P R F F C

THE FLOOD OF AUGUST 1974 IN THE PAMPANGA RIVER BASIN, LUZON

By: J. F. Lirios (I)

Flood Forecasting Center, Quezon City, Philippines

May 1975

(I) Assistant Chief, National Weather Service
Philippine Atmospheric, Geophysical and
Astronomical Services Administration (PAGASA)
Quezon City, Philippines

THE FLOOD OF AUGUST 1974 IN THE PAMPANGA RIVER BASIN, LUZON

By: J. F. Lirios
Flood Forecasting Center, Quezon City, Philippines

ABSTRACT

A flood forecasting system for the Pampanga River Basin has been in operation since September 1973. The paper gives a brief description of the system and its present capability. Operational flood forecasting and the associated meteorological condition during the major flood of August 1974 are discussed and some reported estimates of flood damages are given.

Relevant hydrological and meteorological data and information are also presented in the form of charts and maps.

1. INTRODUCTION

Realizing the importance of Central Luzon to the economy of the country and that effective and timely flood warning can help reduce losses caused by floods in the area, the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) and the Bureau of Public Works (BPW) early in 1971 formalized a Memorandum of Agreement for the establishment and operation of a pilot flood forecasting and warning system for the Pampanga River Basin. The actual establishment of the system commenced early in 1973 under the auspices of the ECAFE/WMO Typhoon Committee; with financial and technical assistance from the Government of Japan. On 13 September 1973, the pilot flood forecasting and warning system was inaugurated after the completion of installation and testing of equipment in the flood forecasting station network.

The flood forecasting system is equipped with a network of rainfall and water level telemetering gauging stations strategically located within the Pampanga River Basin; which includes the provinces of Pampanga, Bulacan and Nueva Ecija. The network (See Figure 1) consists of 7 combined rainfall/water level gauging stations, 2 rainfall stations, 1 repeater station and 1 combined repeater and rainfall station. The Terminal Telemetry and Control Station is located at the Flood Forecasting Center in the PAGASA (Weather Bureau) Central Office in Quezon City and the Monitor Station is located at the BPW Main Office in Manila.

Under normal conditions, the telemetering system network transmits rainfall and water level data every 12 hours to the Terminal Telemetry Station and the Monitor Station. When the Philippines is threatened by the presence of tropical cyclones and weather disturbances, the telemetering system is set to transmit data at more frequent intervals of say every one, three or six hours; depending on the distance and track of the weather disturbances with respect to Luzon. It takes about 5 minutes for all ten (10) stations in the network to transmit a set of water level and/or rainfall data to the Flood Forecasting Center.

2. OPERATIONAL FLOOD FORECASTING AND THE FLOOD OF AUGUST 1974

2.1 FLOOD FORECASTING PROCEDURE

The responsibility for the preparation and issuance of flood forecasts and warnings rests with the Flood Forecasting Center which is operated jointly by PAGASA and BPW personnel. The Center has been in operation since September 1973 and forecasts issued for 12 floods in the Pampanga River Basin ranging from minor to major floods. However, the flood forecasting technique have been limited by insufficient hydrological records from the newly established network of stations. Runoff calculation is done by the Series Storage-Type Model or Tank Model Method developed by M. Sugawara (1) and found suitable for flood forecasting for the lower Pampanga basin by A. Hamamori of the Typhoon Committee Secretariat.(2)

The flood forecasting procedure is outlined briefly as follows:

(1) The 24-hour average basin rainfall is calculated from reports of 10 telemetering rainfall stations by Thiessen Polygon Method. This serves as input to the Tank Model to obtain the runoff at Apalit.

(2) A one or two-day time lag is applied to the computed runoff to obtain the forecast runoff. The choice of a one or two-day lag depends on whether the rainfall is concentrated in the lower or upper portion of the basin. Comparison of the forecast and observed runoff will also indicate whether the time lag chosen is suitable.

(3) The initial storage in the tank model is adjusted by trial and error until the computed runoff is approximately equal to the observed runoff.

(4) The forecast stage at Apalit is obtained by using the stage-discharge relationship for the station. The corresponding forecast stage at Candaba is also obtained by using a derived Candaba stage vs. Apalit stage relationship.

Runoff calculations are based on 24-hour average basin rainfall for the period ending at 0800H and 2000H. Thus, forecasts of stage at Apalit and Candaba are obtained every 12 hours. A running plot of the calculated and observed values of stage serves as a basis for verifying and adjusting the forecast stage. Stage hydrographs are also plotted from incoming reports of the other water level telemetering stations.

Flood advisories are issued by the Center twice daily or at more frequent intervals when the situation warrants and as long as threat of flooding exists within the Pampanga basin. Advisories are relayed promptly to the National Disaster Control Center for dissemination to the general public; particularly the flood-threatened areas. These are also transmitted to the BPW Monitor Station, Pampanga River Control System at Apalit and

the Cabanatuan Synoptic Weather Station by direct communication links.

