



Pampanga River Basin Flood Forecasting & Warning Center  
(PAGASA)  
DOST Region 3 Compound, San Fernando, Pampanga 2000  
Website: [prffwc.webs.com](http://prffwc.webs.com)



## PRFFWC Post-Flood Report 2011-1 <sup>1</sup>

Event: **Enhanced Southwest Monsoon due to Tropical Storm “Falcon” (Meari)  
(June 24 to 27, 2011)**

---

### Summary

Widespread rains on June 23 to 24 over the Pampanga River Basin (PRB) brought about by the Southwest (SW) monsoon as enhanced by Tropical Storm “Falcon” (Meari) resulted in flooding in many parts of the Province of Pampanga, and some areas in Tarlac, Nueva Ecija and Bulacan.

The Provincial Disaster Risk Reduction and Management Council (PDRRMC) of Pampanga declared a province-wide State of Calamity as a result of the continuous rains for two days inundating many areas in the 18 out of 20 towns within the said province. Likewise, for areas in Tarlac province within the PRB, 3 towns were similarly placed under the State of Calamity on that same premise. On the other hand, several riverside areas in the towns along the Sta. Maria and Marilao Rivers in the Province of Bulacan (Sta. Maria River basin system is generally outside the PRB) were flooded by the runoff generated by extensive rains over the said basin. A presumed tornado at the height of the event was also reported in the towns of Marilao, Meycauayan and Obando. Timely warnings and continuous response actions by the PDRRMO of Bulacan through their Community-based Flood Mitigation and Management Program (CBFMMP) can be highlighted as one main reason why the area, which is highly flood-prone, sustained only 2 casualties during the event.

Ipo Dam, located in Norzagaray, Bulacan and draining through the Angat River, released water from its reservoir during the event period. Despite a maximum released discharge of 429 m<sup>3</sup>/sec midday of June 24 for more than an hour, the Angat River channel was able to contain this outflow causing only minor flooding along some riverside areas of the channel from Norzagaray to Calumpit.

The Pampanga River Flood Forecasting and Warning Center (PRFFWC), based in the City of San Fernando, Province of Pampanga issued 2 Flood Advisories (FA) and 7 Flood Bulletins (FB) covering the event period June 23 to 27. The center was able to provide continuous information and related data to various DRRM offices within the basin considering an undermanned facility. Rainfall and/or water level observations from various local flood warning systems (LFWS) within the basin, particularly the PDRRMOs of Bulacan, Pampanga and the MDRRMO of Guagua, complemented the flood data and subsequently the flood warning information of the center to target areas. The close coordination of these various monitoring systems and set-ups within the basin and the timely sharing of data and information among these groups can be seen as grounds for working out a network of flood warning systems in the future.

---

<sup>1</sup> Post-Flood Survey team: H. Hernando, R. Yutuc, A. Griarte and E. Hilario; Post-flood survey date: June 29 to July 01, 2011.

## 1.0 Hydrological Area Background – Pampanga River Basin (PRB)<sup>2</sup>

The Pampanga River basin system covers an aggregate area of 10,434 km<sup>2</sup>, which is broadly divided into three sub-basins, namely: (a) Pampanga main river basin with its catchment area of 7,978 km<sup>2</sup>, (b) Pasac river basin (or alternatively known as Guagua River allied river basin) with 1,371 km<sup>2</sup> and (c) Angat River basin with 1,085 km<sup>2</sup>. These three basins originate in different mountain areas and have separate river mouths to the Manila Bay, while they are interconnected by channels and their water resources management works are mutually and closely related. The basin spreads over the administrative area of eleven (11) provinces covering about 90 cities/municipalities. The substantial part of the basin area (about 95%) is, however, within the bounds of four provinces, namely, Nueva Ecija, Tarlac, Pampanga and Bulacan. The remaining fringe area (about 5%) is a part of the other seven provinces, Aurora, Zambales, Rizal, Quezon, Pangasinan, Bataan and Nueva Vizcaya.

Pampanga River, with a channel length of 265 km., originates in the Caraballo Mountains north of the basin, and flows into Pantabangan storage dam. After the said dam, it further flows southward meeting with several tributaries until emptying into Manila Bay. The major tributaries are Coronel, Peñaranda, and Rio Chico Rivers. Of these tributaries, Rio Chico has the largest catchment area of 2,895 km<sup>2</sup> and it joins the main stream of Pampanga nearby Mt. Arayat (elevation 1,026 m).

The Angat River system originates in the Sierra Madre Mountains and flows into Angat storage dam meandering through a narrow valley. From the dam, the river flows westward and finally empties into the Manila Bay through Labangan Floodway. There is a small connecting channel with Pampanga River, which is Bagbag River, situated in the towns of Pulilan and Calumpit in Bulacan.

The Pasac-Guagua River system includes various channels running on the eastern slope of Mt. Pinatubo, such as the Abacan-San Fernando, Pasig-Potrero and Porac-Gumain Rivers. All these rivers originate in Mt. Pinatubo and flow into Manila Bay. In the lower reaches, the river system is connected with Main Pampanga River by the Bebe-San Esteban Cut-off Channel. The morphologies of Pasac River have been much affected by the eruption of Mt. Pinatubo in 1991; river alignments have changed due to mudflow (lahar) movement, and serious sediment deposition in the river channel is still in progress.

Within the basin are two swamp areas, the Candaba and the San Antonio Swamps with an area of about 250 and 100 km<sup>2</sup>, respectively. Candaba Swamp has the maximum inundation area of about 330 km<sup>2</sup> during rainy season.

Pantabangan and Angat Dams are the two main hydraulic structures within the basin. Pantabangan is located upstream of the upper main Pampanga River and operates both as hydropower and as an irrigation dam. Angat is located on the eastern portion of the lower main Pampanga River and drains through the Angat River via Ipo and Bustos Dams. Angat operates as a hydropower plant while Ipo and Bustos as water supply reservoir and irrigation dams, respectively.

The long-term average annual precipitation in the study area is estimated at about 2,155 mm/year, and about 83% of this is concentrated during the rainy season from May to October.

---

<sup>2</sup> Major Parts taken from the Draft Final Report "The Study on Integrated Water Resources Management for Poverty Alleviation and Economic Development in the Pampanga River Basin". NWRB-JICA Project, December 2010. (PRFFWC – Project TWG member)

