# Pampanga River Basin: Flood of August 2004
# (Southwest Monsoon as enhanced by Typhoon Marce)

## Summary

Typhoon Marce (August 20-24, 2004) became the first destructive tropical cyclone to affect the Pampanga River Basin for the year 2004. Widespread rains for more than 3 days spawned by the intensified southwest monsoon as enhanced by Typhoon Marce inundated extensive areas of the western and central sections of Luzon, including Metro Manila. As a result, 64 persons died, more than 2.1 million people affected, and an estimated damage cost of P 2.3 Billion in both agriculture and infrastructure were incurred.

An investigative survey team of the Pampanga River Flood Forecasting and Warning Center (PRFFWC) composed of Messrs. Armando P. Taruc (Senior Weather. Specialist), Hilton T. Hernando (Weather Facilities Specialist II) and Pablito Villablanca (Weather Observer III), was dispatched to the Pampanga River Basin to take on the following tasks:

1. Conduct a post-flood survey from September 7 to 12, 2004, to assess and make scientific evaluation of the flooding in the area;
2. Coordinate with other concerned agencies (LGU’s and NGO’s) and entities on the conduct of the study in connection with the flooding event; and
3. To recommend measures focusing on the non-structural means to minimize and mitigate flood losses in both life and property.

This disastrous flood is considered the major flood of 2004. A record high of river stage for Pampanga River at Arayat station and, likewise, a record water level for the Candaba Swamp area were attained during this event.

Inundation within the Pampanga River Basin area can be attributed to several interrelated factors:

1. Widespread precipitation over the basin area for more than 3 days (August 23 to 26, 2004); intermittent moderate to occasionally heavy rains prevailed in at least 2 days over the whole catchment.
2. Silted river channels particularly at the middle and lower sections of main Pampanga River.
3. The overflowing of Candaba swamp towards the confluence of Pampanga and Angat Rivers in the Apalit-Calumpit area.

On the other hand, flooding within the Guagua River Basin was mainly due to its silted waterways and flat terrain other than the widespread rains over the area.

Quite unusual about this flood event though, was the immediate recession of floodwaters. Previous inundations within the basin took few weeks to subside. However, during this episode, floodwaters lasted only for days in many of the areas affected.

## 1.0 Background

Pampanga River Basin, by dint of geography, is situated in the central plains of Luzon Island (Figure 1.0), which is regarded as one of the rice granary of the Philippine archipelago. Climatologically, this part of Luzon falls under the First Type, this means that it experiences two pronounced seasons: dry from November to April and wet during the rest of the year especially June to September. Rains falling within the Pampanga River Basin are mainly due to the Southwest Monsoon, the seasonal air mass that originates from the Indian Ocean. There are times when this monsoon is intensified due to the influence of tropical cyclones sometimes hovering along the vicinity of northern or northeastern Luzon. The monsoon rains results in widespread flooding especially in the low-lying areas of the basin causing destruction and damages to properties, infrastructures, agricultural crops and livestock, and sometimes the loss of human lives.

Structural flood mitigation measures have been employed to provide protection to both lives and properties. These structural measures, however, can only withstand flooding up to the level of flood for which it was designed. Although these are very effective in arresting floods, an integrated approach to flood mitigation that combines structural measures with disaster preparedness or non-structural measures is most ideal.

In 1973, a pilot Flood Forecasting and Warning System (FFWS) for Pampanga River Basin was established through technical cooperation between the Philippines and Japan Governments. The main purpose of this instrumentally telemetered FFWS is to issue flood warnings and advisories to the concerned populace for them to take precautionary measures to avoid the disastrous effects of floods. Subsequently, in 1983 the Flood Forecasting and Warning System for Dam Operation (FFWSDO) was established within the basin to integrate in the basin forecast the amount of water released from dams. The Pampanga River Basin includes within its catchment area two large dams; the Angat Dam and the Pantabangan Dam. This FFWSDO scheme is being done in cooperation with other government agencies with PAGASA as the lead agency. Though, during T. Marce, a very much smaller reservoir, Ipo Dam, which is downstream of Angat Dam, released impounded water creating hearsay reports that this was the cause of flooding in the Bulacan area.

This report deals with the flood episode over the Pampanga River Basin as a result of the intensification of the southwest monsoon as enhanced by Typhoon Marce (August 2004).

## 2.0 Physiographical Factor[1]

### 2.1 The Pampanga River Basin

The Pampanga River Basin (PRB) is the 4th largest basin in the Philippines. It drains an aggregate area of 8,550 $km^2$ (Figure 2.0). It encompasses the provinces of Nueva Ecija (almost whole province), part of Bulacan and Pampanga, and portions of Tarlac. Main Pampanga River is about 260 kilometers in length.

The basin is drained through the Pampanga River and via the Labangan Channel into the Manila Bay. Several tributaries support the main river, the principal ones of which are the Peñaranda and the Coronel-Santor Rivers on the eastern side of the basin and the Rio Chico River from the northwest side. The Angat River joins the Pampanga River at Calumpit in Bulacan via the Bagbag River. The Labangan channel, on the other hand, acts as a cut-off channel for the Angat River into Manila Bay. Somewhere between the middle and lower portion of the basin stands the Mount Arayat, standing some 1,026 meters in elevation. Adjacent just on the eastern side, at the left bank of the Pampanga River, is the Candaba swamp, covering an area of some 300 $km^2$ absorbing most of the flood flows coming from the eastern sections of the basin (western slopes of the Sierra Madre mountain range) and the overflowing of the Pampanga River via the Cabiao Floodway. This area acts as a detention basin and is submerged during the rainy season but is relatively dry during summer. At the lower sections of the basin, where the Pampanga delta lies, the Pampanga River system, crisscrossed with fish farms, form a network of sluggish, tidal flats and canals, which eventually find their way to Manila Bay. The main river has a relatively low-gradient riverbed channel particularly at the middle and lower sections, other than being below the mean sea level elevation (Figure 2.1).

The basin experiences, on an average, at least one flooding in a year. The dry season generally occurs from December to May, and wet the rest of the year. The wettest months are from July to September. The frequency of tropical cyclone passage over the basin area is about 4 to 5 in a year on an average (Figure 2.2).

