CHAPTER V

DISCUSSION OF RESULTS

5.1 River Flow

From data of average monthly flow, average maximum and minimum monthly flows(from 1666 - 1972) in Appendix IV, it is evident that the average monthly flow of all gaging stations starts to increase from 0.4 - 25.7 cms. in April and reaches maximum value, 4.7-627.7 cms.during August and September, and sometimes in October. From October, the flow begins to decrease and reaches the minimum value during March and April. This is due to the pre-monsoon or South wind may cause light rain during February and April and the Southwest Monsoon (from May to October) causes the rain to increase steadily in intensity and frequency but the wettest month is usually September. In November the Northeast Monsoon with cool and rainless starts; so the rain decreases during October to November. In December, January and February the rain is parctically negligible.

5.2 Flow-Catchment Area Relationship

Table 2 to 6 and Appendix II show that the average monthly flow, average maximum and minimum monthly flow, average annual flow, and average maximum and minimum annual flow vary as the exponential function of the catchment area. The range of the exponents are summarizied below

	Range of exponents for the twelve months in a year, n_1		
	Set (1)	Set(2)	Set (3)
1. For average monthly flow	1.5600-2.7698	1.9192-3.1422	2.1969-4.1257
2 For average maximum monthly flow	1.0459-2.5325	1.2258-3.1184	1.4527-4.0964
3 For average minimum monthly flow	2.0139-2.9347	2.3824-3.2524	2.8024-4.1255
4 For average annual flow	1.9526	2.3605	3.0457
5 For average maximum annual flow	1.2385	1.6875	2.3709
6 For average minimum annual flow	3.0313	2.7436	3.2673

From these results, it is evident that the exponents of set (1), set (2) and set (3) are quite different and the exponent of set (2) is larger that that of set (1) and set (3) than set (2). This is due to the difference in characteristics of the sub-basins of some gaging stations, such as, tributaries or variation in channel profile, absorptive capacity, and precipitation. Eight gaging stations were used in this investigation, three stations (K9, K10, K13) are on the Kwae Noi river, one (K17) on the Lam Pachee river, three (K6, K19, K20) on Kwae Yai river and one (K12) on the Lam Thaphoen river. The physical characteristics and hydrological conditions on the Lam Pachee basin is quite different from the Kwae Noi, the Kwae Yai and the Lam Thaphoen basins. The Lam Pachee basin has smaller channel profile and lesser amount of annual rainfall than other three basins. Moreover the distribution of rain in the Lam Pachee basin is uneven. In comparing between the Kwae Yai and the Kwae Noi basins, the physical characteristics is almost identical but the precipitation of the Kwae Noi basin which receives its rain from Southwest Monsoon is more than the Kwae Yai basin. This is because the Kwae Noi basin is in the western part and, therefore, will get more rain than the Kwae Yai basin. However, the upper part of the Kwae Yai and the Kwae Noi basins have more slope and get more rain than the lower part. In this way, the station K13 which is located in the upper part of the Kwae Noi basin and the station K19 in the upper part of the Kwae Yai basin yield higher specific run-off (run-off per unit catchment area) than the other stations in the lower part. This is the reason why the exponents of set (1) which includes all eight gaging stations (K6, K9, K10, K12, K13, K17, K19 and K20), set (2) which neglects station K17 , and set (3) which neglects stations K17, K13, and K19 are different. However, the exponents of the average maximum monthly flow are less than these of the average monthly flow and the exponents of the average minimum flow are greatest. This shows that the exponents decrease with the increase of flows. In other regions, the exponent for river in Central New Mexico is 0.79, in England and Wales 0.85, in India 0.67-0.75, in Italy 0.33, in Thailand for Ping river 0.923-1.225, for Thung Ma Hiu Project 0.8 and in U.S.A., for Texas and East Coast watershed 1.0-1.1. For the Mae Klong basin it varies from 1.0 to 4.0, having the average value of 2.5 which is greater than those for the other regions. This may be due to two causes: 1) The Mae Klong basin behaves abnormally from others because the slope of basin is high and varies so much from 1-2.5% , the upper part, to 0.0014%, the lower part,between the Tha Maka and Gulf. Moreover the rainfall is uneven and more in the upper part. 2) The data for this investigation are taken covering a reasonable time span with only one station, K6 having a record of more than twenty years while the other stations have records ranging from 4 to 11 years. Therefore, some errors may be induced into this investigation.

