CHAPTER I

1.1 Introduction

The Mae Klong basin is the third largest basin in Thailand after the Chao Phya and Mune basins. It covers the main area of Kanchanaburi, Ratchaburi and Samut Songkharm provinces. Located in this region are many factories, agricultural area, and residences of most people in the Western part of Thailand. In recent years the agricultural area has been increased rapidly, particularly on the banks of the lower part of Khwai Yai, Khwai Noi and Lam Taphoen rivers. The increased farm produces in this region are cassava, corns, sugar-canes and other farm crops. The Royal Irrigation Department had developed the Mae Klong basin by constructing the Vajiralongkorn Barrage on the Mae Klong river at Tha Muang, which had been in service since 1970, and the Chao Nean Dam on the Khwai Yai river at Sri Sawat, which is under construction and is expected to be finished in 1979. The projects planned for further development are a dam on the Khwai Noi river at Khao Kwang and another on the Lam Taphoen river at Bo Phloi. The agricultural area, about 3,450,000 rais which include Kanchanaburi and the surrounding provinces, will be benefited by these plans. It shows that the Mae Klong river has vigorously influenced the economic conditions and the environments of the residents on its banks and its tributaries. Every year enormous damages on crops, properties, or even human lives are caused by flood in the rainy season. This results in the economic losses in the Western part of Thailand.

Past experiences reveal that adequate hydrologic study is necessary in the proper planning and management of flood protection. It is imperative therefore that the complete knowledge of flood magnitude and its frequency in the Mae Klong basin should be found. It is hoped to gain more knowledge of hydrologic study in the Mae Klong river, by evaluating the physical characteristics of the Mae Klong basin from the topographic map and to study their effects on the flood flow. The annual flood will then be related to the basin characteristics in the form of an exponential equation. By the equation showing the relationship between the annual flood and basin characteristics, the estimation of flood magnitude and its frequency can be made with more accuracy.

1.2 Literature Review

There are many past investigations which relate flood flow of some recurrence interval to the basin characteristics. Some of them are reviewed here as follows :

BODHAINE (1960) developed an empirical equation relating the mean annual flood to the mean annual runoff and basin characteristics for Western Washington. The equation is

$$Q = 0.638\, A^{0.89}\, R^{1.14}\, L^{-0.04}\, G$$

where Q = the mean annual flood in cfs.

A = the basin area in sq.mi.

R = the mean annual runoff in inches

L = the area of lakes and ponds in percent of basin area

G = the geographical factor

CARTER (1961) developed an empirical equation relating the mean annual flood to the lag time and basin characteristics, to determine the effect of urbanization on the mean annual flood in the vicinity of Washington D.C. This equation is

$$Q_{2.33} = 223\ K\ A^{0.85}\ T_3^{-0.45}$$

where $Q_{2.33}$ = mean annual flood in cfs. which is equivalent to the flood having a recurrence interval of 2.33 years

A = drainage area in sq. mi.

T_3 = lag time expressed in hours

K = an adjustment factor based upon the degree of imperviousness of the area.

The factor K was expressed as

$$K = \frac{0.30 + 0.0045\ I}{0.30}$$

where I = percentage of impervious cover

BENSON (1962) studied the relationship between the flood peak, the physiographic factors and the hydrographic factors of basins in the Western Gulf of Mexico. Multiple regression analysis was used to develop the relations and results are shown below :

$$Q_{2.33} = 22.9\ A^{1.20}\ P^{1.57}\ L^{-1.10}$$

$$Q_{2.33} = 19.7\ A.^{1.24}\ S_f^{-1.42}\ P^{1.62}\ L^{-1.10}$$

$$Q_5 = 51.5\ A^{1.05}\ S_f^{-1.81}\ P^{1.49}\ L^{-0.83}$$

$$Q_{10} = 2.08\ A^{0.71}\ S^{0.43}\ S_f^{-1.45}\ P^{2.36}$$

$$Q_{10} = 4.05\ A^{1.05}\ S^{0.38}\ S_f^{-1.53}\ P^{2.28}\ L^{-0.63}$$

$$Q_{25} = 1.11\ A^{0.97}\ S^{0.63}\ P^{2.68}\ L^{-0.43}$$

$$Q_{50} = 4.49\ A^{-0.95}\ S^{0.61}\ P^{2.28}\ L^{-0.49}$$

$$Q_{100} = 0.257\ A^{1.07}\ S^{1.01}\ P^{3.17}\ L^{-0.47}$$

where Q_T = peak discharge in cfs. of return period T years

A = drainage area in sq.mi.