2.2 FLOOD OF AUGUST 1974

This destructive flood is considered the major flood of 1974.

At 0800H August 15, Tropical Storm Norming (NADINE) was about 575 km. east of Luzon, while a severe Tropical Storm (MARY) was located in the vicinity of Chichijima and moving westward (See Figure 2). The Telemetering System has been set to transmit 6-hourly rainfall and water level data to the Flood Forecasting Center and reports showed that moderate (60-180 mm/24 hr) rain has been falling over the Pampanga basin for the past 24 hours and water levels at all gauging station are rising gradually. At 0800H of August 16, reports from the Telemetering Station Network gave moderate to heavy (greater than 180 mm/24 hr) continuous rain during the past 24 hours while stage hydrographs at six upstream gauging stations showed increasing rates of rise of water levels during the past 12 hours. Meanwhile, Tropical Storm MARY had moved west northwest at an average speed of 20 kph. toward NAZE. At 1000H August 16, the initial flood advisory was issued for threatened areas in the Upper and Middle Pampanga basin.

A weather satellite picture received at 1100H gave positive indications of prolonged heavy monsoon rains over Luzon. This information together with the sharp increase in water levels at Zaragoza, San Isidro, Arayat and Candaba prompted the Flood Forecasting Center to issue two more advisories at 1600H and 2200H of August 16. The advisories included the forecast stage at Apalit and appropriate warnings for the Lower Pampanga and threatened areas downstream of Apalit.

A total of sixteen (16) Flood Advisories were issued by the Flood Forecasting Center during the period August 16-22. The text of the advisories included the behaviour of water levels at the gauging stations, a one-day forecast of stage at Apalit and areas likely to be inundated within one or two days. The time when the water level at Apalit was expected to reach the 4-meter critical level was forecast about 15 hours in advance. The approximate time and magnitude of the crest stage height at Apalit from 2000H August 18 to 0200H August 19 was also forecast with a time advantage of about 12 hours.

Figure 3 gives a comparison of the observed stage hydrograph (telemetered data) and the computed or forecast stage hydrograph with a one-day time lag. The hydrographs show good agreement after August 16. The difference between the observed and computed hydrographs prior to August 16 was attributed to choked intake pipe of the stilling well at the Apalit gauging station; after a comparison was made of staff gauge readings and corresponding telemetered water level data at Apalit.

Topographic maps and maps showing the areal extent of past floods were used to translate the water level forecasts at Apalit and Candaba in terms of areas likely to be inundated. A continuous watch on incoming 3-hourly or 6-hourly reports of water level and rainfall from the station network also enabled the Center to issue qualitative forecasts of flood-

ing for certain areas in the Upper and Middle Pampanga basin.

Close consultation between the flood forecasting staff and meteorologists concerning the forecast track and intensity of the typhoon, interpretation of weather satellite pictures and weather radar reports proved extremely helpful in forecasting the flood. Regular reports and information from the BPW Central Office and the Pampanga River Control System on actual conditions at Apalit and other water control structure were found equally important in the preparation of flood advisories.

Rating curves for the Sapang Buho and Arayat gauging stations were established after the flood in October 1974; hence hydrograph analysis was conducted for these two upstream stations in conjunction with the Apalit station. Figure 4 shows the discharge hydrographs for Sapang Buho, Arayat and Apalit during the August 1974 flood. A standard method of base flow separation was applied to the three flood hydrographs in calculating the total volume of direct runoff corresponding to each of the three stations. The basin rainfall for each of the 3 stations was obtained from the storm rainfall map (Figure 6) by isohyetal method. The results are tabulated as follows:

Flood of August 13-18, 1974

Station	Basin Area Km^2	Direct Runoff (m^3)	Equiv. Depth of Runoff (mm)	Basin Rainfall (mm)	RO/RF %
Sapang Buho	2015	274×10^6	136	253	54
Arayat	6487	1020×10^6	157	360	44
Apalit	8550	2619×10^6	306	427	72

The computed runoff for Sapang Buho and Arayat expressed as a percentage of basin rainfall are much less than that for Apalit. This can possibly be explained by the following: (a) flood storage of Pantabangan Dam upstream of Sapang Buho; (b) at a certain range of flood stage, a considerable portion of flow upstream of Arayat was diverted into the Candaba Swamp via the Cabiao-Candaba Floodway; (c) high concentration of very heavy rainfall over the sub-basin between Arayat and Apalit as shown in Figures 5 and 6.

2.3 FLOOD DAMAGES

Some reported flood damages in the Pampanga River Basin during the August 1974 Flood are given below:

National Disaster Control Center initial flood damage report on 21 August

(a) Estimated cost of damage to public works and agricultural crops

Pampanga . . . . . ₱ 5,000,000

Bulacan . . . . . ₱ 4,500,000

(b) Number of hectares of land that went under water

Pampanga . . . . . 5,163 Ha.

