

PRFFWC Post-Flood Report 2020 ¹

PAMPANGA RIVER BASIN Flood Event: Typhoon ULYSSES (*International Name: VAMCO*) November 10 to 17, 2020



¹ PRFFWC Survey team: HTH, NBN, RPY, and JRD (Dec 07 to 11, 2020)

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Typhoon ULYSSES (*International Name: VAMCO*)
November 10 to 17, 2020

PRFFWC, January 2021

Summary

Typhoon Ulysses entered through the Southeast side of the Pampanga River Basin in the early morning of November 12 and cut across the central part of the basin on a generally West Northwest track and before midday exited on a rather westward direction. The Tropical Cyclone had maximum sustained winds of 155 km/h near its center and gustiness reaching up to 255 km/h on its trek within the PRB. It moved from 25 to 30 km/h during its passage within the PRB that lasted for several hours. However, prior to Ulysses, there were already 5 related tropical disturbances that affected the PRB in a span of less than a month: SW monsoon as enhanced by TC Nika (Oct 11-13), TC Ofel (Oct 14-16), TC Pepito (Oct 19-23), TC Quinta (Oct 25-30), and TC Rolly (Oct 30 to Nov 03). These series of disturbances can be associated with the prevailing enhanced La Niña in the last quarter period of 2020.

Continuous moderate to heavy and at times intense rains spawned by Ulysses started on the night of November 11 until the morning of November 12 mostly on the eastern part of the PRB. These caused flash floods in several river channels coming from the eastside of the basin. The flash floods immediately affected several towns on the eastern part of Bulacan and northeast portions of Nueva Ecija Provinces. The floods even inundated portions of the stretch of Maharlika Highway (AH26) in San Ildefonso and San Miguel in Bulacan rendering it impassable for a few hours. By early evening of November 12 the floodwaters from the northeast and east portions of Nueva Ecija and Bulacan, respectively, eventually reached the midstream part of the basin in Pampanga Province. On November 13, floods have affected riverside areas of the towns along the middle and lower Main Pampanga River Basin, in the provinces of Pampanga and Bulacan. The fluvial floods lasted for a few days. Several areas had standing floodwaters for several days to more than a week particularly in the Candaba swamp and several towns in the Pampanga Delta area.

The Angat Dam situated on the eastern part of Bulacan Province started releasing its impounded reservoir water in the afternoon of November 12 as reservoir elevation rose to almost a meter. Eventually, the smaller reservoirs downstream of Angat Dam, Ipo Dam already had its gates opened as early as November 11 while Bustos Dam deflated its reservoir gates in the early morning of November 12. Angat River had its peak discharge before midday of November 12. Similar large discharge was also recorded in the NIA-UPRIIS area, the Atate Dam in Palayan City.

The floods associated with Ty. Ulysses mainly affected the River Basin of Pampanga only. The allied sub-basin of Pasac-Guagua River system, on the Southwest end of the basin, was not totally affected during that period. Generally slight to partly moderate floods mostly due to pluvial effects coupled with recurring tides were the main factors in many of the riverside areas in the allied sub-basin.

As per NDRRMC Situational report no. 29 dated January 13, 2021 at least 3 fatalities were reported within the basin. Damage to Agriculture and Infrastructure for whole Region 3 were ₱ 1.39 B and ₱ 1.87 B, respectively. The Pampanga River Basin Flood Forecasting and Warning Center (PRFFWC) of PAGASA issued a total of 3 Flood Advisories (FAs) and 13 Flood Bulletins (FBs) for the event covering the period from November 10 to 17.

Typhoon Ulysses may be considered as the worst flood event that affected the PRB for the year 2020. Its flood levels, however, are still quite below from other previous flood events, the 2015 events (TCs' Lando and Nona) and the 2011 event (Ty Pedring).