P = rainfall intensity for a given duration in in./hr.

S = main channel slope

L = basin length in miles

S_f = surface area of lakes and ponds in sq.mi.

WU (1967) reported a peak discharge determination method from an extensive multiple regression analysis. Using Gumbel's method, two regression equations were developed :

For the windward side of Oahu

$$Q_{100} = 7.4\times10^{23}\ A^{1.31}\ L^{0.89}\ H^{-10.5}\ P^{5.24}$$

For Honolulu and between mountain ranges of Oahu

$$Q_{100} = 2.06\times10^{-6}\ A^{0.75}\ L^{-0.38}\ H^{1.39}\ P^{3.17}$$

where Q_{100} = 100-yr. peak discharge in cfs.

A = watershed area in acres

L = stream length in feet

H = height in feet

P = 24-hr. rainfall depth in inches

RODDA (1967) studied the flood peak records from 26 small basins in the United Kingdom and related to the characteristics of basin rainfall and basin characteristics. The regression analysis was used and the particular relationships were chosen as the prediction equations in the forms :

$$Q_{2.33} = 1.08\,A^{0.77}\,R_{2.33}^{2.92}\,D^{0.81}$$

$$Q_{10} = 1.22\,A^{0.69}\,R_{10}^{1.63}\,D^{1.06}$$

$$Q_{20} = 1.11\,A^{0.64}\,R_{20}^{1.63}\,D^{1.02}$$

$$Q_{50} = 1.24\,A^{0.51}\,R_{50}^{2.02}\,D^{0.94}$$

where A = basin area (sq.mi.)

R_T = annual daily maximum rainfall (inches) at T years return period

D = drainage density (mi./sq.mi.)

ARMENTROUT and BISSEL (1969) studied the relationship between channel slope and unit runoff by using 32 streams which were gaged by the U.S. Geological Survey. The streams studied are in the Washington D.C. vicinity of Maryland and Virginia. The equations for three recurrence intervals are :

$$q_{10} = 0.035\ S^{0.75}$$

$$q_{25} = 0.046\ S^{0.77}$$

$$q_{50} = 0.054\ S^{0.80}$$

where q = unit runoff in cfs.per acre

S = stream slope in feet per mile

PINKAYAN and SAHAGUN (1973) developed the functional relationship of the average annual stream flow, the drainage area and the mean annual rainfall for the Thung Ma Hiu irrigation project at Ubol Rajathani. The regression equations recommended are

$$Q_a = 0.029\ A^{0.870}$$

$$Q_{as} = 0.094\ A^{0.841}$$

$$Q_a = 2.467 \times 10^{-5}\ A^{1.033}\ R^{3.954}$$

$$Q_{as} = 2.113 \times 10^{-15}\ A^{0.983}\ R^{4.083}$$

where Q_a = mean annual streamflow in cms.

Q_{as} = standard deviation of annual streamflow in cms.

A = drainage area in sq.km.

R = catchment annual rainfall in mm.

ESPEY and WINSLOW (1974) developed empirical equations which predict the peak flow for a specified recurrence interval. By a multiple regression analysis of 27 Texas watersheds, the following equations were developed :

$$Q_{2.33} = 116\ A^{0.75}\ I^{0.28}\ \emptyset^{-1.09}$$

$$Q_{5} = 159\ A^{0.77}\ I^{0.27}\ \emptyset^{-1.23}$$

$$Q_{10} = 193\ A^{0.79}\ I^{0.27}\ \emptyset^{-1.40}$$

$$Q_{20} = 226\ A^{0.79}\ I^{0.27}\ \emptyset^{-1.58}$$

$$Q_{50} = 268\ A^{0.79}\ I^{0.26}\ \emptyset^{-1.83}$$

and for the 26 East Coast watersheds, the following equations were derived :

$$Q_{2.33} = 11700\ A^{0.73}\ S^{0.75}$$

$$Q_{5} = 16800\ A^{0.75}\ S^{0.76}$$

$$Q_{10} = 19800\ A^{0.67}\ S^{0.75}$$

$$Q_{20} = 21000\ A^{0.77}\ S^{0.72}$$

$$Q_{50} = 21200\ A^{0.78}\ S^{0.68}$$

Finally a total of 60 watersheds, including all the basins of Texas and East Coast watersheds, as well as four other watersheds from Missisippi, two from Michigan and one from Illinois, were used in the analysis. The equations obtained are shown below :

