APPENDIX

Appendix A

Location of rainfall and discharge stations

Appendix Table A1 Location of selected rainfall stations within and around Pasak watershed employed in this study

Rainfall station		Latitude			Longitude		
Code	Location	Deg.	Min.	Sec.	Deg.	Min.	Sec.
5052	Kaset Sombun, Chaiyaphum	16	16	43	101	57	26
5023	Chaturat, Chaiyaphum	15	33	52	101	50	56
19052	Chai badan, Lopburi	15	12	12	101	8	11
19042	Kok Samrong, Lopburi	15	4	13	100	43	41
25072	Si Kiew, Nakhon Ratchasima	14	53	27	101	43	33
18032	Dan sai, Loei	17	16	43	101	9	0
25082	Dan Kuntot, Nakhon Ratchasima	15	12	28	101	46	10
25172	Pak Chong, Nakhon Ratchasima	14	38	0	101	18	0
36013	Muang, Phetchabun	16	25	0	101	9	35
36023	Lom Sak, Phetchabun	16	46	42	101	14	45
36032	Lom Kao, Phetchabun	16	53	1	101	13	58
36043	Wichianburi, Phetchabun	15	39	20	101	6	37
54012	Muang, Lopburi	14	31	35	100	54	51
54032	Kaeng khoi, Saraburi	14	35	5	101	0	9
54210	Nong Khae	14	23	42	100	47	49
26102	Nong Bua, Nakhon Sawan	15	51	46	100	35	22
38022	Bang Munnah, Phitchit	16	1	35	100	23	55
39032	Wang Tong, Phitsanulok	16	49	25	100	26	0
39042	Nakhon Thai, Phitsanulok	17	5	56	100	50	53

Appendix Table A2 Location of discharge station (employed in the study) of Pasak watershed

Discharge station		Latitude			Longitude			Map
Code	Location	Deg.	Min.	Sec.	Deg.	Min.	Sec.	sheet
S4B	Mueang, Mueang Phetchabun							5242
	Upper part of Pasak	16	25	12	101	10	13	IV
S13	Ban Tha Yiam, Lom Sonthi, Lopburi,							5239
	Middle part	15	20	21	101	22	30	I
S9	Ban Pa, Kaeng khoi, Saraburi							5238
	Lower part of Pasak	14	37	33	101	1	0	III

Appendix B

Basin average of annual rainfall

Appendix Table B1 Weighted enclosed areas for eight rain gage stations employed in estimating average basin rainfall in Pasak watershed by Thiessen polygon method

Rainfall station	Observed precipitation (mm)	Area	% total area	Weighted precipitation
19052	1340.95	3198.99	20.12	269.80
25172	1536.01	1273.75	8.01	123.05
36013	1112.67	181.93	16.38	182.30
36023	1065.68	88.11	8.08	86.13
36032	1060.89	118.35	11.06	117.38
36043	1185.74	251.01	21.08	250.00
54012	1185.00	82.59	6.21	73.62
54032	1329.64	125.73	9.04	120.23
Total		15899.53	100	1222.51

N. B. Col. 2 Mean annual precipitation for each station
3 Area enclosed for each station determined by Thiessen polygon method
4 percentage of area enclosed to total area
5 Col 2* Col 3 / 15899.53 = mean basin average

Appendix Table B2 Basin average of annual rainfall of Pasak watershed determined by Thiessen polygon method

Unit - mm

Water Year	Rainfall station								Basin avr. of annual rainfall
	19052	25172	36013	36023	36032	36043	54012	54032	
1980	1234.7	1434.1	962	1224.2	1079.2	1194.2	1231.9	1138.7	1170.55
1981	1123.7	2189.6	1216.7	954.5	785.6	1274.6	1726	1726	1296.94
1982	1013.3	1891.4	1190	893	815.8	1051.3	1280	1280	1129.72
1983	1069.3	2238.7	964.2	1020.5	860	1059.3	1259.7	1259.7	1145.60
1984	978.8	2240.5	1193.5	1058.1	1226.2	1307.9	1103.6	1268.7	1252.19
1985	1156.2	1868.4	923.6	1045.6	1127	1244.2	1260.9	1296.3	1200.70
1986	1438.5	1892.8	1049	798.3	939.9	981.6	783	1536.7	1197.47
1987	1477.5	2059.1	1138.9	1035.8	1134.8	1117.5	1107	1291.1	1279.23
1988	1428.5	2224.7	1002.3	947.8	977.6	1198.7	1337.1	1318.5	1269.64
1989	1689.6	1539.2	1251.7	1118.6	1097.3	1139.9	1037.7	1130.9	1287.21
1990	1583.3	1087.7	1160.9	966.2	1171.7	1112.7	1359	1115.5	1223.52
1991	1492.1	1038.7	1055.8	1149.2	1027.7	953.5	1004.7	1141.1	1129.62
1992	1073.5	877.7	730.6	902.9	902.3	1137.7	873.3	1260.3	986.89
1993	1256.6	1143.2	814.5	725.8	876.2	973	960.6	1625	1045.22
1994	1271.7	1081	1277.6	1274.6	1358.8	1164	1198.63	1190.7	1232.69
1995	1732.6	1430.6	1129.9	1155.4	1332.9	1715.3	1422.4	1648.35	1488.25
1996	1505.1	1280.4	1245	1391.9	1169.6	1111.1	1225.1	1472.2	1294.78
1997	1297.9	1092.4	1156.3	1265.6	1057.9	1370.4	667.1	969.5	1175.47
1998	2074.2	1564.8	971.6	917.9	844	1267	1282.4	1438.1	1346.28
1999	2101.6	1318.7	1214.1	985.2	1145.1	1310.5	1289.8	1607.8	1435.54
2000	1127	1474	1513.1	1407.2	1186.4	1093.4	1272.5	1499.9	1282.95
2001	711.5	1047.3	990.9	797.7	880.8	1169.8	1065.1	1344.9	985.75
2002	1004.7	1313.2	1439.1	1474.6	1403.6	1324.4	1161.8	1021.7	1261.40
Avr.	1340.95	1536.01	1112.7	1065.67	1060.88	1185.73	1169.9709	1329.64	1222.51

Appendix Table B3 Sub-basin average rainfall of upper part of Pasak watershed (S4B) determined by Thiessen method

Unit: mm

Year	Rainfall station		Sub_basin
	36023	36032	avr. rainfall
1980	1224.2	1079.2	1150.91
1981	954.5	785.6	869.13
1982	893	815.8	853.98
1983	1020.5	860	939.38
1984	1058.1	1226.2	1143.06
1985	1045.6	1127	1086.74
1986	798.3	939.9	869.87
1987	1035.8	1134.8	1085.84
1988	947.8	977.6	962.86
1989	1118.6	1097.3	1107.83
1990	966.2	1171.7	1070.07
1991	1149.2	1027.7	1087.79
1992	902.9	902.3	902.60
1993	725.8	876.2	801.82
1994	1274.6	1358.8	1317.16
1995	1155.4	1332.9	1245.11
1996	1391.9	1169.6	1279.54
1997	1265.6	1057.9	1160.62
1998	917.9	844	880.55
1999	985.2	1145.1	1066.02
2000	1407.2	1186.4	1295.60
2001	797.7	880.8	839.70
2002	1474.6	1403.6	1438.71
2003	782.2	913.55	848.59
Mean			1060.45

Appendix Table B3 Sub-basin average rainfall of middle part of Pasak determined by Thiessen method

Water Year	Rainfall station			Sub_basin Average Rainfall
	19052	5023	5442	
1980	1234.7	1081.6	1458.7*	1219.036
1981	1123.7	922.5	1274.2*	1071.099
1982	1013.3	969.4	1436.8*	1088.756
1983	1069.3	1096.3	1555.2*	1188.979
1984	978.8	1107.1	1202.8*	1083.544
1985	1156.2	1058.2	1271*	1139.813
1986	1438.5	856.7	1055	1104.215
1987	1477.5	1114.9	1169.7	1253.854
1988	1428.5	913	1316.4	1182.978
1989	1689.6	780.3	1168.9	1184.651
1990	1583.3	615.3	916.3	1020.678
1991	1492.1	998.2	929.33*	1155.535
1992	1073.5	1241.6	942.37	1116.247
1993	1256.6	1060.6	955.4	1105.709
1994	1271.7	1533.6	1220.5	1372.371
1995	1732.6	1068.9	1584.9	1415.743
1996	1505.1	1058	1580.8	1330.636
1997	1297.9	796.9	1274.3	1078.276
1998	2074.2	882.1	1248.4	1380.351
1999	2101.6	1195.4	1643.35	1611.874
2000	1127	1548.6	2019.1	1505.914
2001	711.5	879.1	1197.9	891.4513
2002	1004.7	913	1735.8	1128.152
2003	847.7	1010.8	1062.6	965.3097
2004	753.2	931.2	753.2*	829.3642

Note; * monthly missing data filled up by the highly correlated nearby station's data

Appendix C

Monthly runoff

Appendix Table C1 Monthly runoff (MCM) in Water Year at Ban Pa, Kaeng Khoi, Saraburi (S9)

Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1974	15.8	55.4	21	11.8	54.2	221.6	568.5	240.5	51.8	20.1	10.7	13.9
1975	10.7	21.4	71.2	212	225.6	1084	1318	140.6	60.6	29.9	17.5	17.1
1976	16.6	50.5	47	70.2	264	791.8	1089	407	77.8	38	18.2	16.6
1977	19.9	55.2	37.8	16.5	55.2	667.4	450.1	34.3	23.3	18.1	9.6	8
1978	17.3	39.4	48.9	435	813.9	982	2675	104.6	70.1	42.2	24.4	24.2
1979	15	72.2	81.9	95.3	104.1	215.2	299.5	25.2	17.3	12.1	7.1	7
1980	13.6	18.1	84.8	219	296.1	700.4	1336	132.8	52.4	27.6	12.9	19.9
1981	23.5	49.7	46	231	695.8	602.1	415.9	172.5	66.2	29.7	14.4	11.7
1982	24.4	45.9	68	29.4	43.7	1167	1202	212.1	84.6	39.5	21.7	18
1983	14.1	20.5	35.9	40.9	195	455.2	1383	328.9	106.2	64.2	36.3	31.8
1984	32.6	40.4	105	180	159.3	668.3	1173	232.1	82.9	41.5	25.5	28.7
1985	29.7	62.2	78.7	176	369.5	1072	1090	467.8	109.5	47.5	28.9	24.4
1986	28.2	79.9	88.9	47.6	248.4	342.3	139.2	54.9	40.3	25.5	16.8	17.1
1987	8.6	18.8	44.3	38.7	43.6	1385	1182	170.3	74.8	35	23.7	15.2
1988	13.3	228.1	240	77.2	160.6	243.2	460.2	305.3	60.4	26.2	13.3	10.9
1989	12.1	17.3	260	90.2	153.8	226.5	348.9	155.1	36.2	13.5	5	8.5
1990	3.3	20.5	247	157	202.1	304.9	936.8	217.9	48	14.6	6.7	5.8
1991	10.3	20.8	86.8	53.8	322.2	1294	922.3	56.2	35	42.1	18.1	11.3
1992	7.8	10.6	42.7	28.1	314.8	228.4	464.9	60.7	34	15.1	8.1	7.3
1993	10.7	18.9	30.6	19.8	60	292.3	176.3	15	10.8	9.1	8	13.3
1994	8.5	43.6	140	279	330.7	1131	657.2	35.1	36.3	11.6	7.5	6.2
1995	7.2	25.6	30.3	119	928.7	1849	841.5	137.1	42.1	15.6	9.4	10.3
1996	14.9	156.8	132	133	106.4	567.1	1446	461.4	77.7	22.7	13.4	9.8
1997	19.74	22.55	17.5	48.6	184.9	470.5	795.1	130.46	42.44	16.72	11.87	5.08
1998	12.77	20.29	74.2	142	163.1	426.5	428.5	74.4	10.53	13.59	12.02	12.47
1999	22.2	71.8	13.9	6.6	46.9	417.9	764.9	259.8	20.7	76.5	71.8	88.2
2000	124.8	122.6	272	765	437.6	1690	801.6	145.3	71.9	64.6	136.4	37.7
2001	69.5	63.1	139	65.9	317.1	127.3	106.7	57.9	9.6	44.3	80.4	58.8
2002	112.6	71.5	11.4	91.2	25.5	1972	735.1	145.1	32.2	58.1	82.9	63.8
2003	193.1	106.8	74.5	154	203.2	300.7	208.3	40.3	36.9	62.9	70.2	119.7

Appendix Table C2 Monthly runoff (MCM) in water year at Ban Tha Yiam, Lom Santhi, Lopburi (S13)

Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1979	0.3	2.13	2.22	3.16	14.4	8.48	3.92	1.59	1.2	1	0.55	0
1980	0	2.46	4.49	9.24	5.87	32.75	27.77	2.88	2.05	0.11	0	0
1981	3.16	6.02	4.96	19.63	19.33	12.51	10.85	9.5	3.13	2.58	1.9	1.4
1982	0	2.31	1.44	0.44	5.19	63.11	14.18	3.83	2.06	1.25	0.55	0
1983	0.12	1.75	2.51	3.41	3.7	14.27	34.36	3.71	2.08	1.38	0.83	0.8
1984	0.69	2.56	10.2	11.47	7.7	23.93	24.08	2.12	0.85	0.52	0.25	0.1
1985	0.96	3.18	6.55	17.99	19.67	53.32	16.15	4.64	2.5	1.73	1.08	0.6
1986	1.46	3.31	1.94	2.16	25.39	9.4	2.88	1.44	1.03	0.76	0.55	0.6
1987	0.37	0.72	2.74	3.19	5.53	69.31	22.8	4.38	2.46	1.99	1.74	1.6
1988	2.86	14.77	9.35	5.6	7.63	10.28	13.32	3.16	2.52	2.17	1.69	1.5
1989	0.17	0.6	3.46	5.83	12.01	4.68	10.11	1.45	0.65	0.48	0.3	0.9
1990	1.34	2.15	3.46	3.76	6.39	35.41	27.73	3.22	2.04	1.5	0.67	1.5
1991	1.42	1.34	3.83	2.08	22.05	33.37	12.85	1.62	0.96	0.84	0.24	0
1992	0.38	0.39	1.32	4.13	11.35	3.92	4.04	0.87	0.54	0.33	0.24	0.3
1993	2.11	5.35	5.58	4.26	18.82	16.15	2.34	1.36	4.69	5	1.87	0
1994	0.21	3.12	6.57	13.35	25.4	25.71	4.8	1.48	1.04	0.61	0.41	0.5
1995	0.36	2.26	6.57	8.67	59.16	37.49	20.85	2.14	1.26	0.97	0.76	0.7
1996	2.09	7.25	6.71	4.2	13.42	19.69	12.82	8.09	2.04	1.64	1.01	0.6
1997	1.04	0.82	1.01	4.88	10.28	11.98	18.05	1.85	1.14	0.75	0.43	0.3
1998	1.95	4.4	6.21	2.27	11.03	16.61	17.2	1.88	0.68	0	0	0.5
1999	5.24	6.01	4.15	3.08	5.08	20.59	17.69	4.54	0.95	0.2	0.03	0
2000	1.25	15.02	10.7	13.01	67.81	20.77	13.63	3.71	2.18	1.11	0.64	0.9
2001	0.5	3.1	3.2	9.9	40.8	15.5	6.6	4.2	2.6	2.3	2.1	1.9
2002	3.4	3.1	3	3.2	4.3	40.8	6.5	3.7	1.9	0.4	0.2	0.7

Appendix Table C3 Monthly runoff (MCM) in Water Year at Mueang, Muang Phetchabun (S4B)

Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1969	3.78	1.28	85.48	50.80	62.90	193.88	55.64	40.35	37.67	35.16	30.04	23.32
1970	33.70	30.93	36.98	48.73	184.12	179.71	64.45	48.21	39.31	36.20	31.45	37.07
1972	33.18	21.24	28.36	20.08	40.83	74.04	134.09	39.83	38.53	36.14	13.18	16.14
1973	49.51	40.61	40.44	37.84	26.07	95.21	74.71	13.63	94.35	91.15	51.15	40.61
1974	20.41	29.02	63.16	11.55	43.85	74.74	56.94	44.76	36.63	16.47	8.79	18.89
1978	25.19	37.77	31.81	146.18	192.88	240.60	167.49	41.78	40.20	24.96	29.36	35.27
1979	29.77	37.98	63.11	42.57	81.28	72.04	47.01	30.00	28.30	9.24	5.41	6.87
1980	6.46	22.49	120.41	74.65	119.35	279.44	66.45	42.68	39.52	22.34	29.96	25.67
1981	21.30	38.91	37.35	97.30	194.90	87.10	56.26	45.91	40.33	18.09	7.10	12.96
1982	16.40	25.66	34.12	25.72	19.85	189.20	132.68	41.84	38.73	22.97	20.81	18.54
1983	13.75	9.75	36.47	35.90	74.25	199.25	118.09	46.89	40.94	27.96	21.62	27.15
1995	0.00	13.57	5.27	33.64	323.64	326.18	103.16	25.32	9.68	1.97	2.20	1.64
1996	4.04	28.36	28.95	7.74	86.88	259.11	153.53	77.42	17.35	2.14	2.32	0.25
1997	6.64	2.37	2.37	35.30	125.24	212.36	197.84	20.58	9.11	0.00	0.00	0.00
1998	0.08	3.74	11.58	57.53	93.40	63.98	17.62	5.64	2.70	0.08	0.07	0.06
1999	0.78	21.38	38.30	9.56	80.15	240.07	66.98	40.64	12.43	2.62	0.75	0.80
2000	8.53	84.98	123.17	143.68	182.06	269.11	111.19	28.02	7.67	0.61	2.69	4.27
2001	1.41	18.48	33.93	51.78	195.06	129.46	48.84	33.30	9.10	1.04	0.41	0.30

Appendix D

Historical runoff and sediment in relation to rainfall and land use change

Appendix Table D1 Historical runoff and suspended sediment in relation to annual rainfall and land use changes of Pasak Basin at S4B gaging station