### 2.2 The Guagua River Basin

The Guagua River Basin is an allied system of rivers and creeks to the Pampanga River virtually converging down with the latter close at the outlet into the Manila Bay. The basin drains an approximate area of 1,990 $km^2$. It is bounded on the north partly by the Agno River Basin and on the south by the Manila Bay; on the east by the Pampanga River basin, where an earthdike (Apalit-Arayat Setback Levee)

[1] *Major parts of this section were lifted directly from the Pampanga River Basin Post-Flood Investigation reports of the SW Monsoon event of August 1999 and T.Ditang & Edeng event of July 2000.*

protecting the right bank of the Pampanga River separates them; and on the west by the Zambales mountain Range, where Mt. Pinatubo is a part.

The major river systems draining the basin are the Pasig-Potrero, Porac-Gumain, Abacan and Pasac-Guagua Rivers. Other small creeks and secondary rivers that significantly drain and, on the other hand, flood the basin are the Sapang-Maragul, Gugu creek, etc.

The basin is quite vulnerable to flooding primarily because of its low elevation and flat terrain, its proximity to its outlet at Manila Bay where tides impede the river and creek flows several kilometers upstream, and the narrow and silted waterways brought largely by the eventful Mount Pinatubo eruption (1991). Possible contributory cause is the reported slow sinking of the delta making the area very vulnerable to instant flooding.

### 2.3 Flood Prone Areas

The overall flat topography and the rapidly developing and agriculturally productive flood plain of the Pampanga River Basin make it very vulnerable to floods during intense and prolonged rainfall. The land subject to flooding within the Pampanga River Basin is about 2,200 $km^2$, and about 225 $km^2$ for the allied basin of Guagua River. The latter basin's affected area, however, has expanded considerably partly due to the narrowing and clogging of river channels by "informal settlers" causing, at times, uncontrolled waterway overflows. About 45 municipalities are directly affected in the 4 major provinces encompassed by the whole basin system.

## 3.0 Meteorological Factor

### 3.1 Meteorological Summary

Typhoon Marce (Figures 3.0) happens to be the first destructive tropical cyclone to affect the Pampanga River Basin and major parts of the western sections of Luzon due to the enhanced Southwest Monsoon.

Earlier, Typhoon Igme (Mindulle, 0407), June 25 – July 02, 2004, affected the basin as it brought in near-moderate daily rains over the Pampanga River Basin causing the middle and lower sections of the main Pampanga River to attain alarm stage. However, Igme did not last long enough to cause inundation over the basin.

Typhoon Marce's regional precipitation impact started about 23rd of August and lasted for nearly 5 days before leaving almost half of Luzon's western sections inundated (see Figures 3.1 to 3.6).

### 3.1.1 Typhoon Marce[2]

Typhoon Marce *(International Codename: Aere, 0417)*, August 20-24, 2004.

The origin of Marce was first detected as a broad and active tropical disturbance in the vicinity northwest of Guam on 13th August. Its formation and development was continuous and progressive while embedded in the monsoon trough. During the period when Marce occurred within the PAR together with Typhoon east of it *(Chaba)*, the monsoon depression was likewise deepening.

Marce was already a tropical storm of 65 kph winds when it reached the 135 $^0$E longitude and located at 13.6 $^0$N about 1,130 kilometers east of Luzon in the morning of August 20. Marce took an unusual poleward movement by about 360 kilometers to the north for 18 hours. It changed course to the north-northwest in the next 6 hours taking an average speed of 19 kilometer per hour. It became a severe tropical storm of 95 kilometers per hour in the morning of August 21. From this time until the period it had exited the PAR in the northwestern border, Marce had taken a generally northwestward track. It gained typhoon strength of 120 kilometers per hour while it was about 610 kilometers almost east of Batanes. It underwent structural changes while on a deepening process when it approached land (nearing Taiwan). Another typhoon, T. Chaba (0416), was also intensifying and also being part of the monsoon depression had set the trough in a northwest to southwest orientation across the Northwest Pacific Ocean. As Marce moved through the southern islands of Japan (Okinawa), just about 220 kilometers east of Taiwan, the southern and eastern periphery of Marce had established a monsoon surge, which encompassed most of Northern and Central Luzon including Metro Manila and surrounding areas. These areas experienced heavy rains that its volume ultimately resulted to flooding.

The aftermath of flooding due to Marce continued even when rains no longer occurred. Extensive areas in Central Luzon were flooded as a result of river overflowing. There was suspension of work and classes in some parts of Luzon particularly in Metro Manila that were affected with floods especially on August 25 and 26, 2004. The occurrence of heavy downpour in Metro Manila was on August 24, 2004.

Although Typhoon Marce did not directly hit the country, it did induced / enhanced the Southwest Monsoon "Habagat" which brought heavy rains over northern, central and southern Luzon including the Metro Manila area.

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[2] *PAGASA - Weather Branch Summary on T.Marce by G.P.Nilo, Sr.Weather Specialist*

### 3.1.2 Southwest Monsoon (Habagat)[3]

A great portion of our rainfall may be ascribed to the Southwest (SW) monsoon weather. The SW monsoon is caused by the thermal variations of the Asiatic mainland. During summer in the Northern Hemisphere, the Asiatic continent becomes warmer than the surrounding seas and a low-pressure cell develops over the continent. This causes a flow of moist SW winds over the Philippine area. At times when this SW flow becomes thick in depth, it persists for a long period causing continuous rains that may last for weeks during the months of June to September. Thus aside from typhoons, the SW is responsible for the great portion of the rainfall during the wet season.

At times, however, a SW flow of wind is also induced by the presence of a huge typhoon over the Taiwan-Okinawa area. When this is observed, the weather characteristic of the SW monsoon prevails in the Philippines as what was experienced in most of the western and central Luzon area last August of 1999 and lately last July 2000.