$$Q_{2.33} = 169\ A^{0.77}\ I^{0.29}\ S^{0.42}\ R_{2.33}^{1.80}\ \emptyset^{-1.17}$$

$$Q_{5} = 172\ A^{0.80}\ I^{0.27}\ S^{0.43}\ R_{5}^{1.73}\ \emptyset^{-1.21}$$

$$Q_{10} = 178\ A^{0.82}\ I^{0.26}\ S^{0.44}\ R_{10}^{1.71}\ \emptyset^{-1.32}$$

$$Q_{20} = 243\, A^{0.84}\, I^{0.24}\, S^{0.48}\, R_{20}^{1.62}\, \phi^{-1.38}$$

$$Q_{50} = 297\, A^{0.85}\, I^{0.22}\, S^{0.50}\, R_{50}^{1.57}\, \phi^{-1.61}$$

where Q_T = peak flow in cfs. of recurrence interval T years

A = drainage area in sq.mi.

S = slope of the channel

I = percentage of impervious cover

ϕ = channel urbanization factor which is dimensionless

R = rainfall in inches for 6-hr. duration

PINKAYAN and ACKERMANN (1974) determined the hydrologic information required to design drainage structure for the Hetauda-Narayangarh Road Project in Nepal by studying 19 watersheds having a range of area of 3.34 - 823 sq.km. The equations recommended are as follow :

1. For watershed altitudes greater than 1,000 meters

$$Q_{2.33} = 10.924\, A^{1.196}\, S^{0.579}\, L^{-0.338}\, L_c^{-0.229}\, E^{-0.617}$$

2. For watershed altitudes less than 1,000 meters

$$Q_{2.33} = 0.313\, A^{0.671}\, S^{-0.224}\, L^{2.187}\, L_c^{-1.835}\, E^{-0.238}$$

3. For watersheds where the parameters S, L, L_c and E are not available

$$Q_{2.33} = 2.241\, A^{0.849}$$

where $Q_{2.33}$ = mean annual flood corresponding to the 2.33-yr. return period

A = watershed drainage area in sq.km.

E = altitude of gaging station in km.

L = length of the longest watercourse extended to the watershed boundary in km.

L_c = shortest length from the outlet to the center of area of the watershed measured along the longest watershed in km.

S = slope of the longest watercourse computed by dividing the elevation difference between outlet and extended point of the longest watercourse on the water boundary by L.

PONGPIRODOM (1974) studied the hydrologic characteristics of the Mae Klong basin and submitted that the average annual, average maximum annual and average minimum annual runoff were related to the catchment area in the exponential equations as follow :

$$Q_a = 0.2494 \times 10^{-5} A^{1.9526}$$

$$Q_{a_{max}} = 0.11472 \times 10^{-1} A^{1.2385}$$

$$Q_{a_{min}} = 0.15515 \times 10^{-10} A^{3.0313}$$

where Q_a = average annual flow in cms.

$Q_{a_{max}}$ = average maximum annual flow in cms.

$Q_{a_{min}}$ = average minimum annual flow in cms.

A = catchment area in sq.km.

1.3 Scope of the Research

The purpose of this study is to find

1.) Factors which effect the runoff in the Mae Klong river. Only four factors namely basin area, shape number, drainage density and slope of the main stream, are to be studied.

2.) The relationship between the annual flood at any return period and the basin characteristics.

To achieve this purpose, the catchment area (about 25,600 sq.km. including flood plains) and the discharge records of ten gaging stations locating upstream from Tha Muang district will be studied. The locations of these gaging stations are shown in Fig.2.

1.4 Application

This study can be used in the investigation of the following items :

1.) Flood plain management including flood protection.

2.) Planning of the water supply system and drainage system for the agricultures and industries.

3.) Design and construction of dams and spillways with more reliable estimation.

4.) Planning the improvement of man's environment with respect to water, etc.