Water	Measured sus. Sed.	Measured annual streamflow 1/				Basin. Avr. Rainfall 2/			Existing area of each land use types 3/					Poptn.
Year	SS	Q(Total)	Q(wet)	Q(Dry)	Q(Peak)	Rannual	Rwet	Rdry	For	Agr	Ur	W	Misc	
	m3	mm	mm	mm	mm	mm	mm	mm	ha	ha	ha	ha	ha	no
1980	-	244.05	201.98	42.08	4.01	1150.91	860.52	290.39	158221	183546	162	0	6114	-
1981	-	188.92	149.07	39.85	3.80	869.13	631.25	237.88	155960	184922	180	0	6381	-
1982	-	168.52	127.40	41.12	3.95	853.98	787.22	66.76	153732	186309	201	0	6660	-
1983	-	187.34	146.78	40.56	3.57	939.38	741.46	197.92	151536	187706	224	0	6951	-
1984	-	-	-	-	-	1143.06	940.17	202.90	149371	189114	249	0	7255	-
1985	-	-	-	-	-	1086.74	854.88	231.86	147237	190532	277	0	7572	-
1986	-	-	-	-	-	869.87	510.32	359.55	145133	191961	309	0	7903	-
1987	-	-	-	-	-	1085.84	883.83	202.01	143059	193400	344	0	8249	-
1988	-	-	-	-	-	962.86	595.41	367.45	141016	194851	383	1	8609	-
1989	-	-	-	-	-	1107.83	669.80	438.04	139001	196312	426	1	8986	-
1990	-	-	-	-	-	1070.07	665.59	404.48	137015	197784	475	2	9378	-
1991	-	-	-	-	-	1087.79	825.50	262.29	135057	199267	529	4	9788	-
1992	-	-	-	-	-	902.60	736.32	166.28	133128	200761	589	7	10216	-
1993	-	-	-	-	-	801.82	460.97	340.84	131226	202267	655	11	10663	317534
1994	-	-	-	-	-	1317.16	1023.21	293.95	129351	203783	730	19	11129	319071
1995	-	243.15	234.80	8.35	4.33	1245.11	981.06	264.05	127503	205312	813	33	11615	317247
1996	-	191.96	176.31	15.65	4.02	1279.54	988.06	291.49	125681	206851	905	56	12123	320343
1997	-	175.78	170.58	5.20	3.85	1160.62	908.72	251.91	123885	208402	1008	97	12653	320598
1998	38840.23438	73.69	71.76	1.94	2.62	880.55	591.78	288.77	122115	209965	1122	166	13206	324831
1999	88221.09375	147.82	136.68	11.14	3.05	1066.02	751.93	314.09	120371	211540	1249	285	13783	322557
2000	153503.5156	277.54	246.30	31.24	3.74	1295.60	833.04	462.56	118651	213126	1391	489	14386	323496
2001	-	150.30	141.47	8.83	3.97	839.70	597.36	242.34	119768	68000	1673	453	6828	311818
2002	-	-	-	-	-	1438.71	1139.09	299.63	120896	216959	2012	419	3241	316055
2003	-	136.82	123.16	19.49	-	848.59	633.04	215.55	122035	218901	2420	388	1538	318571
2004	-	-	-	-	-	-	-	-	123184	2208.6	2910	359	730	308897
2005	-	-	-	-	-	-	-	-	-	-	-	-	-	284840

Note: 1/ Qtotal - Annual streamflow, Qwet -Flow during wet season, Qdry - Flow during dry season, Qpeak - Highest daily peak of the year

2/ Rannual - Annual rainfall, Rwet - Rainfall during wet season, Rdry - Rainfall during dry season

3/ Obtained from Markov chain model based on land use data from LANDSAT Imageries detected in 1980, 2000 and 2004

Appendix Table D2 Historical runoff and suspended sediment in relation to annual rainfall and land use changes of Middle Pasak at S13 gaging station

Water	Measured Sus. Sed.	Measured annual streamflow 1/				Basin. Avr. Rainfall 2/			Existing area of each land use types 3/					Poptn.
Year	SS	Q(Total)	Q(wet)	Q(Dry)	Q(Peak)	R	Rwet	Rdry	For	Agr	Ur	W	Misc	Pop
	m3	mm	mm	mm	mm	mm	mm	mm	ha	ha	ha	ha	ha	no
1980	36778.13	247.76	234.72	13.06	18.07	1219.04	928.66	290.38	22525	11184	0	0	1653	-
1981	50091.41	268.60	217.13	51.50	22.53	1071.10	794.20	276.90	22385	11362	0	0	1331.93	-
1982	63404.69	266.89	249.39	17.53	30.36	1088.76	816.71	272.05	22245	11543	0	0	1073.22	-
1983	33741.02	194.95	175.22	19.77	26.07	1188.98	967.29	221.69	22107	11727	0	0	864.76	-
1984	20829.30	238.62	224.70	13.97	8.13	1083.54	806.57	276.98	21969	11913	0	0	696.79	-
1985	66473.05	363.09	334.60	28.53	33.57	1139.81	878.80	261.01	21833	12103	0	0	561.45	-
1986	19619.14	143.91	122.19	21.75	17.76	1104.22	783.85	320.36	21697	12296	0	0	452.40	-
1987	67944.92	330.46	305.27	25.22	27.19	1253.85	1005.07	248.78	21562	12492	0	0	364.52	-
1988	19071.48	211.63	139.53	72.11	13.09	1182.98	724.66	458.31	21428	12690	0	0	293.72	-
1989	9471.48	114.77	106.16	8.63	10.74	1184.65	812.94	371.71	21294	12892	0	0	236.67	-
1990	37951.95	252.20	226.15	26.02	16.97	1020.68	671.39	349.28	21162	13098	0	0	190.70	-
1991	31310.94	227.95	214.35	13.57	11.90	1184.83	937.05	247.78	21030	13306	0	0	153.66	-
1992	6366.02	78.59	72.48	6.14	12.35	1148.28	925.66	222.61	20899	13518	0	0	123.81	-
1993	17417.19	190.91	137.18	53.79	9.74	1105.71	743.00	362.71	20769	13733	0	0	99.76	23729.645
1994	31148.83	235.38	218.62	16.74	17.32	1372.37	894.06	478.31	20640	13952	0	0	80.39	23887.797
1995	72975.39	399.38	381.43	17.96	19.89	1415.74	1097.50	318.24	20511	14174	0	0	64.77	20597.013
1996	23239.06	224.84	183.62	41.26	10.31	1330.64	846.89	483.74	20384	14400	0	0	52.19	20758.044
1997	16801.95	148.53	135.88	12.70	12.01	1078.28	700.48	377.80	20257	14629	0	0	42.05	20922.462
1998	20549.22	177.44	156.10	21.35	11.15	1380.35	939.51	440.84	20131	14862	0	0	33.89	21127.19
1999	10430.47	191.09	155.90	35.15	7.44	1564.35	992.25	572.11	20006	15099	0	0	27.30	21214.318
2000	70785.94	426.19	366.64	59.56	53.68	1505.91	978.15	527.77	19881	15383	0	76	22.00	21802.295
2001	10505.86	262.12	226.80	35.35	49.82	891.45	656.06	235.39	19851	15427	0	78.39	3.21	22390.273
2002	13005.47	201.29	173.92	27.43	20.43	1128.15	699.79	428.36	19820	15471	0	80.85	0.47	22978.25
2003	-	-	-	-	-	965.31	701.65	263.66	19790	15516	0	83.38	0.07	23566.22
2004	-	-	-	-	-	898.21	671.48	226.73	19760	15561	0	86	0.01	24154.205

Note: 1/ Qtotal - Annual streamflow, Qwet -Flow during wet season, Qdry - Flow during dry season, Qpeak - Highest daily peak of the year, 2/ Rannual - Annual rainfall, Rwet - Rainfall during wet season, Rdry - Rainfall during dry season, 3/ Obtained from Markov chain model based on land use data from LANDSAT Imageries detected in 1980, 2000 and 2004

Appendix Table D3 Historical runoff and suspended sediment in relation to annual rainfall and land use changes of Lower Pasak at S9 gaging station

Water	Measured sus. Sed.	Measured annual streamflow 1/				Basin. Avr. Rainfall 2/			Existing area of each land use types 3/					Poptn.
Year	SS	Q(Total)	Q(wet)	Q(Dry)	Q(Peak)	R	Rwet	Rdry	For	Agr	Ur	W	Misc	Pop
	m3	mm	mm	mm	mm	mm	mm	mm	ha	ha	ha	ha	ha	no.
1980	2,60,119.92	204.60	194.45	10.15	5.37	1170.55	925.42	245.13	491099	1041238	2166	872	54578	-
1981	2,34,485.16	165.66	151.95	13.71	1.99	1296.94	979.58	317.36	485944	1045830	2334	1020	52530	-
1982	736536.33	207.63	191.18	16.44	4.83	1129.72	886.43	243.29	480844	1050442	2515	1194	50558	-
1983	230016.80	190.49	171.30	19.18	5.17	1145.60	907.48	238.12	475797	1055075	2710	1397	48661	-
1984	228637.50	194.51	176.84	17.67	3.49	1252.19	968.27	283.92	470803	1059728	2920	1635	46835	-
1985	373768.75	249.76	228.53	21.23	4.78	1200.70	956.29	244.41	465862	1064402	3147	1913	45077	-
1986	63483.98	79.31	64.71	14.60	1.06	1197.47	790.68	406.79	460972	1069096	3391	2239	43386	-
1987	343835.16	213.50	201.13	12.37	6.04	1279.23	1055.28	223.95	456134	1073811	3654	2620	41758	-
1988	228987.89	129.13	104.39	24.74	2.55	1269.64	761.79	507.86	451346	1078547	3937	3066	40191	-
1989	85485.94	93.22	86.71	6.50	1.10	1287.21	878.09	409.11	446609	1083303	4243	3587	38682	-
1990	187370.70	152.04	145.09	6.95	4.43	1223.52	852.02	371.50	441921	1088081	4572	4198	37231	-
1991	403247.66	201.79	192.12	9.67	3.99	1129.62	884.88	244.74	437283	1092879	4926	4912	35833	-
1992	91133.20	85.87	80.05	5.82	1.79	986.89	811.12	175.78	432693	1097699	5308	5748	34489	-
1993	42952.73	46.70	41.72	4.97	1.43	1045.22	673.11	372.12	428152	1102540	5720	6726	33194	1650967
1994	260001.95	188.74	180.76	7.99	3.55	1232.69	904.89	327.80	423658	1107403	6164	7871	31949	1665582
1995	452861.72	282.07	274.33	7.74	7.56	1488.25	1142.55	345.70	419211	1112287	6642	9210	30750	1679514
1996	434761.17	220.64	199.90	20.74	5.02	1294.78	938.48	356.30	414811	1117192	7157	10778	29596	1700303
1997	416660.63	124.00	115.68	8.32	2.48	1175.47	850.48	324.99	410457	1122119	7712	12612	28485	1707267
1998	398560.08	97.64	91.91	5.74	1.55	1346.28	895.37	450.91	406149	1127068	8310	14758	27416	1731975
1999	380459.53	130.73	106.06	24.67	2.30	1435.54	944.43	491.11	401886	1132038	8954	17269	26387	1731183
2000	362358.98	327.98	288.79	39.19	4.72	1282.95	861.23	421.72	397668	1137031	9649	20208	25397	1730211
2001	52873.83	80.04	57.16	22.88	1.41	985.75	654.88	330.86	390569	1144050	10437	20356	24087	1756138
2002	146551.95	238.94	209.36	29.58	9.71	1261.40	910.79	350.61	383596	1151112	11289	20505	22844	1782066
2003	-	110.16	68.78	41.41		965.32	725.08	240.24	376748	1158218	12210	20656	21665	1807993
2004		-	-	-	-	-	-	-	370023	1165368	13207	20807	20548	1833920