Bulacan . . . . . 8,425 Ha.

No estimate of damage in Nueva Ecija was available, however it was reported that young rice plants in low areas were heavily damaged by flood waters of Peñaranda and Rio Chico rivers. Several barrios of Licab, Jaen, Aliaga, Zaragoza, San Antonio, Sta. Rosa and Cabanatuan went under water.

A report of the Engineer in Charge, Pampanga River Control System estimated the total cost of emergency works and damages to water control structures in the Pampanga River Basin at ₱ 2,290,000.

According to a news report on 21 August, 15 persons perished in the flood in the Pampanga River Basin.

2.4 METEOROLOGICAL CONSIDERATIONS

Meteorological conditions associated with the destructive flood consisted of a series of tropical disturbances over the Pacific and South China Sea from the first to the third week of August (See Figure 2). The first was a tropical depression which developed about 880 km. east of the Visayas on August 4. It followed a northwesterly track and weakened into a low pressure area over the Batanes on August 8 when another low pressure area west of Luzon intensified into a tropical storm and moved north-north east towards Formosa. Southwest monsoon conditions induced by these two disturbances prevailed over Luzon and western Visayas during the second week of August. The third disturbance was Severe Tropical Storm Mary which followed a west-northwesterly track from Chichijima on August 15, over Naze on August 18 and reached the eastern coast of China mainland on August 20. Intensification of the prevailing southwest monsoon flow which resulted in moderate to heavy continuous rain over Luzon during the third week of August is attributed to Tropical Storm Mary and the low pressure areas to the east and west of the Batanes.

Although none of these tropical disturbances crossed Luzon, the associated southwest monsoon condition gave flood-producing rainfall over the Pampanga basin from August 16-18. The 24-hr. average basin rainfall calculated from data transmitted by the telemetering station network are given below:

August 16	128.7mm.
August 17	183.6mm.
August 18	86.5mm.

A maximum 24-hr. average basin rainfall of 200 mm. was recorded for the period 16/1700H-17/1700H.

Areal distribution of rainfall over the basin during the prevailing southwest monsoon conditions were found markedly different from those associated with tropical cyclones crossing Central Luzon. Duration of heavy falls were longer and maximum rainfall areas occurred in the lower portion of the basin. Hence, a one-day instead of a two-day time lag for the computed runoff was found more suitable for forecasting the August flood.

Figures 5 and 6 show the distribution of rainfall over the basin for the 24-hour period ending at 0800H August 18 and the 5-day storm rainfall from 0800H August 13 to 0800H August 17 respectively. The isohyetal analyses were based on reports of the 10 telemetering stations and 52 other stations within and in the vicinity of the basin; of which 34 are equipped with recorders.