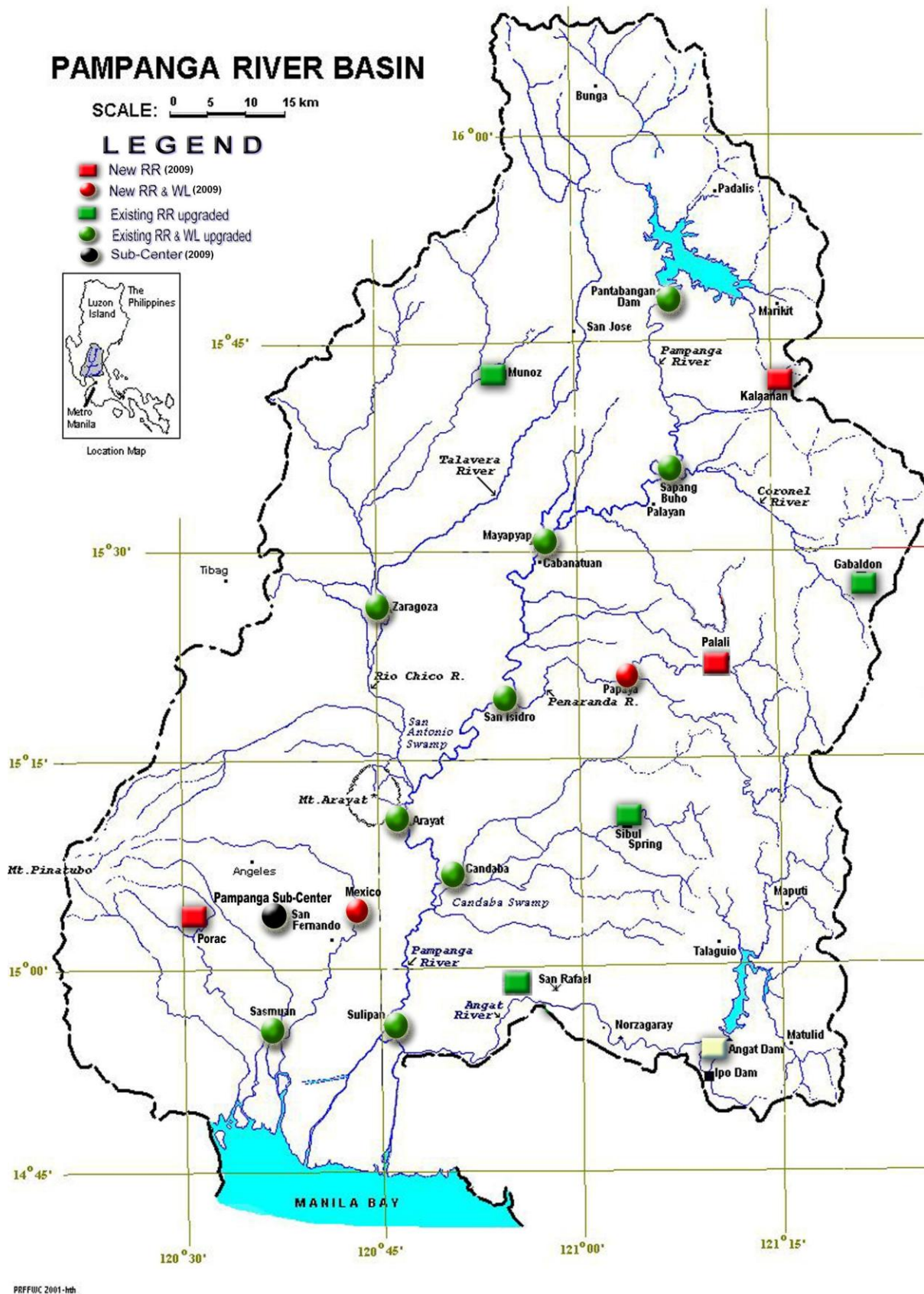


Figure 1.0 The Pampanga River Basin Map showing locations of the network of telemeterized rainfall and water level stations of the present system of PRFFWC.

## 2.0 The Pampanga River Basin Flood Forecasting & Warning Center (PRFFWC)

The PRFFW system consists of 17 rainfall (RR) and 10 water level (WL) stations within its monitoring network and is complemented with several RR observations in Bulacan and Pampanga and a digital RR gage in the center. Though there are 2 synoptic and 1 agrometeorological stations within the basin, however, these stations are not transmitting data on a real-time basis (hourly) to the center which is located in DOST Region 3 compound in the city of San Fernando, Province of Pampanga.

Table 1.0 RR and WL Stations within the Pampanga River Basin System

Station	Station Type	Coordinates
Muñoz	Telemeterized RR	15°44'17"N, 120°57'38"E
Sapang Buho	Telemeterized RR & WL	15°35'39"N, 121°07'09"E
Calaanan	Telemeterized RR	15°38'53"N, 121°11'09"E
Mayapyap	Telemeterized RR & WL	15°30'52"N, 120°57'20"E
Gabalton	Telemeterized RR	15°29'55"N, 121°21'20"E
Palali	Telemeterized RR	15°29'55"N, 121°21'20"E
Zaragoza	Telemeterized RR & WL	15°26'36"N, 120°45'03"E
Peñaranda	Telemeterized RR & WL	15°21'14"N, 121°00'20"E
San Isidro	Telemeterized RR & WL	15°18'49"N, 120°54'09"E
Sibul Spring	Telemeterized RR	15°10'05"N, 121°03'33"E
Arayat	Telemeterized RR & WL	15°10'06"N, 120°46'56"E
Candaba	Telemeterized RR & WL	15°06'56"N, 120°51'01"E
San Rafael	Telemeterized RR	14°58'05"N, 120°54'52"E
Sulipan	Telemeterized RR & WL	14°56'21"N, 120°45'39"E
Porac	Telemeterized RR	15°04'48"N, 120°32'43"E
Mexico	Telemeterized RR & WL	15°04'05"N, 120°43'51"E
Sasmuan	Telemeterized RR & WL	14°56'11"N, 120°37'23"E
San Fernando	Digital tipping-bucket RR	15°04'04"N, 120°39'22"E
Clark	Synoptic	15°10'N, 120°34'E
Cabanatuan	Synoptic	15°44'N, 120°56'E
CLSU, Muñoz	Agrometeorological	15°43'N, 120°54'E

## 3.0 Meteorological Aspect

### Tropical Storm "Falcon" (*International name: MEARI*)

Started as a low pressure area (LPA) east of Visayas, "Falcon" developed into a tropical depression (TD) on the morning of June 21, with a West Northwest direction at 19 kph towards the Bicol Region. By morning of the following day, June 22, Falcon had veered slightly on a Northwest direction over the Philippines Sea but was now packing winds of 55 kph near its center. Later that evening, Falcon developed into a tropical storm (TS) with maximum sustained winds of 65 kph and gusts of up to 80 kph and now back to its original West Northwest direction.

Afternoon of June 23, after slowing down a bit and located some 270 kms. Northeast of Virac, Catanduanes, Falcon merged with a low pressure area (LPA) on its east. It eventually intensified slightly as it moved westward with winds now at 75 kph and gustiness of 90 kph. Its winds intensified further the following day, June 24, to 85 kph and gusts of 100 kph while located some 370 kms. east of Tuguegarao, Cagayan. By nightfall after gaining more strength at 95 kph winds near its center and gusts of up to 120 kph, Falcon, located some 410 kms. Northeast of Basco, Batanes, left the

Philippines area of responsibility on a North Northwest direction moving at 22 kph. Tropical Storm Falcon recorded a minimum center pressure of 970 mb (millibars) and maximum sustained winds reaching up to 60 knots (more than 110 kph winds).

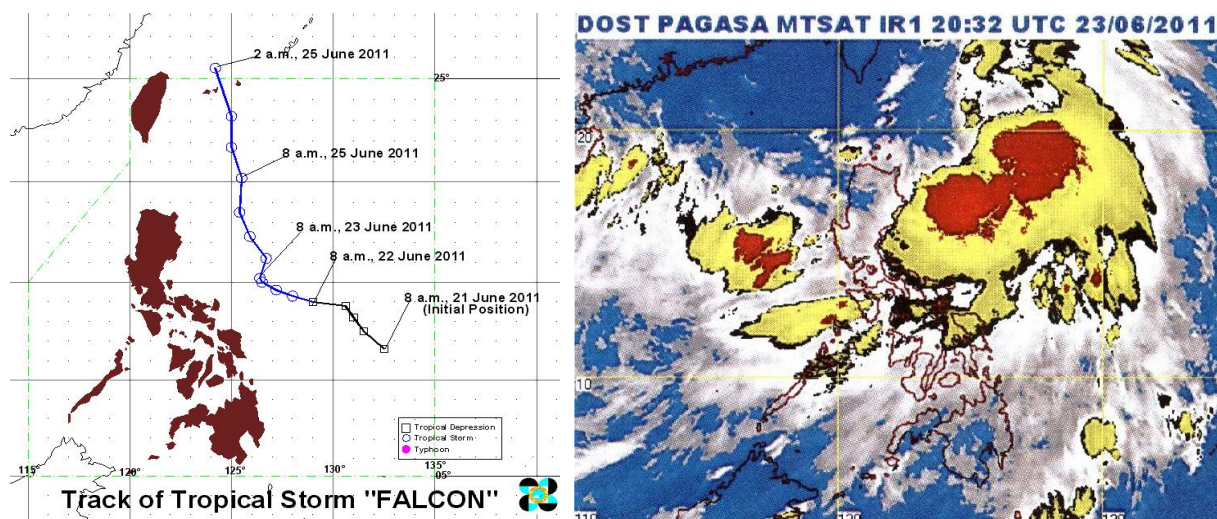


Figure 2.0 Track of Tropical Storm “Falcon” on above left<sup>3</sup>; Figure 2.1 Above right is the satellite picture taken around 0430H (LST), 24 June 2011, as “Falcon” merges with the LPA east of it.