Note: 1/ Qtotal - Annual streamflow, Qwet -Flow during wet season, Qdry - Flow during dry season, Qpeak - Highest daily peak of the year

2/ Rannual - Annual rainfall, Rwet - Rainfall during wet season, Rdry - Rainfall during dry season

3/ Obtained from Markov chain model based on land use data from LANDSAT Imageries detected in 1980, 2000 and 2004

Appendix E

Regression analysis

Appendix E1

Relationship between Rainfall during wet period (Rwet) and Annual flow (Qtotal) in Lower part of Pasak Basin at S9 station, Thailand

Regression analysis: Linear model Y = a + b*X

Dependent variable: Qtotal
Independent variable: Rwet

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	-285.04	77.8012	-3.6637	0.0019
Rwet	0.50070	0.086090	5.816	0.0000

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	48971.1	1	48971.1	33.83	0.0000
Residual	24611.6	17	1447.74		
Total(Corr)	73582.7	18			

Correlation co-efficient = 0.82
R-squared = 66.5525 percent
Standard Error of Est. = 38.0492
Mean absolute error = 31.1287
Durbin-Watson statistic = 2.41462 (P=0.8245)

The Explaining results

The output shows the results of fitting a multiple linear regression model to describe the relationship between Qtotal and 1 independent variable. The equation of the fitted model is

Qtotal = -285.04 + 0.500701*Rwet

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between the variables at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 66.5525% of the variability in Qtotal. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 64.585%. The standard error of the estimate shows the standard deviation of the residuals to be 38.0492. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 31.1287 is the average value of the residuals.

Appendix E2

Relationship between Rainfall during wet period (Rwet) and Wetflow (Qwet) in Lower part of Pasak Basin at S9 station, Thailand

Regression analysis: Linear model Y = a + b*X

Dependent variable: Qwet
Independent variable: Rwet

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	-292.562	71.5763	-4.0874	0.0008
Rwet	0.49533	0.079202	6.25401	0.0000

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	47926.2	1	47926.2	39.11	0.0000
Residual	20830.8	17	1225.34		
Total (Corr.)	68757.0	18			

R-squared = 69.7038 percent
Standard Error of Est. = 35.0048
Mean absolute error = 28.5475
Durbin-Watson statistic = 2.39897 (P=0.8151)

The Explaining Results

The output shows the results of fitting a multiple linear regression model to describe the relationship between Qwet and 1 independent variable. The equation of the fitted model is

Qwet = -292.562 + 0.49533*Rwet

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between the variables at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 69.7038% of the variability in Qwet. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 67.9217%. The standard error of the estimate shows the standard deviation of the residuals to be 35.0048. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 28.5475 is the average value of the residuals.

Appendix E3

Relationship between Agriculture (Agri) and Dryflow (Qdry) in lower part of Pasak Basin at S9 station, Thailand

Regression analysis: Linear model Y = a + b*X
Dependent variable: Qdry
Independent variable: Agri

Coefficients

Parameter	Least Squares Estimate	Standard Error	T Statistic	P-Value
Intercept	125.849	53.2585	2.36298	0.0303
Slope	-0.000104747	0.000049134	-2.1318	0.0479

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	142.187	1	142.187	4.54	0.0479
Residual	531.867	17	31.2863		
Total(Corr)	674.055	18			

Correlation Coefficient = -0.459286
R-squared = 21.0943 percent
Standard Error of Est. = 5.59342
Mean absolute error = 4.07241
Durbin-Watson statistic = 1.76585 (P=0.2136)

The Explaining Results

The output shows the results of fitting a linear model to describe the relationship between Qdry and Agri. The equation of the fitted model is

Qdry = 125.849 - 0.000104747* Agri

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between Qdry and Agri at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 21.0943% of the variability in Qdry. The correlation coefficient equals -0.459286, indicating a relatively weak relationship between the variables. The standard error of the estimate shows the standard deviation of the residuals to be 5.59342. This value can be used to construct prediction limits for new observations by selecting the Forecasts option from the text menu.

Appendix E4

Relationship between Annual rainfall (Rannual) and Totalflow (Qtotal) in upper part of Pasak Basin at S4B station, Thailand

Regression analysis: Linear model Y = a + b*X

Dependent variable: Qtotal
Independent variable: Rannual

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	-36.2866	70.7058	-0.51320	0.6190
Rannual	0.21090	0.067308	3.13335	0.0106

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	16377.4	1	16377.4	9.82	0.0106
Residual	16681.2	10	1668.12		
Total(Corr)	33058.6	11			

Correlation co-efficient = 0.77
R-squared = 49.5405 percent
Standard Error of Est. = 40.8426
Mean absolute error = 32.7728
Durbin-Watson statistic = 0.88574 (P=0.0141)

The Explaining results

The output shows the results of fitting a multiple linear regression model to describe the relationship between Qtotal and 1 independent variable. The equation of the fitted model is

Qtotal = -36.2866 + 0.210902*Rannual

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between the variables at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 49.5405% of the variability in Qtotal. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 44.4945%. The standard error of the estimate shows the standard deviation of the residuals to be 40.8426. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 32.7728 is the average value of the residuals.

Appendix E5

Relationship between Annual Rainfall (Rannual), Forest (For) and total flow (Qwet) in upper part of Pasak Basin at S4B station, Thailand

Multiple regression analysis: $Y = a + bX_1 + cX_2$
Dependent variable: Qtotal
Independent variables: Rannual
For

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	-274.86	118.531	-2.3188	0.0456
Rannual	0.245322	0.0580518	4.22592	0.0022
For	0.0015224	0.00065619	2.3201	0.0455

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	22620.4	2	11310.2	9.75	0.0056
Residual	10438.2	9	1159.8		
Total(Corr)	33058.6	11			

R-squared = 68.4252 percent
Standard Error of Est. = 34.0558
Mean absolute error = 23.5117
Durbin-Watson statistic = 1.20925 (P=0.0247)

The Explaining Results

The output shows the results of fitting a multiple linear regression model to describe the relationship between Qtotal and 2 independent variables. The equation of the fitted model is

Qtotal = -274.86 + 0.245322*Rannual + 0.00152243*For

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between the variables at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 68.4252% of the variability in Qtotal. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 61.4086%. The standard error of the estimate shows the standard deviation of the residuals to be 34.0558. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 23.5117 is the average value of the residuals.

Appendix E6

Relationship between Annual rainfall (Rannual) and Wetflow (Qwet) in upper part of Pasak Basin at S4B station, Thailand

Regression analysis: Linear model Y = a + b*X
Dependent variable: Qwet
Independent variable: Rannual

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	-66.6419	51.5184	-1.2935	0.2249
Rannual	0.21932	0.049043	4.47203	0.0012

Analysis of Variance

Source	Sum of Squares	df	Mean Square	F-Ratio	P-Value
Model	17711.3	1	17711.3	20.00	0.0012
Residual	8856.06	10	885.606		
Total(Corr)	26567.4	11			

Correlation co-efficient = 0.8547
R-squared = 66.6656 percent
Standard Error of Est. = 29.7591
Mean absolute error = 23.3688
Durbin-Watson statistic = 1.30576 (P=0.0929)

The Explaining Results

The output shows the results of fitting a multiple linear regression model to describe the relationship between Qwet and 1 independent variable. The equation of the fitted model is

Qwet = -66.6419 + 0.219323*Rannual

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between the variables at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 66.6656% of the variability in Qwet. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 63.3322%. The standard error of the estimate shows the standard deviation of the residuals to be 29.7591. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 23.3688 is the average value of the residuals.

Appendix E7

Relationship between Forest (For) and Dryflow (Qdry) in upper part of Pasak Basin at S4B station, Thailand

Regression analysis: Linear model Y = a + b*X

Dependent variable: Qdry
Independent variable: For

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	-86.8341	22.3644	-3.8827	0.0030
For	0.00081743	0.00016666	4.90463	0.0006

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	1925.58	1	1925.58	24.06	0.0006
Residual	800.477	10	80.0477		
Total(Corr)	2726.06	11			

R-squared = 70.6361 percent
Standard Error of Est. = 8.94694
Mean absolute error = 5.5771
Durbin-Watson statistic = 1.90795 (P=0.3038)

The Explaining Results

The output shows the results of fitting a multiple linear regression model to describe the relationship between Qdry and 1 independent variables. The equation of the fitted model is

Qdry = -86.8341 + 0.000817439*For

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between the variables at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 70.6361% of the variability in Qdry. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 67.6997%. The standard error of the estimate shows the standard deviation of the residuals to be 8.94694. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 5.5771 is the average value of the residuals.

