Hydrological Characteristics of the Mae Klong River Basin in Thailand

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Abstract

This paper discusses hydrological characteristics in the Mae Klong River Basin in Thailand. Firstly, rainfall distribution characteristics are examined by using daily rainfall data in sixteen rainfall observatories. Secondly, hydrological events of the two dam basins were qualitatively analyzed. It was found that, there was a relationship between the Western Monsoon and the rain occurrences; Si Sawat (Sri Nagarind) zone was draughtier in the Mae Klong River Basin. Si Sawat Dam Basin and Khao Laem Dam Basin, although they are close to each other (50 Km in distance), their differences concerning hydrological characteristics are high.

1.Introduction

A lot of papers on hydrological characteristics in a tropical Monsoon region have been published by many hydrologists. Particularly, discussions in Chao Phraya River Basin have been done since there is a reliable hydrological data base. However, there are few academic papers on the Mae Klong River Basin. Therefore, Hydrological characteristics of the Mae Klong

River Basin is examined.

2. Outline of the Mae Klong River

The Mae Klong River is located in the west of Thailand and has a border with Myanmar. The basin total area is 30800 km^2. The Mae Klong River is composed of two main tributaries: the Khwae Yai River and the Khwae Noi River. The khwae Yai River is 450 km in length and has a catchment area of 14630 Km^2. The Khwae Noi River has a length of 320 km with a catchment area of 10960 km^2.

The climate of the Mae Klong Basin may be divided into three seasons: summer (February to May), the southwest monsoon season or rainy season (May to October), Winter or the northeast monsoon season (October to February). But there is no real winter in the Mae Klong River basin.

2.2 Geology

The Mae Klong River Basin is composed of the hard base rocks with a linear distribution from North to South and belongs to the Mesosoic, the Paleozoic or proterozoic era. The tertiary soft sedimentary rocks, form a flat topography along the upstream tributaries of Kwae Noi and Kwae Yai rivers. The quaternary deposits forming an alluvion downstream of Kanchanaburi and terrace along the Kwae Noi and Kwae Yai rivers, cover the tertiary rocks.
The granite, granidiorite and diorite, intrusive rocks of the base rocks are not distributed linearly.
the soils of the Mae Klong Rivers (table 1) are mostly alluvial with a relatively high content of clay. The soils show a high natural fertility but present a poor acidity and a poor internal drainage capacity accentuated by the topographic conditions.

2.3 Topography

The Mae Klong River is surrounded, in its northern part and its central part by mountains from where its two tributaries , the Kwae Yai and the Kwae Noi, originate to flow in a hilly zone intercepted with some plains up to Kanchanaburi. From Kanchanaburi where the two tributaries join up to form the main river, the plains cover, southward, largely both banks of the Mae Klong River.

2.4 Discharge and Rainfall observational system

Sixteen rainfall stations (Fig.1) are used for the analysis of the Mae Klong Basin rainfall characteristics. The period is chosen between 1952 and 1994. The stations have different recording lengths. The station 13013 has the longest length with 43 years and the station 13142 the shortest length with 13 years. The 16 stations are spatially chosen, in an attempt to meet a uniform map repartition. The lenght takes into consideration the time series without any break. If the south west is well furnished in stations, the north mountainous and the west, bounded by Myanmar is lacking stations to have a uniform covering of the Mae Klong River.
The gaging station records at Thong Pha Phum and Si Sawat will be used to study the discharge characteristics. The study recording period at Khao Laem Dam is from 1984 to 1996, and from 1980 to 1994 at Sri Nagarind Dam.

2.5 Land use

The Mae Klong River is mainly covered by the forest land, with 73% of the total basin area. Agriculture is the second largest area with 18.5% of the total basin area. the major crops are: sugar cane (78.7%), rice (3.6%), field crop (3.21%), orchard trees (2.72%). The water surface occupies 7.06% of the total basin area.

