CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The purpose of this study is to find the basic characteristics of the Mae Klong basin by using suitable methods and formulas such as using the least square method for finding relationship between runoff and catchment area, Gumbel's formula for estimating the flood and the drought at any return period. The results of this investigation are summarized as follows.

1. The flows of all gaging stations start to increase from April and reaches the maximum during August and September, then decreases and reaches the minimum during March and April. For example station K6, the average monthly flow increases from 23.2 cms. in April and reaches maximum 327 cms. in September and decreases to minimum 22.95 cms. in March which corresponds with the rainfall distribution in that period.

2. The relationship between the flow and the catchment area can be expressed by the exponential equation

$$Q = K_1 A^{n_1}$$

a) For the average maximum monthly flow, $\bar{Q}_{m_{max}}$

K_I varies from 0.37736×10^{-13} to 0.28770×10^{-1}

n_I varies from 1.0459 to 4.0964

b) For the average monthly flow, $\bar{Q}_m$

K_I varies from 0.14187×10^{-13} to 0.14888×10^{-3}

n_I varies from 1.5600 to 4.1257

c) For the average minimum monthly flow, $\bar{Q}_{m_{min}}$

K_I varies from 0.88472×10^{-14} to 0.44213×10^{-6}

n_I varies from 2.0139 to 4.1255

d) For the average maximum annual flow, $\bar{Q}_{a_{max}}$

K_I varies from 0.35101×10^{-6} to 0.11472×10^{-1}

n_I varies from 1.2385 to 2.3709

e) For the average annual flow, $\bar{Q}_a$

K_I varies from 0.10241×10^{-9} to 0.24294×10^{-5}

n_I varies from 1.9526 to 3.04537

f) For the average minimum annual flow, $\bar{Q}_{a_{min}}$

K_I varies from 0.14566×10^{-11} to 0.20658×10^{-9}

n_I varies from 2.7436 to 3.2673

g) For the annual flood of 2.33-year return period

K_I varies from 0.69270×10^{-6} to 0.73660×10^{-2}

n_I varies from 1.3108 to 2.3225

h) For the annual flood of 10-year return period

K_I varies from 0.24864×10^{-5} to 0.22245×10^{-1}

n_I varies from 1.2381 to 2.2300

i) For the annual flood of 20-year return period

K_I varies from 0.34154×10^{-5} to 0.29669×10^{-1}

n_I varies from 1.2222 to 2.2106

j) For the annual flood of 50-year return period

K_I varies from 0.46949×10^{-5} to 0.39799×10^{-1}

n_I varies from 1.2073 to 2.1929

k) For the annual flood of 100-year return period

K_I varies from 0.56930×10^{-5} to 0.47668×10^{-1}

n_I varies from 1.1990 to 2.1830

l) For the annual drought of 2.33 -year return period

K_I varies from 0.55223×10^{-20} to 0.35813×10^{-16}

n_I varies from 4.4326 to 5.3590

m) For the monthly drought of 2.33-year return period in April

K_I varies from 0.49808×10^{-14} to 0.25050×10^{-11}

n_I varies from 3.2190 to 3.8757

n) For the monthly drought of 2.33-year return period in December

K_1 varies from 0.17514×10^{-13} to 0.11554×10^{-8}

n_1 varies from 2.6516 to 3.8517

From the above results, the value of n_1 decreases with magnitude of the flow for instance, n_1 of annual flood decreases from 1.3108 - 2.3225 for 2.33-year return period to 1.1990-2.1830 for 100-year return period and the value of K_1 increases with magnitude of flow, for instance, K_1 increases from $0.69270 \times 10^{-6} - 0.73660 \times 10^{-2}$ for 2.33-year return period to $0.56930 \times 10^{-5} - 0.47668 \times 10^{-1}$ for 100-year return period.

Finally it can be concluded that the runoff in the lower part of the Mae Klong basin, including the Lam Pachee sub-basin should be estimated from the equations of set (1), but in the above part and the bottom part of the upper part should be estimated from the equations of set (2) and set (3) respectively.

3. The annual flood magnitudes of the Mae Klong basin are found to be as follows

a) For 2.33-year return period, the flood magnitude ranges from 24.53 cms. at station K12 to 2626.98 at K4

b) For 100-year return period, the flood magnitude ranges from 66.98 cms. at station K12 to 5526.92 at K4

c) For 1000-year return period, the flood magnitude ranges from 92.97 cms. at station K12 to 7303.14 at K4

Table P. 68 shows that in general the flood increases with catchment area.