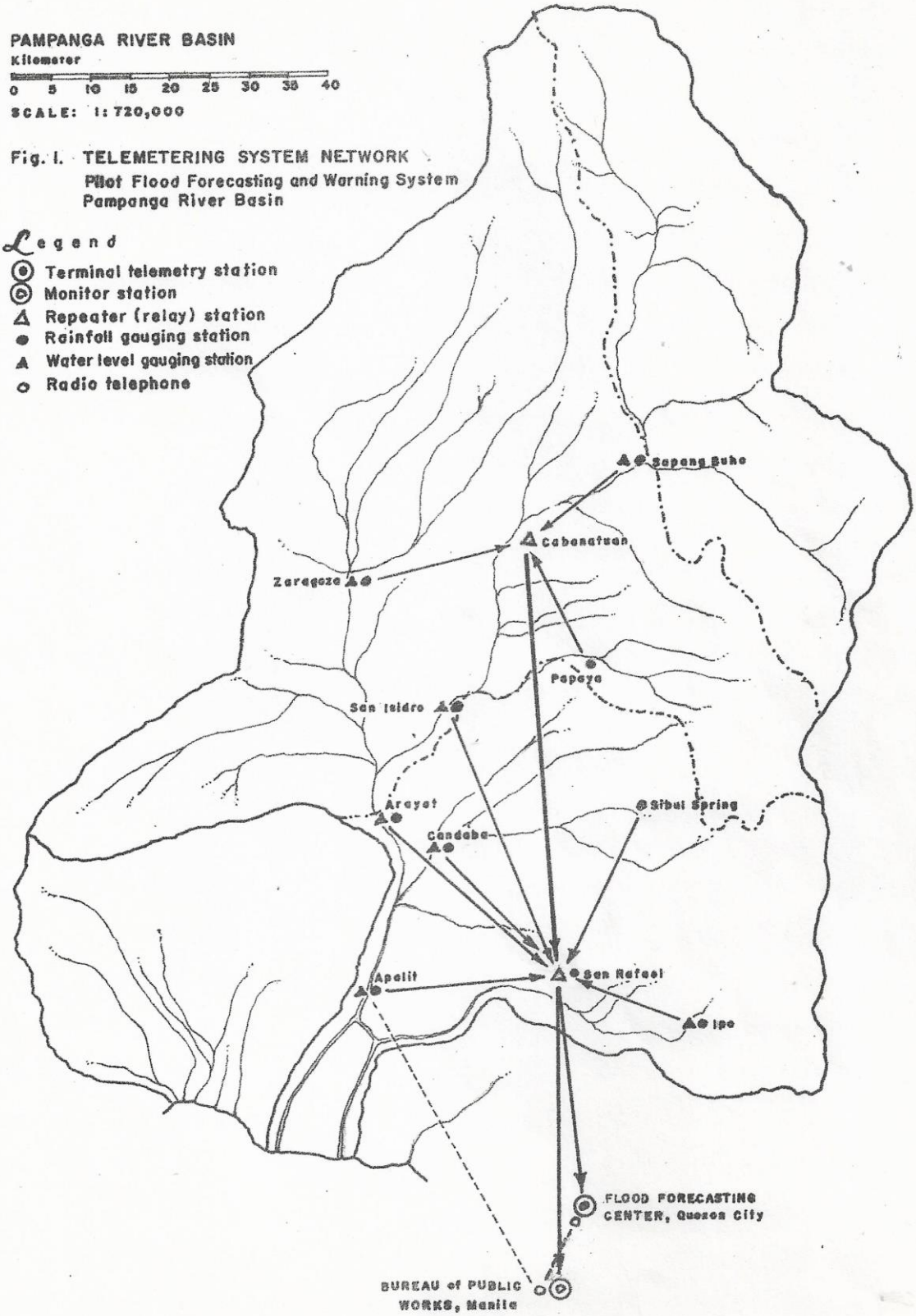
3. ACKNOWLEDGEMENT

The cooperation of the Hydrometeorological Division of the National Weather Service, PAGASA in the preparation of this paper is gratefully acknowledged. In particular, thanks are due to Messrs. N. Canuel, R. Paculan and F. Camacho for the necessary computational work and preparation of the illustrations and to Mr. C. Schneider and Miss T. Peras for typing the manuscript.

REFERENCES

1. Sugawara, M., "On the Analysis of Runoff Structure about Several Japanese Rivers." Japanese Journal of Geophysics Vol. 2. No. 4, March 1961.

2. Typhoon Committee Secretariat, October 1972. "Runoff Analysis and Flood Forecasting Study of the 1972 Flood in the Pampanga River Basin (Philippines)."


PAMPANGA RIVER BASIN
Kilometer
0 5 10 15 20 25 30 35 40
SCALE: 1: 720,000
Fig. I. TELEMETERING SYSTEM NETWORK
Pilot Flood Forecasting and Warning System
Pampanga River Basin
Legend
Terminal telemetry station
Monitor station
Repeater (relay) station
Rainfall gauging station
Water level gauging station
Radio telephone
Sapang Buho
Cabanatuan
Zaragoza
Papaya
San Isidro
Arayat
Sibul Spring
Candaba
Apalit
San Rafael
Ipo
FLOOD FORECASTING CENTER, Quezon City
BUREAU of PUBLIC WORKS, Manila