During Marce, the torrential southwest monsoon rains triggered massive flooding in low-lying areas and flashfloods on relatively high-elevated areas; landslides and drowning incidents in various parts of Regions I, III, IV, and CAR; the spillage of Ambuklao, Binga and San Roque Dams in Pangasinan; the overflowing of Magliman Creek in San Fernando; the collapse of Amburayan Dike in Bangar, La Union and Mandasig Flood Control in Candaba, Pampanga; and the breaching of Colibangbang Dike in Paniqui and Malayap Dike in Gerona, Tarlac.[4]

## 4.0 Hydrometeorological Factor

### 4.1 The Pampanga River Basin Flood Forecasting & Warning System[5]

The Pampanga River Basin Flood Forecasting and Warning System at present have a total of 14 rainfall (RR) stations, one is in Guagua River Basin, 7 water level (WL) stations, and 7 streamgaging sites (refer back to Figure 2.0). Within the two basin systems (Pampanga and Guagua) are 2 synoptic stations. An agrometeorological station also exists in PRB. A standard rain gage in the Municipality of Guagua was set-up just recently, through a community-based flood

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[3] *Public Information Series 4, Weather Causing Phenomena, produced by Public Information & International Affairs Staff, PAGASA, DOST / Post-Flood Investigation Report for Pampanga River Basin, Southwest Monsoon August 1999.*
[4] *Final Report on the After-Effects of Southwest Monsoon Rains Induced by Tropical Storm "Marce", Administrator, OCD and Executive Officer, NDCC, September 14, 2004.*
[5] *Post-Flood Investigation Report for Pampanga River Basin, Southwest Monsoon August 1999*

management program of the office, and manual observation is undertaken during times of inclement weather.

**Table 1.0** Stations within the Pampanga River Basin System.

| Station | Station Type | Location | Frequency of reports |
|---|---|---|---|
| Gabaldon | Telemeterized RR | 15°29'55" N 121°21'20"E | Hourly |
| Sapang Buho | Telemeterized RR & WL (sensing pole) | 15°35'39" N 121°07'09"E | Hourly |
| Mayapyap | Telemeterized RR & WL (sensing pole) | 15°30'52"N 120°57'20"E | Hourly |
| Munoz | Telemeterized RR | 15°44'17"N 120°57'37"E | Hourly |
| San Isidro | Telemeterized RR & WL (sensing pole) | 15°8'49"N 120°54'37"E | Hourly |
| Arayat | Telemeterized RR & WL (stilling well) | 15°10'06"N 120°46'56"E | Hourly |
| Candaba | Telemeterized RR & WL (stilling well) | 15°06'59"N 120°51'01"E | Hourly |
| Zaragoza | Telemeterized RR & WL (stilling well) | 15°26'36"N 120°45'03"E | Hourly |
| Sulipan | Telemeterized RR & WL (stilling well) | 14°56'22"N 120°45'31"E | Hourly |
| Papaya | Telemeterized RR | 15°21'17"N 121°03'56"E | Hourly |
| Sibul Spring | Telemeterized RR | 15°10'04"N 121°03'27"E | Hourly |
| San Rafael | Telemeterized RR | 14°58'48"N 120°55'36"E | Hourly |
| Sasmuan | Telemeterized RR | 14°56'14"N 120°37'23"E | Hourly |
| Ipo Dam | Telemeterized RR | 14°52'30"N 121°03'44"E | Hourly |
| Clark | Synoptic | 15°10'N 120°34'E | 3-Hourly |
| Cabanatuan | Synoptic | 15°44'N 120°56'E | 3-Hourly |
| CLSU, Munoz | Agrometeorological | 15°43'N 120°54'E | 6-Hourly |
| Guagua | Std. Non-recording Rainfall gage | 14°58'N (est.) 120°37'E (est.) | As requested, by cellphone |

### 4.2 Status of Stations during the Event (August 23-30, 2004)

**Table 2.0** Status of Telemeterized Water Level Station during the event

| WL Stations | Status / Remarks |
|---|---|
| Sapang Buho | Was not transmitting correct data during the event; "0" value almost whole event |
| Mayapyap | Worked properly during the event with minimal data errors and transmission breaks |
| Zaragoza | Worked generally fine during the event with minimal transmission breaks |
| San Isidro | "0" data reading during the whole event (erroneous) |
| Arayat | Worked properly during the event with fairly irregular transmission breaks |
| Candaba | Worked generally fine during the event with minimal transmission breaks |
| Sulipan | Worked properly during the event with minimal data transmission breaks |

*Note: 5 out of 7 Telemeterized WL stations reported a fairly valid data during the said event.*

**Table 3.0** Status of Telemeterized Rainfall Station during the event

| RR Station | Status / Remarks |
|---|---|
| Munoz | Worked properly during the event with minimal data transmission breaks |
| Sapang Buho | Worked properly during the event with minimal data transmission breaks |
| Mayapyap | Worked properly during the event with minimal data transmission breaks |
| Gabaldon | Worked properly during the event with minimal data transmission breaks |
| Zaragoza | Worked properly during the event with minimal data transmission breaks |
| Papaya | Worked properly during the event with minimal data transmission breaks; possible deficient RR values due to tree obstructions |
| San Isidro | Worked properly during the event with minimal data transmission breaks; possible deficient RR values due to tree obstructions |
| Arayat | Worked OK during the event with intermittent data transmission breaks |
| Candaba | Worked properly during the event with minimal data transmission breaks |
| Sibul Spring | Worked properly during the event with minimal data transmission breaks |
| Sasmuan | Worked properly during the event with minimal data transmission breaks |
| Sulipan | Obvious error data transmitted during the event; possibly a clogged funnel |
| Ipo | RR values may be deficient due to tree obstructions. Likewise chart values are similarly deficient. |
| San Rafael | Worked properly during the event with minimal data transmission breaks |

### 4.3 Rainfall Aspect

**Table 4.0** Rainfall Intensity Classification Table (mm)

| Category | 1 hour | 3 hours | 6 hours | 12 hours | 24 hours |
|---|---|---|---|---|---|
| Light | < 2.5 | < 7.5 | < 15 | < 30 | < 60 |
| Moderate | 2.5 – 7.5 | 7.5 – 22.5 | 15 – 45 | 30 - 90 | 60 – 180 |
| Heavy | > 7.5 | > 22.5 | > 45 | > 90 | > 180 |