2.6 Rainfall and Discharge Characteristics in the Mae Klong River Basin

The northeast monsoon begins later in the Mae Klong Basin than in the northern and northeastern parts of Thailand. The northeastwind comes at October ending or early November and is directed easterly. It creates a decline in temperature but less colder than in the North.
In February, the northeast wind, present in the Mae Klong River from October to February, shifts easterly or more southeasterly and are then called the southeast winds.
There are many rainfall observatories in the Mae Klong River Basin. In order to examine rainfall characteristics over the Mae Klong River Basin, sixteen rainfall observatories were selected by taking into account the homogeneity of their distribution. Figure 2 shows time series of maximum and minimum annual rainfall of each year picked up from the given data. Smoothing was done with the moving average method because periodicities in hydrologic time series could not be derived.
Figure 3 shows time series smoothed with a five terms moving average.
It is indicated that oscillation is large until 1977, but is smaller after that, and then long time trend gradually descends. On the other hand, the curve of minimum annual rainfall shows that although a decreasing trend is shown until 1983, time trend after that increases more or less radically.
The probability assessment for annual rainfall over a given basin area is done by using sixteen rainfall points. In figure 4, the annual rainfall less than any chosen probability (10, 50 and 90 percent) are shown. This Figure shows that the two regions (rainfall stations 13083 and 47012) are in a very drought condition accentuated by the mountainous zone in the central area of the upstream basin area.
The rain in the Mae Klong River Basin is subject to the Southwest Monsoon. The rainy months are from May to October. They are in accordance with the occurrences of the Southwest Monsoon (Fig. 6 and Fig. 7). The droughty months are December, January and February. The histograms of the 16 stations show that a maximum annual rainfall of 2889 mm with a not exceedence probability of 97.73 % , a return period of 44 years, and a minimum of 202 mm have been observed in the Mae Klong River Basin.

Annual rainfalls with the highest absolute frequency are given in the following table:

Station	1301	1302	13032	13053	13063	1308	13142	13171	13211
mm	900	1000	900	1550	2550	850	1650	850	1350

Station	47012	47022	47042	47052	52022	53012	63042
mm	1050	600	1050	1250	1450	1150	1400

For each station, a cumulative frequency distribution curve was obtained by plotting the annual rainfall data against the calculated values of not exceedence probability (Weibull method), on a arithmetic probability paper. For all the stations, the annual rainfall values plot as a straight line indicating that they are normally distributed. therefore, the mean (50% probability), the standard deviation and the drought probability can be derived, (table 2).

The lowest standard deviation (178.41mm) is given by station 63042 and the highest by Si Sawat Station (600 mm).The highest mean (2216 mm) is given at station 13063 and the lowest mean at station 13032 with 895.35 mm.

Hydrological Characteristics between the two Dam Basin, Sri Nagarind (Si Sawat) and Khao Laem Dam Basin Areas are also compared in this paper.
The relationship between rainfall and runoff is given in fig. 7. In the two areas, runoff depth is less than rainfall depth. In Khao Laem Dam Basin Area, yearly runoff rate is about 65 to 75%. In Sri Nagarind, yearly runoff rate is about 39 to 49%.
Rainfall amount Comparison is given in Fig.8. The rainfall amount is higher as much as twice at Khao Laem Dam Basin area.
The flow duration curves of the two stations were drawn and the results in the Basin Area Characteristics (Table 3) show that higher discharges are obtained in Khao Laem Dam Basin area (Fig. 10).

Conclusion

In Mae Klong River Basin, the northern part receives more rainfall than the south (about double), reaching an annual peak of more than 2500 mm. From station 13013, southward, annual rainfall is less than 1500 mm. Station

61'3083 is the station with the highest severe droughty condition.
The general annual rainfall trend in the Mae Klong River Basin shows a continuous decreasing of rainfall amount from year to year. The Southwest Monsoon brings the maximum quantity of rain to Khao Laem Dam Basin area, from May to October or November, explaining the double quantity of rainfall in Khao Laem Dam.
Yearly runoff rate is higher as much as twice at Khao Laem Dam Basin area. Although its catchment area is three times less than that of Sri Nagarind, Khao Laem Dam Basin area presents the highest discharges, such as the annual maximum discharge, the 95, 185, 275 and 355 day discharge, predicting therefore a better prospective of rural development (Fig. 10).