#### 4.0 Basin Hydrological Aspect

##### 4.1 Rainfall

Table 2.0 Rainfall Intensity Classification Table (mm/hr)

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

Rainfall observations from various stations within the basin, including adjacent to the basin, were used to produce the 24-hr isohyets for the meteorological day of June 23 and 24.

The 24-hour (8:01am to 8am) rainfall depths in millimetres (mm) from telemeterized and other various stations within the Pampanga River Basin during the event (June 2011) is presented below:

Table 3.0 Pampanga River Basin

Stations	June 2011			Maximum observed 1 –hr RR	Time (LST) / Day of maximum 1-hr RR for the period June 23-25, 2011
	23rd	24th	25th		
Sapang Buho	88	105	44	30	0600H / 25th
Gabalton	34	110	31	26	0700H / 25th
Zaragoza	72	96	66	22	0500H / 25th
Mayapyap	61	112	53	26	0500H / 25th
Peñaranda	29	130	45	21	0600H / 25th
Calaanan	107	99	39	40	2100H / 23rd

<sup>3</sup> Track of Tropical Cyclone Falcon courtesy of “ dyuwi@yahoo.com”

Palali	26	128	43	18	1000H / 24th
San Isidro	32	129	47	14	0400H / 25th
Arayat	59	173	75	28	0700H / 24th
Candaba	34	99	32	10	0800H / 25th
Sibul Springs	71	188	26	35	0200H / 25th
Sulipan	69	162	25	30	0800H / 24th
<i>Note: Muñoz and San Rafael RR stations were providing erroneous data during the event, and hence were not included in the isohyetal analyses.</i>					

Table 3.1 Pasac-Guagua River Basin (Allied basin)

Stations	June 2011			Maximum observed 1-hr RR	Time (LST) / Day of maximum 1-hr RR for the period June 23-25, 2011
	23rd	24th	25th		
Sasmuan	58	126	21	25	0700H / 25th
Mexico	73	128	64	19	0800H / 24th
Porac	55	242	92	52	0300H / 24th
San Fernando	59.2	160	159.5		
<i>San Fernando rainfall station is situated in the PRFFW Center.</i>					

Table 3.2 Other stations (Synoptic and Bulacan Province CBFMMP)

Stations	June 2011			Maximum observed 1-hr RR	Time (LST) / Day of maximum 1-hr RR for the period June 23-25, 2011
	23rd	24th	25th		
Clark		94.6	47.4		
Cabanatuan	38.6	134.8	57.2		
Muñoz	79.8	86.6			
Subic	121.2		31.0		
Bustos	40.6	68.8	32.0	10.4	1100H / 24th
Calumpit	35.1	125.7	38.1		
DRT	34	198.9	39.4		
Kaybanban, SJDM	61.5	254.3	58.2	37.3	1100H / 24th
Sta. Maria	81.5	171.5	15.0	32.8	1000H / 24th
San Miguel	90.4	120.1	30.2	25.9	0800H / 24th
Pulilan	85.9	146.8	33.8		
Parada, Sta. Maria	72.6	183.4	13.0	39.9	1000H / 24th
Meycauayan	71.4	161.8	39.1	31.8	1100H / 24th
Marilao	84.8	177.5	47.5	38.9	1000H / 24th
F. Halili H.S., Sta. Maria	46.2	138.7	18.0		
<i>Note: F. Halili High School is part of Bulacan's SHINE program. Blanks indicate no data available.</i>					

Isohyets for June 23 (Figure 3.0) show a rather fairly even rainfall depth distribution with a relatively higher values situated at the northeast and southwest portions of the basin. However, the June 24 isohyets apparently points to a southwest monsoon associated rainfall depths as indicated by maximum rains over the southern portion of the basin. It was during such time that floods affected most of the towns of Bulacan Province, within the Sta. Maria River Basin area. Likewise, it was also during such time when floodwaters affected most of the towns within the Pasac-Guagua River Basin system.

Generally moderate rains were observed over the basin on June 23 while moderate rains becoming heavy at the southern part of the basin were observed on June 24.

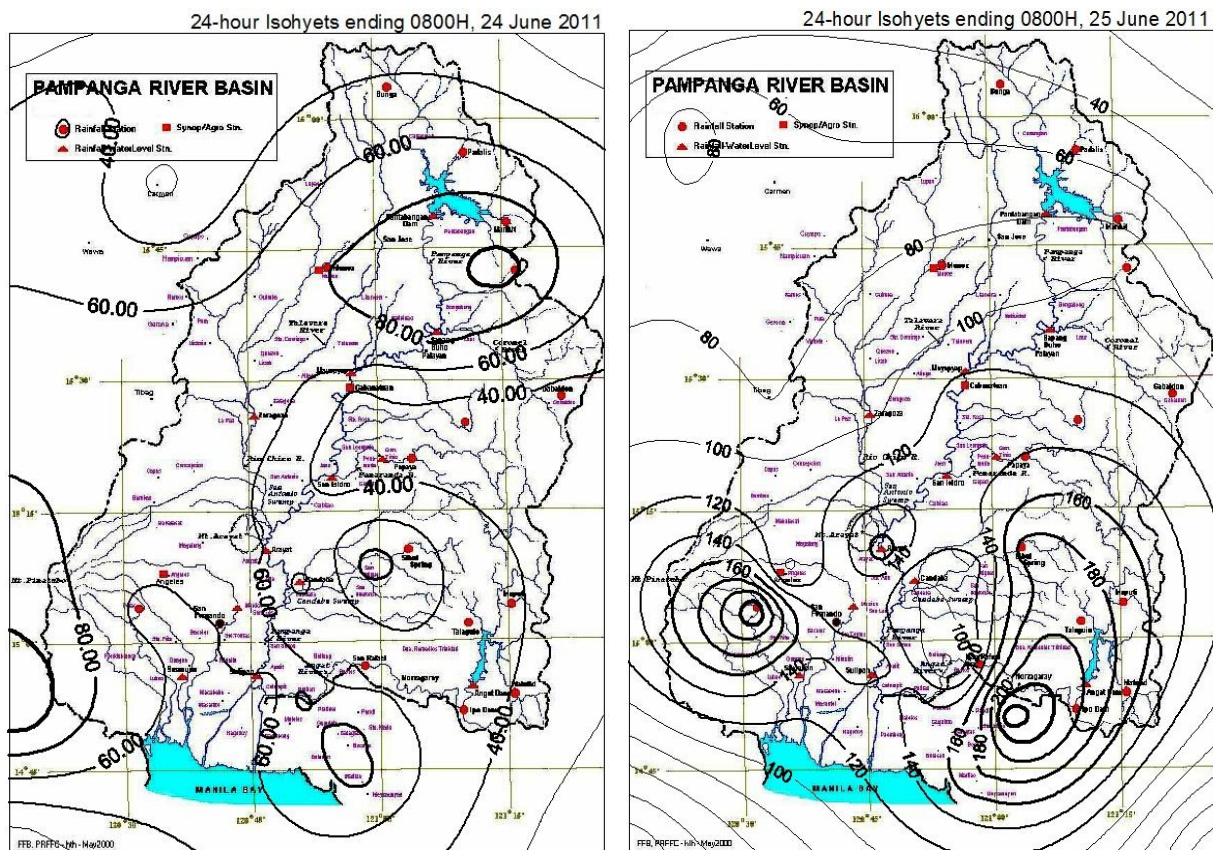


Figure 3.0 The 24-hour isohyets (meteorological day) for June 23 (top left) and June 24 (top right ) during the T.S. Falcon enhanced SW monsoon event.