**Table 4.1** Daily (8 AM-8AM / Met. Day) Rainfall patterns during the Event

| | |
|---|---|
| August 23 | Isolated light to occasionally moderate rains prevailed over the Pampanga River Basin and the allied basin of Guagua River. Significant moderate rainfall totals in some stations starting in the evening of the day. |
| August 24 | Generally light to occasionally moderate rains was recorded over at the Pampanga River Basin for the day signifying the start of the rainfall regime for the event. A relatively much more intense rainfall, however, was observed over at the Guagua River sub-basin for the same day. Rains were concentrated more on the southwest region of the two basins. (Figure 4.0) |
| August 25 | Continuous light rains becoming moderate towards the evening were being registered for both of the basins. Heavy rains for the past 24-hours have been recorded over at the western sections and southeast section, particularly over at the Angat-Ipo watershed (Figure 4.1). |
| August 26 | Maximum rainfall patterns were generally observed over on the western sections of both basins. Heavy rains were concentrated over at the Candaba swamp area and over at the Angat watershed (Figure 4.2). |
| August 27 | Light rains still prevailed over at the basin with isolated moderate rainfall breaks. Rains have almost ceased by early morning of the following day (Figure 4.3). |
| August 28 | Isolated brief light rains throughout the day with some isolated brief heavy burst in one station – Munoz. Rains have completely ceased by evening signifying the end of the event's rainfall regime. |

Hyetographs and hydrographs for each station are presented in Figures 5.0 to 5.12.Temporal patterns indicated in the accumulated basin rainfall curves (Figure 6.0) for the event shows that the most intense rainfall period for the allied basin of Guagua River started late of the 23rd until the 25th of August. On the other hand, intense rainfall period for the basin of Pampanga was between the 24th till the 26th of August. Based on available data, intense rainfall for both basins started late night of the 23rd of August. The most steep slope line manifests the intense period of rainfall for the event. A plot of the basin's average rainfall and corresponding hydrographs for each gaging station is shown in Figure 7.0.

Rainfall records for Cabanatuan synoptic station during the event registered a maximum rainfall total of 150.6 mm for 24-hours on August 26. This amount falls within a 2 to 5 year return period (from HISSS, FFB RIDF values). Smaller periods for the event daily totals were not available to determine other frequency periods.

Table 5.0 shows the daily (8 AM to 8 AM - meteorological day) RR values observed at stations within and around the basin system.

## 5.0 Basin Hydrological Factor

### 5.1 River Heights and Basin Situation during the Event

Generally, river water level readings (based on staff gage) of reporting stations and based on telemetered data prior to the event were all way below their respective alert status except for Zaragoza and Arayat stations. Arayat station had already reached alert status even before the 23rd of August. Likewise, river stage at Zaragoza station was already way above its alert and alarm status prior to the flooding event.

All readings basically refer to or close to the actual river stages at the station points. River stage readings for San Isidro station were taken from the DPWH gagekeeper's report for the month. Although there were some doubtful data recorded for the month, specifically before the flooding event and at the start of the month, it is believed that the gagekeeper may have conscientiously recorded close to the actual river stage reading from the DPWH staff gage during the flood episode. Flood marks at the streamgaging station, particularly at the San Isidro-Jaen Bridge, closely relates to the maximum stage recorded during the event.

**Table 6.0** Time/Date Station's Flood Assessment Gage Heights were attained

| Station Point | (Alert Level) Time & Day attained | (Alarm Level) Time & Day attained | (Critical Level) Time & Day attained | Remarks |
|---|---|---|---|---|
| Sapang Buho | (3.7 m) attained | (4.5 m) attained | (6.5 m) not attained | Peak WL at about 5.45 m (55.644 m. AMSL) based on flood marks. (Pic 12.0) |
| Mayapyap | (3.0 m) attained at around 1700H of the 26th | (3.5 m) attained at around 2200H of the 26th | (4.5 m) attained at about 0500H of the 27th | Peak WL recorded was at 5.06 m (30.416 m. AMSL) attained at around 1100H, 27 August. |
| San Isidro | (3.2 m) estimated time attained was around 0900H, of the 26th | (4.5 m) estimated time attained – before noon of the 26th | (6.0 m) estimated time attained – early morning of the 27th | Water Level recorder not transmitting correct data that time. Est. peak water level of 6.70 m. (15.933 m. AMSL) attained at around 12 noon of 27 August. |
| Zaragoza | (11.0 m) already attained prior to the event | (12.5 m) already attained prior to the event | (14.5 m) attained around 1500H of the 26th | Recorded peak gage height of 15.39 m (15.725 m. AMSL) attained at about 2100H, 27 August |
| Arayat | (5.0 m) 2100H, 24 August | (6.0 m) past 0200H, 25 August | (8.5m) past 2000H, 26 August | Peak of 10.03 m (10.112 m AMSL) based on flood marks attained after |

| | | | | |
|---|---|---|---|---|
| | | | | 1700H, 28 August (Pic 4.1) |
| Candaba | | (4.5 m) 0100H, 26 August | (5.0 m) past 1400H, 26 August | Recorded Peak of 7.38 m (7.223 m AMSL) attained at around 0100H, 29 August. |
| Sulipan | (3.6 m) past 1600H, 28 August | (4.2 m) past 0400H, 29 August | (5.0 m) not attained | Peak gage height at 4.39 m (4.328 m AMSL) attained 1800H, 29 August. |
| Sasmuan | | | | Est. peak floodwaters of 2.065 m. (AMSL) at the station; attained sometime between 25 – 28 of August |
| Norzagaray | | | | No record of water level data during the event. No reported flooding at this section during the event. |

*Note: Elevation of gage heights (in MSL) were based on survey of elevation of zero "0" of gage at various streamgaging stations undertaken on November 1996.*

Based on the preceding table, river stages at Mayapyap, San Isidro, Arayat and Zaragoza water level gaging stations overtopped their respective established assessment critical levels – level 10, bankful stage. Surveyed section of Zaragoza station undertaken after the event showed flood marks exceeding the natural banks of the river. Likewise, similar situations at Arayat station were observed based on flood marks on the station's housing. This was the highest, so far, for the gauging station in more than 30 years of record. At Sulipan station, river stage overtopped its natural banks at the station's section. Overflowing, however, was controlled at the section due to dike structures at both banks. The Candaba swamp area was practically submerged during the event with a record high swamp water level.

Tides may have somehow caused a slow recession of floodwaters from the Pampanga River, particularly at the Sulipan station. Based on predicted tides (NAMRIA) during the event, high tides were not relatively high. There was no report of a storm surge either at that time (Figure 8.0). Nonetheless, this flood event has a relatively shorter flooding duration as compared with other flooding in the area in the last 10 years. Flooding was in the order of hours to a day, particularly at the upper main Pampanga River portion; 2 to 3 days at middle main Pampanga River portion; to less than a week at the Candba swamp area.