Appendix E8

Relationship between Rannual and Annual flow (Qtotal) in Upper part of Pasak Basin at S4B station, Thailand

Regression analysis: Non-linear model $Y = a * X^{b}$

Dependent variable: Qtotal
Independent variable: Rannual
Linear expression: LnY = Ln*a + b*LnX

Coefficients

	Least Squares	*Standard*	*T*	
Parameter	*Estimate*	*Error*	*Statistic*	*P-Value*
Intercept	-1.50103	1.45143	-1.03417	0.3254
Slope	1.24298	0.48220	2.57771	0.0275

Analysis of Variance

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Model	0.0987328	1	0.0987328	6.64	0.0275
Residual	0.148592	10	0.0148592		
Total(Corr)	0.247325	11			

Correlation Coefficient = 0.631825
R-squared = 39.9203 percent
Standard Error of Est. = 0.121898
Mean absolute error = 0.0881305
Durbin-Watson statistic = 0.956633 (P=0.0206)

The explaining results

The output shows the results of fitting a linear model to describe the relationship between Qtotal and Rannual. The equation of the fitted model is

Qtotal = -1.50103 + 1.24298*Rannual

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between Qtotal and Rannual at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 39.9203% of the variability in Qtotal. The correlation coefficient equals 0.631825, indicating a moderately strong relationship between the variables. The standard error of the estimate shows the standard deviation of the residuals to be 0.121898. This value can be used to construct prediction limits for new observations by selecting the Forecasts option from the text menu.

Appendix E9

Relationship between Rannual, Forest and Annual flow (Qtotal) in Upper part of Pasak Basin at S4B station, Thailand

Regression analysis: Non-linear model $Y = a * X^{b} * Y^{c}$

Dependent variable: Qtotal
Independent variables: Rannual
For
Linear expression: LnY = Ln*a + bLogX + cLogY

		Standard	*T*	
Parameter	*Estimate*	*Error*	*Statistic*	*P-Value*
CONSTANT	-9.1721	3.76725	-2.4347	0.0377
Rannual	1.46235	0.42504	3.44048	0.0074
For	1.3688	0.63461	2.15689	0.0594

Analysis of Variance

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Model	0.149368	2	0.0746838	6.86	0.0155
Residual	0.097957	9	0.0108841		
Total Corr)	0.247325	11			

R-squared = 60.3933 percent
Standard Error of Est. = 0.104327
Mean absolute error = 0.0678524
Durbin-Watson statistic = 1.25942 (P=0.0305)

The explaining results

The output shows the results of fitting a multiple linear regression model to describe the relationship between Qtotal and 2 independent variables. The equation of the fitted model is

Qtotal = -9.17212 + 1.46235*Rannual + 1.3688*For

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between the variables at the 95.0% confidence level.
The R-Squared statistic indicates that the model as fitted explains 60.3933% of the variability in Qtotal. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 51.5919%. The standard error of the estimate shows the standard deviation of the residuals to be 0.104327. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu.

Appendix E10

Relationship between Rannual and Suspended sediment (SS) in Upper part of Pasak Basin at S4B station, Thailand

Regression analysis: Linear model Y = a + b*X

Dependent variable: SS
Independent variables: Rannual

		Standard	*T*	
Parameter	*Estimate*	*Error*	*Statistic*	*P-Value*
CONSTANT	-205385	5633.0	-36.461	0.0175
Rannual	276.58	5.14911	53.7141	0.0119

Analysis of Variance

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Model	6.61369E9	1	6.61369E9	2885.20	0.0119
Residual	2.29228E6	1	2.29228E6		
Total(Corr)	6.61598E9	2			

R-squared = 99.9654 percent
Standard Error of Est. = 1514.03
Mean absolute error = 822.585
Durbin-Watson statistic = 2.9925

The Explaining results

The output shows the results of fitting a multiple linear regression model to describe the relationship between SS and 1 independent variables. The equation of the fitted model is

SS = -205385. + 276.58*Rannual

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between the variables at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 99.9654% of the variability in SS. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 99.9307%. The standard error of the estimate shows the standard deviation of the residuals to be 1514.03. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu.

Appendix E11

Relationship between Total flow (Qwet) and Suspended sediment (SS) in middle part of Pasak Basin at S13 station

Dependent variable: SS
Independent variables: Qwet

		Standard	T	
Parameter	Estimate	Error	Statistic	P-Value
CONSTANT	-17247.4	6039.82	-2.85561	0.0095
Qwet	240.985	27.2748	8.83544	0.0000

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	8.33785E9	1	8.33785E9	78.07	0.0000
Residual	2.24294E9	21	1.06806E8		
Total(Corr)	1.05808E10	22			

R-squared = 78.8018 percent
Standard Error of Est. = 10334.7
Mean absolute error = 6976.54
Durbin-Watson statistic = 1.29544 (P=0.0412)

The explaining results

The output shows the results of fitting a multiple linear regression model to describe the relationship between SS and 1 independent variable. The equation of the fitted model is

SS = -17247.4 + 240.985*Qwet

Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between the variables at the 95.0% confidence level.

The R-Squared statistic indicates that the model as fitted explains 78.8018% of the variability in SS. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 77.7924%. The standard error of the estimate shows the standard deviation of the residuals to be 10334.7. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu.

Appendix E12

Relationship between Rannual, Total flow (Qtotal), Forest and Suspended sediment (SS) in lower part of Pasak Basin at S9 station, Thailand

Regression analysis: Linear model $Y = a + b*X_1 + c*X_2$

Dependent variable: SS
Independent variables: Qtotal, Rannual, For

		Standard	T	
Parameter	*Estimate*	*Error*	*Statistic*	*P-Value*
CONSTANT	784546.	780607.	1.00505	0.3308
Qtotal	1936.54	597.789	3.23951	0.0055
Rannual	-134.17	339.671	-0.39500	0.6984
For	-1.4569	1.32362	-1.10069	0.2884

Analysis of Variance

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Model	2.34601E11	3	7.82002E10	4.15	0.0251
Residual	2.82979E11	15	1.88653E10		
Total Corr)	5.1758E11	18			

R-squared = 45.3265 percent
Standard Error of Est. = 137351.
Mean absolute error = 83996.9
Durbin-Watson statistic = 1.59288 (P=0.0945)

The Explaining results

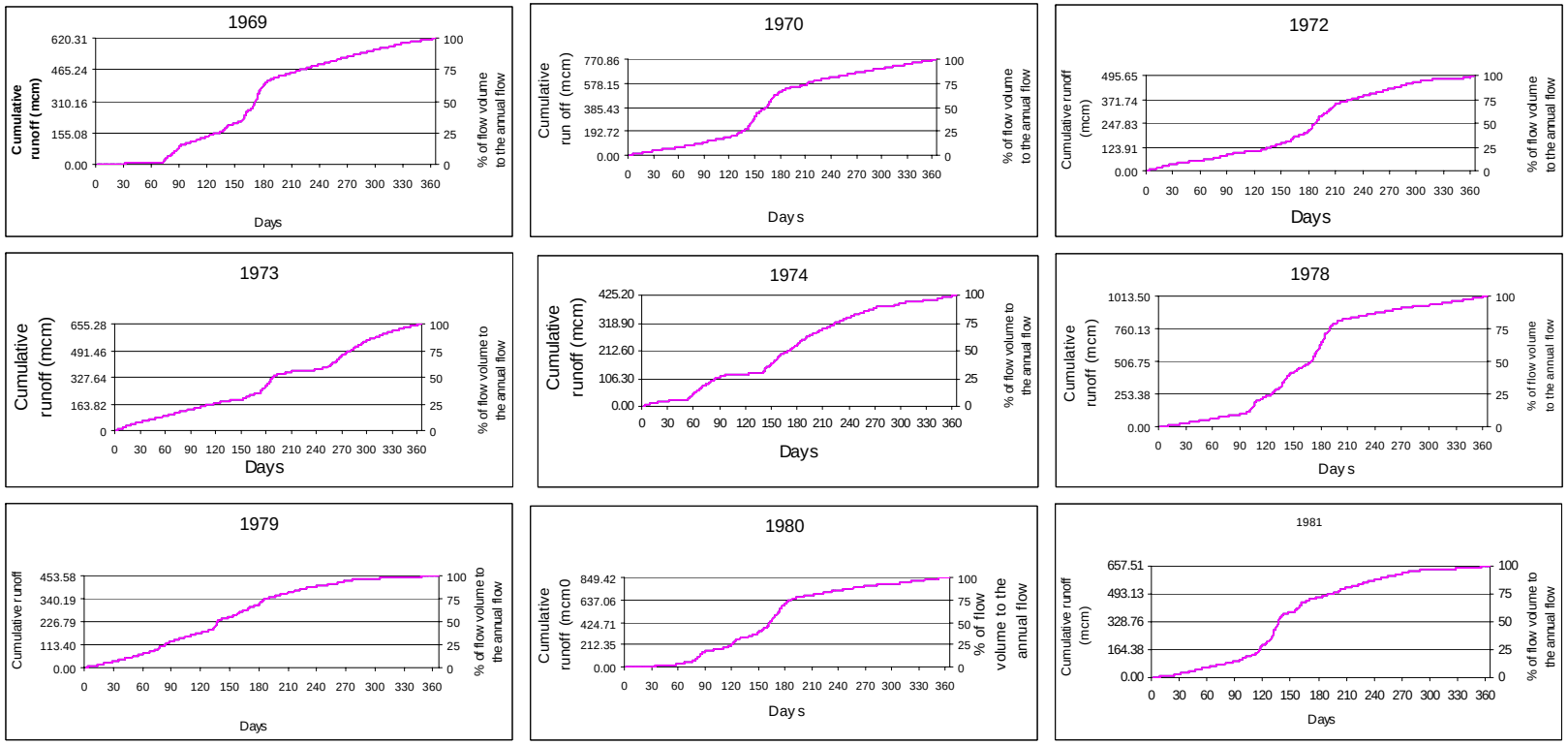
The output shows the results of fitting a multiple linear regression model to describe the relationship between SS and 3 independent variables. The equation of the fitted model is