#### 4.2 River Heights Situation during the event

Table 4.0 Time / Date of Station’s Flood Assessment Gage Heights were reached

Station Point	Alert Level	Alarm Level	Critical Level	Remarks
Sapang Buho	(3.70 m) Not reached	(4.50 m) Not reached	(6.50 m) Not reached	Peak WL based on telemetry reading was 3.47 m (53.664 m AMSL) attained at about 1800H of June 25th.
Mayapyap	(3.00 m) Not reached	(3.50 m) Not reached	(4.50 m) Not reached	Peak WL based on telemetry reading was 2.57 m (28.37 m AMSL) attained at around 0100H of June 26th.
Zaragoza	(11.00 m) Already above this level prior to the event	(12.50 m) Before 12 noon of June 24th	(14.50 m) About 1700H of June 26th	WL crested as per telemetry records at 4.67 m (14.883 m AMSL) attained on 0100H, June 27.
Peñaranda	No assigned assessment levels yet			Maximum telemetry reading of 2.56 m (20.856 m TBM based) recorded on 1100H of June 25th.
San Isidro	(3.20 m) Before 1300H of June 25th	(4.50 m) Not reached	(6.00 m) Not reached	Peak WL based on telemetry records was 4.08 m (13.665 m AMSL) attained at around 0200H of

				June 26th.
Arayat	(5.00 m) Before 1900H of June 24th	(6.00 m) About 0200H, June 25th	(8.50 m) Not reached	WL crested as per telemetry records at 8.37 m (8.447 m AMSL) attained on 1600H of June 26th.
Candaba	(3.00 m) Already above this level prior to the event	(4.50 m) About 0500H, June 25th	(5.00 m) Just after 1300H of June 25th	Swamp water crested, as per telemetry records, at 6.24 m (6.083 m AMSL) reached on 0500H, June 27th and remained at that level for some 10 hours.
Mexico	No assigned assessment levels yet			Maximum WL based on telemetry readings was 2.72 m (8.653 m TBM based) and was attained on 0800H of June 25th.
Sasmuan	No assigned assessment levels yet			Guagua River at Sasmuan station crested, as per telemetry records, at 3.22 m (1.803 m AMSL) attained on 0900H of June 26th.
Sulipan	(3.60 m) Not reached	(4.20 m) Not reached	(5.00 m) Not reached	Maximum WL based on telemetry readings was 2.80 m (2.738 m AMSL) attained on 0800H of June 27th.
<i>Note: Elevation of "0" of staff gages were based on surveys undertaken on August 2009. TBM – Temporary Bench Mark</i>				

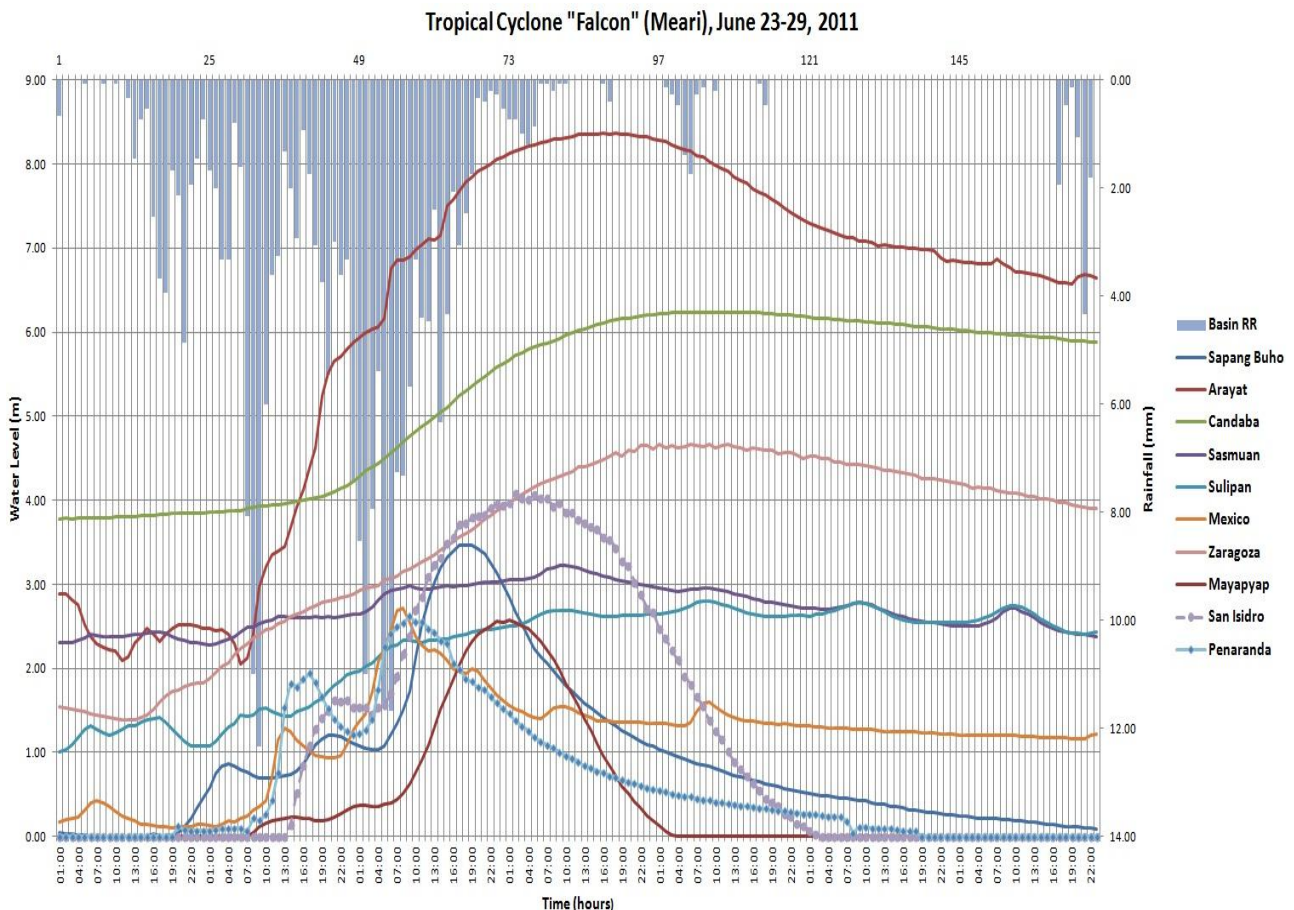


Figure 4.0 Event hyetograph (mean basin rainfall) and hydrographs at various forecasting points within the basin.



Only two (2) stations reached and exceeded their critical assessment levels, Candaba and Zaragoza stations, which are within and adjacent to swamp areas of Candaba and San Antonio, respectively.

Peak stage at Mayapyap station lags Sapang Buho by at least 7 hours. This condition fairly validates observations from previous storms for the two sections and can be an immediate basis for future forecasting of flood travel time between said sections. For other sections, validating flood travel time would further require analysis of flow of the main river and inflows from quite a number of tributaries coming in prior to each section and obviously from a continuous observations of river stage.

Candaba swamp waters stayed for more than 7 days before receding below the established critical level of 5 meters. Considering that the area being a marshland, the prolonged recession is also attributed to the later rain periods upstream of the area, at eastern sections of the basin.