### 5.2 Streamflow

There were no discharge measurements undertaken during the flooding event. The closest measurement activity performed was on the 31st of August and only undertaken at 2 streamgaging sites only, Arayat and at Apalit Bridge. For Arayat, discharge was around 1,880 $m^3$/sec corresponding to a gage height of 8.63 m at the station. Similar undertaking at Apalit Bridge resulted to a discharge of 1,784 $m^3$/sec corresponding to a gage height of 3.84 m at the gaging station.

An updated rating curve for Arayat station that includes the latest measurements (consolidated discharges for the station disregarding dates of measurements) was made to determine the peak discharge attained during the event. For a 10.03 m maximum river stage attained at Arayat for the event, the corresponding discharge is 2,955 $m^3$/sec.[6] Rating Curve for Apalit has yet to be made considering the tidal effects experienced at the site.

On the other hand, an estimate of discharge, using Manning's Formula, at Sapang Buho, Mayapyap and San Isidro based on the recorded gage height attained at each station during the event is presented in Table 7.0. Rating curves for the said stations, including that for Zaragoza station, are yet to be updated based on actual field-measured discharge data. It should be noted, though, that the estimated discharge are highly dependent and quite sensitive on the assigned values of Manning's roughness coefficient "n".

**Table 7.0** Maximum Discharge (SW as enhanced by T.Marce, August 2004)

| Station | **n** | **I** (average riverbed slope) | Computed Area **A** ($m^2$) | HWL in meters (AMSL) during the event | Computed Discharge **Q** ($m^3$/sec) |
|---|---|---|---|---|---|
| Sapang Buho | 0.040 | 1/1000 | 506.9 | 55.6 | 2,160 |
| Mayapyap | 0.040 | 1/2000 | 795.2 | 30.4 | 2,887 |
| San Isidro | 0.035 | 1/3000 | 1496.6 | 15.9 | 3,481 |

Manning's Formula: $\mathbf{Q = VA = (1/n)\ (R^{2/3})\ (I^{1/2})\ (A)}$

Where: A = cross-sectional area of flow; R = hydraulic radius; I = river bed gradient
V = average velocity; n = Manning's roughness coefficient; Q = discharge

*Note: Values for n and I were taken from the Design Report – Hydrological & Hydraulic Calculation for FFWSDO Project by NK, CTIE & BASIC Team, June 1987.*

### 5.3 Major Hydraulic Structures and Dam Releases

Pantabangan and Angat Dams are the two main hydraulic structures within Pampanga River Basin. Pantabangan Dam, located upstream of the upper main Pampanga River operates as a hydropower and an irrigation dam. The Angat Dam, on the other hand, is located on the eastern portion of the lower main Pampanga River and drains through the Angat River via the Ipo Dam and operates as a hydropower plant. Ipo Dam, which supports and partly regulates releases coming from the Angat Dam, is situated about to 7 kilometers downstream of the latter. Ipo

[6] *Based on a rating equation, $Q=0.365\ [H - (-3.06)]^{3.499}$*

serves as an active reservoir for water supply requirement of Metro Manila. It is not an impounding reservoir but as a diversion dam and relatively a lot smaller than the other two dam structures.

Ipo Dam was the only reservoir that released water during the flooding event. Ipo Dam is primarily a diversion dam. It diverts water from the Angat and Ipo Rivers into tunnels that lead to La Mesa reservoir and Balara filtration plant. Only a small impounding reservoir of around 7.5 million $m^3$ compared to Angat Dam which has a reservoir capacity of 850 million $m^3$. If the impounded water exceeds this volume, water starts to overflow the radial gates.

Standard operating procedures for flood operations of Ipo Dam are as follows:
Preparatory Measures -

- Reduce NPC-Angat potable water supply releases to Ipo to maintain elevation at only 100.0m to 100.5m;
- If water elevation starts rising due to heavy rainfall, ask for further reduction of NPC-Angat releases to Ipo;
- In case of continuous heavy rains, ask NPC-Angat to maintain only minimum release to Ipo.

Flood Operations -

- If water level is rising such that Ipo Dam will overflow within one hour, Ipo operator calls CPF-Angat operator of imminent opening of Ipo gates;
- Angat operator phones Bgy. San Lorenzo Officer-on-duty, who then calls Norzagaray, and in turn relays the message to Malolos;
- Just before opening the gates, a siren is sounded to warn the immediate downstream residents;
- When Ipo elevation reaches 101.1m and over, one gate is opened at 30cm only.
- If elevation still continues to rise, open another gate.
- Add or reduce gate openings, depending on inflows and the Ipo reservoir elevations.
- Fully close all gates when Ipo elevation goes below critical levels.
- Inform Angat operator that Ipo releases have ceased.

Considering a smaller watershed area of about 6 $km^2$, Ipo Dam opened partly its gates and released water from its reservoir during the event. Dam releases started at about 1815H of August 25 at a reservoir elevation of 100.95 m. Releases continued for the next 2 days until it shut-off completely at 1945H, 27 August at reservoir elevation of 100.82 m. The total spilled water for the whole duration was 18,537,684 $m^3$. Peak release discharge of about 564.9 $m^3$/sec was attained at 0825H of August 26 for about 35 minutes. According to Ipo Dam authorities, the flood operation procedures were initiated, as explained above, during the flooding event. There were no reports of river overflowing along the Angat River during the event except at its confluence with the Pampanga River.

**Table 8.0** Ipo Dam Daily Releases and Maximum Discharge

| Day (Year 2004) | Total Spilled Water ($m^3$) at Ipo Dam* | Maximum Recorded Discharge for the day ($m^3/s$) |
|---|---|---|
| August 25 | 1,087,212 | 175.2 |
| August 26 | 11,468,952 | 564.9 |
| August 27 | 5,981,520 | 175.8 |

* *Dam release data from Ipo Dam Reservoir Plant*

The Angat River in Bgy. Matictic, Norzagaray, Bulacan can handle a discharge capacity rate of 770 $m^3/s$ as per hydrographic survey (1997) and by hydraulic calculation at that section. The total cross-sectional area at this part is 683 $m^2$ with a river width of 172 meters.

Ipo Dam releases during the event have little effect on the river stage along the main Angat River as release of water was regulated. Nonetheless, the released water volume, in a way, may have partly contributed to the already worsening situation at the confluence between Pampanga and Angat Rivers. Ipo Dam has yet to be a part and a coordinating member of the FFWSDO for the Angat Dam System.