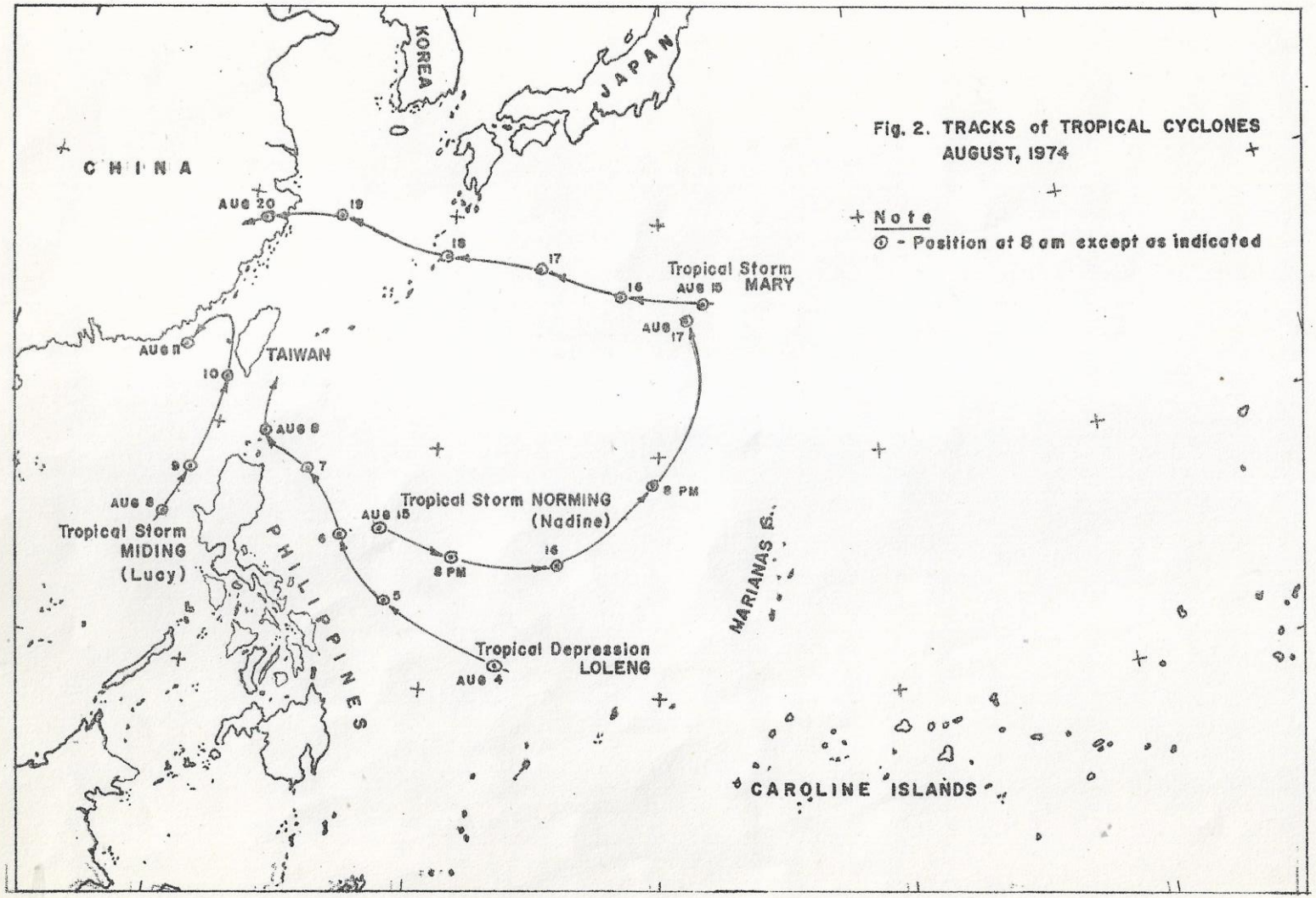
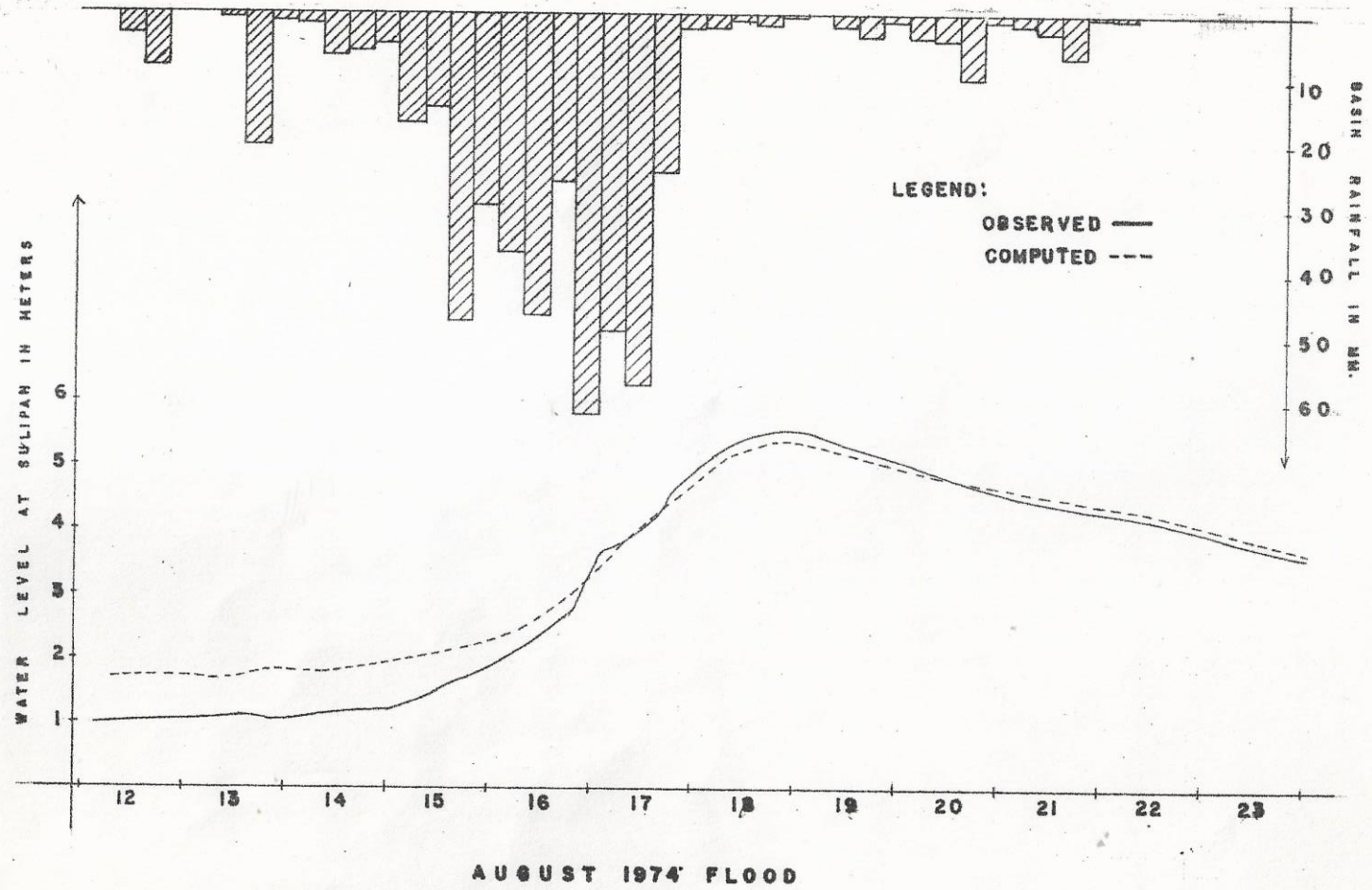