### 4.3 Tides

Tides during the event were relatively not that high in terms of level of magnitude. High tide magnitudes were increasing towards the end of the month, in a way may have contributed to the slow recession at the estuarine areas particularly in Hagonoy town and areas in the Pasac-Guagua River system in the later days.

Table 5.0 High Tide (highest for the day) June 2011

Day	Time	Height (in meters)
24	5:41 AM	0.57
25	6:11 AM	0.69
26	6:41 AM	0.82
27	7:14 AM	0.96
28	7:45 AM	1.09

Note: Based on Navotas port, Latitude 14° 41' N, Longitude 120° 56' E

### 4.4 Hydraulic Structure / Dam Releases

Pantabangan and Angat Dams are the two major hydraulic structures within Pampanga River Basin. Pantabangan Dam, which is located upstream of upper main Pampanga River operates both as hydropower and as an irrigation dam. On the other hand, Angat Dam is located on the eastern portion of the lower main Pampanga River and drains through the Angat River via the Ipo Dam. It operates mainly as a hydropower plant. Ipo Dam, which supports and minimally regulates releases coming from the Angat Dam, is situated about 7 kms downstream of the latter. Ipo serves as an active reservoir for water supply requirements of Metro Manila. It is not an impounding reservoir but more of a diversion dam and relatively a lot smaller than the other two dam structures.

Ipo dam was the only dam that released reservoir water during “Falcon”. Releases started even before the event, June 20, starting with a relatively small discharge of 60.2 cumecs. There were several opening and closing of the dam gates during the event with maximum outflow discharge reaching up to 429 cumecs.

Reservoir discharges by Ipo Dam caused minimal flooding along the river channel of Angat River during the SW-“Falcon” event.

Table 6.0 Ipo Dam Spilling Record during the event

Date / Time (Gate Opened)	Reservoir Elevation at opening (m. AMSL)	Discharge (Q) in cumecs	Date / Time (Gate Closed)	Reservoir Elevation at closing (m. AMSL)
June 19 / 2125H	100.86	60.2	June 20 / 0050H	
June 20 / 0530H	100.86	60.2	June 20 / 0840H	100.65
June 20 / 2100H	100.92	48.2	June 21 / 0148H	100.56
June 23 / 2230H	100.85	47.9		
June 24 / 0015H	100.88	67.0		
June 24 / 0040H	100.90	60.2 to 66.0	June 24 / 0415H	100.65
June 24 / 0900H	100.67	85.7		
June 24 / 1030H		(+) 53.0		
June 24 / 1200H		(total) 429.0		
June 24 / 1335H		(reduced) 306.8	June 24 / 1530H	
June 24 / 1800H	100.70	86.6		
June 24 / 1915H	100.83	(+) 66.7		
June 24 / 2215H	100.84	(total) 200.6		
June 25 / 0100H	100.38	(total) 267.5		
June 25 / 0240H	100.30	(reduced) 58.0	June 25 / 0240H	
June 25 / 0700H	100.86	66.7		
June 25 / 0730H	100.97	(total) 154.8	June 25 / 1310H	100.86
June 25 / 1700H	100.98	135.2		
June 25 / 1943H	100.74	107.2	June 25 / 2010H	
			June 26 / 0120H	100.57

*Ipo Dam spilling operation record provided by FFWS, HMD, PAGASA.*

### 5.0 Event-related Situations and Damages (PRB / Region 3)<sup>4</sup>

The Sangguniang Panlalawigan of Pampanga declared the Province of Pampanga under a State of Calamity on June 27. Likewise, the Sangguniang Panlalawigan of Tarlac Province declared the municipalities of Camiling, San Clemente and Paniqui (towns covered within Agno River Basin); Concepcion and La Paz (within PRB) under a State of Calamity on the same day.

Region 3 Department of Education (DepEd) declared a suspension of classes in the pre-school, elementary and high school levels in the provinces of Bataan, Bulacan, Zambales and Pampanga including the cities of Malolos, Olongapo and Balanga during the period June 24 to 25.

Table 7.0 Breakdown of the population, towns / cities and barangays affected (in Region 3)

Province	Total Towns & Cities affected	Total Barangays affected	Number of Families affected	Number of persons affected
Bataan	8	92	40,865	190,134
Bulacan *	21	276	115,235	511,207
Nueva Ecija	3	37	6,187	27,324
Pampanga	20	326	125,212	583,359
Tarlac *	9	95	16,428	67,091
Zambales	10	78	6,040	25,619
<b>Total for Region</b>	<b>71</b>	<b>904</b>	<b>309,967</b>	<b>1,404,734</b>

*\*Bulacan & Tarlac - towns are mostly outside of PRB system; Bataan and Zambales are both outside the basin*

<sup>4</sup> NDRRMC Sitrep 14 re TS Falcon, dated 02 July 2011 ([www.ndrrmc.gov.ph](http://www.ndrrmc.gov.ph))

More than 300,000 families were affected within the Region, almost a third of it coming from Pampanga alone. There were a total of 6 drowning casualties, two (2) each from Bulacan and Pampanga, and one (1) each from Olongapo and Bataan; one (1) injured and two (2) missing.

Damaged houses totalled about 109, of which 100 being totally damaged. Thirty seven (37) houses in Barangays Bahay Pare and Bayugo in Meycauayan, Bulacan were damaged as a result of a reported tornado that hit the town on June 25 falling within the whole event.

Total damage to both infrastructure and agriculture for whole of Region 3 amounted to about Philippine ₱ 440,129,457.50. Agricultural related damage, particularly to rice and corn crops occupy a bulk of the aforementioned damage. The province of Pampanga got the biggest share in terms of agricultural damage amounting to some Philippine ₱ 153,757,482.00.

### 6.0 Areas Flooded (PRB system) during the Event

Areas Flooded per Province with corresponding estimated flood depths (meters) within the PRB system are listed below:

Table 8.1 Province of Pampanga

Towns / City	Number of Barangays affected	Estimated range of flood depths observed within the area (m)
Guagua	31	0.6 – 1.3
Lubao	29	0.7
Minalin	15	0.3 – 1.2
Sasmuan	12	0.3 – 1.2
Macabebe	21	0.9
San Fernando City	17	0.3 – 1.5
Floridablanca	19	0.6 – 1.5
Candaba	33	0.3 – 0.6
Arayat	9	0.3 – 0.6
Bacolor	16	0.3 – 0.9
Sto. Tomas	7	0.9 – 1.2
Mexico	16	0.3 – 1.2
Magalang	6	0.3 – 0.6
Sta. Ana	4	0.3 – 0.6
Apalit	4	0.6 – 1.2
Masantol	26	0.6
Sta. Rita	5	0.3 – 0.9
San Luis	3	0.3 – 0.9
San Simon	10	0.6 – 0.9
<i>Source: Pampanga PDRRMO situational report as of 1800H, 26 June 2011</i>		

As per Pampanga PDRRMO terminal report dated July 05, 2011, 19 towns were flooded as a result of widespread rains over the province, covering some 283 barangays out of 507 for the province.

Based on the table above, most number of barangays and towns within the province affected by flood are within the Pasac-Guagua River Basin area, situated at the western portion of PRB. This apparently shows the effects of SW monsoon on the flooding regime in the province and on the

basin as a whole. Moreover, reports by the Pampanga PDRRMO stated that waterways were mostly blocked by water hyacinths hence aggravating further the flooding in the province.

