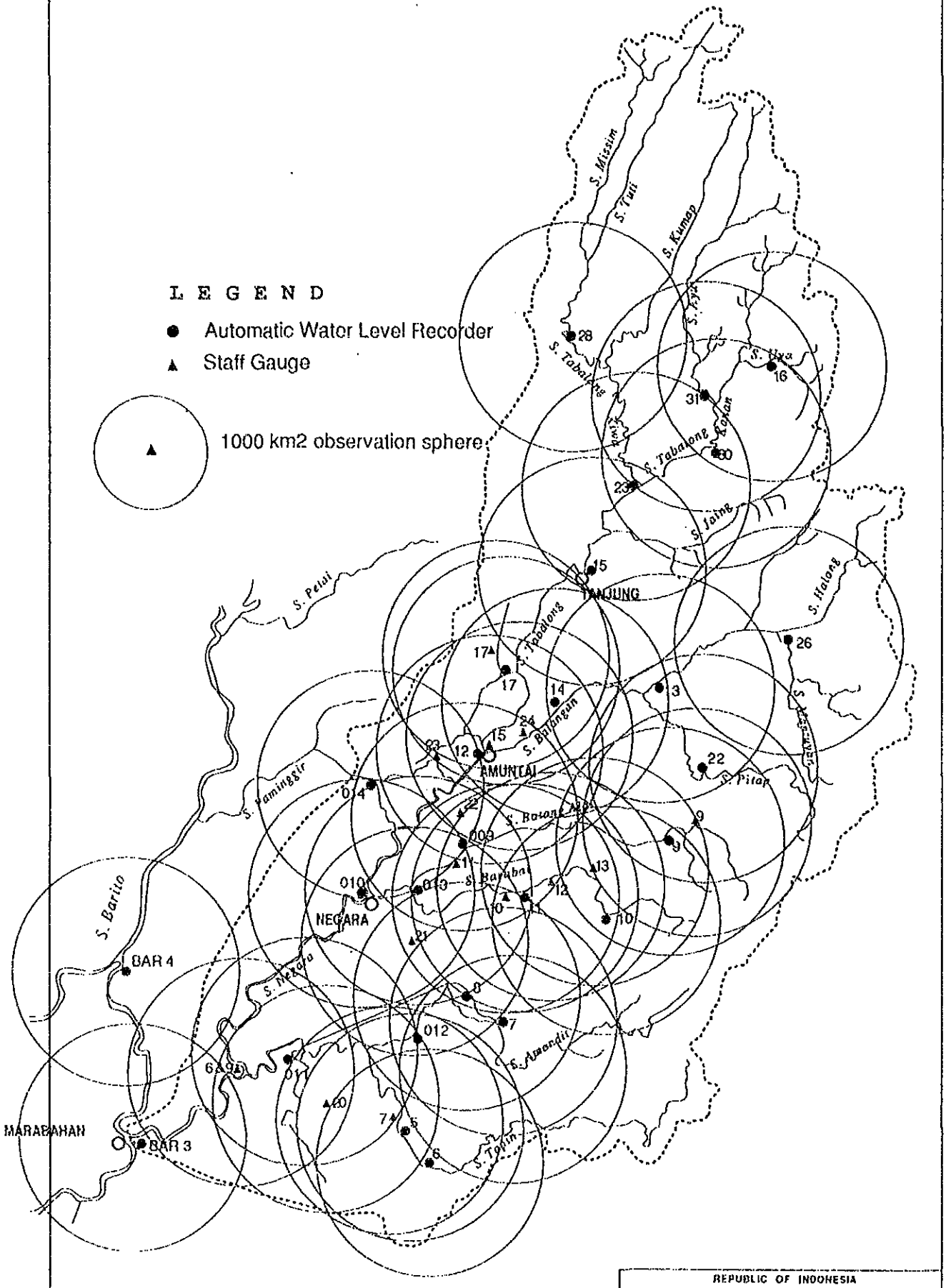

Figure 9.1 Present Observation Sphere of Water Level Gauging Station

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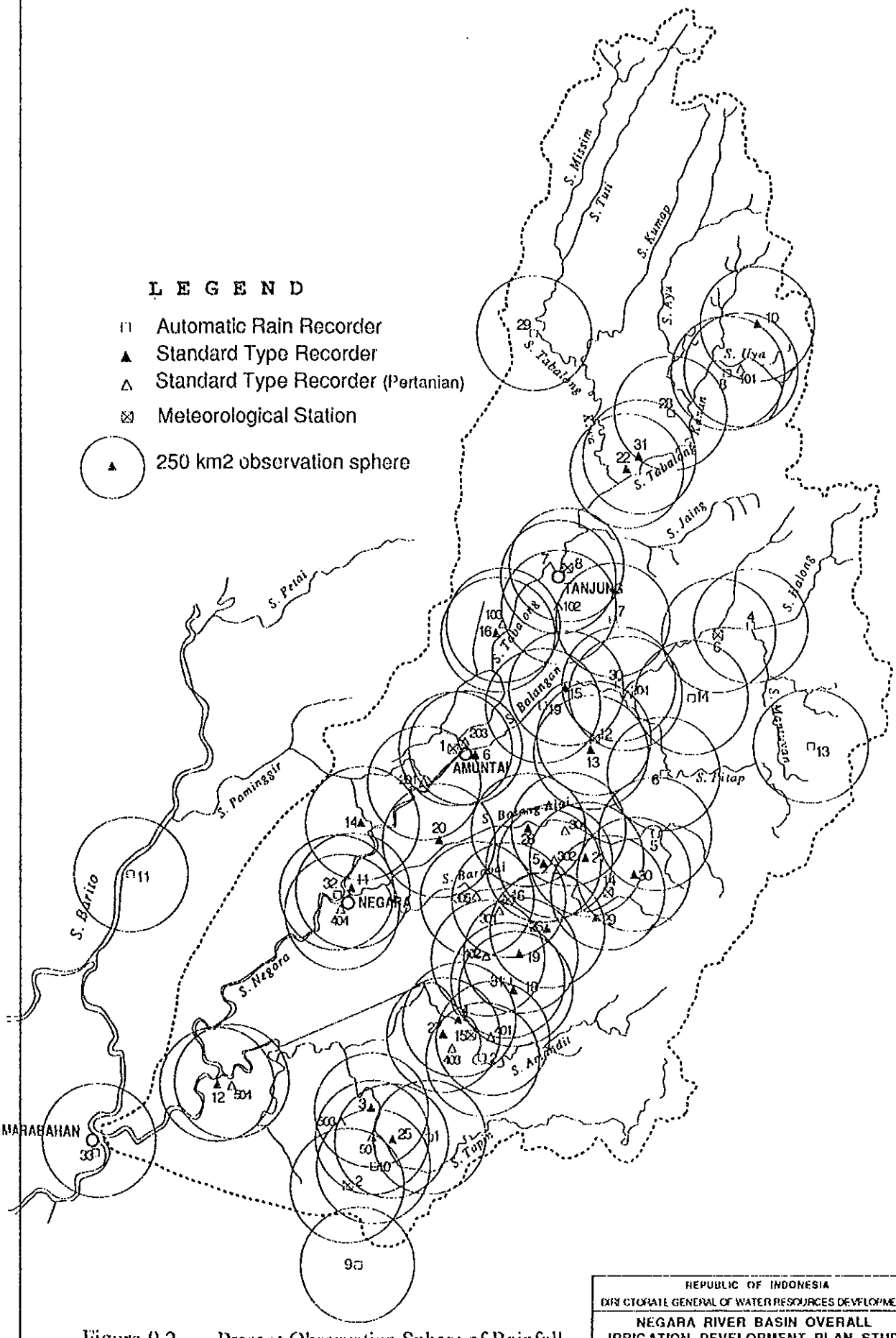

Figure 9.2 Present Observation Sphere of Rainfall Station

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APPENDIX

Appendix

Tank Model for Inundation Simulation

Contents

Figures

Appendix Tank Model for Inundation Simulation

1. General

This appendix describe the how to simulate the condition in lowland area by using tank model method developed by Japan Institute of Irrigation and Drainage[1/]. In this method, the area (Study area) is divided into some basin tanks and some river channel tanks. The hydraulic phenomena in the series of channel tank is solved by using varied flow formula and flow formula for over a broad-crested weir is applied to solve flow condition between a basin tank and a river tank.

For instance, the low of continuity for the model (See Figure 1) established following equation.

$$\frac{dV_j}{dt} = Q_i - Q_j$$

or using mean value of at the time of n and n+1, above equation may be written

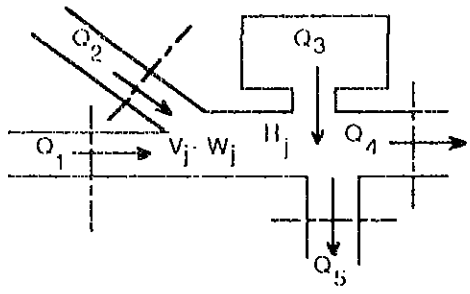

Figure 1 Flow of Water

$$\frac{A_j^{n+1} + A_j^n}{2} \cdot \frac{H_j^{n+1} + H_j^n}{dt} = \frac{Q_i^{n+1} + Q_i^n}{2} - \frac{Q_j^{n+1} - Q_j^n}{2} \quad \cdots\cdots\cdots\cdots \quad (a)$$

$$Q_i = Q_1 + Q_2 + Q_3$$

$$Q_j = Q_4 + Q_5$$

where V_j : storage volume of river tank j, A_j : water surface area of river tank j, H_j : water surface elevation of river tank j, Q_j : in flow to the river tank j, Q_j : out flow from the river tank j, dt : time of unit and n : time (n+1 = n+dt).

If in flow and out flow volume are known, water level of the tank can be calculated. The inflow and outflow may obtained by applying appropriate flow formula (uniform flow, varied flow, flow over weir etc.).

Then the water levels of tanks can be calculated by solving Eq (a) and flow formulas simultaneously. This is flood analysis of low land by tank model. Following section gives the explanation of application of those flow formulas and formulation of simultaneous equation.

To perform those calculation, rather big electronic computer is indispensable tool.

1/ Ref. B-29.