SS = 784546. + 1936.54*Qtotal - 134.172*Rannual - 1.4569*For

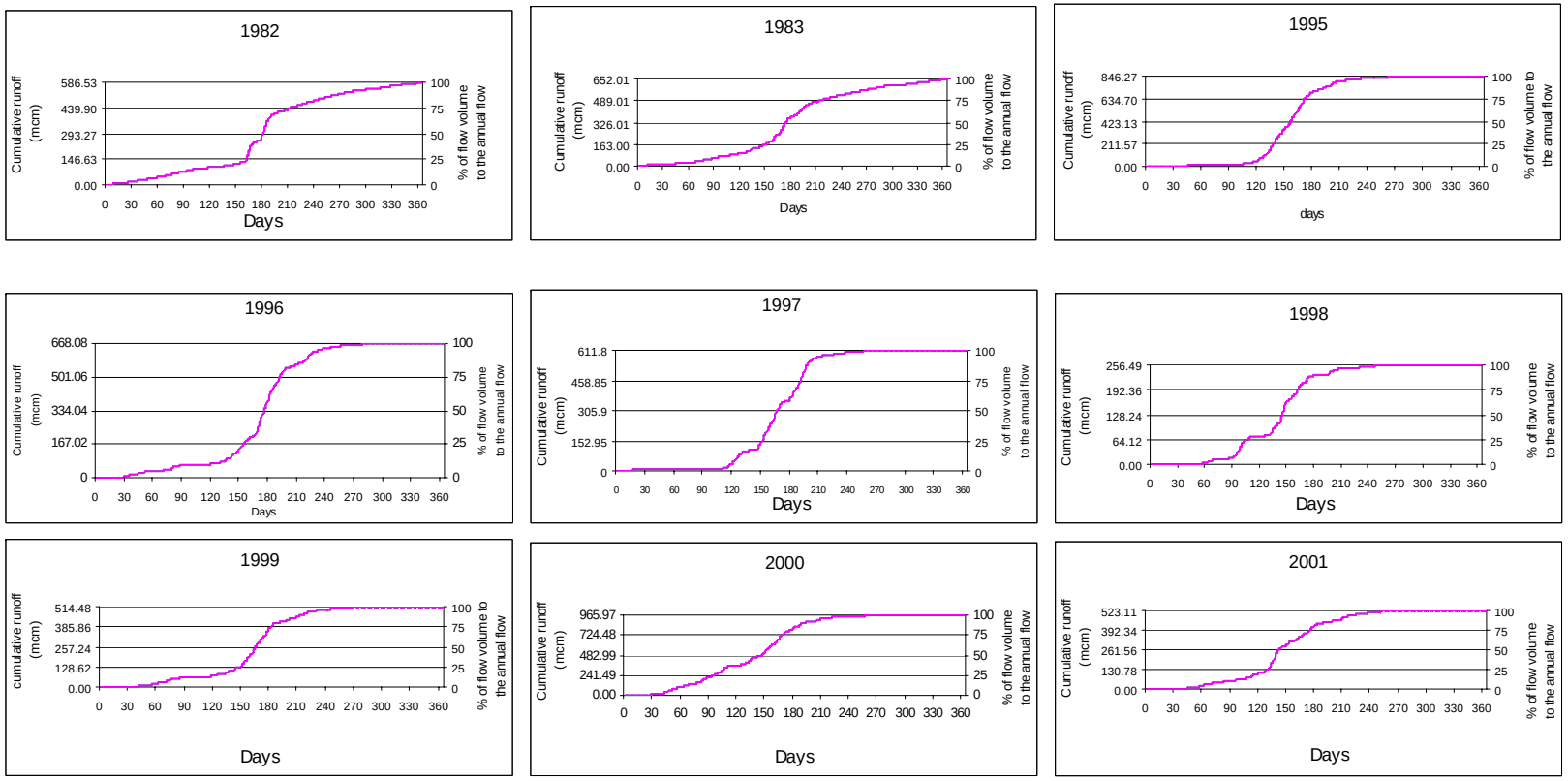
Since the P-value in the ANOVA table is less than 0.05, there is a statistically significant relationship between the variables at the 95.0% confidence level.
The R-Squared statistic indicates that the model as fitted explains 45.3265% of the variability in SS. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 34.3918%. The standard error of the estimate shows the standard deviation of the residuals to be 137351. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu.