Table 8.2 Province of Bulacan

Towns (within PRB)	Number of Barangays affected	Estimated range of flood depths observed within the area (m)
Calumpit	4	0.3 – 1.2
Malolos City	5	0.3 – 0.9
Plaridel	2	
Pulilan	7	
San Ildefonso	4	0.3
San Rafael	4	0.3 – 0.6

*Source: Bulacan PDRRMO update report as of 1700H, 27 June 2011*

Flooding situation within the province were mainly focused at areas within the Candaba swamp area, upper and lower sections of the swamp land, particularly some barangays in San Ildefonso and San Rafael that are within the swamp area; and within the Sta. Maria and Marilao River systems which are topographically outside of PRB. Said latter river systems are situated south of the basin.

As per flood reports provided by Calumpit MDRRMO, the 29 barangays within the town were affected during the event at varying degrees. By comparison with usual events, flooding within the town was relatively minor except for Barangays Meysulao and San Miguel, situated at the right bank of Pampanga River which experienced prolonged flooding similar to its usual regular flood events. Flooding in the said barangays was attributed to the entrapment of rainwater by the earth road dike protecting the right bank of the Pampanga River, therefore flooding by ponding of rainwater.

Table 8.3 Province of Nueva Ecija

Towns / City	Number of Barangays affected
Cabanatuan City	26
San Isidro	2
Gapan City	
Cabiao	1
San Antonio	6
Zaragoza	
Licab	
Quezon	2
Jaen	2

*Source: Nueva Ecija PDRRMO Terminal Report TD Falcon dated 30 June 2011.*

Flooding within the province of Nueva Ecija was not that extensive. Flooding was mainly due to rains from the enhanced SW monsoon. At the height of the event, some provincial roads were rendered impassable due minor landslides particularly in the towns of Bongabon and Rizal.

Province of Tarlac: The municipalities of Concepcion and La Paz were reportedly the only towns within the PRB affected by flooding during the event.

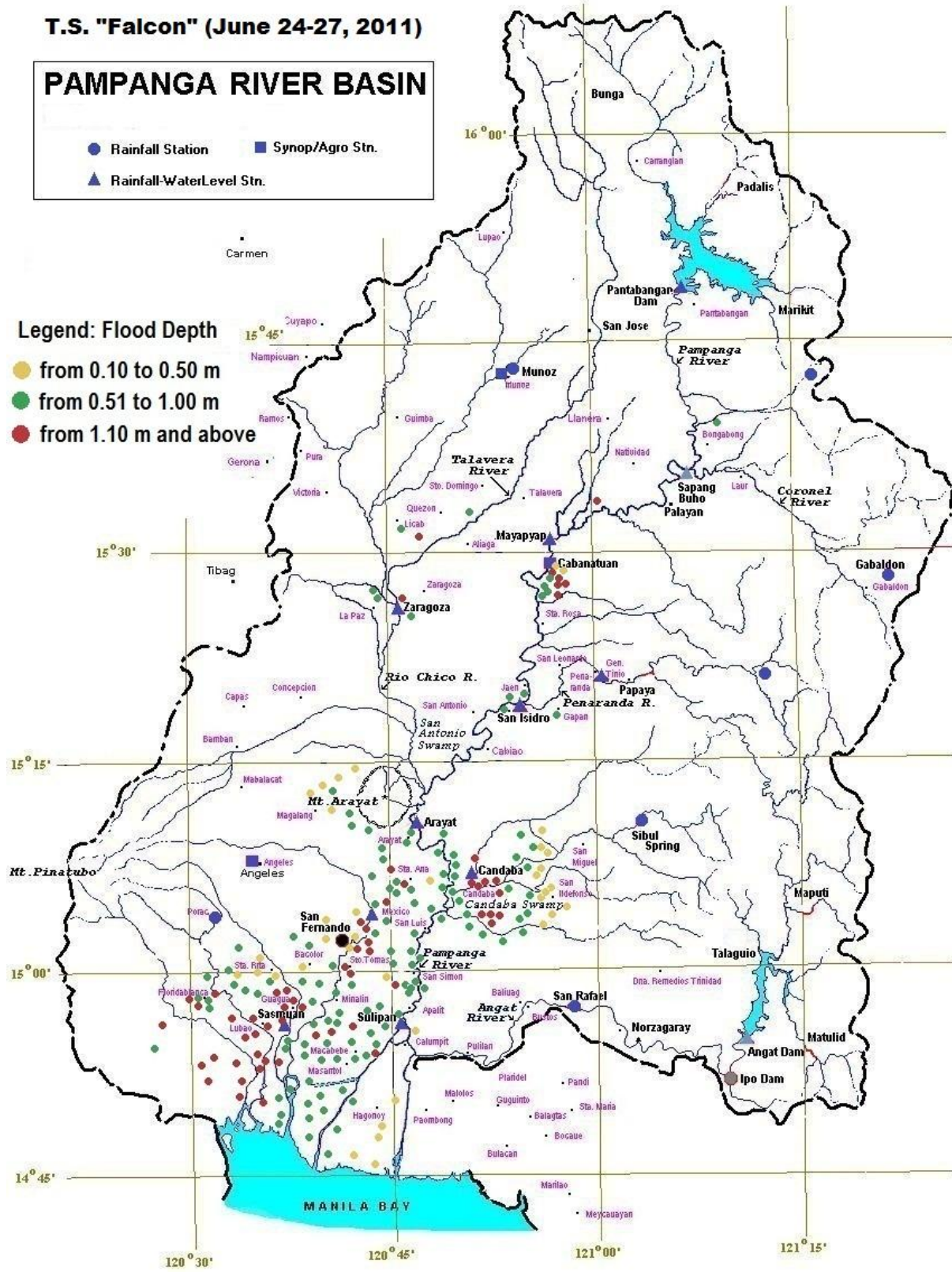


Figure 5.0 Estimated spot flood level (maximum) map during the event as per available reports from the various DRRMOs within the PRB.

### 7.0 Flood Forecasting & Warning Activities

Prior to “Falcon”, PRFFWC has had several issuances of Flood Advisories (FA) already in the recent events, during Tropical Depressions “Dodong” and “Egay”, both within the month of June.

During the said month, there were several hitches and downtimes in data transmissions, in particular downtime as a result of missing station-to-water level sensor cables at Peñaranda station, obviously had been stolen. Eventually, cables were replaced and became operational on June 22, in due time for Falcon’s enhanced SW monsoon. It is quite fortunate though that during event SW-Falcon there were no data transmission downtimes for the period from June 23 to 29. There were, however, doubtful and erroneous data during that period, in particular Muñoz and San Rafael rainfall data. Rainfall readings for both stations during the whole month were “0” and hence were disregarded. Further, doubtful readings of rainfall data at Mayapyap station were observed prior to the event, possibly clogged receiver funnel.

PRFFWC issued 2 Flood Advisories (FA) and 7 Flood Bulletins (FB) throughout the whole flood watch operation during the “Falcon” enhanced SW monsoon event.