Figure 9.0 shows the Ipo Dam releases and the corresponding reservoir elevation during the event. This shows that the amounts of releases from the Dam that were made were clearly in relation to the prevailing reservoir stage.

### 5.4 Areas Flooded

A list of areas inundated within the two basin systems during the event is presented in Table 9.0. Flood depths of areas inundated from previous events are also presented for general comparison.

The approximate point flood depth map (Figure 10.0) of the basin shows maximum estimated floodwater heights observed and/or reported at various places during the event. Likewise, a map showing the flow of floodwaters during the event is presented in Figure 10.1.

## 6.0 Flood Forecasting and Warning activities

Flood monitoring operations for the Pampanga River were initiated on 24 August 2004 and shift work, under Flood watch conditions, begun on the 25th August 2004. Most of the rainfall gauges were observed as functional during the event but there were WL gauges that were not reporting correct readings, particularly the Sapang Buho and San Isidro gaging stations.

Flood Bulletin No. 1 was issued on 0900H, 26 August 2004 after significant rainfall (moderate to heavy) was recorded over at the upper sections of Pampanga River. Arayat WL during this time was showing a slow increase in the river stage and was, obviously, expected to reach ALARM level. WL level readings for Mayapyap was also rising from alarm to critical levels and a forecast of light to moderate rainfall would result to a slow rise for the Rio Chico and Talavera rivers in view of accumulated rainfall with light to moderate intensity since 24 August. Flood advisory No. 1 was issued for the Guagua River one day ahead of the issuance for the Pampanga River. This was in view of the forecast of moderate to heavy rainfall. Flood bulletins for the two basins were regularly issued thereafter.

Final General Flood Advisory for the Guagua sub-basin was issued on 1600H, 28 August 2004, following forecast of light rainfall. The Final Bulletins for the Pampanga River was issued on 1600H, 29 August 2004, following recession of river stages at Mayapyap and Arayat and no observed significant rainfall.

The issuance of flood bulletins for Pampanga River was somehow issued on time (some 18 hours ahead before a reported flooding within the basin). Although by river basin forecasting standards this could be regarded as rather short.

Post-flood investigation noted flooding in the upper Pampanga River, especially in low-lying areas and areas near river embankments, the flooding lasting for short-duration (less than 48hours) from 26-27 August 2004. It was also noted that record high flood marks were indicated in river sections within the upper Pampanga River, indicating the large volume of rainwater that overtopped narrow and shallow embankments, eventually being concentrated at the middle-Pampanga river.

A very slow recession of flood due to the volume of accumulated rainwater was observed at the Candaba swamp and the lower Pampanga River causing several days of inundation.

**Table 10.0** Issuance of Flood Bulletins (FB) & General Flood Advisory (GFA)

| Date (2004) | Time | Pampanga | Guagua |
|---|---|---|---|
| 25 August | 0900H | | GFA 1 |
| 26 August | 0900H | FB 1 | GFA 2 |
| 26 August | 1600H | FB 2 | |
| 27 August | 0400H | FB 3 | GFA 3 |
| 27 August | 1600H | FB 4 | GFA 4 |
| 28 August | 0400H | FB 5 | GFA 5 |
| 28 August | 1600H | FB 6 | GFA 6 (Final) |
| 29 August | 0400H | FB 7 | |
| 29 August | 1600H | FB 8 (Final) | |

A total of 8 Flood Bulletins (FB) and 6 General Flood Advisories (GFA) were issued for the whole flood watch duration during the SW Monsoon-T.Marce event for Pampanga River and Guagua River Basins, respectively.

Figure 11.0 presents the relations between flood bulletins issued for the Pampanga River Basin and observed water levels for each streamgaging station during the flood event. The Final Flood Bulletin issued on 1600H August 29 was based primarily on the rainfall records observed. As no rainfall was observed, it was predicted that water level would decrease in the basin, therefore the final bulletin. However, it was observed that at the downstream area of Sulipan gauging station, water level continued to rise even after the issuance of the final bulletin. Peak gage height at the Sulipan was registered 2 to 3 hours after the final flood bulletin for Pampanga River was issued.

The final bulletin forecasted that flooding in the lower Pampanga River shall persist for a few days and in the Candaba swamp shall remain for a few weeks. Nevertheless, future forecast should be based on observed water level data even at the downstream area.

Contents of the Flood Bulletins:

From the flood bulletins issued can be gleaned clearly that the rainfall conditions were being monitored. The PRFFWC have summarized the rainfall data for the basin, but station data should also be emphasized, to show the extent of coverage of the flood-causing phenomenon. In the basis for forecast, the observations on the progression of the river stages should also be mentioned. The August 2004 Monsoon showed observed record high water level and which should be communicated to the target recipient.

The General Flood Advisory for the Guagua River was noted to be similar throughout despite the changes in the rainfall and at times the affected river system.

The PRFFWC have made efforts to communicate other data by establishing a local website, other than the agency's main homepage, *http://www.dost.gov.ph*, which carried information of isohyetal maps and hydrographs during the event. Their site, *http://groups.msn.com/PampangaRiverBasin/prffwc.msnw*, which has been in operation for about 2 years now, happens to be the only existing information site for any of the river basins being monitored by the FFB. Such effort should be encouraged.

## 7.0 Flood Damages (Region III)[7]

Local declaration of areas under State of Calamity through their respective Sangguniang Panlalawigan / Bayan / Panglungsod in Region III, where the Pampanga River Basin system is situated as follows: Province of Pampanga and Tarlac; Municipalities of Calumpit and San Miguel both in Bulacan; and Mexico, Pampanga.

As per joint report of OCD and NDCC, "the massive flooding in the low-lying areas of Region III was due to the silted rivers and waterways in the provinces of Tarlac, Pampanga and Bulacan, aggravated by the breaching of Culibangbang Earthdike in Paniqui and Malayep Dike in Gerona, Tarlac". Furthermore, it reports that "Based on the findings of aerial survey conducted by LGUs on August 31, 2004, heavily silted rivers and waterways caused the widespread flooding in Pampanga and that water was relatively stagnant due to lahar sediments that accumulated at the channel of the following rivers: Gumain-Porac River (4 kms), Upper Dalan Bapor River (4.35 kms) and Lower Dalan Bapor River (3.65 kms) all in Lubao, Pampanga; and Guagua-Porac River, Malusac Section (5 kms.)".