2. Flow between a Basin Tank and a River Tank

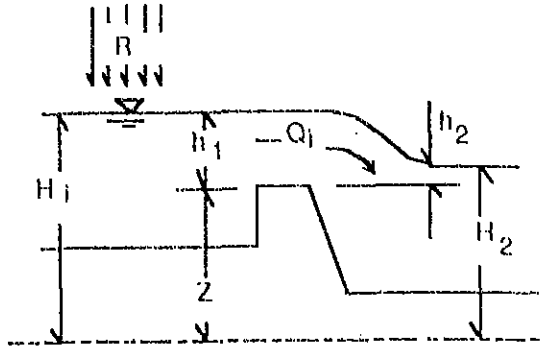

Figure 2 Flow from Basin Tank

1) Fundamental equation

The law of flow continuity gives:

$$W\frac{H_i^{n+1} + H_i^n}{dt} = WR - \frac{Q_i^{n+1} + Q_i^n}{2}$$

or,

$$Q_i^{n+1} = -\frac{2W}{dt} \cdot H_i^{n+1} + \left(\frac{2W}{dt} \cdot H_i^n - Q_i^n + 2WR\right) \quad \cdots\cdots\cdots\cdots \quad (1)$$

where, W : area of basin tank
H : water level
Q : flow from basin tank
n : time
R : rainfall
dt : unit time of interval
i : number of tank

Formulas for flow over a broad-crested weir are:

$$Q_i = \pm C_1 \cdot B \cdot h_1^{3/2} \quad \cdots\cdots \text{(for free over flow)}$$

$$Q_2 = \pm C_2 \cdot B \cdot h_2 \cdot \sqrt{|H_i - H_j|} \quad \cdots\cdots \text{(for submerged over flow)}$$

where, B : crest width
H_i : water level of basin tank
H_j : water level of river tank
c_1, c_2 : coefficients
h_1 : $H_H - Z$ (H_H : higher water elevation between H_i and H_j)
h_2 : $H_L - Z$ (H_L : lower water elevation between H_i and H_j)

2) Approximation of Q & H at the time of n+1

i) Free over flow

$$Q_i^{m+1} = D_W \cdot H_i^{m+1} - \frac{1}{3} D_W \cdot (H_H^m + 2Z) \quad \cdots\cdots\cdots\cdots \quad (2)$$

where, $D_W = \frac{3}{2} \cdot C_1 \cdot B \cdot \sqrt{H_H^m + Z}$

m : approximatatin of m th degree

Since Eq (1) = Eq (2), following Eq (3) which solving for unknown value of water level is given

$$\frac{2W}{dt} \cdot H_i^{m+1} + D_W \cdot H_{II}^{m+1}$$

$$= \frac{1}{3} \cdot D_W \cdot (H_{II}^m + 2Z) + (\frac{2W}{dt} \cdot H_i^n - Q_i^n + 2WR) \quad \ldots\ldots\ldots\ldots \quad (3)$$

ii) Submerged over flow

$$Q_i^{n+1} = 2D_J (H_i^{n+1} - H_j^{m+1}) \quad \ldots\ldots\ldots\ldots \quad (4)$$

where, $D_J = C_2 \cdot B \cdot (H_L^m - Z) \cdot \dfrac{1}{2\sqrt{H_i^m - H_j^m}}$

Solving for unknown value of water level, H_i^{m+1} and H_j^{m+1} using Eq (1) and Eq (4), following Eq (5) is given:

$$(\frac{2W}{dt} + 2D_J) \cdot H_j^{m+1} - 2D_j H_j^{m+1} = \frac{2W}{dt} H_i^n - Q_i^n + 2WR \quad \ldots\ldots \quad (5)$$

3. Flow between River Tanks

1) Fundamental equation

By the law of continuity, the following may be written.

By the varied flow formula, river channel flow discharge can be written.

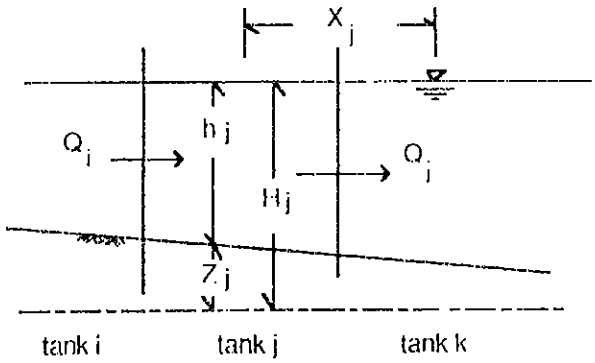

Figure 3 Flow between River Tank

$$Q^{n+1} = \frac{W_j^{n+1} + W_j^n}{dt} H_i^{n+1} + \frac{W_j^{n+1} + W_j^n}{dt} H_j^n$$

$$+ (Q_i^n - Q_j^n) + Q_i^{n+1} \quad \ldots\ldots\ldots\ldots \quad (6)$$

By the varied flow formula, canal flow discharge can be written.

$$Q_j = G_j \cdot \sqrt{F_j} \qquad \cdots\cdots\cdots\cdots \quad (7)$$

where, $$G_j = \frac{A_j \cdot R_j^{2/3}}{N} \doteq \alpha h^{\beta}$$

$$F_j = \frac{H_j - H_k}{X_j}$$

A : Flow area
R : Hydraulic radius
N : Manning's coefficient
h : Water depth of river tank
α, β : constant value
H : Water elevation of river tank
X : Distance
W : Width of river water surface
j, k : Number of river tank

2) Approximation of Q and H at the time of n+1

$$Q^{m+1} = (D_{Gj} + D_{Fj}) \cdot H_j^{m+1} - D_{Fj} H_k^{m+1} - (D_{Gj} - D_{Fj}) \cdot H_j^m$$

$$- D_{Fj} \cdot H_k^m \qquad \cdots\cdots\cdots\cdots \quad (8)$$

where, $$D_{Gj} = \sqrt{\frac{H_j^m - H_k^m}{X_j}} (\alpha h^{\beta-1})_j^m$$

$$D_{Fj} = \frac{1}{2\sqrt{x_j}\sqrt{H_j^m - H_k^m}} (\alpha h^{\beta-1})_j^m$$

Solving Eq (6) and Eq (8) simultaneously for eliminating Q_j^{m+1}, following may be written with condition of $W^{n+1} \doteq W^m$.

$$\left(\frac{W_j^m + Q_j^n}{dt} + D_{Gj} + D_{Fj}\right) \cdot H_j^{m+1} - D_{Fj} \cdot H_k^{m+1} - Q_j^{m+1}$$

$$= \frac{W_j^m + W_j^n}{dt} \cdot H_j^n + (D_{Gj} + D_{Fj}) \cdot H_j^m + D_{Fj} \cdot H_k^m + (Q_i^n - Q_j^n) \qquad \cdots\cdots \quad (9)$$

4. Application

In this section, explanation will be made for preparation of simultaneous equation for solving unknown value of river channel water levels and basin water levels by applying sample modal as shown in Figure 4.

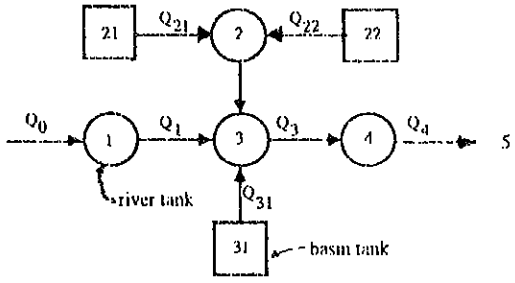

Figure 4 Sample Model

In this sample, Q_0 and river water level are given value and flow from all basin tanks are assumed submerged over flow.

1) River tank 1

J = 1, k = 3 and $Q_1^{m+1} - Q_0^{n+1}$ is given value then Eq(9) may be written.

$$a_1 \cdot Q_1^{m+1} + c_1 \cdot Q_3^{m+1} = u_1 \qquad \cdots\cdots\cdots\cdots \quad (10)$$

where,
$$a_1 = \frac{W_1^m + W_1^n}{dt} + D_{G1} + D_{F1}$$

$$c_1 = - D_{F1}$$

$$u_1 = \frac{W_1^m + Q_1^n}{dt} \cdot H_1^n + (D_{G1} - D_{F1}) \cdot H_1^m$$

$$+ D_{Fj} \cdot Q_3^m + (Q_0^n - H_1^n) - Q_0^{n+1}$$

2) River tank 2

Q_{21} : i = 21, j = 2 then Eq (4) may be written

$$Q_{21}^{m+1} = 2D_j \cdot (H_{22}^{m+1} - H_2^{m+1})$$

Q_{22} : i = 22, j = 2 then Eq (4) may be written

$$Q_{22}^{m+1} = 2D_j \cdot (H_{22}^{m+1} - H_2^{m+1})$$

In Eq (9), j = 2, k = 3 and $Q_j^{m+1} = Q_{21} + Q_{22}$ then Eq (9) may be written.

$$b_2 \cdot H_2^{m+1} + c_2 \cdot H_3^{m+1} + e_2 \cdot H_{21}^{m+1} + f_2 \cdot H_{22}^{m+1} = u_2 \qquad \ldots\ldots\ldots\ldots \quad (11)$$

where, $b_2 = \dfrac{W_2^m + Q_2^n}{dt} + D_{G2} + D_{F2} + 2D_J$

$c_2 = - D_{F3}$

$e_2 = - 2D_J$

$f_2 = - 2D_J$

$$u_2 = \frac{W_2^m + Q_2^n}{dt} \cdot H_2^n + (D_{G2} - D_{F2}) \cdot H_2^m + D_{F2} \cdot H_3^m + Q_{21}^n + Q_{22}^n - Q_2^n$$

3) River tank 21

In Eq (5), i = 21, j = 2 then Eq (5) may be written

$$b_5 \cdot H_2^{m+1} + e_5 \cdot H_{21}^{m+1} = u_5 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (12)$$

where, $b_5 = - 2D_J$

$e_5 = \dfrac{2W}{dt} + 2D_J$

$u_5 = \dfrac{2W}{dt} H_{21}^n - Q_{21}^n + 2WR$

4) River tank 22

In Eq (5), i = 22 and j = 2 then Eq (5) may be written

$$b_6 \cdot H_2^{m+1} + f_6 \cdot H_{22}^{m+1} = u_6 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

where, $b_6 = - 2D_J$

$f_6 = \dfrac{2W}{dt} + 2D_J$

$u_6 = \dfrac{2W}{dt} \cdot H_{22}^n - Q_{22}^n + 2WR$

5) River tank 3

Q_1 : In Eq (8), j = 1 and k = 3 then Eq (8) may be written.

$$Q_1^{m+1} = (D_{G1} + D_{F1}) \cdot H_1^{m+1} - D_{F1} \cdot H_3^{m+1} - (D_{G1} - D_{F1}) \cdot H_1^m - D_{F1} \cdot H_3^m$$

Q_2 : In Eq (8), j = 2 and k = 3 then Eq (8) may be written.

$$Q_2^{m+1} = (D_{G2} + D_{F2}) \cdot H_2^{m+1} - D_{F2} \cdot H_3^{m+1} - (D_{G2} - D_{F2}) \cdot H_2^m - D_{F2} \cdot H_3^m$$

Q_{31} : In Eq (4), i = 31 and j = 3, then z Eq (4) may be written.

$$Q_{31}^{m+1} = 2 D_J \cdot (H_{31}^{m+1} - H_3^{m+1})$$

In Eq (9), j = 3, k = 4 and $Q_i = Q_1 + Q_2 + Q_{31}$ then Eq (9) may be written.

$$a_3 \cdot H_1^{m+1} + b_3 \cdot H_2^{m+1} + c_3 \cdot H_3^{m+1} + d_3 \cdot H_4^{m+1} + g_3 \cdot H_{31}^{m+1} = u_3 \quad \ldots\ldots\ldots\ldots\ldots \quad (14)$$

where, $a_3 = D_{G1} + D_{F1}$

$b_3 = D_{G2} + D_{F2}$

$$c_3 = \frac{W_3^m + W_3^n}{dt} + D_{G3} + D_{F3} + D_{F1} + D_{F2} + 2D_J$$

$d_3 = - D_{F3}$

$g_3 = -2D_J$

$$u_3 = \frac{W_3^m + W_3^n}{dt} \cdot H_3^n + (D_{G3} - D_{F3}) \cdot H_3^m + D_{F3} \cdot H_4^m + (Q_1^n + Q_2^n + Q_{31}^n - Q_3^n) - (D_{G1} - D_{F1}) \cdot H_1^m \quad D_{F1} H_3^m - (D_{G2} - D_{F2}) \cdot H_2^m - D_{F2} \cdot H_3^m$$

6) River tank 31

In Eq(5), i = 31 and j = 3 then Eq(5) may be written.