4. Drought magnitude of the basin is as follows:-

a) For the annual drought of 2.33-year return period the drought ranges from 0 cms. at station K17 to 29.619 at K4

b) For the monthly drought of 2.33-year return period

1. April

The drought varies from 0.0207 cms. at station K17 to 38.813 at K4

2. December

The drought varies from 0.0794 cms. at station K12 to 111.824 at K4

3. February

The drought varies from 0 cms. at station K12 to 57.178 at K4

4. For 10-year return period, the drought has lower limit at station K12 and K17 and upper limit at station K4 as shown below

0 - 11.660 cms. for annual

0 - 18.160 cms. for April

0 - 67.485 cms. for December

0 - 29.828 cms. for February

However, from Table in 5.3.2 the drought magnitude varies with catchment area and the severe drought occurs during February and April.

5. From correlation coefficients in Table 9, it is evident that the flows on the same river are strongly correlated ($r > 0.9$) because the flow came from the same sources and the characteristics of the river basin vary so little from upstream to downstream and correlation of the monthly flow of Kwae Yai and Kwae Noi rivers which is relatively high ($r > 0.8$) may be due

to the similarity of topographic, soil and hydrologic conditions of the Kwae Yai and the Kwae Noi sub-basins. However, the monthly flow of these two rivers have weak correlation with the Lam Thaphoen and the Lam Pachee rivers. This is due to the difference in sub-basins characteristics and slight difference in climate.

6. In this investigation the data of the flows at the stations below the Chao Nen Dam-site and the Vajiralongkorn Headworks were not affected by both dams since they were recorded before their completion. The Chao Nen Dam is located near the station K6 on the Kwae Yai river and the Vajiralongkorn Dam near the station K4 on the Mae Klong river. The former will be completed in 1979 and the latter was in 1970. However, the flows in the Mae Klong basin will be controlled by both dams after their completion. This will result in considerable change in the hydrologic characteristics of the Mae Klong basin depending on the operation of the dams.

7. The knowledge from this investigation can be applied in conjuntion with the Vajiralongkorn and Chao Nen Dams after the construction is completed as follows:

7.1 Flood Protection

According to the R.I.D. feasibility report, "First Stage Development for Irrigation and Flood Protection," if the flood discharge exceeds 3,100 cms. at Tha Muang, the river will overtop its banks below Tha Muang, and furthermore, if the flood discharge exceeds 5,000 cms., large area downstream will be inundated.

From this investigation, the return periods of floods with discharges of 3,100 cms. and 5,000 cms. at Tha Muang are about 5 years and 50 years, respectively, and about 42 percent of the flow of the Mae Klong river came from the Kwae Yai river. Thus, if the Chao Nen Dam can store all the flood from the Kwae Yai river, the flood at Tha Muang and downstream will probably be reduced roughly by about the same percentage. As a rough estimate the Chao Nen Dam will reduce the flood at Tha Muang by 33 percent, so the return period of floods 3,100 cms. and 5,000 cms. at Tha Muang will increase to about 30 years and 1,000 years, respectively.

7.2 Drought Protection, Irrigation Project, Navigation, Salinity Control and River Pollution

From the R.I.D. feasibility report, "First and Second Stage Development for Irrigation, Flood Control and Hydro-Power", the water requirement along the downstream of the Vajiralongkorn Dam for navigation, domestic uses, and preventing saltwater intrusion in the estuary in the dry season is 50 cms. For irrigation project about 277 cms. is needed. Therefore, the total rate of requirement is 327 cms. Furthermore, at the present time there exists a river pollution problem resulting from the wastes of the factories below Karnchanaburi being drained into the river in the dry season. In order to solve this problem a considerable amount of water is required to flush the wastes into the Gulf.

This study clearly indicates that the mean minimum monthly flow (T = 2.33=yr.) in dry season (February to April) is about 35 cms. and is much less than 327 cms. plus some water for flushing the wastes. To meet this requirement, the excess flow during the months between July and November must be stored in both dams, especially the Chao Nen Dam and released in dry season.

6.2 Recommendations

Further investigation of this study should do as follows,

1. The rainfall and slope of the basin should be used in estimating of the runoff for elimination of the effect of non uniform rainfall distribution over the basin and of different slopes of each sub-basins. By this way, the form of the equation is

$$Q = K_3 A^{n_1} R^{n_2} S^{n_3}.$$

where Q = runoff

A = catchment area

R = rainfall

S = slope of basin or bed of channel

K_3, n_1, n_2, n_3 = constants

The values of K_3, n_1, n_2 and n_3 can be estimated by multi-regression analysis.

2. Try to find the flood and the drought in terms of the return period, T and the catchment area, A. The form of the equations are as follows;

For the flood

$$Q_T = K_1 (1 + C \ln T_x) \cdot A^{n_1}$$

(from equation 20)

For the drought

$$Q_T = K_1 (1 - C \ln T_{x_1}) A^{n_1}$$

where Q_T = flood or drought at return period T_x or T_x

T_x, T_{x_1} = return period, years

A = catchment area

K_1, C, n_1 = constants

3. To increase the accuracy of estimating the flood and drought at any return period, the stream records of the short-record stations should be extended and the missing data at some stations should be estimated from the long-record stations which have the complete data if the flow of those stations are highly correlated.