Reference

Ray K. Linsley, JR., Max A. Kohler, Joseph L. H. Paulhus, 1949, Applied Hydrology. McGraw-Hill Civil Engineering Series.

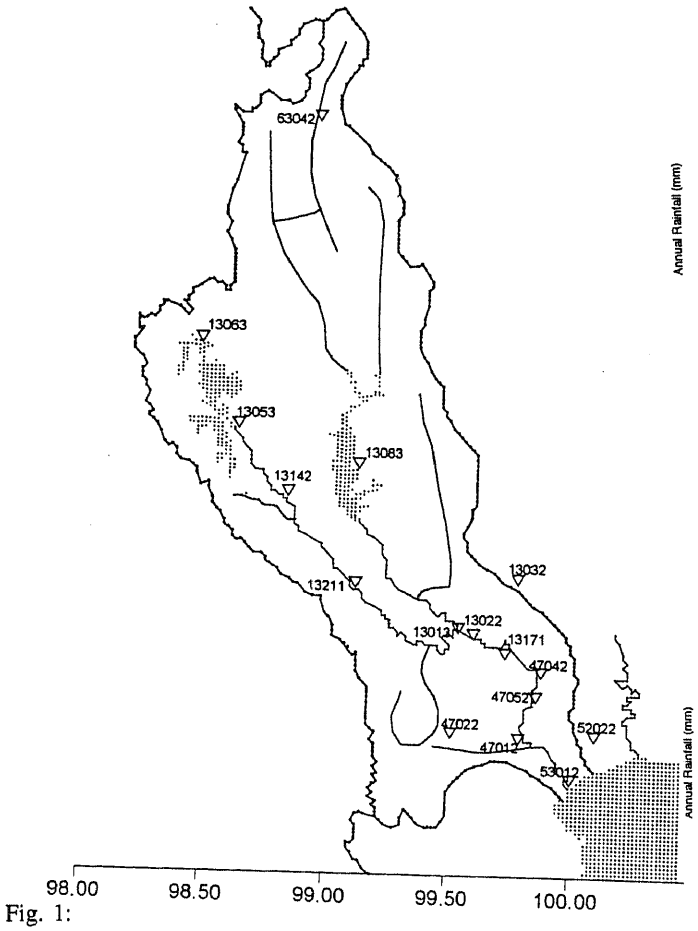


Fig. 1:
Location of Rainfall Station in The Mae Klong River Basin

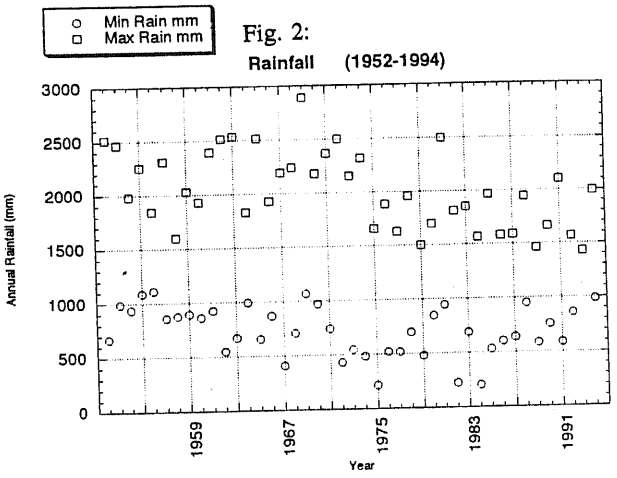


Fig. 2:

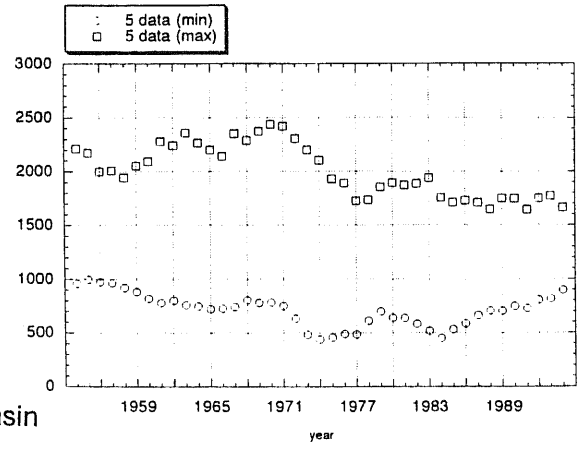
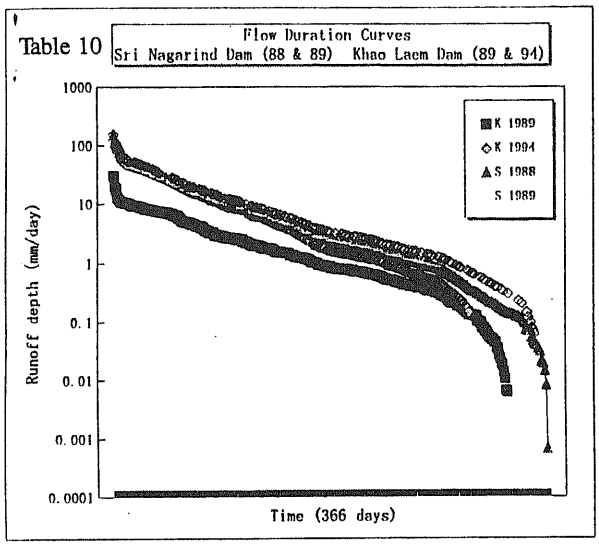


Fig. 3: Moving Average (Annual Rainfall)

Table 10 Flow Duration Curves
Sri Nagarind Dam (88 & 89) Khao Laem Dam (89 & 94)



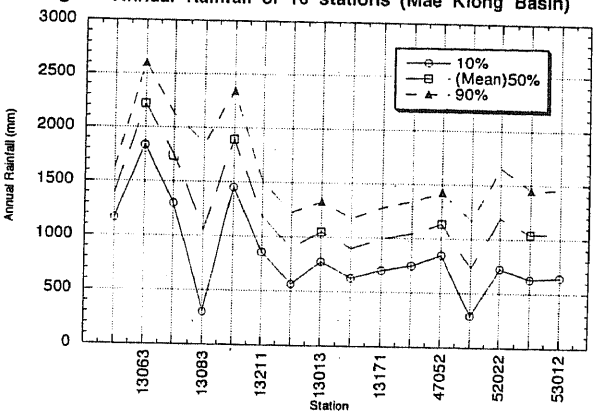
K 1994 & S 1988: maximum daily discharge

K 1989 & S 1989: minimum daily discharge

K: Khao Laem Dam

S: Sri Nagarind Dam

Fig. 4: Annual Rainfall of 16 stations (Mae Klong Basin)