$$c_7 \cdot H_3^{m+1} + g_7 \cdot H_{31}^{m+1} = u_7 \qquad \text{..... (15)}$$

where, $c_7 = -2D_J$

$$g_7 = \frac{2W}{dt} + 2D_J$$

$$u_7 = \frac{2W}{dt} \cdot H_{31}^{m} - Q_{31}^{n} + 2WR$$

7) River tank 4

Q_3 : In Eq(8), j = 3 and k = 4 then Eq(8) may be written.

$$Q_3^{m+1} = (D_{G3} + D_{F3}) \cdot H_3^{m+1} - D_{F3} \cdot H_4^{m+1}$$

$$- (D_{G3} - D_{F3}) \cdot H_3^{m} - D_{F3} \cdot H_4^{m+1}$$

In Eq (9), j = 4, k = 5, $Q_i = Q_3$ and H_5 is given then Eq (9) may be written.

$$c_4 \cdot H_3^{m+1} + d_4 \cdot H_4^{m+1} = u_4 \qquad \text{..... (16)}$$

where, $c_4 = D_{G3} + D_{F3}$

$$d_4 = \frac{W_4^{m} + W_4^{n}}{dt} + D_{G4} + D_{F4} + D_{F3}$$

$$u_4 = \frac{W_4^{m} + W_4^{n}}{dt} \cdot H_4^{n} + (D_{G4} - D_{F4}) \cdot H_4^{m} - D_{F4} \cdot H_5$$

$$+ (Q_3^{n} - Q_4^{n}) - (D_{G3} - D_{F3}) \cdot H_3^{m} - D_{F3} \cdot H_4^{m} - D_{F4} \cdot H_5$$

Above seven equations (Eq(10) - Eq(16)) can be written in matrix expression as follow:

$$\begin{bmatrix} a_1 & 0 & c_1 & 0 & 0 & 0 & 0 \\ 0 & b_2 & c_2 & 0 & e_2 & f_2 & 0 \\ a_3 & b_3 & c_3 & d_3 & 0 & 0 & g_3 \\ 0 & 0 & c_4 & d_4 & 0 & 0 & 0 \\ 0 & b_5 & 0 & 0 & e_5 & 0 & 0 \\ 0 & b_6 & 0 & 0 & 0 & f_6 & 0 \\ 0 & 0 & c_7 & 0 & 0 & 0 & g_7 \end{bmatrix} \cdot \begin{bmatrix} H_1^{m+1} \\ H_2^{m+1} \\ H_3^{m+1} \\ H_4^{m+1} \\ H_{21}^{m+1} \\ H_{22}^{m+1} \\ H_{31}^{m+1} \end{bmatrix} = \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \\ u_6 \\ u_7 \end{bmatrix}$$

All unknown value of water levels (H_i^{m+1}) can be obtained by solving above matrix.

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B - 02	Rating Tables		D P M A
B - 03	Discharge Record	1982	D P M A
B - 04	Mothly Rainfall		P 3 S A
B - 05	Inventory Table of Hydrological Station		P 3 S A
B - 06	River Discharge Measurement Record		P 3 S A
B - 07	Climatological Record at JUAI Station (1980-1984)		P 3 S A
B - 08	Table of Hydrologial Station in Negara River Basin	1988	P 3 S A
B - 09	The Catchment Area and Length of Rivers in South Kalimantan	1986	P 3 S A
B - 10	Final Report on Study for optimum water resources development in the Negara and the Martapura (Vol 1)	1981	P 3 S A
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B - 18	Sediment Concentration Analysis	1979	DPMA
B - 19	Sediment Concentration Analysis	1980	DPMA
B - 20	Sediment Concentration Analysis	1981	DPMA
B - 21	Sediment Concentration Analysis	1982	DPMA

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B - 24	Survey on Hydrology and Hydrological equipment in Barito River	1986	D P M A
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ANNEX C
LAND RESOURCES

ANNEX C LAND RESOURCES

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1 Study Area

Under the present Study, the coverage of the Study Area is set up to be 12,682.68 km^2 the whole administrative territories of five Kabupatens such as Tabalong, Hulu Sungai Utara, Hulu Sungai Tengah, Hulu Sungai Selatan and Tapin. On the basis of officially approved figures in June 1988 by the Governor of the South Kalimantan Province as shown in Table 1.1, these five Kabupatens' areas are fixed to be 12,655.18 km^2 in total as below:

Kabupaten	Area (km^2)
Tabalong	3,946.00
Hulu Sungai Utara	2,771.00
Hulu Sungai Tengah	1,472.00
Hulu Sungai Selatan	1,803.00
Tapin	2,663.18
Total	12,655.18

Along the left bank of the Barito river, there exists a narrow strip covering a total area of 27.5 km^2 and being located in Kabupaten Banjar and Barito Kuala. For the purpose of evaluating the present and future conditions of socio-economy and agriculture, however, this strip is left out of consideration. In case of hydrological analysis, the study coverage is limited to the Negara sub-basin having around 11,000 km^2 of drainage area.

1.2 Data

To clarify land use patterns and available land resources for agricultural development, relevant data are collected from Governor's Office, Department of Public Works, Directorate of Land Use System and Directorate of Rural Development in South Kalimantan as well as Center for Data Processing and Mapping, Ministry of Public Works, and Directorate General of Settlement Preparation, Ministry of Transmigration, in Jakarta. The list of reference is attached to the end of this Annex. Among data collected, information interpreted from satellite images is fully referred to in studying land resources and their potential in the Study Area.

2. PHYSIOGRAPHIC CONDITION

The Study Area is broadly divided into two physiographic regions; Central Kalimantan Lowlands and Meratus Mountains. The first region is further divided into two subregions; Barito Swamplands, and Interior Plains and Foothills.

The Barito Swamplands contain wide recent alluvial plains which are mostly formed of fine-grained riverine sediments and overlie the older and broader basins by peat. Peat has accumulated in the largest basin between main rivers. The inner part of swampy lowlands is subject to flooding and inundation, while zones fringing the Interior Plains and Foothills are alluvial areas and frequently flooded by small streams. The Interior Plains and Foothills comprise a fringe of undulating to hilly sedimentary plains and foothills in the east of the Study Area. The Meratus Mountains form a continuous high chain of ridges stretching 370 km from near the southern tip of South Kalimantan into East Kalimantan.

The above physiographic regions and subregions are composed of several physiographic types as below:

Region	Subregion	Type
Central Kalimantan Lowlands	Barito Swamplands	Swamps Alluvial Plains
	Interior Plains and Foothills	Alluvial Valleys Plains Hills
Meratus Mountains	Mountains	

The followings are general description of physiographic types:

Swamps with less than 10 m altitude contain permanently waterlogged floodplains, shallow peat swamps, and deeper peat swamps commonly domed. These cover a total area of 4,120.00 km^2. The average steepness is less than 2%.

Alluvial plains with less than 2 m altitude are formed by coalescent riverine plains and coalescent inland riverine plains covering 1,409.74 km^2. The average steepness is less than 2%.

Alluvial valleys with less than 10 m altitude are of minor valley floors within hills and have a total coverage of 435.34 km^2. The average steepness is less than 2%.

Plains with less than 50 m altitude comprise undulating to rolling sedimentary plains, undulating karstic plains with humus, hillocky sedimentary plains and hillocky sedimentary plains with steep parallel ridges. The total extent is 2,831.92 km^2. The average steepness ranges between 2% and 40%.

Hills with 50 to 300 m altitude include asymmetric/non-orientated/sedimentary hills, linear sedimentary ridge systems with steep dipslopes, long/narrow-crested steep-sided sedimentary ridges, non-orientated/non-sedimentary hills and ultrabasic hills. These cover 1,265.79 km^2. The average steepness is from 26% to 60% with an exceptional case of more than 60%.

Mountains with more than 300 m altitude are composed of non-orientated/sedimentary mountains, mountainous sandstone cuestas with dissected dipslopes, rugged karst ridges and mountains, weakly oriented/metamorphic mountain ridge systems, orientated/granite mountain ridge systems, and ultrabasic/basic mountains. The total coverage is 2,619.89 km^2. The average steepness is above 40% with an exceptional case of 26% to 40%.

3. SOILS

3.1 Soils in Barito Swamplands

The alluvial plains are intensively used for paddy rice, vegetable and coconut cultivation in the Barito basin. Soils extending over the coalescent riverine plains are physically fine-textured, both on the incipient levees and the backswamp margins. The former may contain thin surface layers or intercalation of silt or fine sand, and be imperfectly to well drained. The latter is mostly poorly to very poorly drained and uniformly clayey. Such surface riverine clays overlie at shallow depth former marine clays being locally rich in oxidisable sulphur derived mainly from debris of mangrove vegetation. The probability of occurrence of marine clays increases with distance from rivers, though the source material of the sulphur in the former marine clays varies irregularly with depth and areally. The favoured low-cost way to avoid the development of acid-sulphate conditions is to maintain a high water table to ensure permanent non-oxidising conditions. Control of the water table through drainage and irrigation is critical in these circumstances.

Soils of the coalescent inland riverine plains are of younger and freshwater riverine sediments covering deeply marine sediments. Soil characteristics are imperfectly to poorly drained, fine-textured and very strongly acid condition with moderate levels of available phosphorus, exchangeable cations and exchange capacity in the topsoil decreasing to low in the subsoil.

Soils in the swamps are featured by peats which are partly decomposed, mainly woody but locally fibrous organic debris. These are extremely acid and low in essential major and minor plant nutrients, but the cation exchange capacity is very high.

3.2 Soils in Interior Plains and Foothills

Soils of the plains have yellowish to reddish, very deep, well drained, moderately fine-textured, strongly weathered and acid features. These are leached and inherently infertile. Where the topsoil is present, the levels of exchangeable bases, cation exchange capacity, available and total phosphorus are low. In the absence of topsoil all nutrient levels are very low and exchangeable aluminium is high. Without organic matter, the weak ability of the kaolinitic clay complex to retain nutrients makes fertilizing difficult.

3.3 Soils in Meratus Mountains

Due to very steeply sloping landscapes in this physiographic subregion, soils are subject to constant loss of surface materials, even under forest cover. Soils have shallow, stony, well drained and poorly developed characteristics.

3.4 Soil Great Groups

When soils cover more than 60% of one component area of the respective physiographic types, these are defined as dominant Soil Great Groups. If the above coverage rate is more than 20%, such soils are called as associated Great Groups. In accordance with USDA's definitions of 1975, a brief description is given below for each of 15 Great Groups identified in the Study Area.

- Tropudalfs : Well weathered soils of hot climates with finer textured subsoils.
- Fluvaquents : Permanently saturated, unweathered soils with varied texture and organic matter down the profile.
- Tropaquents : Permanently saturated, unweathered, undifferentiated soils of hot climates.
- Tropofluvents : Unweathered soils of hot climates with varied texture and organic matter down the profile.
- Tropofibrists : Swampy, slightly decomposed, organic soils of hot climates often with interbedded mineral layers.
- Tropofolists : Freely drained, little decomposed and mostly shallow organic soils of hot climates.
- Tropohemists : Swampy, half decomposed, organic soils often of hot climates with interbedded mineral layers.
- Troposaprists : Swampy, highly decomposed, organic soils of hot climates, often with interbedded mineral layers.
- Tropaquepts : Permanently saturated, slightly weathered, undifferentiated soils of hot climates.
- Dystropepts : Slightly weathered soils of hot climates with low subsoil base saturation values.
- Eutropepts : Slightly weathered soils of hot climates with high subsoil base saturation values.
- Rendolls : Moderately weathered, shallow, dark, weakly acid to neutral soils on calcareous parent materials.
- Troporthods : Strongly weathered, undifferentiated soils of hot climates with upper subsoil depletion and lower subsoil enrichment of humus, aluminium and, in places, iron.
- Paleudults : Strongly weathered, acid soils with thick, uniform, finer textured subsoils.
- Tropudults : Strongly weathered, undifferentiated, acid soils of hot climates with finer textured subsoils.