KOREA
JAPAN
CHINA
TAIWAN
PHILIPPINES
MARIANAS IS.
CAROLINE ISLANDS
Tropical Storm MARY
Tropical Storm NORMING (Nadine)
Tropical Storm MIDING (Lucy)
Tropical Depression LOLENG
AUG 20
19
18
17
16
AUG 15
AUG 17
AUG 11
10
AUG 9
9
7
AUG 8
8 PM
AUG 15
8 PM
16
5
AUG 4
Fig. 2. TRACKS of TROPICAL CYCLONES
AUGUST, 1974
Note
⊙ - Position at 8 am except as indicated

Fig. 3. OBSERVED and COMPUTED HYDROGRAPHS at APALIT (Sulipan)
and
6-HOURLY AVERAGE BASIN RAINFALL



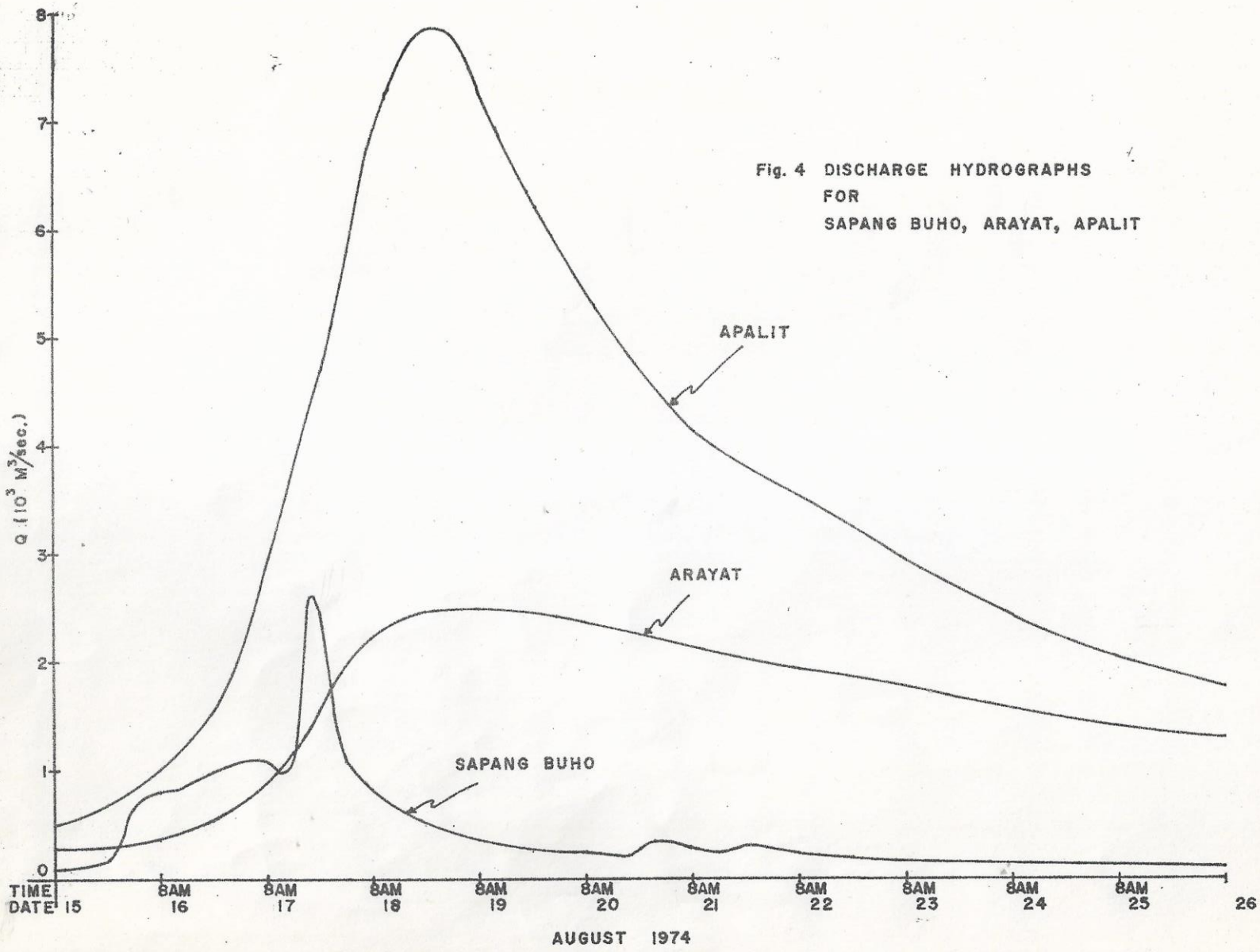


Fig. 4 DISCHARGE HYDROGRAPHS
FOR