A Flood Advisory (FA) is hydrological information in general or in its simple form. It is initialized anytime during flood watch period for awareness or preparedness of the flood prone areas within telemetered basin areas, when their rivers and streams are likely to be affected by high streamflow or flooding or flash flooding. A basin general flood advisory is issued also if there is a forecast of significant rainfall based on meteorological/numerical models and other forecasting tools, even if the past rainfall over the basin is nil. The basins FFWC provide the Main Operation Center (MOC), HMD with a copy of the basins’ general flood advisories.<sup>5</sup>

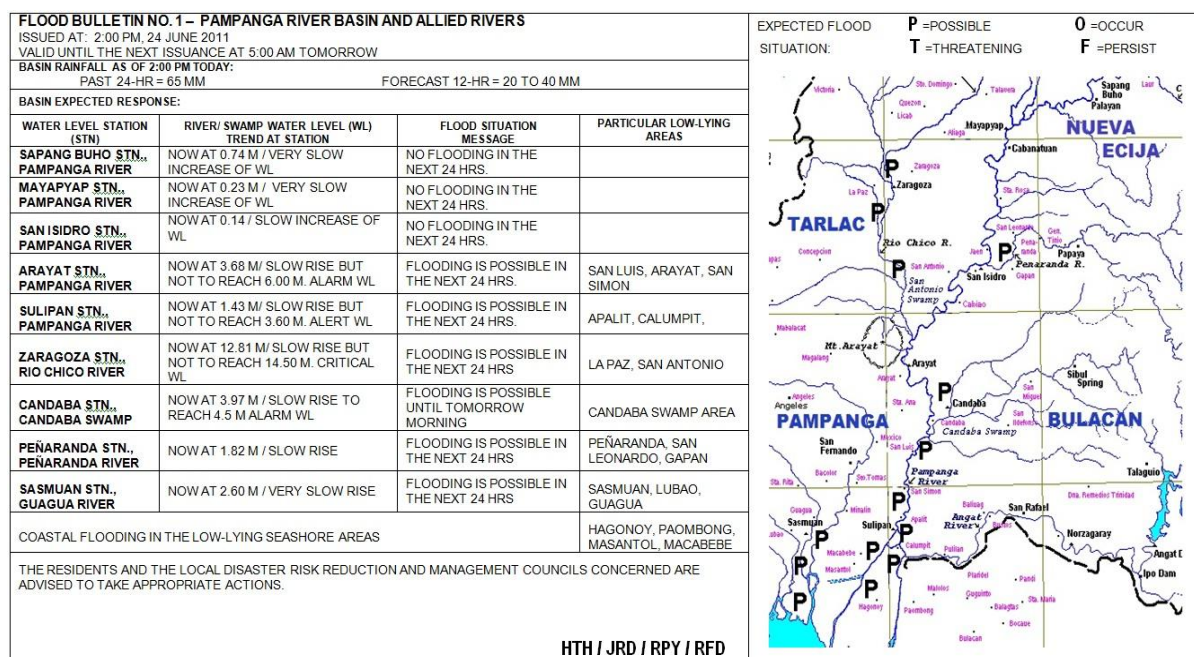


Figure 6.0 FB No. 1 text and expected flood situation map issued 1400H, 24 June 2011.

<sup>5</sup> Provision of Hydro (Flood) Information Protocol (as of July 2011) by H.M. Borja, AWSC, HMD

Flood Bulletins (FB) are more specific flood information prepared and issued whether or not it is being preceded by a basin general flood advisory (depending on the situation) during flood watch monitoring. It is initialized anytime and regularly issued by a FFWCs thereafter until being finalized when floodwaters have generally subsided or no significant increases in the present situation is expected further. FB is more near definite and specific as to river level changes, in terms of its rising and falling trends and the possible areas (towns) to be affected.

During event Falcon, initial FA was issued at 1900H, 23 June after widespread rains were observed over the basin. Initial target waterways of the FA were those that are situated at the western side of the basin, at the Pasac-Guagua River basin system, the Rio Chico River and Candaba swamp area. FA No. 2 was issued 12 hours after, at 0700H of 24 June, still maintaining targeted waterways at the western sections of the basin and now including the lower main Pampanga River. Initial FB (number 1), however was issued on the same day at 1400H as target waterways had relatively increased from the upper main down to middle main Pampanga River.

Subsequent FBs, No. 2 to No. 6, were issued at 0500H and at 1700H daily starting on June 25th to 27th. Final FB, No. 7, was issued in the afternoon of June 27, at 1700H, after continued recession of river stages at middle and lower main Pampanga River were observed. Candaba and San Antonio areas, being a swamp land still remained flooded at issuance of FB No. 7, but both had crested already and as stated in previous FBs, would take quite some time for floodwaters to totally ebb. For Candaba station, it took about 10 days before swamp level receded below the 5.0 meter critical level. Zaragoza water level had a shorter time of 2 days, inasmuch as peak was considerably lower compared to the peak at Candaba. Also, Rio Chico River at Zaragoza is a flowing waterway unlike Candaba where floodwater remain for several days due to its swamp characteristics.

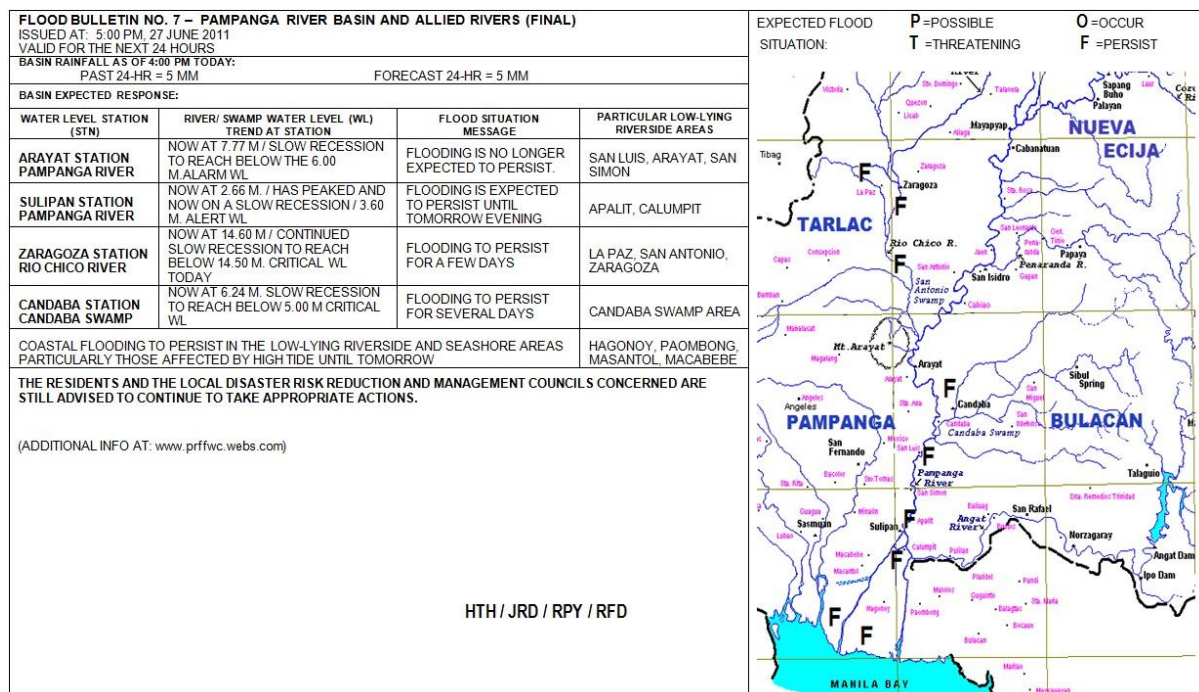


Figure 7.0 Final FB, number 7 (above) issued 1700H of 27 June, its contents and corresponding flood map still maintaining persistence flooding (symbol “F”) at several areas along the main river.

FB No. 1 was issued some 50 hours ahead reckoned to the crest of water level of Pampanga River at Arayat station, 8.37 meters, which is just below the critical level of 8.50 meters; almost 60 hours to Rio Chico River crest at Zaragoza and around 63 hours before Candaba swamp water level crested.