3.5 Distribution of Soils

Table 3.1 and Figure 3.1 reveal distribution of dominant and associated Soil Great Groups in the Study Area. About 85% of the Study Area is covered with the following Soil Great Groups:

- Tropaquepts as a dominant Soil Great Group with an association of Fluvaquents covers 18% and are distributed in alluvial plans and swamps.

- An association of Fluvaquents, Tropaquents and Tropohemists covers 14% and extends over swamps and alluvial plains.

- An association of Tropudults and Dystropepts occupies 13% and is found in mountains.

- Tropudults as a dominant Soil Great Group associated by Tropaquents shares 12% covering plains.

- Tropudults as a dominant Soil Great Group with an association of Dystropepts is one of typical soils in plains with an areal extent of 11%.

- An association of Tropohemists, Troposaprists and Tropaquents is predominant soils in peat swamps occupying 10%.

- Tropudults as a dominant Soil Great Group associated with Dystropepts extends over hills covering 9%.

4. LAND SYSTEM

4.1 Land System Concept

The land system concept is cited from the proceedings for UNESCO Conference on Principles and Methods of Integrating Aerial Surveys of Natural Resources for Development, 1964, especially the paper presented by Christian and Stewart.

The land system concept is based on ecological principles and presumes closely inter-dependent links among rock types, hydrology, climatology, landform, soils and organisms. The same land system is recognized wherever the same combination of such ecological or environmental factors occurs. It can be said that a land system is not unique to one locality, but unique to all areas having the same environmental properties. Further it has the same potential and limitation wherever it occurs because one land system consists always of the same combination of rocks, soil and topography.

4.2 Obtainable Information from Land System

Information on 14 items is presently obtainable from each land system in the same manner. The following descriptions reveal definitions of the respective items.

(1) Land type

Land type gives general characters of the land system.

(2) Lithology

Lithology expresses six sub-items, i.e. type, induration grade, mineralogy, rock type and rock outcrop with classification criteria respectively.

- Type : 1) volcanic 2) plutonic 3) metamorphic 4) sedimentary 5) undifferentiated 6) mixed 7) not known
- Induration : 1) hard 2) soft
- Grade : 1) coarse 2) medium 3) fine 4) mixed
- Mineralogy : 1) calcareous 2) quartzitic 3) felsic 4) intermediate 5) basic 6) ultrabasic 7) mixed
- Rock type : predominant type of rock
- Rock outcrop : estimated percentage of area covered by outcropping rock

(3) Groundwater quality

Groundwater quality indicates the following degree of groundwater salinity, being inferred from the natural vegetation and land use.

- None or slight	:	0	ppm NaCl
- Fresh	:	< 250	ppm NaCl
- Brackish	:	250 - 4,000	ppm NaCl
- Saline	:	> 4,000	ppm NaCl

(4) Fisheries

This shows the potential for fisheries development based on the occurrence within or adjacent to the land system of suitable water bodies as below.

- Sea	- Estuary	- Swamp
- Lake	- River	- None

(5) Rivers flood risk

There are two distinct forms of potential damage by water, i.e. rivers flood risk and inundation. Rivers flood risk is further divided into floodwater only and flood with heavy sediment.

Floodwater only ; The assessment is a combined estimate of the depth and duration of damaging overbank flooding in the growing season for both arable and tree crops. This is rapidly moving but shallow water with little power to transport sediment.

- None or slight :
- Low : up to 25 cm deep, for up to 3 consecutive days, once or more per season
- Medium : up to 25 cm deep, for 3 to 5 consecutive days, once or more per season
- High : up to 25 cm deep, for over 5 consecutive days, once or more per season

Flowing water at depths greater than 25 cm would cause unacceptable damage to arable crops at any stage of growth.

Flood with heavy sediment ; Where there is overbank flooding by rapidly moving and possibly deep water carrying substantial sediment loads (for example on geologically young alluvial fans), this is indicated by circling zero risk for floodwater alone, followed by an estimate of the degree of frequency and severity of sediment damage as follows :

- Low : damage infrequent, vegetation intact except in gravel channels
- Medium : damage common, vegetation disturbed over large areas
- High : damage frequent, devegetated over large areas

(6) Inundation

This is an estimate of the occurrence and duration of damaging standing water more than 25 cm deep, i.e. stagnant or non-flowing water, (for example in backswamps or ox-bow lakes), at any time of the year, or an estimate of tidal range where inundation is caused by water moving slowly under tidal influences.

- Slight : 0 - 1 week
- Seasonal : 1 - 6 weeks
- Permanent : >6 weeks
- Tidal range : very large (>3.0 m) large (1.5-3.0 m)
  medium (0.5-1.4 m) small (<0.5 m)

(7) Climate

With regard to climate, information consists of 1) mean annual rainfall based on long-term records of more than 20 years, 2) the number of consecutive wet months with the average monthly rainfall of more than 200 mm, 3) the number of consecutive dry months with the average rainfall of less than 100 mm, 4) the approximate minimum length of the growing periods, and 5) mean maximum and minimum temperatures.

Among the above, the growing periods both for arable (rooting depth 0.25 m) and tree crops (rooting depth 1.5 m)are estimated from the duration of available moisture excess over evapotranspiration loss in four years out of five.

(8) Vegetation/land use

This item shows combined information on natural vegetation and land use. Categories set up for this item comprise 1) forest, 2) bush, 3) grassland, 4) shifting cultivation, 5) upland permanent cultivation, 6) wetland, 7) estate, 8) agroforestry, 9) reafforestation, 10) water, 11) unvegetated and 12) settlement. Each category is further divided into sub-categories.

(9) Accelerated erosion extent

Where dominant slopes exceed about 30%, accelerated erosion is probable, even under forest. Under arable cropping systems accelerated erosion is probable on slopes exceeding 5% with poorly structured soils. The degree of probable occurrence is categorized into 1) none, 2) local, 3) common and 4) extensive.

(10) Soils

Obtainable information on soils includes 1) Soil Great Groups, 2) texture, 3) acid sulphate hazard and 4) salinity. Also, peat depth and mineral soil depth are indicated as additional notes in item (14).

Soil Great Groups ; When more than 60% of one land system is covered by one Great Soil Group, this is called as the dominant, while coverage of less than 60% is called as associated.

Soil texture ; The following six categories are set up.

- Fine : heavy clay, clay, sandy clay, silty clay
- Moderately fine : clay loam, silty clay loam, sandy clay loam
- Medium : loam, silt loam, silt
- Moderately coarse : sandy loam
- Coarse : loamy sand, sand
- Organic : peat

Acid sulphate hazard ; This indicates depth of occurrence.

- Very shallow : 0 - 25 cm (major hazard)
- Shallow : 26 - 50 cm
- Moderately shallow : 51 - 75 cm
- Moderately deep : 76 - 100 cm
- Deep : 101 - 150 cm
- Very deep : >150 cm (no hazard)

Soil salinity ; This gives soil salinity indicated by electric conductivity EC of subsoil saturation extract.

- Salt-free : EC 0 - 3.9 mmhos/cm
- Very slightly saline : EC 4.0 - 5.9 mmhos/cm
- Slightly saline : EC 6.0 - 7.9 mmhos/cm
- Moderately saline : EC >8.0 mmhos/cm

Peat depth ; This indicates the presence of peat within the land system.

- Very shallow : <10 cm
- Shallow : 11 - 25 cm
- Moderately shallow : 26 - 50 cm
- Deep : 51 - 75 cm
- Very deep : 76 - 100 cm
- Extremely deep : >200 cm

Mineral soil depth ; This shows the depth to hard rock or cemented layer.

- Very shallow : <10 cm
- Shallow : 11 - 25 cm
- Moderately shallow : 26 - 50 cm
- Moderately deep : 51 - 75 cm
- Deep : 76 - 100 cm
- Very deep : 101 - 150 cm
- Extremely deep : >150 cm

(11) Altitude

The maximum and minimum altitude within one land system are shown with an estimate of general altitude range.

(12) Drainage

Typical condition of land drainage system is indicated in terms of drainage patter and density.

Drainage pattern ; This shows a typical pattern out of 16 drainage patterns, i.e. dendritic, parallel, trellis, rectangular/angulate, pinnate, centripetal, radial, deranged, karstic, complex, sinuous, meandering, braided, anastomotic, reticular, and distributary.

Drainage density ; It gives the degree of drainage density.

- Very low : <0.5 km/km^2
- Low : 0.5 - 1.0 km/km^2
- Moderate : 1.1 - 2.0 km/km^2
- Moderately high : 2.1 - 4.0 km/km^2
- High : >4.0 km/km^2

(13) Slope

This gives kinds of information, i.e. 1) dominant steepness and 2) distribution.

Steepness ; Dominant steepness is indicated by the following categories.

- Flat : <2%
- Very gentle : 2-8%
- Gentle : 9-15%
- Moderately steep : 16-25%
- Steep : 26-40%
- Very steep : 41-60%
- Extremely steep : >60%

Distribution ; This gives distribution of steepness in a land system with four classes, i.e. 0-3%, 0-8%, 9-25%, 26-40%. Where the sum of these classes does not equal 100%, the balance has slopes of more than 40%.

4.3 Information on Land System Identified in Study Area

In and around the Study Area, there exist 21 land systems. Obtainable information for each land system is summarized in a data sheet with the following order and given in Tables 4.1 to 4.21.

LS : 01	GBT	Gambut		LS : 05	TNJ	Tanjung
LS : 02	MDW	Mendawai		LS : 06	BKN	Bakunan
LS : 03	KLR	Klaru		LS : 07	KPR	Kapor
LS : 04	KHY	Kahayan		LS : 08	LLW	Lawanguwang

LS	: 09	TWH	Tewch	LS	: 16	PLN	Pakalunai
LS	: 10	TWB	Tewai Baru	LS	: 17	TWI	Telawi
LS	: 11	BRW	Beriwit	LS	: 18	BPD	Bukit Pandan
LS	: 12	SST	Sungai Seratai	LS	: 19	OKI	Okki
LS	: 13	MPT	Maput	LS	: 20	LHI	Lohai
LS	: 14	MIL	Mantalat	LS	: 21	LNG	Luang
LS	: 15	PDH	Pendreh				

4.4 Distribution of Land System

The areal distribution of Land System in the Study Area is shown in Table 4.22 and Figure 4.1. The summary is as follows:

Land System	Area (km^2)
Marsh	10.25
GBT	195.97
MDW	1,264.19
KLR	520.11
KHY	1,232.93
TNJ	2,306.29
BKN	435.34
KPR	19.40
LWW	1,478.13
TWH	1,215.61
TWB	118.78
BRW	2.77

Land System	Area (km^2)
SST	6.93
MPT	990.53
MIL	168.19
PDH	1,272.82
PLN	15.95
TWI	94.06
BPD	719.96
OKI	3534.92
LHI	84.19
LNG	195.36
Total	12,682.68

5. LAND SUITABILITY CLASSIFICATION

The basic requirement for planning crop diversification is a technical information on land suitabilities for crops.

In order to meet such requirement, physical limits have to be clarified for relevant items which are included in land system information sheets.