Appendix F

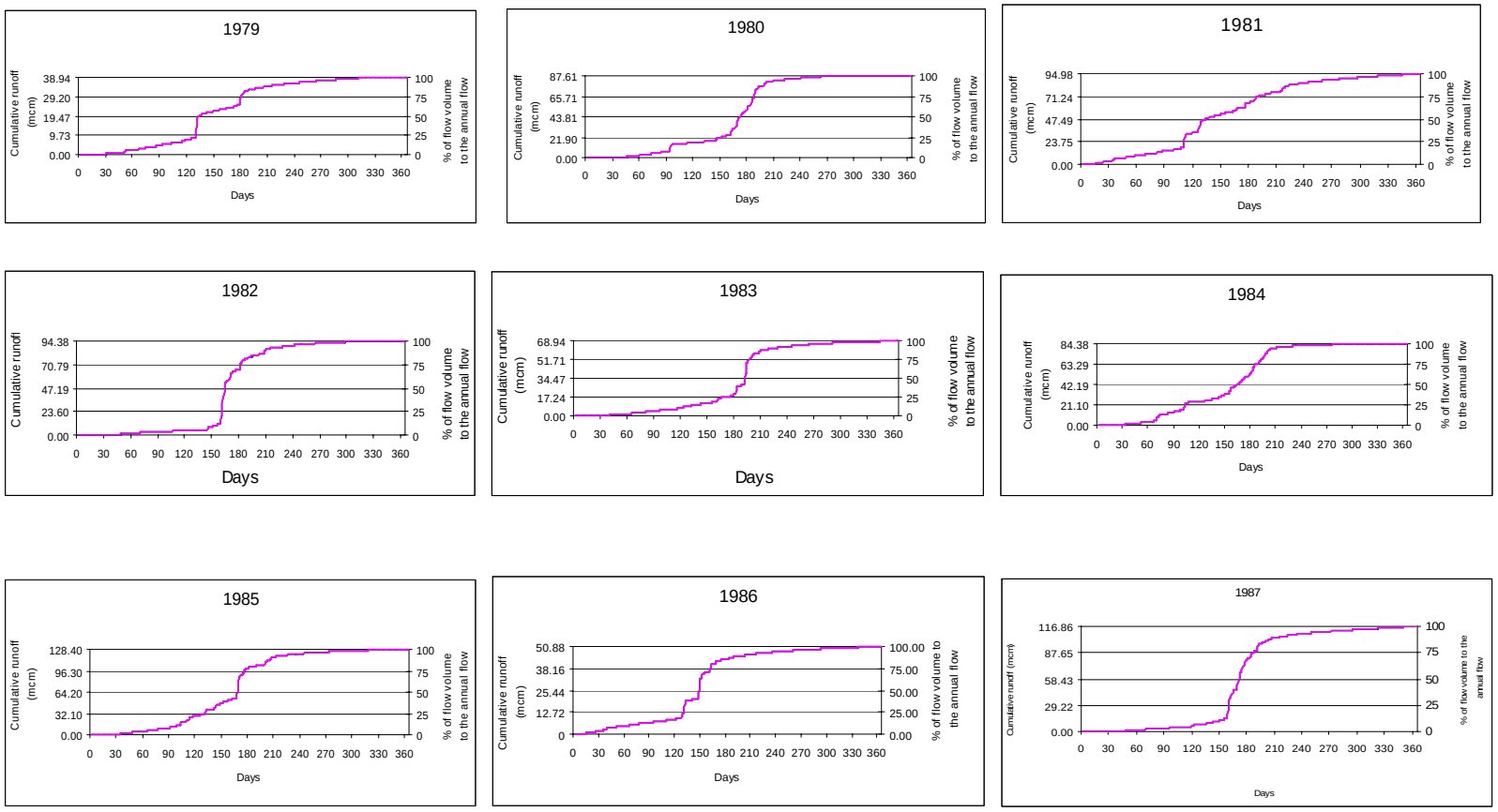
Streamflow timing



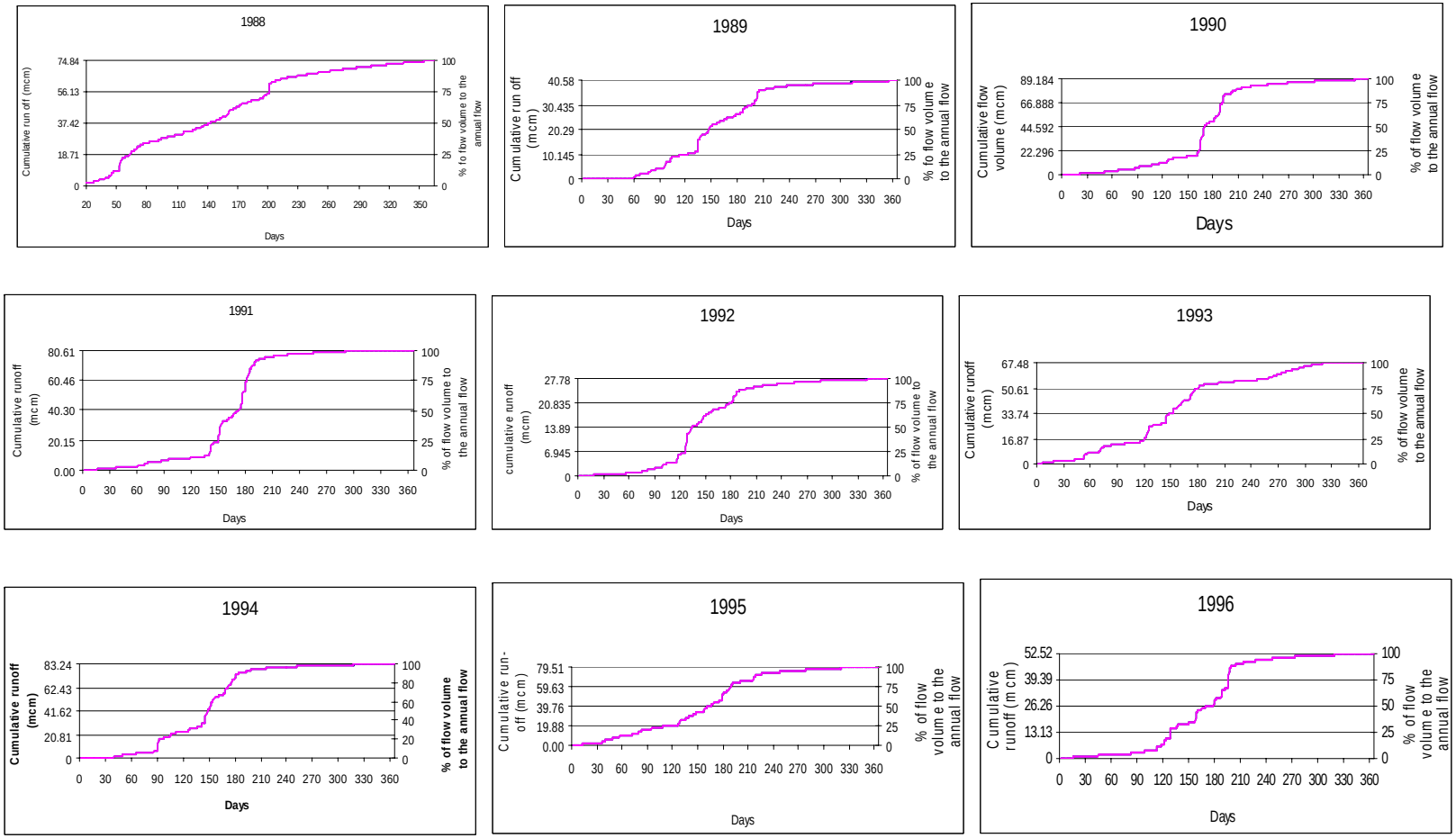
Appendix Figure F1 Streamflow timing estimation for Pasak watershed at Mueang, Mueang Phechabun (S4B) during water year 1969 – 1981.
Note: 1971-many missing data, 1975-1977-data not available.



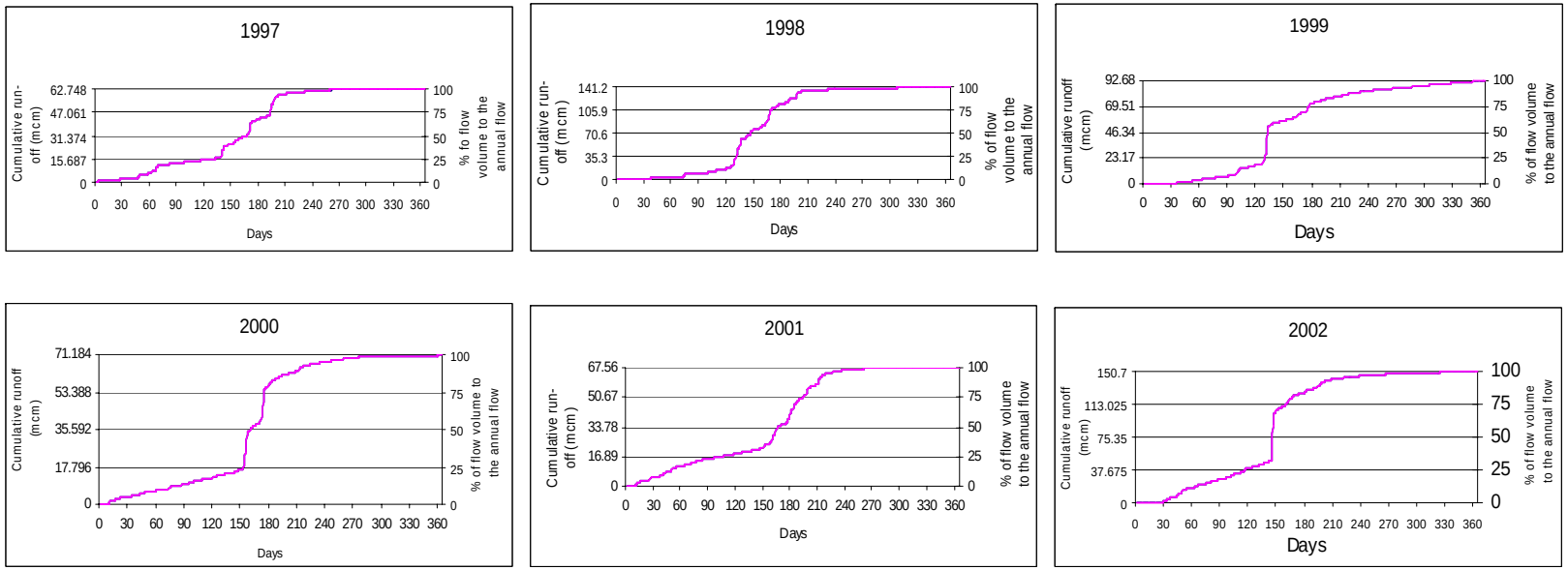
Appendix Figure F2 Streamflow timing estimation for Pasak watershed at Mueang, Mueang Phechabun (S4B) during water year 1982 – 2001.
Note: 1984-1994 data not available.



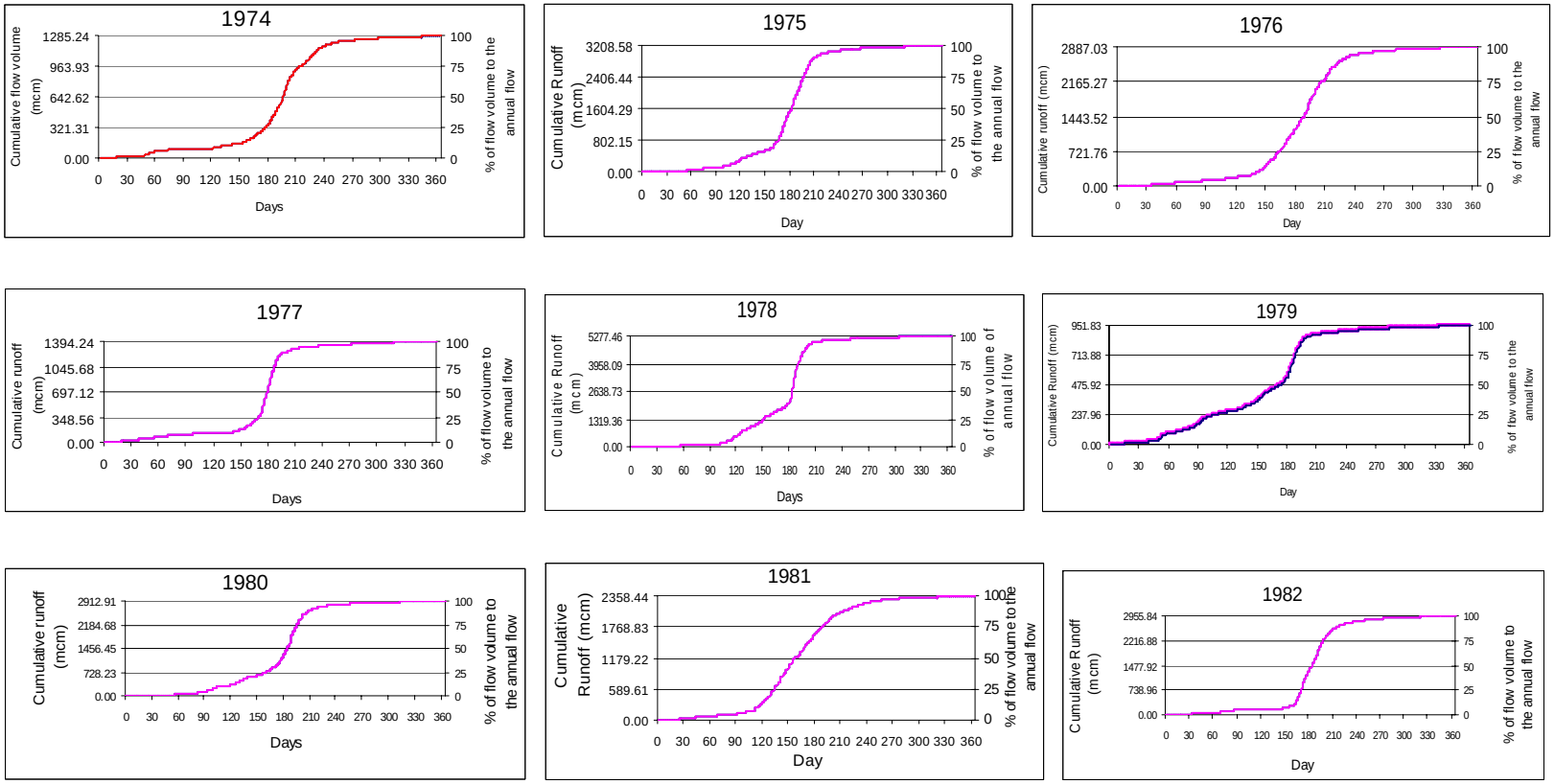
Appendix Figure F3 Streamflow timing estimation for Pasak watershed at Ban Tha Yiam, Lom Santhi, Lop Buri (S13) during water year 1979-1987.