Acronyms & Abbreviations:

AH26	Asian Highway; Pan-Philippine Highway or the Maharlika Highway
Bul	Bulacan
CL	Central Luzon
CSFP	City of San Fernando, Pampanga
cms / cumecs	Cubic meters per second
DMGC	Diosdado Macapagal Government Center
DRRM	Disaster Risk Reduction & Management
D/S	downstream
D/T	downtime
FA	Flood Advisory
FB	Flood Bulletin
HMD	Hydro-Meteorology Division
kph or km/h	kilometers per hour
km ²	square kilometers
LB	left bank
LGU	Local government Unit
LPA	Low Pressure Area
LST	Local Standard Time
MDSI	Met Hydro Decision Support Infosys
mps	meters per second
NCR-PRSD	National Capital Region – PAGASA Regional Services Division
NE	Nueva Ecija
NIA-UPRIIS	National Irrigation Administration – Upper Pampanga River Integrated Irrigation System
OCD	Office of Civil Defense
PAR	Philippine Area of Responsibility
Pamp	Pampanga
PRB	Pampanga River Basin
PRFFWC	Pampanga River Basin Flood Forecasting & Warning Center
PAGASA	Philippine Atmospheric, Geophysical & Astronomical Services Administration
Q	Discharge
RB	right Bank
RR	Rainfall
SG or S.G.	Staff Gauge or staff gage
SW monsoon	Southwest monsoon (or Habagat)
SWB	Severe Weather Bulletin
TC / TCWS	Tropical Cyclone / Tropical Cyclone Wind Signal
TD	Tropical Depression

TS	Tropical Storm
T or Ty	Typhoon
UTC	Universal Time Coordinated
U/S	upstream
WD	Weather Division
WL	Water Level
WMO	World Meteorological Organization
Wx or wx	weather
N/R/P/C/M DRRMO	National / Regional / Provincial / City / Municipal Disaster Risk Reduction & Management Office

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1.0 Hydrological area background of Pampanga River Basin (PRB)²

The Pampanga River Basin is the 4th largest river basin in the Philippines and drains an aggregate area of 10,434 km². It is generally divided into three sub-basins, namely: (a) Main Pampanga River Basin with its catchment area of 7,978 km², (b) Pasac River sub-basin (also known as the allied sub-basin of Pasac-Guagua River system) with 1,371 km² and (c) Angat River sub-basin with 1,085 km². The main rivers of the three basins originate from different mountain sources having separate river mouths towards the Manila Bay but are interconnected by channels and their water resources / geomorphological features are mutually and closely interrelated. The basin area (about 95%) transcends the bounds of four provinces of Region 3, namely, Nueva Ecija, Tarlac, Pampanga and Bulacan while the remaining fringe area (about 5%) is a part of other seven provinces namely Aurora, Zambales, Rizal, Quezon, Pangasinan, Bataan and Nueva Vizcaya.

Pampanga River has a river length of about 265 kilometers with its headwaters originating in the Caraballo Mountains at north of the basin. It flows into the Pantabangan storage dam. After the dam, it generally flows southward meeting with several tributaries until emptying into Manila Bay. Its major tributaries are the Digmala, Coronel, Peñaranda, and Rio Chico Rivers. Rio Chico has the largest catchment area at 2,895 km² and joins the main stream of Pampanga just before Mt. Arayat (estimated elevation of 1,026 m).



Figure 1.0. Pampanga River at Arayat on Nov 14, 2020. Taken a few hours after it crested from Ty Ulysses (pic from FB post of Arayat MDRRMO). Peak river level for Arayat station registered at 8.81 meters around 0600H of Nov. 14.

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



Figure 1.1 Pampanga River at Arayat Station on Nov 26 after Ty. Ulysses. River stage at that time estimated at 3.20 meters.