Criteria on physical limits are set up for the following crops and agricultural activities :

- Wetland arable crops
- Tidal irrigation
- Fish cultures
- Houselot (garden crops)

- Dryland arable crops
- Pasture/Livestock
- Agroforestry
- Estate and industrial crops ;
  Rubber, Oil palm, Coconut, Sago palm, Clove, Cocoa, Cashew, Tea, Robusta coffee, Pepper, Tobacco, Sugar cane, Banana, Pineapple, Mandarin Orange

Suitability of each crop is expressed in the following manner :

- S ; Suitable
- S ; Suitable with one or more limiting factors
- $; Suitable for estates but not suitable for smallholders
- N ; Not suitable

Tables 5.1 to 5.22 indicate criteria on physical limits to assess land suitabilities for the above 22 crops.

Suitabilities of each land system for each crop can be obtained through integration of information of the respective land systems and physical limits of the respective crops/agricultural activities. Table 5.23 shows its combined results.

Land Systems Tanjung (TNJ) and Bakunan (BKN) have a wide range of suitabilities for both wetland and dryland arable crops. Land Systems Lawanguwang (LWW) and Teweh (TWH) are suitable for growing dryland arable crops and estate and industrial crops. Land System Kahayan (KHY) is suitable for wetland arable crops.

6. Land Use

6.1 Present Land Use

The present land use condition is grouped into four categories and further divided into 18 patterns as follows:

Category	Symbol	Pattern
Forest	Hr	Swamp forest
	Hg	Peat swamp forest
	Hn	Nipa forest
	Hk	Health forest
	Hh	Lowland forest
	Hf	Submontane forest
	Hi	Forest on limestone
	Hu	Forest on ultrabasic hills

	Hx	Logged primary forest
	Fr	Reafforestation of forestry areas
Bush & Grassland	B	Bush
	Ra	Alang-alang
	Rr	Swamp including sedges, pandanus
Cultivated Land	Paddy	Paddy
	P	Estate crops
	L	Upland and shifting cultivation
Others	K	Settlement
	W	Water

In the Study Area, cultivated land amounts to 391,104 ha comprising paddy field of 165,000 ha, estate and industrial crops area of 142,174 ha, upland crop and shifting cultivation area of 83,430 ha as indicated in Table 6.1 and summarized below:

Land Use Category	Study Area (ha)	(%)
Forest	465,736	36.7
Bush & Grassland	356,482	28.1
Cultivated land	391,104	30.9
Others	54,946	4.3
Total	1,268,268	

The present land use pattern is illustrated in Figure 6.1.

6.2 Relationship between Land System and Land Use

About one third of the Study Area has been used for crop growing purposes which include shifting cultivation.

Taking such fact into account, special attention is paid to the existence of new agricultural land development potential in the Study Area. For this purpose, analysis is made for grasping relationships among the present land use condition, physiographic condition and land system.

(1) Relationship with physiographic condition

In the swamps covering 412,000 ha as a whole, land use patterns comprise forest of 147,535 ha, bush and grassland of 121,591 ha, cultivated land of 128,238 ha and others of 14,636 ha. About 30% of the swamps is presently utilized for the agricultural purpose.

Of these, paddy field amounts to 91,474 ha and the remaining 36,764 ha is upland and shifting cultivation area.

In the alluvial plains covering 140,974 ha, land use patterns comprise bush of 2,325 ha, cultivated land of 113,390 ha and others of 25,259 ha including forest of 707 ha. About 80% of the alluvial plains is used for agricultural purposes. Paddy cultivation area occupies 71,700 ha, while estate and industrial crops cultivation area amounts to 37,686 ha. Upland and shifting cultivation area is limited to 4,004 ha.

In the alluvial valleys covering 43,534 ha, land use patterns comprise forest of 1,060 ha, grassland of 3,878 ha, cultivated land of 33,861 ha and others of 4,735 ha. Nearly 80% of the alluvial valleys is grown with crops. Estate and industrial crops are predominant with a total area of 28,747 ha followed by upland area of 2,788 ha and paddy planted area of 2,326 ha.

In the plains covering 283,192 ha, land use patterns comprise forest of 52,591 ha, bush and grassland of 114,980 ha, cultivated land of 104,598 ha and others of 11,023 ha. Cultivated area with an occupancy of around 35% is featured by estate and industrial crops planting with a total coverage of 75,741 ha. The remaining part is categorized as upland and shifting cultivation area.

In hills covering 126,989 ha, land use patterns comprise forest of 59,458 ha, bush and grassland of 59,984 ha and cultivated land of 7,137 ha. Only shifting cultivation is done.

In mountains covering 261,989 ha, land use patterns comprise forest of 204,385 ha, bush and grassland of 53,724 ha and shifting area of 3,880 ha.

Table 6.2 indicate relationship between land use patterns and physiographic condition for the Study area and Tables 6.3 to 6.7 shows respective five Kabupatens.

(2) Relationship with land system

Table 6.8 show relationship between land use patterns and land system in the Study Area and its breakdown by Kabupaten is presented in Tables 6.9 to 6.13.

7. Land Resources Allocation

7.1 Land Resources Development Potential

Resulting from the analysis on suitabilities of land systems as shown in Table 5.23, land with the average steepness of more than 25% is not suitable for crop cultivation. In the Study Area, distribution of land by average slope is as follows:

Average Slope	Area (ha)	Proportion (%)
< 2%	596,508	47.0
2 - 8%	149,753	11.8
9 - 25%	121,561	9.6
26 - 40%	12,848	1.0
40% >	1,268,268	100.0

As described in Chapter 5, Land Systems Tanjung (TNJ), Bakunan (BKN), Lawanguwang (LWW) Teweh (TWH) and Kahayan (KHY) have land resources development potential with a wider range. On the other hand, the present land use condition as shown in Table 6.8 reveals that such land resources development potential has been already realized to some extent. The focal points are as follows:

In the Land System Tanjung (TNJ) area of 230,629 ha, there is no room for the further use of land for agricultural purposes because 84% of this area is presently used as paddy field, upland crop field and estate crop area and 16% is of villages, home yards and forest/bush. The only one exception is a small patch of bush area in Kabupaten Tapin. Farmers use properly this Land System area in harmony with micro relief and crop characteristics. In other words, farmers grow paddy in lower parts suitable for impounding water and rubber in higher parts with well soil drainage condition.

In the areas of 269,374 ha where Land Systems Lawanguwang (LWW) and Teweh (TWH) extend over, there exists development potential of 95,611 ha comprising alang-alang grassland and shifting cultivation area.

In the Land System Kahayan (KHY) area of 123,293 ha, paddy is grow in 10,368 ha. Agricultural potential area comprises upland and shifting cultivation area of 30,379 ha and bush of.

7.2 Land Resources Allocation

Land resources available in the Study Area are allocated by the following manner.

In the swamps, the existing upland and shifting cultivation area, grassland, bush and forest of 24,295 ha are to be allocated to new drainage improvement and polder development schemes. These areas are of the Land System Kahayan (KHY) of 18,640 ha and the Land System Klaru (KLR) of 5,655 ha.

In the alluvial plains, the existing bush area of 2,100 ha categorized as Land System Tanjung (TNJ) is to be allocated to new irrigation development schemes.

In the alluvial valleys of which Land System is Bakunan (BKN), the existing grassland area of 3,878 ha is to be reserved for expansion of the present settlement areas.

In the plains covered by the Land Systems, Lawanguwang (LWW) and Teweh (TWH) with the average slope of less than 25%, the existing upland and shifting cultivation area and grassland of 95,611 ha are to be reserved for expansion of estates, reafforestation and settlements. In the Land System Terai Baru (TWB) area, alang-alang grassland of the 125 ha is to be allotted to reafforestation.

In the hills and mountains, all of shifting area and alang-alang grassland of 39,360 ha are to be allocated to reafforestation..

7.3 Watershed Management

In hills and mountains of the Study Area, shifting cultivation is predominant resulting in the vast existence of alang-alang grassland and regrowing bushes. Such land cover situation may cause much increase in sediment yield to the Negara river system. In order to clarify the necessity of watershed management in the Study Area, therefore, data and information are analyzed paying particular attention to the existing forest resource management condition.

(1) Forest resources situation in South Kalimantan

Presently, forest land of Indonesia is classified by a method called Tata Guna Hutan Kesepakatan (TGHK) or Classification of Forest Use by Consensus agreed by the Minister for Forestry. Under this system, forest use is grouped into five categories as shown below:

Category	Symbol	Purpose	Permitted Exploitation
Nature reserve	PPA/HSA	Genetic conservation	None
Protected	HL	Watershed protection	None
Limited production	HPT	Timber production	Selective felling
Normal production	HPB	Timber production	Selective or clear-felling
Convertible	HPK	Conversion to agriculture	Clear-felling

Except for the first category to conserve specific biological resources, the other four categories are defined based on three criteria, i.e. slope, soil erodibility and rainfall intensity. In this categorization, however, no indications regarding a standing volume of

trees are taken up in justifying whether a certain area is retained as the Production Forest or not.

The following table shows the existing TGHK classification for the whole South Kalimantan as of 1987.

Forest Category	Area (km^2)
Nature Reserves	620
Protected Forest	5,130
Limited Production Forest	2,380
Normal Production Forest	13,650
Convertible Forest	4,970
Unclassified	11,125
Total	37,875

According to Sub Directorate of Land Use System South Kalimantan, however, the areal extent by type of land use and vegetation is as follows:

Land Use Category	Area (km^2)
Town and village	814
Kitchen yard	413
Wet paddy field	3,856
Dry crop field	2,610
Perennial crop field	645
Grassland	4,369
Bush/scrub	2,850
Forest	19,798
Swamp and lake	1,453
Others	177
Total	36,985

When compared with the both figures of forest cover, it can be found that there is an inconsistency to a considerable extent. These figures indicate that large parts of officially agreed forest categories have already been felled or converted to other land use purposes.

According to the interpretation of satellite images by the Ministry of Transmigration, the existing natural forest area has reduced to 17,960 km^2 in the South Kalimantan Province. In addition, there exist bush/scrub of 4,950 km^2, grassland of 6,160 km^2 and shifting cultivation area of 2,370 km^2.

(2) Forest conservation and reafforestation in Study Area

Current forest condition in the Study Area is shown in Tables 6.8 to 6.13 and summarized below:

Forest Category	Symbol	Area (ha)	Proportion (%)
Peat swamp forest	Hg	126,770	15.4
Swamp forest	Hr	21,315	2.6
Nipah forest	Hn	157	0.0
Health forest	Hk	8,938	1.1
Lowland forest	Hh	225,318	27.4
Submontane forest	Hf	10,748	1.3
Forest on limestone	Hi	26,001	3.2
Forest on ultrabasic	Hu	16,421	2.0
Logged primary forest	Hx	16,422	2.0
Reafforestation area	Fr	13,646	1.7
Bush	B	202,566	24.6
Dry grassland	Ra	106,542	12.9
Swamp grassland	Rr	47,374	5.8
Total		822,218	

As seen in the above, primary forests share 53.0% of the total forest and grassland areas, while regenerated forests and alang-alang grassland occupy 24.6% and 12.9% of the total area, respectively. On one hand a total of 13,646 ha has been reforested by Forest Department is south Kalimantan and on the other hand primary forests of 16,422 ha are under felling works.