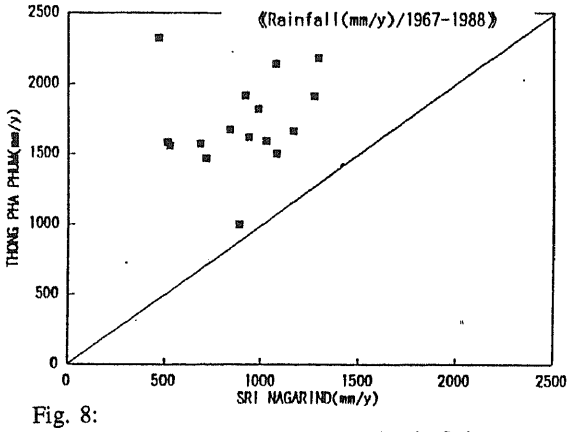
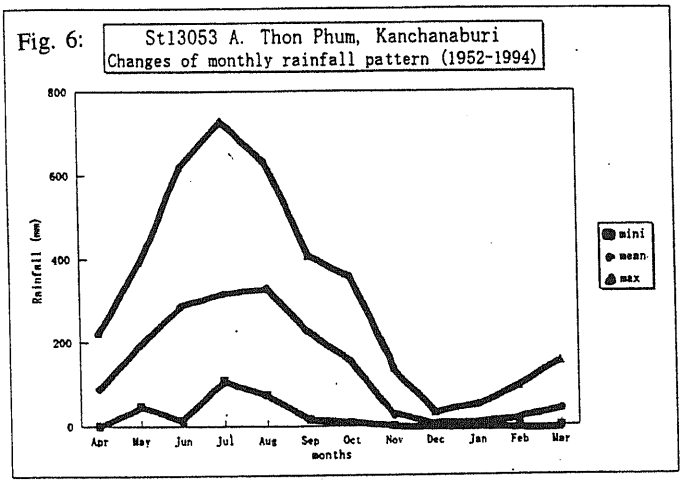


Fig. 8:
Rainfall Comparison between Sri Nagarind and Khao Laem Dam Basin areas

Fig. 6: St13053 A. Thon Phum, Kanchanaburi
Changes of monthly rainfall pattern (1952-1994)



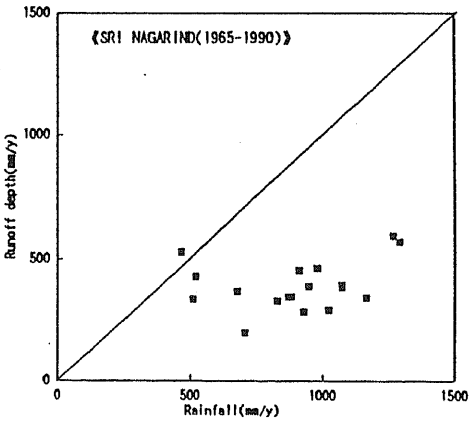


Fig. 9a:
Relation between Rainfall and Runoff Depth in Sri Nagarind Dam Basin

Table 2 ⚡Annual Rain.(16 St) 10%-50%-90%ℓ

	Station	Stand Deviat	10%	(Min)16%	25%	(Mean) 50%	(Max) 84%	90%
0	63042	178.41	1163.8	1215.6	1273.2	1394.0	1572.4	1624.2
1	13063	296.50	1833.4	1919.5	2015.3	2216.0	2512.5	2598.6
2	13053	375.00	1300.0	1375.0	1500.0	1750.0	2075.0	2125.0
3	13083	600.00	300.00	450.00	650.00	1050.0	1650.0	1850.0
4	13142	343.57	1450.9	1550.5	1661.5	1894.1	2237.7	2337.3
5	13211	252.91	856.61	929.99	1011.7	1182.9	1435.8	1509.2
6	13032	255.71	565.45	639.64	722.24	895.35	1151.1	1225.3
7	13013	225.00	775.00	825.00	900.00	1050.0	1275.0	1325.0
8	13022	225.00	625.00	675.00	750.00	900.00	1125.0	1175.0
9	13171	230.00	700.00	760.00	840.00	990.00	1220.0	1280.0
10	47042	229.44	748.10	814.66	888.78	1044.1	1273.5	1340.1
11	47052	224.32	846.40	911.48	983.94	1135.8	1360.1	1425.2
12	47022	339.29	290.30	388.74	498.34	728.03	1067.3	1165.8
13	52022	361.29	723.59	828.41	945.12	1189.7	1551.0	1655.8
14	47012	318.48	628.92	721.32	824.19	1039.8	1358.3	1450.7
15	53012	313.47	643.98	734.93	836.19	1048.4	1361.9	1452.8