The allied sub-basin of Pasac-Guagua River system includes various channels running on the eastern slope of Mt. Pinatubo. These are the Abacan-San Fernando, Pasig-Potrero and Porac-Gumain Rivers. All these rivers originate in Mt. Pinatubo and flow towards Manila Bay. At the lower reaches, the river system is connected with Main Pampanga River by the Bebe-San Esteban Cut-off Channel. The Pasac River had been much affected by the eruption of Mt. Pinatubo in 1991 such that river alignments changed significantly due to mudflow (lahar). Substantial sediment deposition in the river channel is still active.

² Portions 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 was a project TWG member)

The basin has two swamp areas, the Candaba and the San Antonio Swamps with an area of about 250 and 100 km², respectively. Candaba Swamp covers a maximum inundation area of around 330 km² during rainy season.

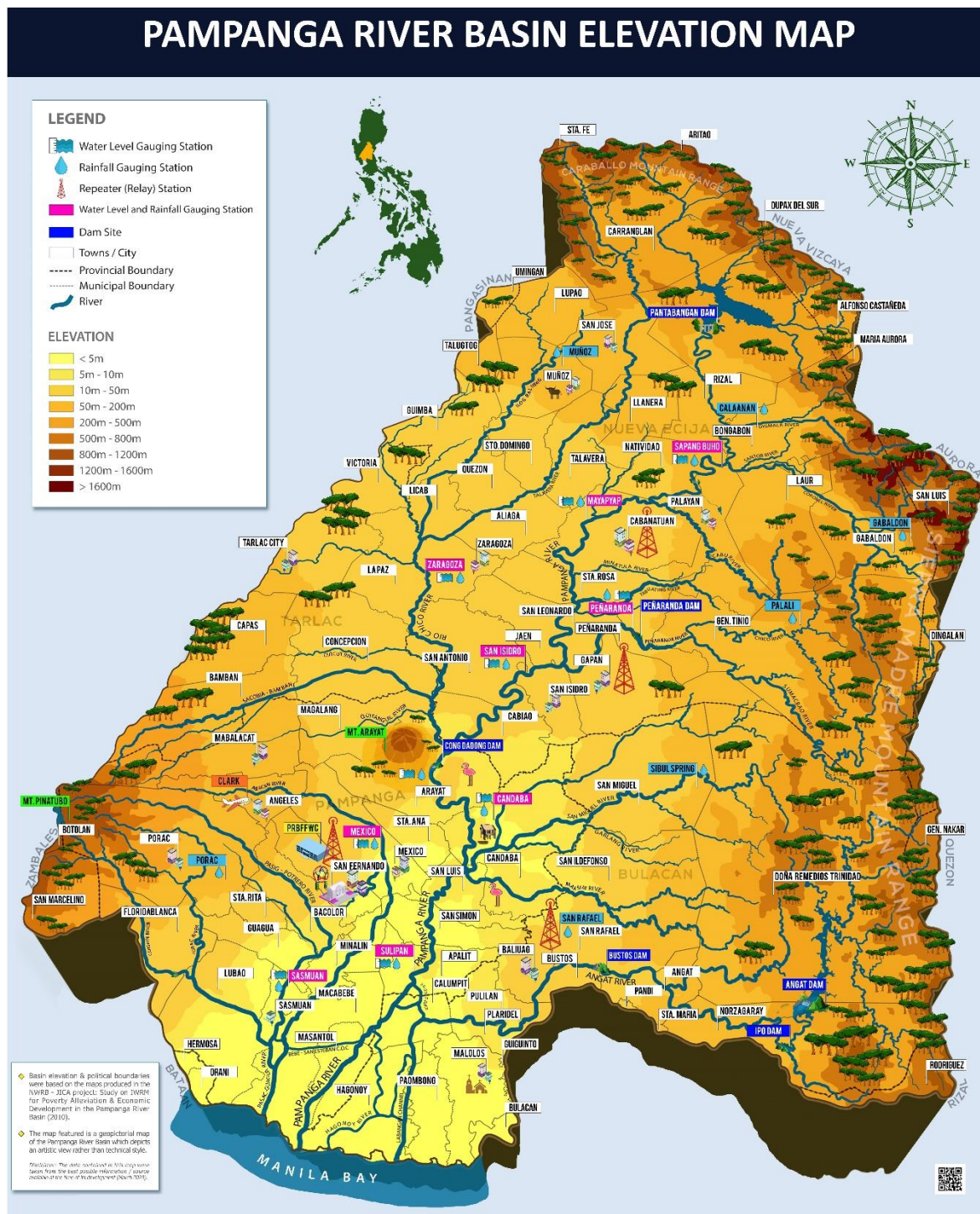


Figure 1.2 Geopictorial representation of the Pampanga River Basin elevation map and its estimated location in the Philippines (PRFFWC, 2020).

There are two major hydraulic structures within the basin, the Pantabangan and Angat Dams. Pantabangan is located at the upper main Pampanga River northeast part of the basin and operates both as hydropower and as an irrigation dam. Angat is located on the eastern portion of the basin and drains through the Angat River via Ipo and Bustos Dams. Angat mainly 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.