Forest conservation ad reafforestation are practical countermeasures for effective watershed management. To meet urgent requirements for solution of the pressing sedimentation problems in the Negara river system, particularly, introduction and practice of soil conservation are indispensable in steep areas having the average steepness of more than 25%. From the viewpoint of watershed management, thus, two countermeasures are taken up for further consideration: one is to limit logging activities in the existing forest areas by legal procedures and the other is to promote afforestation in shifting cultivation areas and alang-alang grassland.

Promotion of agro-industries is also prerequisite to boost the regional economy and to provide shifters with new job opportunities. Rattan processing has been playing a key role in taking off small scale industries in the Study Area. Guarantee of constant raw material supply is needed for further promotion of such type of rural industrialization. In connection with this situation, the regenerated bush areas are to be reserved as the growing base of natural rattan.

Presently, there is only one gazetted reserve in the Study Area. This reserve is called as CA. Gn. Kentawan and located in Kabupaten Hulu Sungai Selatan. Its coverage is 245 ha out of nine gazetted/recommended reserved with a total area of 140,193 ha in the South Kalimantan Province. Taking into account necessity of proper forest resources management system, establishment of new reserve are proposed. The proposed forest reserves are as shown in Table 7.1. Besides the proposed forest reserves, a part of primary forests is

proposed to be designated as nature reserves. In the South Kalimantan Province, 11 forests with a total area of 344,500 ha are delineated for the proposed nature reserves as shown in Table 7.1. The proposed forest and nature reserves in the Study Area cover about 220,000 ha and 75,000 ha, respectively.

Further and accelerated promotion of reafforestation program is recommended basically for all shifting cultivation areas and alang-alang grassland having an average slope of more than 25%. The total area required for reafforestation amounts to 53,202 ha in the Study Area.

7.4 Recommended Land Use Plan

(1) Transmigration

About 50 transmigration sites are distributed throughout the South Kalimantan Province as shown in Table 7.2. Of these, locations of about 40 sites opened till Repelita II period are not identified because of the difficulty of reconciling frequent changes of site names and areas. These sites have already been absorbed into the general land use pattern in intensively settled areas.

According to the Regional Physical Planning Programme for Transmigration prepared by the Ministry of Transmigration, 19 areas in total are delineated and recommended as new transmigration sites throughout the South Kalimantan Province. These recommended new transmigration sites amount to 416,600 ha in gross as shown in Table 7.3. Within the Study Area, however, no new transmigration sites are identified. All recommended sites are located in Kabupatens Kota Baru, Tanah Laut and Barito Kuala. Carrying capacity is estimated to be 67,839 households in total.

Criteria for delineating new transmigration sites employed in the said Programme are of the following five items:

- A gross area of 15,000 to 20,000 ha to permit large-scale planning,
- Land systems classed suitable for one or more of the models considered and covering at least 60% of the area,
- Land outside Nature Reserves, gazetted or proposed,
- Land not already intensively used by local population, and
- Land not already allocated for development.

(2) Estates and oilfield

The existing extension plans of estates and oilfield in the South Kalimantan Province are as follows:

Scheme	Kabupaten	Area (ha)
1. Estate		
Batulicin PIR Khusus I	Kotabaru	17,800
PT Inhutani II, Sejahtera Sejati	Kotabaru	9,300
Pamukan PIR Khusus II	Kotabaru	47,800
Pleihari NES	Tanah Laut	8,100
Muara Uya PIR Khusas II	Tabalong	16,900
Paringin PIR Khusas II	H.S.U.	40,900
Danau Salak NES III	Tapin and Banjar	29,100
Total		169,900
2. Oil field		
Tanjung	Tabalong	86,700

(3) Recommended land use plan

All the outputs from engineering sectors under the present Study are fed back to allocation of available land resources in setting up the future land use plan in the Study area. Tables 7.4 to 7.9 indicate change in land use patterns by physiographic type in the Study area and five Kabupatens. The relationship between the recommended land use pattern and physiographic type is shown in Table 7.10 for the Study Area and in Tables 7.11 to 7.15 for the respective Kabupatens. The main points considered in formulating the recommended land use plan are summarized as below:

In Kabupaten Tabalong, the existing upland and shifting cultivation area, grassland and bush amounting to 67,568 ha in the plains are t be reserved for Muara Uya PIR scheme area of 16,900 ha and Tanjung Oil Field concession area of 86,700 ha. As the required area is 103,600 ha in total, the balance of 36,032 ha is to be allocated from the existing forest of 44,344 ha in the plains to the said concession area. This forest is to be designated as limited production forest under the TGHK's classification method. The present upland and shifting cultivation area and grassland extending over the hills and mountains are to be reforested with a total area of 15,729 ha. A part of primary forests presently covering 167,540 ha in the mountains is to be designated as nature reserve under the TGHK's method. These are of forest on limestone, forest on ultrabasic and lowland forest. The recommended nature reserve covers 50,800 ha and is splitted into two locations, i.e. Meratus Nature Reserve of 26,400 ha and Muala Uya Nature Reserve of 24,400 ha. Both reserves extend in northeastern parts of the Kabupaten.

In Kabupaten Hulu Sungai Utara, paddy field of 6,395 ha is to be newly developed in the swamps of which Land systems are Kahayan (KHY) for 3,140 ha and Klaru (KLR) for 3,255 ha. Its current vegetation covers comprise forest. In order to reserve and enhance areas for natural fish spawning and nursery, the remaining

upland and shifting cultivation area of 407 ha in the swamps is to be kept in such condition that no farming and felling activities can be allowed so as to regenerate naturally vegetation covers. For Paringin PIR Khusas II scheme area covering 40,900 ha, land resources to be reserved include upland and shifting cultivation area and grassland amounting to 6,280 ha in the alluvial valleys and also upland and shifting cultivation area, grassland, bush and forest totalling 34,620 ha in the plains. The present grassland of 2,617 ha in the hills is to be reforested. Of the existing primary forests of 54,082 ha in the mountains, the northeasternmost part of 36,800 ha is to be designated as Maratus Hulu Barabai Nature Reserve.

In Kabupaten Hulu Sungai Tengah, paddy field of 2,400 ha in the swamps is to be newly converted from upland and shifting cultivation area under the Land System Klaru (KLR). In the swamps, the remaining upland and shifting cultivation area of 481 ha is to be reserved as natural fish spawning and nursery areas. In the plains and hills, the present grassland of 3,361 ha is to be reforested.

In Kabupaten Hulu Sungai Selatan, paddy field of 11,500 ha in the swamps is to be newly open up in the Land System Kahayan (KHY) area. The land use patterns at present are of upland and shifting cultivation area for 204 ha and bush for 11,296 ha. The remaining upland and shifting cultivation area of 818 ha is to be kept for natural fish spawning and nursery reserve areas. Reafforestation is to be carried out in the existing grassland of 22,631 ha extending over the plains, hills and mountains.

In Kabupaten Tapin, new paddy field of 6,100 ha is to be developed. This comprises the Land System Kahayan (KHY) area of 4,000 ha in the swamps presently used for upland and shifting cultivation purposes and the Land System Tanjung (TNJ) area of 2,100 ha in the alluvial plains presently covered with bush. In the swamps, the remaining upland and shifting cultivation area covering 27,116 ha is to be reserved as natural fish spawning and nursery areas.

The areal change in land use is summarized for the Study Area as below:

(Unit: ha)

Land Use	Present	Increase	Decrease	Future
Forest	465,736	53,202	40,685	478,253
Bush	202,567	28,822	34,214	197,175
Grassland	153,915	0	108,883	45,032
Sub-total	822,218	82,024	183,782	720,460
Paddy	165,500	26,395	0	191,895
Estate	142,174	66,901	0	209,075
Upland and shifting cultivation	83,430	0	78,238	-
Upland	-	-	-	5,192
Sub-total	391,104	93,296	78,238	406,162
Town and others	49,692	86,700	-	136,392
Water	5,254	0	0	5,254
Sub-total	54,946	86,700	0	141,646
Total	1,268,268	262,020	262,020	1,268,268

With regard to paddy field distribution patterns under the present and future conditions. Tables 7.16 and 7.17 show the areal extent by physiographic type, by Land system and by availability of irrigation, drainage and polder facilities.

TABLES

Table 1.1 Area by Kecamatan in Kabupatens

(Unit: ha)

Kabupaten	Kecamatan	Area
1. Tabalong	Tanjung	32,334
	Kelua	11,578
	Murung Pudak	11,872
	Tanta	17,210
	Muara Uya	92,416
	Haruai	86,127
	Upau	32,300
	Muara Harus	6,290
	Pugaan	6,406
	Banua Lawas	16,167
	Jaro	81,900
	Sub-total	394,600
2. Hulu Sungai Utara	Paringin	38,937
	Batu Mandi	28,181
	Lampihong	28,411
	Awayan	32,659
	Halong	35,727
	Juai	21,253
	Amuntai Selatan	4,400
	Amuntai Tengah	13,644
	Amuntai Utara	10,810
	Babirik	18,222
	Danau Panggang	26,722
	Sungai Pandan	18,144
	Sub-total	277,110
3. Hulu Sungai Tengah	Barabai	5,457
	Batang Alai Utara	14,729
	Batang Alai Selatan	43,794
	Labuan Amas Selatan	8,654
	Labuan Amas Utara	16,181
	Batu Benawa	29,098
	Pendawan	14,424
	Haruyan	14,863
	Sub-total	147,200
4. Hulu sungai Selatan	Kandangan	14,500
	Daha Utara	36,300
	Daha Selatan	39,600
	Padang Batung	19,400
	Simpur	12,200
	Sungai Raya	8,700
	Angkinang	6,800
	Telaga Langsat	10,000
	Kelumpang	10,000
	Loksado	22,800
	Sub-total	180,300
5. Tapin	Tapin Utara	7,249
	Tapin Selatan	36,600
	Tapin Tengah	32,217
	Candi Laras Utara	73,048
	Candi Laras Selatan	32,785
	Binuang	34,208
	Bakarangan	10,754
	Piani	11,173
	Lokpaikat	13,388
	Bungur	14,896
	Sub-total	266,318
	Total	1,265,518

Source: Governor's Office, South Kalimantan

Table 3.1 Distribution of Soils

(Unit: ha)

Soil Great Group		Tablong	H.S.U.	H.S.T.	H.S.S.	Tapin	Strip along the Barito	Total	Related Land
Dominant	Associated								
	Tropohemists & Tropofibrists	2,148	17,449	0	1,025	0	0	20,622	GBT & Marsh
	Tropohemists, Troposaprists & Tropaquents	7,691	17,970	560	38,855	61,343	0	126,419	MDW
	Fluvaquents, Tropaquents & Tropohemists	1,940	30,588	8,884	30,264	100,878	2,750	175,304	KLR & KHY
Tropaquepts	Fluvaquents	28,338	44,777	65,558	52,420	39,536	0	230,629	TNJ
	Tropaquepts, Fluvaquents & Tropofluvents	21,410	16,805	3,361	546	1,412	0	43,534	BKN
	Tropudults, Tropudalfs & Eutropepts	1,940	0	0	0	0	0	1,940	KPR
Tropudults	Tropaquepts	76,427	48,324	4,962	136	17,964	0	147,813	LWW
Tropudults	Dystropepts	67,072	23,321	23,933	11,111	8,002	0	133,439	TWH & TWB
Tropudults	Dystropepts, Tropudults & Troporthods	970	0	0	0	0	0	970	BRW & SST
Tropudults	Dystropepts	66,932	17,795	6,484	11,247	13,414	0	115,872	MPT & MTL
	Tropudults & Dystropepts	79,474	13,026	23,853	31,424	16,866	0	164,643	PDH, TWI, LHI & LNG
Dystropepts	Tropudults	1,595	0	0	0	0	0	1,595	PLN
Dystropepts	Tropudults & Paleudults	18,777	43,614	9,605	0	0	0	71,996	BPD
Rendolls	Eutropepts & Tropofolists	19,776	3,431	0	3,272	6,903	0	33,492	OKI
Total		394,600	277,100	147,200	180,300	266,318	2,750	1,268,268	