Damage assessments for the region are as follows:

- Estimate of Area and Population affected – 6 Provinces; 8 Cities; 76 Municipalities; 974 Barangays; 261,040 Families; 1,198,131 Persons.
- Casualties – 31 Dead and 2 Missing
- Damaged Houses – 216 Totally; 1,254 Partially
- Damaged Agriculture (₱ Millions): 597.325 for Crops; 5.204 for Livestock; 846.788 for Fisheries.
- Damaged Infrastructure (₱ Millions): 289.670 for Infrastructure

Roads / Bridges

- Vega Bridge in Bongabon-Rizal Road
- Paniqui-Camiling-Wawa Road
- Tarlac, Sta. Rosa Road, La Paz section Bgy. San Roque
- San Fernando-Gapan Road Magliman section
- Norzagaray-Bigte Road, Bgy. Minuyan section

## 8.0 Highlights during the event and other significant findings

- The Guagua River Basin area was one of the most severely flooded area within the region (Region III), particularly the towns of Guagua, Lubao, San Fernando, Macabebe, and Masantol during the event. The western sections of the Pampanga River Basin, particularly the upper western portions of sub-basin of

[7] *Final Report on the After-Effects of Southwest Monsoon Rains Induced by Tropical Storm "Marce", Administrator, OCD and Executive Officer, NDCC, September 14, 2004.*

Rio Chico River, particularly Quezon, Aliaga, Zaragoza and Licab in Nueva Ecija and La Paz in Tarlac; the Candaba swamp area, and the Pampanga delta area were similarly heavily inundated.

- Widespread flooding in these areas could be attributed to several factors; one is the intensification of the SW Monsoon, which was enhanced by Typhoon Marce. Another thing is the decrease of conveyance capacity of river channels for both basins due to siltation aside from its low-gradient channel at downstream sections. Survey of cross-sections of Pampanga River at Arayat shows a decrease in river section (Figure 12.0). It is believed that similar situations exists at other sections unless those where dredging works are being undertaken.

- The Arnedo Dike at Mandasig section in Candaba was overtopped by floodwaters (between August 26-27) during the event and was nearly breached if not for the army and residents who protected the dike with sandbags. Arnedo dike was named after the first elected provincial governor of Pampanga (1904) – Macario Arnedo. He accomplished many projects including construction of railroads, concrete and asphalt roads, government buildings, schools, irrigation systems and flood-control works particularly the "human-made" Arnedo Dike which extends from northeastern towns of Arayat and Candaba passing through the municipalities of San Luis, San Simon, Apalit, Macabebe and Masantol.

- Flooding of Candaba area – floodwaters reached the second step of the municipal building; Bgy. San Agustin was the worst-flooded area within the town; this event was ranked as the worst for the town according to the municipal secretary; flooding within the town proper lasted from 7 to 8 days before normal traffic flow resumed.

- The peak river height attained at Arayat gaging station, which is estimated at 10.03 m, and the maximum water level attained at Candaba swamp area, around 7.38 m, are record highs based on available record, since the start of the FFWS operation (late 1973) for the Pampanga River Basin.

- The 1st General Flood Advisory for Guagua River Basin was issued on the morning of August 25 (0900H) following significant rainfall amounts recorded (Sasmuan & Clark stations) over the area. By nighttime, there were already reports of minor flooding within the Guagua basin area. On the morning of the following day, August 26, Flood Bulletin No.1 for Pampanga River Basin was issued as widespread moderate to occasionally heavy rainfall was monitored over the basin. Likewise, minor floods were already being reported at relatively low-lying areas within the basin, particularly in the Candaba swamp area. Succeeding flood advisories and bulletins for Guagua and Pampanga River Basins were regularly issued following the prescribed issuance time of 0400H and 1600H daily. There were no intermediate bulletins issued throughout the whole flood-warning phase for said event.

- Final General Flood Advisory (No. 6) for Guagua River Basin was issued at 1600H of August 28. On the other hand, Final Flood Bulletin (No. 8) for Pampanga River Basin was issued on the afternoon of August 29 (1600H). No intermediate bulletins or advisories were issued throughout the flood watch operation activities.

- The termination of Flood watch activities for the Pampanga River Basin was decided even before the peak at Sulipan has not yet been attained. This is in view of the widespread flooding already persisting in the lower main Pampanga River area. Though, this could be seen as a basic fault on the part of the center's duty hydrologists. The center's personnel status at that time was short and basing on the judgment that the area (lower main Pampanga River) had already been forewarned 2 days earlier for disaster entities to conduct necessary evacuation procedures. Also, portions of the downstream areas particularly Apalit, Calumpit, Hagonoy and Paombong are already inundated. Peak stage at the gauging station (Sulipan) was attained 2 hours after the issuance of final Flood Bulletin.

- The lack of rainfall stations and not a single water level station within the Guagua River basin stand to be a setback in the timely issuance of flood advisories over the said area. Considering this handicap, the center (PRBFFWC) was judiciously able to prepare, issue and furnish the flood bulletins to its intended recipients for both basins.

- Although a record high of river stage at Arayat and Candaba swamp was observed during the event, it is quite enlightening to note that flooding within the Pampanga and Guagua River basins did not last long – at most 2 to 3 days (except those areas that have relatively low elevation, ponding / pooling of rainwater), thus having less disastrous impact to most of the affected areas within the basin. Dredging of the Pampanga River along the Pampanga Delta Development Project (PDDP) stretch could have been one of the reason for the recession of floodwaters.

## 9.0 Recommendations

The following recommendations are offered as a result of the hydrological analyses, post-flood survey and investigations undertaken within the Pampanga-Guagua River Basins, Operational activities during the SW Monsoon-T.Marce event. Some of the items have already been recommended in previous post-flood reports.

### A. Short Term:

**(1)** Continuous and extensive public information drive (PID) to step-up level of awareness by the concerned populace on flood hazards, disaster preparedness, environmental protection awareness, weather and flood information interpretation, etc. in direct coordination with various regional and local Disaster Coordinating Councils (PDCC/RDCC) and other concerned agencies and Non-Governmental Organizations (NGOs) within the area. Solicit and tap the help of mass media and school systems to educate the public especially on the dangers of floods and the need for proper, life-preserving measures.