5.3 Flow at Any Return Period

5.3.1 Flood

The flood magnitude of all gaging stations in the Mae Klong basin (by Gumbel's formula) is summarized as follows:-

Flood at Any Return Period in cms.

Return Period T, years	Kwae Noi River			Lam Pachee River	Kwae Yai River			Lam Taphoen River	Mae Klong River	
	K13	K9	K10	K17	K19	K6	K20	K12	K4	K11
2.33	1976.50	1937.94	2030.31	177.37	844.27	1280.97	808.38	24.53	2626.98	2241.14
100	4449.71	3616.26	3899.21	453.09	1919.44	2987.75	1775.15	66.98	5526.92	3959.01
1000	5964.23	4644.24	5043.91	612.96	2577.98	4033.15	2367.31	92.97	7303.14	5011.21

Specific Flood at Any Return Period in lit. per sec per sq.km.

Return Period T, years	Kwae Noi River			Lam Pachee River	Kwae Yai River			Lam Taphoen River	Mae Klong River	
	K13	K9	K10	K17	K19	K6	K20	K12	K4	K11
2.33	488.39	280.78	289.71	130.90	91.61	108.66	67.57	10.48	96.57	82.31
100	1099.51	523.94	556.39	334.81	208.27	253.44	148.39	28.62	203.05	145.40
1000	1473.74	672.88	719.74	459.01	279.73	342.11	197.89	39.73	263.30	184.05

From the results, the flood magnitude increases with catchment area and ranges from 25 to 2627 cms. for 2.33 years return period, 67 to 5527 cms. for 100 years, and 90-7300 cms. for 1000 years. The specific flood magnitude ranges from 10 to 488 lit per sec. per sq.km. for 2.33 years return period, 29-1100 lit per sec per sq. km. for 100 years, and 40-1474 lit per sec per sq.km. for 1000 years. However, in the Kwae Noi river the flood in the head water, station K13 is larger than at other stations (K9, K10 and K17) which are located down stream of K13 because the upper part of the Kwae Noi river receives more rain (1600 m.m.) and has higher slope (1%) than the lower part (1100 m.m. and .05%) as mentioned before in chapter II, and station K13 also has greatest specific flood in the basin. By comparising between the Kwae Noi and the Kwae Yai rivers, it is evident that the floods at any return period of the stations K13, K19 and K10 with smaller catchment areas (4047 - 7008 sq.km.) in the Kwae Noi river are larger than these at stations K19, K6 and K20 with larger catchment areas (9216 - 11963)sq.km.) in the Kwae Yai river. This is due to the Kwae Noi river which rises in the west of the Kwae Yai river. Therefore, it receives more rain from the Southwest Monsoon than the Kwae Yai river although the Kwae Yai river also has steep bed channel profile than the Kwae Noi river.

However, it is noticeable that the station K20 with the catchment area of 11,963 sq.km. has smaller flood at any return period than the station K6, located just up-stream and with the catchment area of 11,789 sq.km., although these two stations have the same physical and hydrological corriditions. This shows that the 6-year flow record of the station K20 is insufficient and thus an error is induced in the flow analysis. The same situation as mentioned above occurs again at the station K11 which locates just downstream of the station K4 but in this case there are two causes, firstly, the flow record of the station K11 is insufficient, and secondly, the flow of the station K11 is affected by the tidal change in the estuary of the lower Mae Klong river.