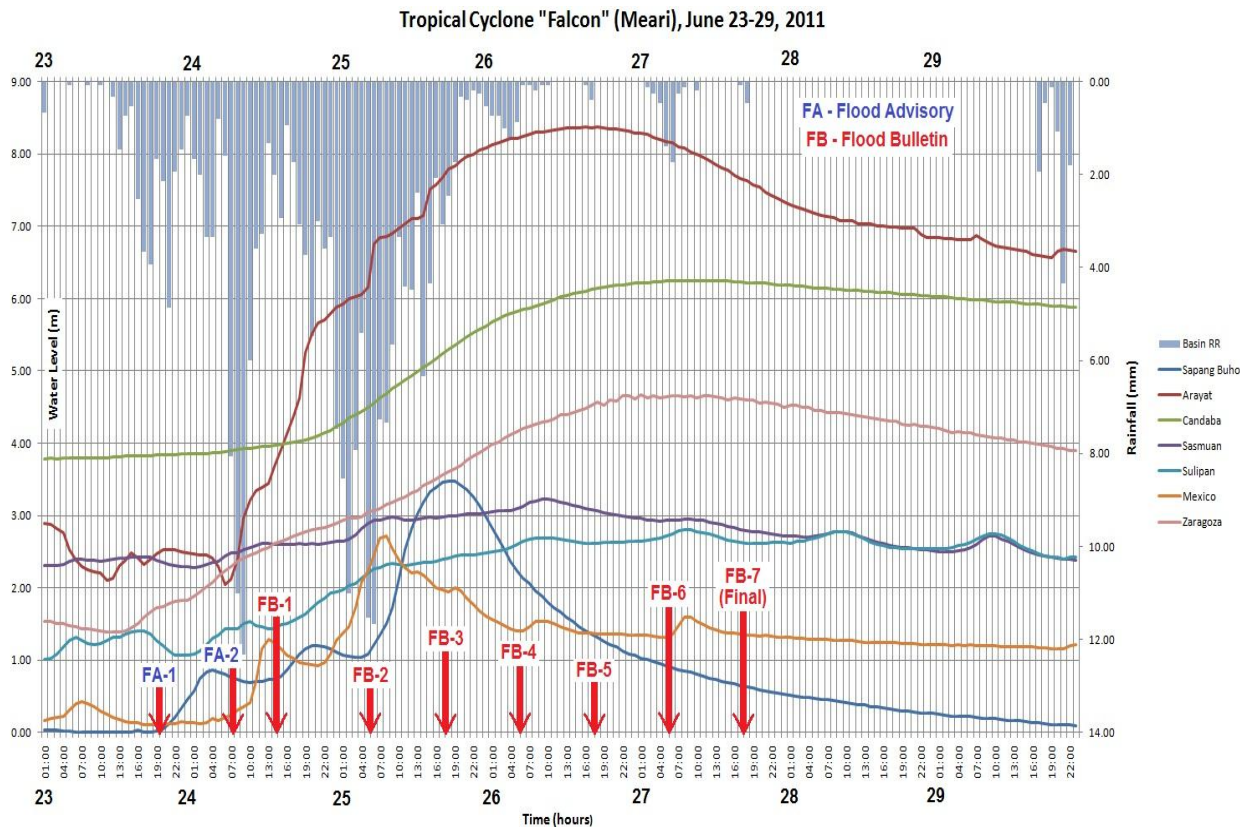


Figure 8.0 Event basin hyetograph and hydrographs (above) at various WL monitoring stations with the corresponding FAs and FBs issued relative to the basin’s hydrological flood event.

**8.0 Event Highlights (in Pictures)**

<p>Water hyacinths such as those pictured above were partly blamed for the floods in Pampanga province, clogging-up some of the waterways particularly small waterways and canals.</p>	<p>About 0.5 meter of floodwaters as pointed out by the school principal, Mr. Reynaldo Buan, inside one of the classrooms of the San Jose Matulid Elementary School in Bgy. San Jose Matulid, Mexico, Pampanga.</p>





Bgy. San Agustin of Candaba in Pampanga still flooded as of noontime of June 29, 2011 (falling within the post-flood survey date). Floodwaters reportedly started in the area on June 24, and by the following day rose to about 1.5 meters at some portions of the barangay.



Bgy. Paralaya in Candaba still flooded as of 1300H, 29 June. Candaba water level station reading at about that same time was at 5.95 meters.



San Agustin bridge, Arayat, Pampanga with flood marks (debris) still clinging to the steel support of the WL sensor of Arayat telemetry station. WL peaked at 8.37 m. attained on 1600H of June 26th.



The lower Candaba swamp area as seen from the North Luzon Expressway (NLEX) viaduct. (29 June, 1500H)



River crested at almost 2.72 meters (flood marks) at the Mexico RR and WL station. Peak was attained at around 0800H of June 25.



Portions of the Jose Abad Santos Highway (Gapan-SFDO-Olongapo Highway) with knee-deep floodwaters due to a heavy downpour taken at around 1730H of June 25, 2011.



Interior roads of the Government Center in Bgy. Maimpis, San Fernando, Pampanga with almost knee-deep of floodwaters (25 June, 1700H)



Maximum river level reading based on the telemetry records of Mayapyap RR-WL telemetry station during the event was 2.57 meters attained at 0100H of June 26, 2011.



Flood depth of more than 0.5 meters from natural road level along the La Paz-Zaragoza Hi-way in Bgy. San Roque, La Paz, Tarlac.



The Guagua-Sasmuan Provincial road in Bgy. Bancal, town of Guagua, Pampanga with floodwaters as of June 25, 2011.



Flood situation of the interior roads of Bgy. Bancal, town of Guagua in Pampanga on June 25, 2011.



Flooded barangay roads in Bgy. San Nicolas 2<sup>nd</sup> (top left) and in Bgy. San Juan 1<sup>st</sup> (top right), town of Guagua in Pampanga taken on June 26, 2011.



The provincial road at Bgy. San Antonio, town of Guagua taken on June 26, 2011. Some areas within the barangay were flooded by more than a meter as per MDRRMO reports.

The debris left by subsiding floodwaters of Sapang Maragul Creek in Bgy. San Juan Nepo, town of Guagua can be evidently seen from the picture above.



The stretch of MacArthur Hi-way along Bgys. San Nicolas 1<sup>st</sup> and San Juan Bautista in the town of Guagua were flooded during the event by about 0.3 to 0.5 meters. Pictures above were taken on June 26, 2011.

## 9.0 Significant Observations during the Event

Tropical Storm “Falcon” was relatively far from the country when it passed through the Philippine Area of Responsibility, crossing it at its northeast corner. It did enhanced though the southwest (SW) monsoon that brought widespread rains mostly at the west and southwest portions of PRB. This is quite similar to the event Typhoon “Marce” (August 2004).

Floods within the basin are more focused, in terms of depth and spread, over at the allied river basin system of Pasac-Guagua which is situated at the southwest side of the Pampanga River basin (see figure 5.0). For the main Pampanga River, while there may be some significant increases in the river stages at different sections along the said river, there was relatively no major channel overflows observed along its stretch. Floods at some parts of the basin (e.g. Cabanatuan City) were mainly due to the rains accumulating at relatively low elevated areas.

The Sta. Maria River Basin system (which is basically outside the PRB) was more evidently flooded as compared to the towns of Bulacan that are situated within the PRB. The said basin system is located at the southeast end of the PRB.

---

### References:

#### Report:

PRFFWC Post-Flood Report 2009-1 (Nov. 30, 2009) Pampanga River Basin Flood Events: Tropical Storm “Ondoy”, Sept. 25 to 27, 2009; and Typhoon “Pepeng”, October 6 to 15, 2009; PRFFWC, HMD, PAGASA, DOST. November 2009

#### Resource Entities:

1. Office of Civil Defense Reg. 3 and the Regional Disaster Risk Reduction & Management Council 3
2. Pampanga Provincial Disaster Risk Reduction & Management Office
3. Bulacan Provincial Disaster Risk Reduction & Management Office
4. Nueva Ecija Provincial Disaster Risk Reduction & Management Office
5. Guagua Municipal Disaster Risk Reduction & Management Office
6. National Disaster Risk Reduction & Management Council ([www.ndrrmc.gov.ph](http://www.ndrrmc.gov.ph))
7. Flood Forecasting & Warning Section (FFWS), HMD, PAGASA