**(2)** Establishment of rainfall and water level gages at strategic points especially within the Guagua River Basin systems. These instruments should be provided to LGU's and responsibilities be given to them to facilitate prompt observations and reporting of rainfall intensities through special or dedicated communication link. This could possibly pave the way for the possible establishment of community-based flood management network within the area.

The installation of flood markers in strategic areas within the river basin would provide data to PAGASA on the extent of the flood events. This can be a part of the proposed community-based flood management network as mentioned above. Mobile communication such as cell phones can be the network's system of reporting.

**(3)** Continuous physical re-survey of target basin areas, especially Guagua River Basin, to familiarize basin forecasters of the ever-changing basin features particularly its river system and present structural works.

**(4)** Regular maintenance of all telemetering stations, their equipment, and the stations' housing. Physical maintenance of station condition, particularly cleaning of water level intake pipes (declogging and desilting works) and wells during low river level status.

**(5)** Memorandum of Agreement / Manual on Ipo Dam Operations regarding Dam Discharge Activities. The lack of pre-release information for the Ipo dam discharge, called attention to the absence of a clear procedure for Dam Discharge Warning between the FFWSDO and the Ipo Dam operations. This should be addressed through a joint Memorandum of Agreement and a manual of operation between PAGASA and Ipo Dam authorities so as to establish information exchange on the status of the Dam and catchment basin and detail the responsibilities for future discharge and warning operations.

**(6)** Joint Monitoring of Status on Dam Discharge Warning Systems. While there were no reported discharges from the Pantabangan and Angat Dams, it is important for future flooding that coordination on the monitoring of the status of the dam catchment be maintained. In this regard, there should be a continued joint-agency monitoring activity focused on updating the status of FFWSDO Warning Equipment for said dams, including monitoring if the dam discharge warning communications system/equipment is still functional.

**(7)** Improved systems for information exchanges (inter-agency). Information on the actual conditions of flooding was not available to the FFWS and PRFFWC personnel during the flooding event. Actual conditions are also factual basis for continuing forecast; therefore it will be significant to establish information links during the flood event. It would be beneficial to pursue activities aimed at an inter-agency Flood Watch Hotline during major flood events among the agencies of the LGU's, OCD, PDCC, DSWD, DPWH, NPC, and NIA. The hotline or dedicated communication link could be a venue for exchanging information on forecast, actual flooding conditions during flood events aimed at better disaster responses.

**(8)** On-line Communications and Data-entry. On-line information through the Internet should be upgraded and sustained among the disaster-related agencies. This facilitates the exchange of forecast and flood conditions, other than Flood Bulletins which are exchanged through faxed communications or those exchange by phone. This requires the upgrading of computers at the Field Centers and linkages with computer systems of the Dam Operations within the PABC. An on-line telemetered data for easier computation and analysis and possible reduction of data gaps due to interferences or malfunction.

Efforts should also be undertaken to link the system to the Short Messaging Services. Since this would require support from service providers, efforts should be directed to engage them for the project.

**(9)** Repairs and Maintenance of Telemetered stations. Immediate repairs are required from the TSSS on the WL gauges for Sapang Buho and San Isidro. Maintenance of telemetering stations is necessary to include clearing of foliage overgrowth for stations partially obscured for rainfall data (Mayapyap, Papaya, Ipo Dam, San Isidro and Arayat), the clearing of flood debris on staff gages and cleaning of water level intake pipes.

**(10)** There is a need to augment personnel of the PRFFWC for floodwatch operations. At present, the office has 2 hydrologist and 3 hydrological aides. During the 10-day floodwatch, the shift rotation would be exhausting for the limited staff. On the immediate, staff from the FFWS could be detailed to the PRFFWC during floodwatch operations.

**B. Medium / Long Term:**

**(1)** Development of simple hydrologic models that may incorporate advanced mapping methods such as Geographic Information System (GIS) and others. Emphasis should be placed on antecedent meteorological and hydrological conditions, flash-flood guidance indices, and instantaneous rainfall rates as determined from satellites or radar images.

**(2)** Establishment of a telemeterized rainfall and water level monitoring system for enhanced flood forecasting and warning operations particularly for Guagua River basin.

**(3)** There is a need to rehabilitate the telemetering system of the Pampanga River Basin in order to get reliable real-time data on the rainfall and water level readings at each station. Rehabilitation should include the installation of additional telemetered stations in strategic locations, particularly in the Guagua River system whose catchment, at the moment, has only one telemetered RR station.

On the immediate, the WL telemetering stations should be installed with staff gage for manual water level reading. Local observers who can be engaged on short-term contracts during the flood season can undertake manual reading. These observers can provide data through Short Messaging Services (SMS) of cellular phones.

Staff gages should be installed in strategic points (especially Rio Chico and Talavera rivers) to complement readings from telemetered stations. Local observers should also be engaged on a contractual basis or acceptable arrangements with the local government through community-based flood management networking.

**(4)** Appropriations should be provided for equipment with the aim of improving the present FFW system, enhancing the mobility of flood forecasting personnel during flood events, facilitating post-flood field investigation surveys and for supplemental data on rivers not covered by the present system. The need for the following items:

- Vehicle w/ boom & tackle - for mobility during floodwatch operations; for the conduct of post-flood investigation; Boom and tackle attachment for use in discharge measurements at relatively high flows.
- Staff gages – for installation in Rio Chico and Talavera rivers, initially, and at other significant river systems within the basin.
- Flood marker gages - For installation as flood markers in specific points in flood prone areas, based on list of perennially flooded barangays.
- River floats made of young bamboos (“buho”) to support river velocity measurements at relatively high flow periods.

## References

A. Reports:

1. Post-Flood Investigation Report - Area: Pampanga River Basin & Guagua River Basin, Event: Southwest Monsoon of August 1999. PRFFWC, Flood Forecasting Branch, PAGASA, DOST. October 1999.
2. Design Report – Hydrological & Hydraulic Calculation for FFWSDO Project. NK, CTIE & BASIC Team. June 1987.
3. Water and Floods: A Look at Philippine Rivers and Flood Mitigation Efforts. DPWH-JICA-PKII. March 2004.
4. Encarrnacion, R. P. and Hernando, H. T., "Post-Flood Investigation Report – Widespread Flooding in Pampanga River Basin due to the Influence of Typhoons Ditang and Edeng (July 2000)". PRFFWC, Flood Forecasting Branch, PAGASA, DOST. September 2000.

B: Resource Persons:

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