For similar observed floods the estimated return periods, T_x obtained by Plotting Positions formulas correspond very well with those by Gumbel's formula. This is shown in Appendix I. In other words every formulas give almost the same values of T_x for the low floods and the normal floods. However, for the high floods, the Gumbel's formula yield rather high values of T_x

The results plotted by using Gumbel's and Weibull formulas in a Gumbel's paper are as shown in Appendix II. They show a very good only the high flood magnitude, the return period by Weibull formula is less than Gumbel's formula.

5.3.2 Drought

The annual and monthly drought magnitudes of all gaging stations in the basin (by Gumbel's formula) are summarized below

Annual and Monthly Drought at 2.33 and 10-yr Return Period in cms.

	Kwae Noi River			Lam Pachee River	Kwae Yai River			Lam Taphoen River	Mae Klong River	
	K13	K9	K10	K17	K19	K6	K20	K12	K4	K11
T = 2.33 years										
April	8.521	11.172	11.408	0.0207	13.670	14.918	15.295	0.0282	38.813	30.776
December	28.347	31.046	36.974	0.4449	33.216	41.333	40.354	0.0794	111.824	91.755
February	12.519	17.547	17.750	0.1534	18.776	21.344	21.717	0	57.178	49.397
Annual	6.985	9.732	10.040	0	12.525	13.174	14.107	0.0023	29.619	29.755
T = 10 years										
April	7.188	8.138	7.117	0	10.539	7.568	8.730	0	18.160	7.670
December	24.510	17.701	24.100	0	16.170	19.085	26.161	0	67.485	42.766
February	8.724	12.118	10.983	0	14.112	11.356	13.835	0	29.828	24.968
Annual	4.251	5.755	5.216	0	9.357	7.365	8.475	0	11.660	10.960

From results as shown in Table pp71, it can be shown that the drought magnitude of 2.33-year return period in the basin increases with the catchment area and ranges from 0 to 30 cms. for the annual, 0 to 39 cms. for April, 0 to 112 cms. for December and 0 to 57 cms. for February. For 10-year return period, it ranges from 0 to 12 cms., 0 to 18 cms., 0 to 67 cms. and 0 to 30 cms. for the annual, April, December and February respectively. The severe drought occurs during February and April. The interesting results can be seen from the results of stations K12 and K17 which have a zero drought magnitude for a 2.33-year return period and in the real situation.the drought magnitudes of Station K12 and K17 are obviously zero in some year. This shows that the results is reasonable. From Appendix I and II, it can be shown that the drought magnitude of all gaging stations by Gumbel's formula is smaller than by Plotting Positions formulas especially Weibull formula, but the results from Gumbel's equation should be used in the design because it is on the safeside.

5.4 Correlation

The results of the correlations of the records from the various gaging stations are summarized in Table 9. The results show that the correlation between the records from two gaging stations on the same river is strong. The correlation coefficient between the stations K4 and K11 on the Mae Klong river is 0.9985, 0.9805 between K6 and K20 on the Kwae Yai river, and 0.9896 between K9 and K13 on the Kwae Noi river. The correlations between the records from the stations on the Kwae Yai and the Kwae Noi rivers, the Kwae Yai and the Mae Klong rivers, and the Kwae Noi and the Mae Klong rivers are relatively high. The correlation coefficients between K6 and K10, K6 and K4, K9 and K4 are 0.844, 0.9605 and 0.9542 respectively. This may be due to similarity of the river characteristics. It means that there are inter-correlations among the Kwae Yai, the Kwae Noi and the Mae Klong rivers. However, the correlation coefficients between the stations on the Lam Pachee and the Kwae Yai rivers, the Lam Pachee and the Kwae Noi rivers, the Lam Thaphoen and the Kwae Yai rivers, the Lam Taphoen and the Kwae Noi rivers, and the Lam Thaphoen and the Lam Phachee rivers are very low. The correlation coefficients between stations K17 and K6, K17 and K9, K12 and K6, K12 and K9, and K17 and K12 are 0.2638, 0.1173, 0.3978, 0.2336 and 0.6415 respectively. This implies that there are weak correlations of flows between these stations. This may be because of differences in characteristics and climate.