SAPANG BUHO, ARAYAT, APALIT

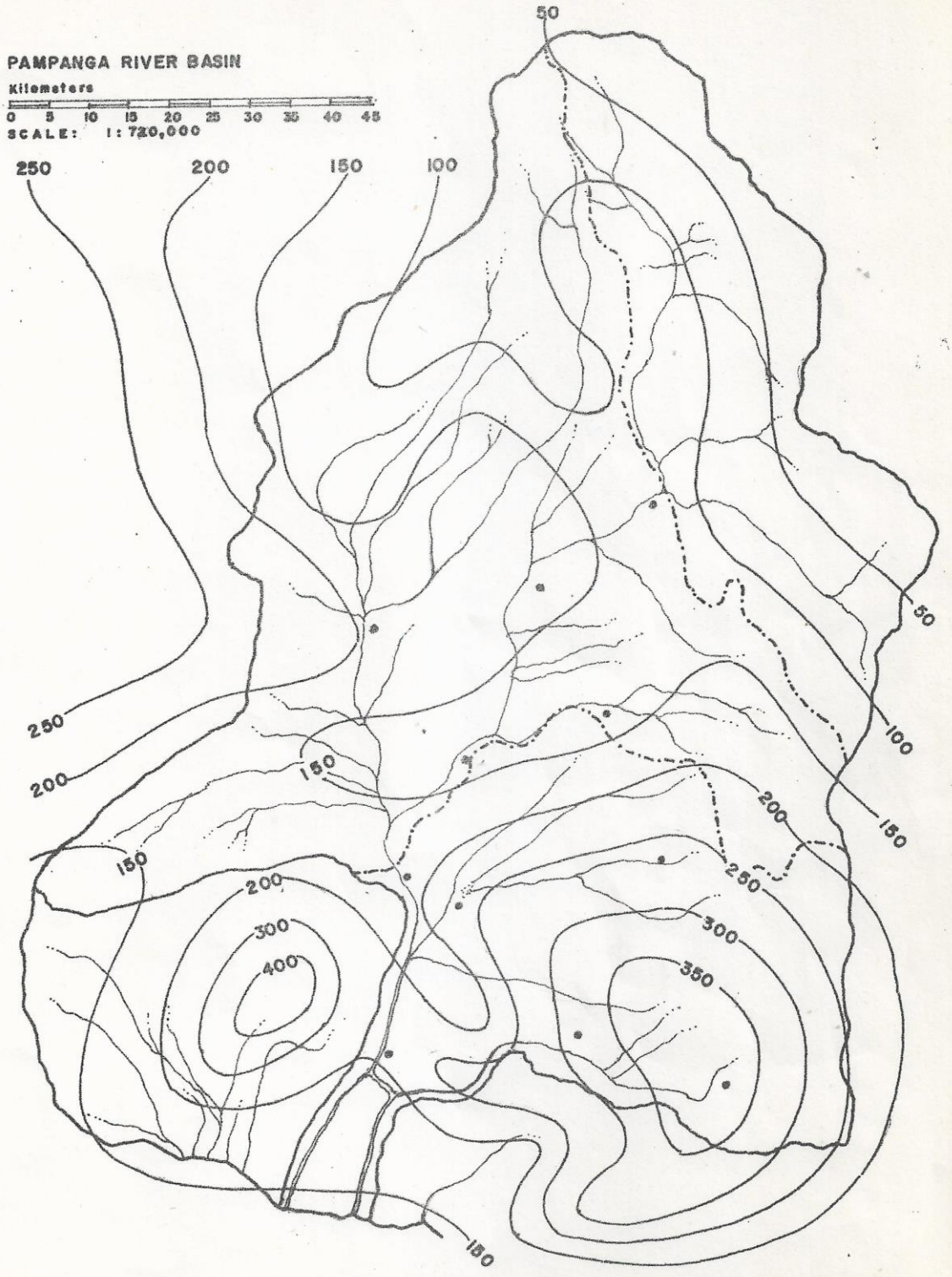


Fig. 5. ISOHYETAL MAP of the 24-HOUR RAINFALL for the PERIOD ENDING at 0800H AUGUST 17

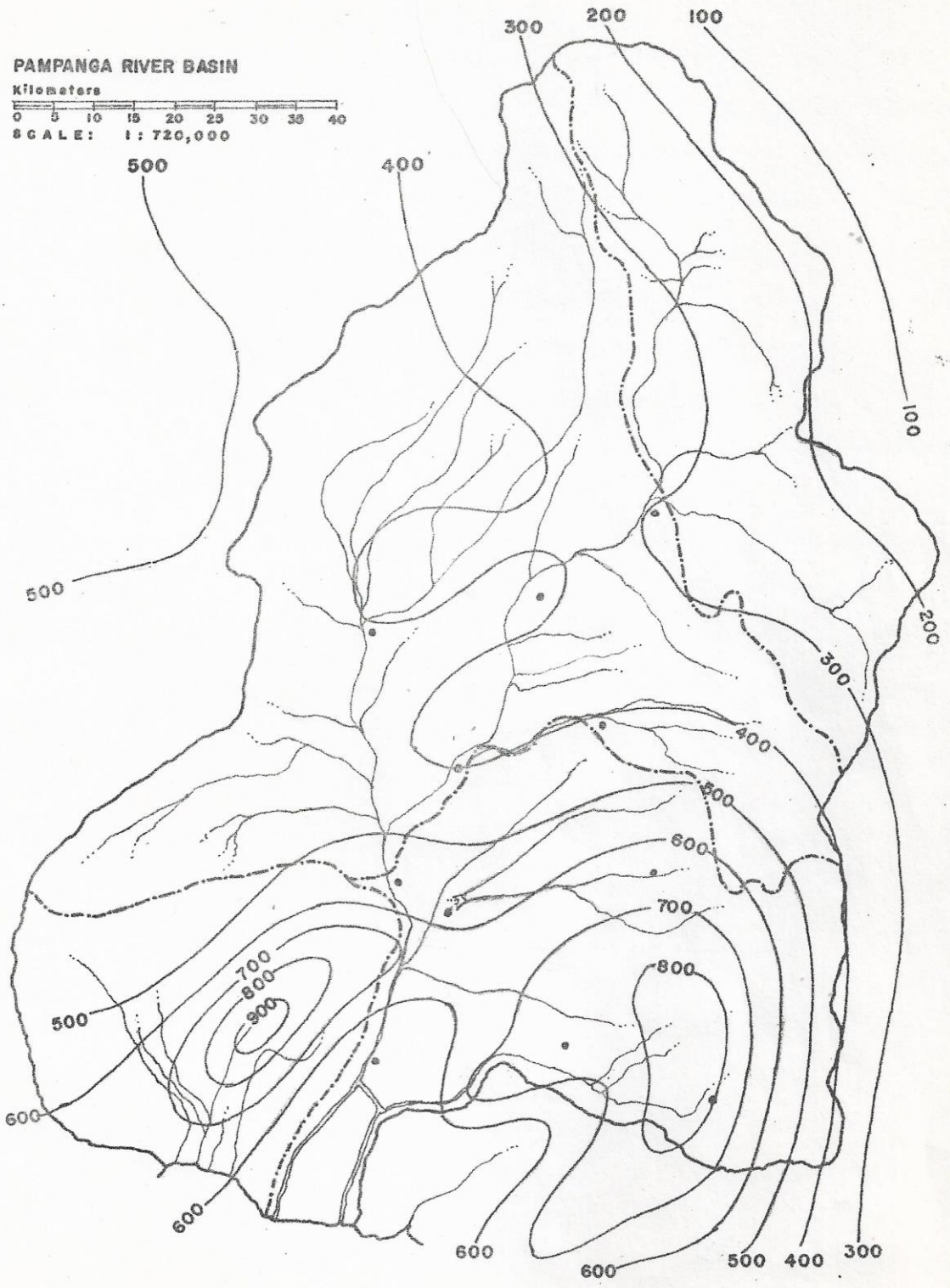


Fig. 6. STORM RAINFALL ISOHYETAL MAP for the PERIOD 0800H AUGUST 13 TO 0800H AUGUST 18