Source : Directorate General of Settlement Preparation, Ministry of Transmigration

Table 4.1 Information on Gambut Land SysteM (GBT)

1.	Land Type	:	deeper peat swamps, commonly domed
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	soft
	- Grade	;	fine
	- Mineralogy	;	-
	- Rock type	;	peat
	- Rock Outcrop	;	0 %
3.	Groundwater Quality	:	fresh
4.	Fisheries	:	none
5.	Rivers Flood Risk	:	low
6.	Inundation	:	none
7.	Climate :		
	- Mean annual rainfall	;	1,700 - 3,900 mm
	- Wet months	;	1-12
	- Dry months	;	0-4
	- Growing period	;	180 - 365 days for arable crops 150 - 300 days for tree crops
	- Mean temperature	;	min. 23°C, max. 31°C
8.	Vegetation/Land Use	:	peat swamp forest
9.	Accelerated Erosion Extent	:	none
10.	Soils :		
	- Great soil groups		
	Dominant	;	
	Associated	;	Tropohemists, Tropofibrists
	- Texture (top/sub soils)		
	Dominant	;	
	Associated	;	peat/peat, peat/peat
	- Acid sulphate hazard at	;	
	- Salininy	;	<4.0 mmhos/cm EC
11.	Altitude	:	- Min ; 0 m - Max ; 30 m - Range ; 0-30 m
12.	Drainage	:	- Pattern ; sinuous - Density ; 0.5 km/km^2
13.	Slope :		
	- Steepness	;	< 2%
	- Distribution	;	(0 - 3%) 0% (0 - 8%) 100% (9 - 25%) 0% (26 - 40%) 0%
14.	Additional Notes	:	Peat depth is > 200 cm.

Table 4.2 Information on Mendawai Land System (MDW)

1.	Land Type	:	shallow peat swamps
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	soft
	- Grade	;	fine
	- Mineralogy	;	mixed
	- Rock type	;	peat
	- Rock Outcrop	;	0%
3.	Groundwater Quality	:	fresh
4.	Fisheries	:	swamp
5.	Rivers Flood Risk	:	low
6.	Inundation	:	none
7.	Climate :		
	- Mean annual rainfall	;	1,700 - 3,900 mm
	- Wet months	;	0 - 12
	- Dry months	;	0 - 4
	- Growing period	;	180 - 365 days for arable crops 150 - 330 days for tree crops
	- Mean temperature	;	min. 23°C, max. 31°C
8.	Vegetation/Land Use	:	peat swamp forest
9.	Accelerated Erosion Extent	:	none
10.	*Soils* :		
	- Great soil groups		
	Dominant	;	
	Associated	;	Tropohemists, Troposaprists,
	- Texture (top/sub soils)		
	Dominant	;	
	Associated	;	peat/fine, peat/fine, fine/fine
	- Acid sulphate hazard at	;	0 - 25 cm
	- Salininty	;	< 4.0 mmhos/cm EC
11.	Altitude	:	- Min ; 1 m - Max ; 30 m - Range ; 1-10 m
12.	Drainage	:	- Pattern ; sinuous - Density ; 1.1 - 2.0 km/km^2
13.	Slope :		
	- Steepness	;	< 2 %
	- Distribution	;	(0 - 3%) 0% (0 - 8%) 100% (9 - 25%) 0% (26 - 40%) 0%
14.	Additional Notes	:	Peat depth is 51 - 200 cm and mineral soil depth is < 150 cm

Table 4.3 Information on Klaru Land System (KIIR)

1.	Land Type	:	permanently waterlogged floodplain
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	soft
	- Grade	;	fine
	- Mineralogy	;	mixed
	- Rock type	;	alluvium, recent riverine, peat
	- Rock Outcrop	;	0%
3.	Groundwater Quality	:	fresh
4.	Fisheries	:	swamp, river
5.	Rivers Flood Risk	:	high
6.	Inundation	:	permanent
7.	Climate :		
	- Mean annual rainfall	;	1,700 - 3,500 mm
	- Wet months	;	0 - 12
	- Dry months	;	0 - 4
	- Growing period	;	180 - 365 days for arable crops 150 - 330 days for tree crops
	- Mean temperature	;	min. 23°C, max. 31°C
8.	Vegetation/Land Use	:	swamp forest, swamp including sedges, pandanus, lake
9.	Accelerated Erosion Extent	:	none
10.	Soils :		
	- Great soil groups		
	Dominant	;	
	Associated	;	Fluvaquents, Tropaguents, Tropohemists
	- Texture (top/sub soils)		
	Dominant	;	
	Associated	;	fine/fine, peat/fine, fine/fine
	- Acid sulphate hazard at	;	
	- Salininty	;	4.0 mmhos/cm EC
11.	Altitude	:	- Min ; 2 m - Max ; 10 m - Range ; 2-10 m
12.	Drainage	:	- Pattern ; none - Density ; 0.5 km/km^2
13.	Slope :		
	- Steepness	;	< 2 %
	- Distribution	;	(0 - 3%) 0% (0 - 8%) 100% (9 - 25%) 0% (- 40%) 0%
14.	Additional Notes	:	Peat depth is 26 - 50 cm and mineral soil dept is 101 - 150 cm

Table 4.4 Information on Kahayan Land System (KHY)

1.	Land Type	:	coalescent estuarine/riverine plains
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	soft
	- Grade	;	fine
	- Mineralogy	;	mixed
	- Rock type	;	alluvium, peat
	- Rock Outcrop	;	0%
3.	Groundwater Quality	:	fresh, brackish
4.	Fisheries	:	sea, estuary
5.	Rivers Flood Risk	:	high
6.	Inundation	:	seasonal, tidal
7.	Climate :		
	- Mean annual rainfall	;	1,600 - 3,900 mm
	- Wet months	;	0 - 12
	- Dry months	;	0 - 4
	- Growing period	;	180 - 365 days for arable crops 150 - 330 days for tree crops
	- Mean temperature	;	min. 23°C, max. 31°C
8.	Vegetation/Land Use	:	riparian forest of meander belt, bush, rainfed wetland rice, rubber, coconut, settlements
9.	Accelerated Erosion Extent	:	none
10.	Soils :		
	- Great soil groups		
	Dominant	;	
	Associated	;	Tropaquepts, Fluvaquents, Tropohemists
	- Texture (top/sub soils)		
	Dominant	;	
	Associated	;	fine/fine, fine/fine, peat/fine
	- Acid sulphate hazard at	;	51 - 75 cm
	- Salininty	;	4.0 mmhos/cm EC
11.	Altitude	:	- Min ; 0 m - Max ; 25 m - Range ; 0-10 m
12.	Drainage	:	- Pattern ; meandering - Density ; 0.5 - 1.0 km/km^2
13.	Slope :		
	- Steepness	;	2%
	- Distribution	;	(0 - 3%) 100% (0 - 8%) 0% (9 - 25%) 0% (26 - 40%) 0%
14.	Additional Notes	:	Peat depth is 26 - 50 cm and mineral soil depth is 150 cm

Table 4.5 Information on Tanjung Land System (TNJ)

1.	Land Type	:	coalescent inland riverine plains
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	soft
	- Grade	;	mixed
	- Mineralogy	;	mixed
	- Rock type	;	alluvium
	- Rock Outcrop	;	0%
3.	Groundwater Quality	:	fresh
4.	Fisheries	:	lake, river
5.	Rivers Flood Risk	:	high
6.	Inundation	:	seasonal
7.	Climate :		
	- Mean annual rainfall	;	1,700 - 3,300 mm
	- Wet months	;	1 - 8
	- Dry months	;	0 - 4
	- Growing period	;	180 - 365 days for arable crops 150 - 270 days for tree crops
	- Mean temperature	;	min. 23°C, max. 31°C
8.	Vegetation/Land Use	:	swamp forest, swamp including sedges, pandanus, rainfed wetland rice, lakes, settlements
9.	Accelerated Erosion Extent	:	none
10.	Soils :		
	- Great soil groups		
	Dominant	;	Tropaquepts
	Associated	;	Fluvaquents
	- Texture (top/sub soils)		
	Dominant	;	fine/fine
	Associated	;	fine/fine
	- Acid sulphate hazard at	;	>150 cm
	- Salininy	;	not know
11.	Altitude	:	- Min ; 2 m - Max ; 20 m - Range ; 5-15 m
12.	Drainage :		
	- Pattern	;	dendritic, anastomotic, reticulate, distributary
	- Density	;	0.5 - 1.0 km/km^2
13.	Slope :		
	- Steepness	;	2 %
	- Distribution	;	(0 - 3%) 0% (0 - 8%) 100% (9 - 25%) 0% (26 - 40%) 0%
14.	Additional Notes	:	Mineral soil depth is 101 - 150 cm

Table 4.6 Information on Bakunan Land System (BKN)

1.	Land Type	:	minor valley floors within hills
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	soft
	- Grade	;	mixed
	- Mineralogy	;	mixed
	- Rock type	;	alluvium, recent riverine
	- Rock Outcrop	;	0%
3.	Groundwater Quality	:	fresh
4.	Fisheries	:	river
5.	Rivers Flood Risk	:	high
6.	Inundation	:	seasonal
7.	Climate :		
	- Mean annual rainfall	;	1,800 - 3,300 mm
	- Wet months	;	0 - 12
	- Dry months	;	0 - 4
	- Growing period	;	210 - 365 days for arable crops 180 - 365 days for tree crops
	- Mean temperature	;	min. 22°C, max. 30°C
8.	Vegetation/Land Use	:	riparian forest of meander belt, swamp forest, shifting cultivation, upland crops undifferenciated, rainfed wetland rice, settlements
9.	Accelerated Erosion Extent	:	none
10.	Soils :		
	- Great soil groups		
	Dominant	;	
	Associated	;	Tropaquepts, Fluvaquents, Tropofluvents
	- Texture (top/sub soils)		
	Dominant	;	
	Associated	;	mod. fine/fine, mod. fine/fine, mod. fine/fine
	- Acid sulphate hazard at	;	
	- Salininy	;	4.0 mmhos/cm EC
11.	Altitude	:	- Min ; 0 m - Max ; 500 m - Range ; 0-500 m
12.	Drainage	:	- Pattern ; meandering - Density ; 0.5 km/km^2
13.	Slope :		
	- Steepness	;	2%
	- Distribution	;	(0 - 3%) 0% (0 - 8%) 100% (9 - 25%) 0% (26 - 40%) 0%
14.	Additional Notes	:	Peat depth is 0 - 10 cm and mineral soil depth is 150 cm

Table 4.7 Information on Kapor Land System (KPR)