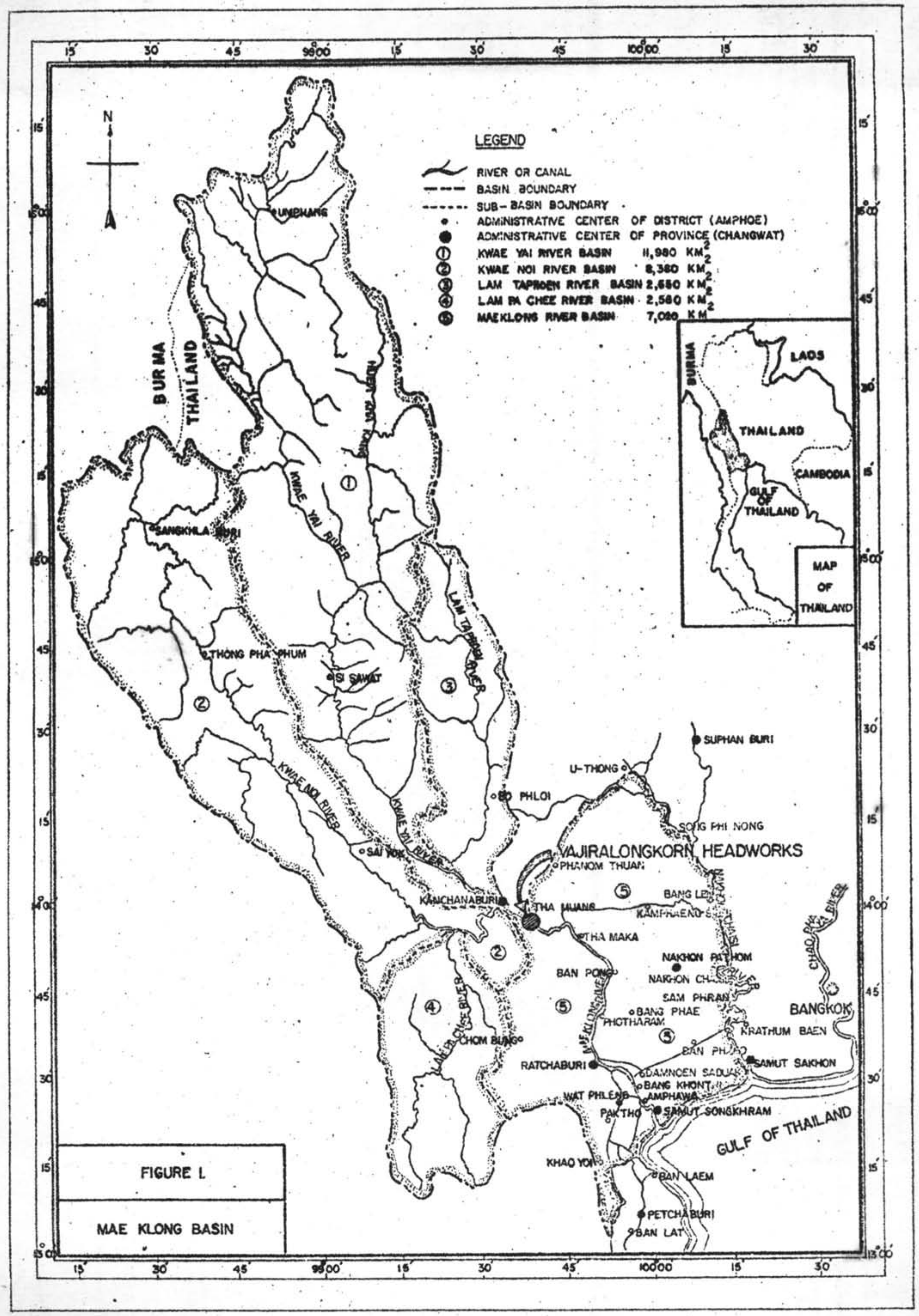

FIGURE I

MAE KLONG BASIN

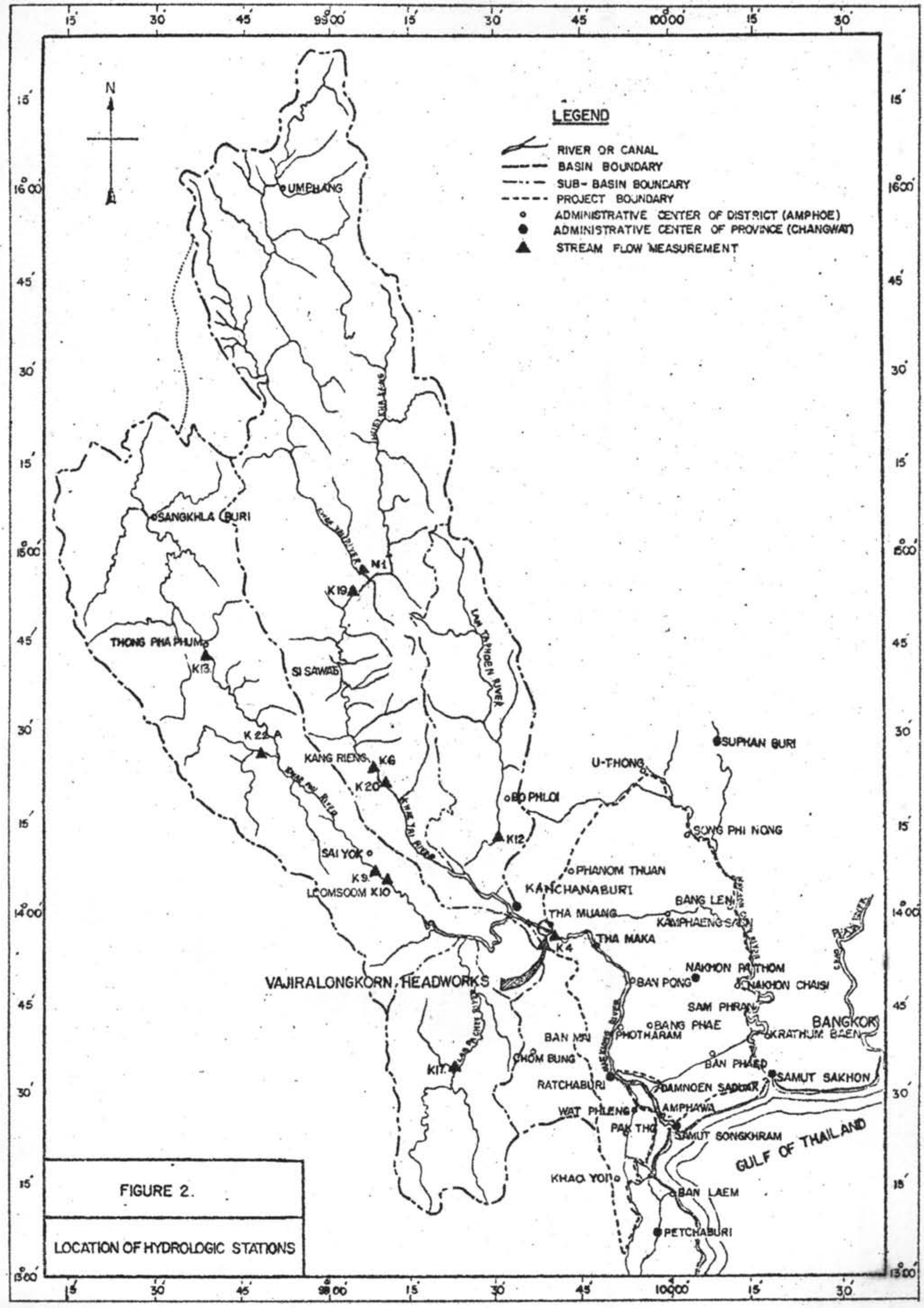

FIGURE 2.

LOCATION OF HYDROLOGIC STATIONS

1.5 Plan of Investigation

In order to follow the objective of this study, the following steps are planned :

1.) Obtain the discharge records from Royal Irrigation Department and National Energy Authority.

2.) Use the recorded data obtained in (1) to determine the annual flood by applying Gumbel's Formula.

3.) Find the basin characteristics namely basin area, shape number, drainage density and slope of the main stream by using the contour map scale 1:250,000 and contour interval 20 meters.

4.) Use the multiple regression method and computer programming to find the relationship between the annual flood and the above basin characteristics at any return period.

5.) Discuss and conclude the results.

6.) Recommend for further investigation.

1.6 Definition of Technical Terms

The definition of the technical terms used in this study are as follows :

1.) Daily discharge is the average discharge in one day.

2.) Monthly discharge is the average of the daily discharges for all the days in the month.

3.) Annual discharge is the average of the monthly discharges for all months in the years, or the average of the daily discharges for all days in the year.

4.) Maximum annual discharge or Annual peak discharge is the largest monthly discharge in the year.

5.) Minimum annual discharge is the smallest monthly discharge in the year.

6.) Annual flood or Flood flow is the greatest rate of flow at any time for a series of years.

7.) Specific flood yield is the flood flow per unit area of the basin.

8.) Return period or Recurrence interval is the average number of years within which a given event (discharge) will be equalled or exceeded for flood, and equalled or less for drought.