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

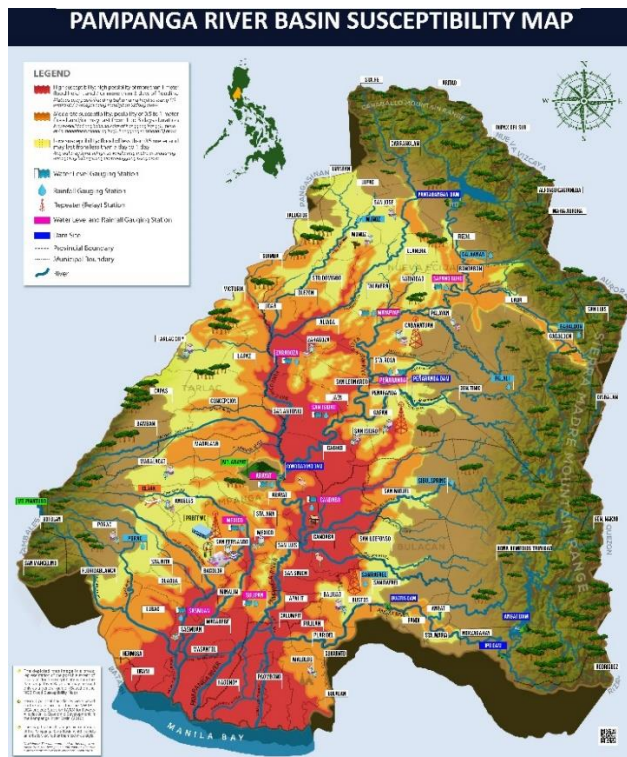


Figure 2.0 Geopictorial representation of the flood susceptibility map of areas within the Pampanga River Basin. (PRFFWC, 2020)

The PRFFWC is the main office responsible in providing hydrological related information and flood warnings to the flood-prone communities within the PRB. The center issues flood warnings in the form of Flood Advisories (FAs) and Flood Bulletins (FBs) during imminent flood situations, floods that are likely to affect areas within the PRB. It operates a hydrological monitoring system composed of 18 rainfall and 10 water level (WL) stations. It is complemented with several RR and WL observations from the provinces of Bulacan, Pampanga, the Optimization Project stations, and PAGASA-DOST MDSI stations. There are 2 synoptic and 1 agrometeorological stations within the basin. These latter stations, however, are not transmitting data on a real-time basis to the center.

The PRFFWC operations is located in the DMGC in CSFP. Additional information on PRFFWC is available at the following website: <http://prffwc.synthasite.com/>

For Station location, please check the following link: <http://prffwc.synthasite.com/station-info.php>
Estimated locations of stations can also be viewed in the basin elevation map in Figure 1.2.