1.	Land Type	:	undulating karstic plains with hums
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	hard
	- Grade	;	fine
	- Mineralogy	;	calcareous
	- Rock type	;	limestone
	- Rock Outcrop	;	10%
3.	Groundwater Quality	:	fresh
4.	Fisheries	:	river
5.	Rivers Flood Risk	:	none
6.	Inundation	:	none
7.	Climate :		
	- ean annual rainfall	;	1,600 - 2,700 mm
	- Wet months	;	0 - 10
	- Dry months	;	0 - 2
	- Growing period	;	210 - 330 days for arable crops 150 - 270 days for tree crops
	- Mean temperature	;	min. 23°C, max. 31°C
8.	Vegetation/Land Use	:	moist primary lowland forest, shifting cultivation
9.	Accelerated Erosion Extent	:	none
10.	Soils :		
	- Great soil groups		
	Dominant	;	
	Associated	;	Tropudults, Tropudalfs, Eutropepts
	- Texture (top/sub soils)		
	Dominant	;	
	Associated	;	mod. fine/fine, mod.fine/fine, fine/rock
	- Acid sulphate hazard at	;	> 150 cm
	- Salininy	;	not known
11.	Altitude	:	- Min ; 20 m - Max ; 50 m - Range ; 20-50 m
12.	Drainage	:	- Pattern ; karstic - Density ; < 0.5 km/km^2
13.	Slope :		
	- Steepness	;	2 - 8 %
	- Distribution	;	(0 - 3%) 0% (0 - 8%) 80% (9 - 25%) 0% (26 - 40%) 0%
14.	Additional Notes	:	Mineral soil depth is 26 - 50 cm

Table 4.8 Information on Lawanguwang Land System (LLW)

1.	Land Type	:	undulating to rolling sedimentary plains
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	hard
	- Grade	;	fine
	- Mineralogy	;	felsic
	- Rock type	;	shale, mudstone, marl, sandstone, alluvium
	- Rock Outcrop	;	0%
3.	Groundwater Quality	:	none
4.	Fisheries	:	river
5.	Rivers Flood Risk	:	none
6.	Inundation	:	none
7.	Climate :		
	- Mean annual rainfall	;	1,600 - 4,100 mm
	- Wet months	;	0 - 12
	- Dry months	;	0 - 7
	- Growing period	;	210 - 365 days for arable crops 150 - 365 days for tree crops
	- Mean temperature	;	min. 22 - 23 °C, max. 30 - 31 °C
8.	Vegetation/Land Use	:	moist primary lowland forest, logged forest, shifting cultivation, settlements
9.	Accelerated Erosion Extent	:	local
10.	Soils :		
	- Great soil groups		
	Dominant	;	Tropudults
	Associated	;	Tropaquepts
	- Texture (top/sub soils)		
	Dominant	;	mod. fine/mod. fine
	Associated	;	fine/fine
	- Acid sulphate hazard at	;	
	- Salininty	;	
11.	Altitude	:	- Min ; 0 m - Max ; 500 m - Range ; 0-150 m
12.	Drainage	:	- Pattern ; dendritic - Density ; > 4.0 km/km^2
13.	Slope :		
	- Steepness	;	2 - 8%
	- Distribution	;	(0 - 3%) 20% (0 - 8%) 35% (9 - 25%) 30% (26 - 40%) 15%
14.	Additional Notes	:	Peat depth is 0 - 10 cm and mineral soil depth is 101 - 150 cm

Table 4.9 Information on Teweh Land System (TWH)

1.	Land Type	:	hillocky sedimentary plains
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	hard
	- Grade	;	mixed
	- Mineralogy	;	mixed
	- Rock type	;	sandstone, shale, mudstone, marl
	- Rock Outcrop	;	0%
3.	Groundwater Quality	:	none
4.	Fisheries	:	river
5.	Rivers Flood Risk	:	none
6.	Inundation	:	none
7.	Climate :		
	- Mean annual rainfall	;	1,600 - 4,400 mm
	-Wet months	;	0 - 12
	- Dry months	;	0 - 7
	- Growing period	;	210 - 365 days for arable crops 150 - 365 days for tree crops
	- Mean temperature	;	min. 22 - 23°C, max. 29 - 31°C
8.	Vegetation/Land Use	:	moist primary lowland forest, logged forest, shifting cultivation, settlements
9.	Accelerated Erosion Extent	:	local
10.	Soils :		
	- Great soil groups		
	Dominant	;	Tropudults
	Associated	;	Dystropepts
	- Texture (top/sub soils)		
	Dominant	;	mod. fine/mod. fine
	Associated	;	mod. fine/mod. fine
	- Acid sulphate hazard at	;	
	- Salininy	:	
11.	Altitude	:	- Min ; 0 m - Max ; 500 m - Range ; 0-300 m
12.	Drainage	:	- Pattern ; dendritic - Density ; > 4.0 km/km^2
13.	Slope :		
	- Steepness	;	16 - 25%
	- Distribution	;	(0 - 3%) 0% (0 - 8%) 15% (9 - 25%) 55% (26 - 40%) 30%
14.	Additional Notes	:	Mineral soil depth is 101 - 150 cm

Table 4.10 Information on Tewai Baru Land System (TWB)

1.	Land type	:	hillocky plains with steep parallel ridges
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	hard
	- Grade	;	mixed
	- Mineralogy	;	felsic
	- Rock type	;	sandstone, mudstone, shale
	- Rock Outcrop	;	0%
3.	Groundwater Quality	:	none
4.	Fisheries	:	river
5.	Rivers Flood Risk	:	none
6.	Inundation	:	none
7.	Climate :		
	- Mean annual rainfall	;	1,800 - 4,400 mm
	- Wet months	;	1 - 12
	- Dry months	;	0 - 2
	- Growing period	;	180 - 365 days for arable crops 150 - 365 days for tree crops
	- Mean temperature	;	min. 21 - 23°C, max. 29 - 31°C
8.	Vegetation/Land Use	:	moist primary lowland forest, logged forest, shifting cultivation
9.	Accelerated Erosion Extent	:	local
10.	Soils :		
	- Great soil groups		
	Dominant	;	Tropudults
	Associated	;	Dystropepts
	- Texture (top/sub soils)		
	Dominant	;	mod. coarse/mod. fine
	Associated	;	mod. fine/mod. fine
	- Acid sulphate hazard at	;	
	- *Salininy*	;	
11.	Altitude	:	- Min ; 0 m - Max ; 500 m - Range ; 0-300 m
12.	Drainage	:	- Pattern ; trellis - Density ; > 4.0 km/km^2
13.	Slope :		
	- Steepness	;	26 - 40%
	- Distribution	;	(0 - 3%) 5% (0 - 8%) 5% (9 - 25%) 30% (26 - 40%) 50%
14.	Additional Notes	:	Peat depth is 0 - 10 cm and mineral soil depth is 101 - 150 cm

Table 4.11 Information on Beriwit Land System (BRW)

1.	Land Type	:	mountainous sandstone cuestas with dissected dipslopes
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	hard
	- Grade	;	coarse
	- Mineralogy	;	quarts
	- Rock type	;	sandstone
	- Rock Outcrop	:	50%
3.	Groundwater Quality	:	none
4.	Fisheries	:	river
5.	Rivers Flood Risk	:	none
6.	Inundation	:	none
7.	Climate :		
	- Mean annual rainfall	;	2,500 - 4,400mm
	- Wet months	;	3 - 12
	- Dry months	;	0 - 1
	- Growing period	;	300 - 365 days for arable crops 240 - 365 days for tree crops
	- Mean temperature	;	min. 17-20°C, max. 24-28°C
8.	Vegetation/Land Use	:	heath forest, submontane forest, logged forest
9.	Accelerated Erosion Extent	:	local
10.	Soils :		
	- Great soil groups		
	Dominant	;	
	Associated	;	Dystropepts, Tropudults, Troporthods
	- Texture (top/sub soils)		
	Dominant	;	
	Associated	;	medium/mod. fine, mod. fine/ fine, coarse/mod. coarse
	- Acid sulphate hazard at	;	
	- Salininty	;	
11.	Altitude	:	- Min ; 500 m - Max ; 1,200 m - Range ; 500-1,200 m
12.	Drainage	:	- Pattern ; rectangular - Density ; 2.1 - 4.0 km/km^2
13.	Slope :		
	- Steepness	;	26 - 40%
	- Distribution	;	(0 - 3%) 0% (0 - 8%) 0% (9 -25%) 0% (26 - 40%) 80%
14.	Additional Notes	:	Rock outcrops are found as part of scarp faces.

Table 4.12 Information on Sungai Seratai Land System (SST)

1.	Land Type	:	ultrabasic hills
2.	Lithology :		
	- Type	;	plutonic
	- Induration	;	hard
	- Grade	;	coarse
	- Mineralogy	;	ultrabasic
	- Rock type	;	peridotite, serpentinite
	- Rock Outcrop	;	0%
3.	Groundwater Quality	:	none
4.	Fisheries	:	none
5.	Rivers Flood Risk	:	none
6.	Inundation	:	none
7.	Climate :		
	- Mean annual rainfall	;	1,800 - 3,500 mm
	- Wet months	;	4 - 9
	- Dry months	;	0 - 2
	- Growing period	;	240 - 330 days for arable crops 180 - 270 days for tree crops
	- Mean temperature	;	min. 22°C, max. 30°C
8.	Vegetation/Land Use	:	moist primary lowland forest
9.	Accelerated Erosion Extent	:	none
10.	Soils :		
	- Great soil groups		
	Dominant	;	
	Associated	;	Tropudults, Dystropepts, Troporthods
	- Texture (top/sub soils)		
	Dominant	;	
	Associated	;	mod. fine/fine, mod. fine/mod. fine, fine/fine
	- Acid sulphate hazard at	;	
	- Salininty	;	
11.	Altitude		- Min ; 100 m - Max ; 200 m - Range ; 100-200 m
12.	Drainage	:	- Pattern ; dendritic, trellis - Density ; 1.1 - 2.0 km/km^2
13.	Slope :		
	- Steepness	;	26 - 40%
	- Distribution	;	(0 - 3%) 0% (0 - 8%) 5% (9 - 25%) 20% (26 - 40%) 50%
14.	Additional Notes	:	Mineral soil depth is 101 - 150 cm

Table 4.13 Information on Maput Land System (MPT)

1.	Land Type	:	sedimentary hills, non-orientated
2.	Lithology :		
	- Type	;	sedimentary
	- Induration	;	hard
	- Grade	;	mixed
	- Mineralogy	;	felsic
	- Rock type	;	sandstone, shale, mudstone, marl
	- Rock Outcrop	;	5%
3.	Groundwater Quality	:	none
4.	Fisheries	:	river
5.	Rivers Flood Risk	:	none
6.	Inundation	:	none
7.	Climate :		
	- Mean annual rainfall	;	1,600 - 4,400 mm
	- Wet months	;	0 - 12
	- Dry months	;	0 - 3
	- Growing period	;	210 - 365 days for arable crops 150 - 365 days for tree crops
	- Mean temperature	;	min. 15 - 23 °C, max. 22 - 31 °C
8.	Vegetation/Land Use	:	moist primary lowland forest, submontane forest, shifting cultivation
9.	Accelerated Erosion Extent	:	local
10.	Soils :		
	- Great soil groups		
	Dominant	;	Tropudults
	Associated	;	Dystropepts
	- Texture (top/sub soils)		
	Dominant	;	mod. fine/mod. fine
	Associated	;	mod. fine/fine
	- Acid sulphate hazard at	;	
	- Salininty	;	
11.	Altitude	:	- Min ; 0 m - Max ; 1,500 m - Range; 0-1,500 m
12.	Drainage	:	- Pattern ; dendritic - Density ; > 4 km/km^2
13.	Slope :		
	- Steepness	;	41 - 60%
	- Distribution	;	(0 - 3%) 5% (0 - 8%) 5% (9 - 25%) 10% (26 - 40%) 30%
14.	Additional Notes	:	Peat depth is 0 - 10 cm and mineral soil depth is 26 - 50 cm