Table 3 Basin Area Characteristics

	Sri Nagarind Dam	Khao Laem Dam
Catchment Area(Km^2)	10880	3720
Period	1980–'94	1985–'94
Record Length(year)	15	10
Geology		
Predominant Rock Types	Limestone, shale	Shale, sandstone, and limestone
Annual max, discharge(mm/d)	1.3–25.4	19.3–121.4
Plentiful–water discharge(mm/d) (95–day discharge)	0.18–2.38	2.62–7.73
Ordinary–water discharge(mm/d) (185–day discharge)	0.26–0.95	0.47–1.74
Low–water discharge(mm/d) (275–day discharge)	0.12–0.32	0.0–0.53
Scanty–wateer discharge(mm/d) (355–day discharge)	0.0–0.04	0.0–0.0

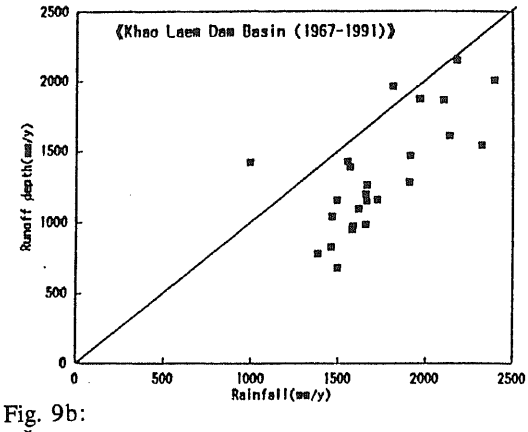


Fig. 9b:
Relation between Rainfall and Runoff Depth in Khao Laem Dam Basin

Table 1 GEOLOGY OF THE TWO BASIN AREAS

SEDIMENTARY, METAMORPHIC AND IGNEOUS ROCKS	Khao Laem Dam	Sri Nagarindra Dam
Alluvial deposits: Gravel, sand, silt, and clay, unconsolidated to semiconsolidated.	31%	7%
Dolomitic limestone, sandstone; and shale, gray, and red, thick-bedded to massive.	0%	23%
Limestone, limestone conglomerate and shale, grayto dark gray, and red, well bedded.	3%	46%
Shale, sandstone, and limestone, alternated, grayish black.	35%	5%
Shale, dark brown to black, well-bedded.	11%	5%
Limestone with argillaceous bands.	9%	3%
Granite	11%	11%

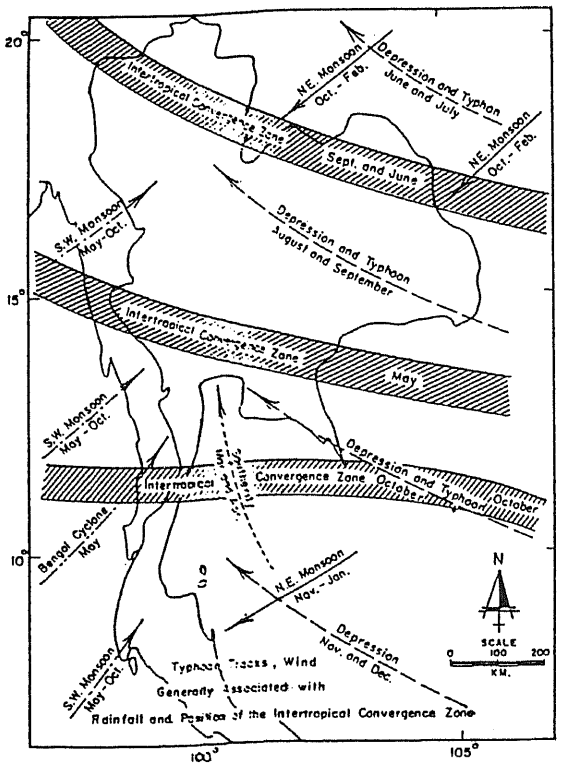


Fig. 7: Storm Tracks in Thailand