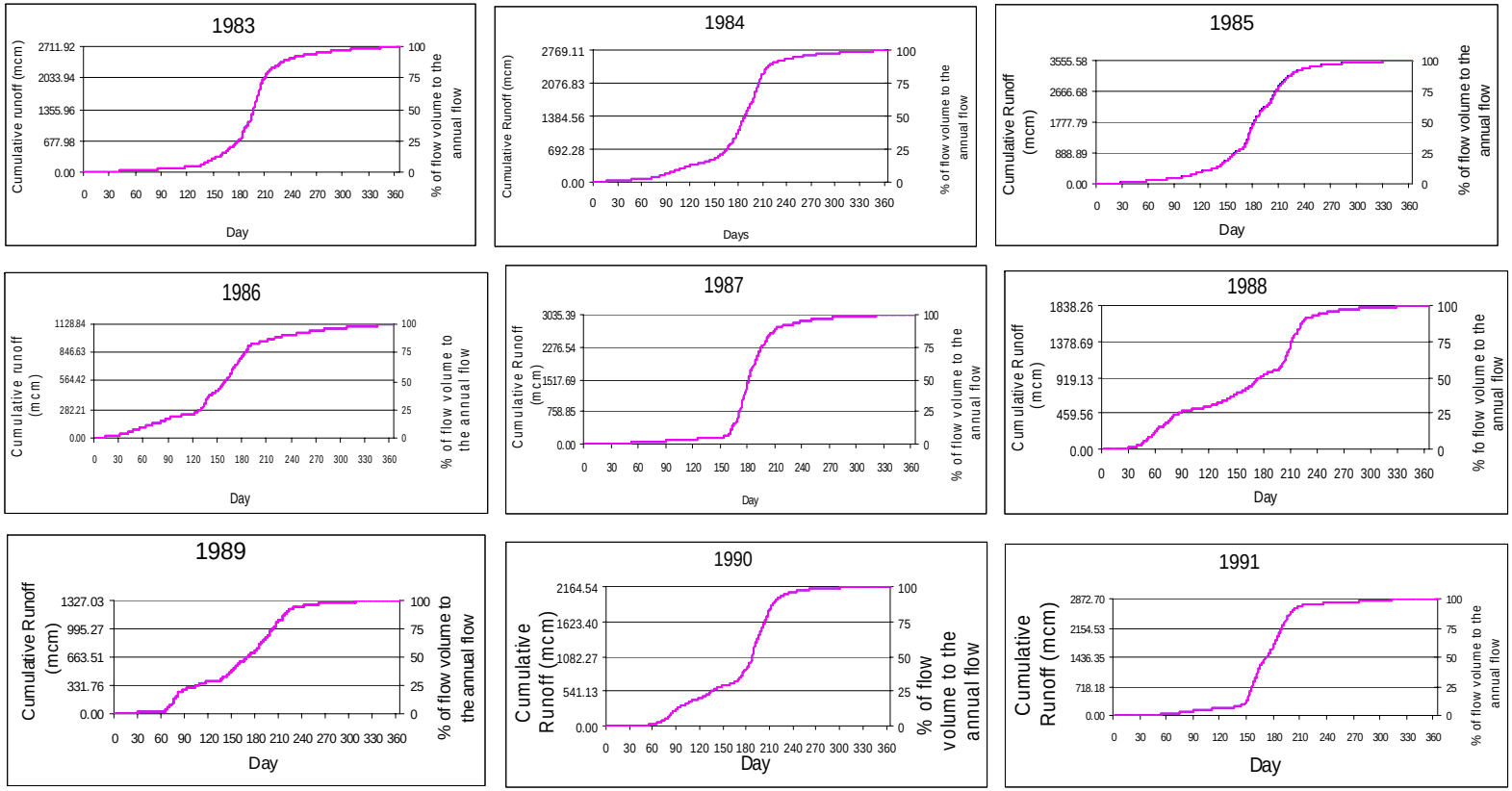
Appendix Figure F4 Streamflow timing estimation for Pasak watershed at Ban Tha Yiam, Lom santhi, Lop Buri (S13) during water year 1988-1996.



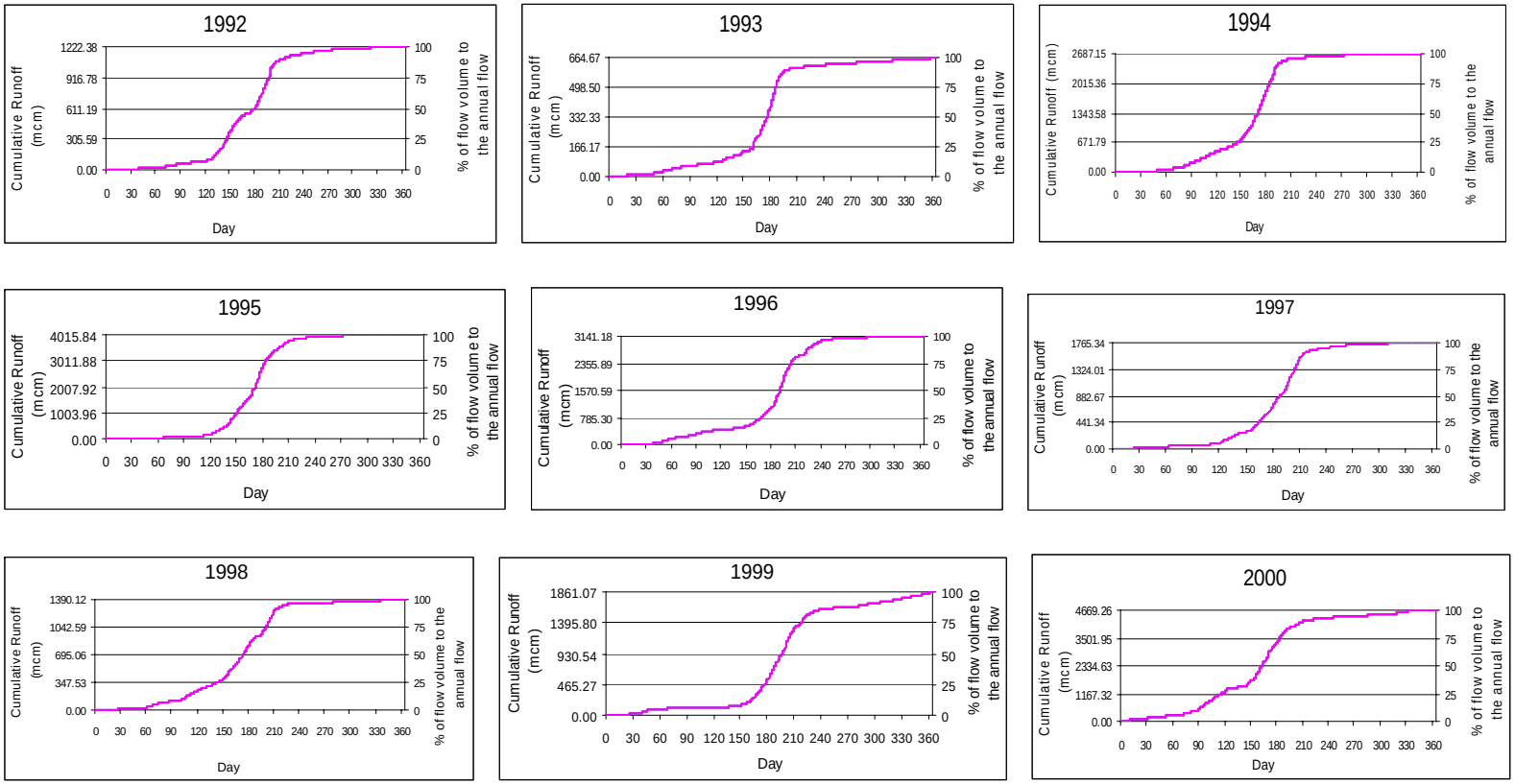
Appendix Figure F5 Streamflow timing estimation for Pasak watershed at Ban Tha Yiam, Lom Santhi, Lop buri (S13) during water year 1992-2002.



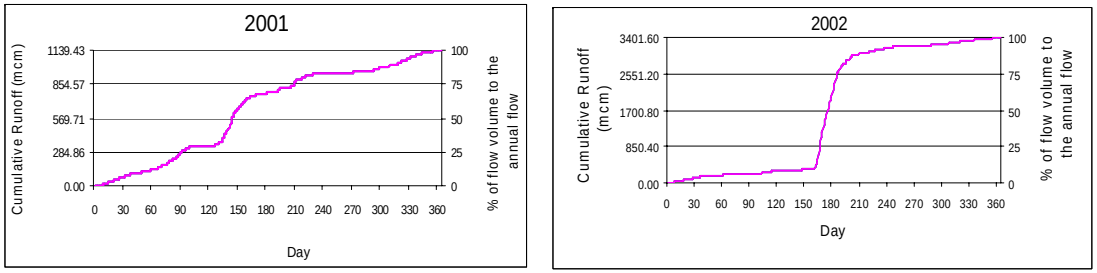
Appendix Figure F6 Streamflow timing estimation for Pasak watershed at Ban Pa, Kaeng Khoi, Sara Buri (S9) during the water year 1974 – 1982.



Appendix Figure F7 Streamflow timing estimation for Pasak watershed at Ban Pa, Kaeng Khoi, Sara Buri (S9) during the water year 1983 – 1991.



Appendix Figure F8 Streamflow timing estimation for Pasak watershed at Ban Pa, Kaeng Khoi, Sara Buri (S9) during the water year 1992 – 2000.



Appendix Figure F9 Streamflow timing estimation for Pasak watershed at Ban Pa, Kaeng Khoi, Sara Buri (S9) during the water year 2001 – 2003.