3.0 Meteorological aspect: Typhoon “Ulysses” (International name: “Vamco”)³

“**ULYSSES**” as a tropical depression entered the PAR on the night (around 2000H LST) of November 08. The next day before 1700H LST, the system intensified into a tropical storm. The WMO Regional Specialized Meteorological Center in Tokyo, the JMA (Japan Meteorological Agency) has assigned the international name “**VAMCO**” for this TC. The name “Vamco” is a river found in southern Vietnam and was contributed by the Socialist Republic of Vietnam.



Figure 3.0 Track of Ty Ulysses during its passage within the PAR (Nov 08 to 13, 2020)⁴

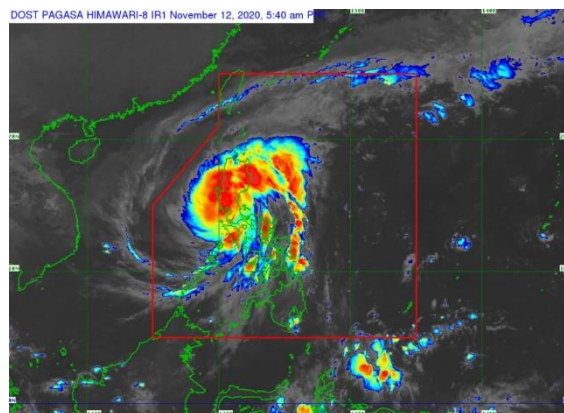


Figure 3.1 A satellite image of Ty Ulysses during its landmass course over Luzon (0540H LST, Nov 12).

The system maintained a Northwestward direction while still at sea moving at a steady pace of 15 to 20 km/h. By nighttime, around 1900H LST, of Nov 10, Ulysses was upgraded to a severe tropical storm. It was now moving on a West Northwestward at a much faster rate of 30 km/h. On November 11, around 1000H LST, Ulysses intensified further into a typhoon category. It was now packing sustained winds of 125 km/h near its center with gustiness of up to 155 km/h moving on a west Northwestward direction at 20 km/h towards the Quezon-Aurora Area. By now, many areas of CL down to Southern Luzon were under TCWS #3 including most of the provinces within the PRB. Around 2030H LST and 2120H LST, Ulysses made its first two landfalls over the island towns of Patnanungan and Burdeos, respectively, both in Quezon Province.

Later, in the early hours of November 12 (around 0140H LST), Ulysses made its third landfall over General Nakar, Quezon, in the main landmass of Luzon. The TC on landmass maintained a 155 km/h sustained winds near the center but gusts reached to a more destructive wind force of 255 km/h. Around 0400H LST the center of Ty. Ulysses was already within the middle of the PRB in the town of San Antonio, Nueva Ecija. By 0700H LST, on a rather westward movement, it was already in Cabangan, Zambales. A few hours before midday of November 12, the disturbance had departed landmass but its fringe effects still posed a problem to several areas of CL until the end of the day. Ty. Ulysses exited the PAR in the morning of the November 13 around 1000H LST at some 500 km West of Iba, Zambales.

³ Taken from Severe Weather Bulletins issued by WD of PAGASA; NDRRMC SitRep No. 29 dated Jan 13, 2021; and from the website [https://en.wikipedia.org/wiki/2020_Pacific_typhoon_season#Typhoon_Vamco_\(Ulysses\)](https://en.wikipedia.org/wiki/2020_Pacific_typhoon_season#Typhoon_Vamco_(Ulysses));

⁴ PAGASA



Figure 3.2 (Top L) Classification of Tropical Cyclones and (Top R) PAGASA's Tropical Cyclone Wind Signals for the Philippines. (Source: PAGASA)

All provinces covering the PRB were placed under TCWS #3, the whole of CL (7 provinces: Aurora, Bataan, Bulacan, Nueva Ecija, Tarlac, Pampanga, and Zambales) including the provinces of Rizal, Quezon, Pangasinan, and Nueva Vizcaya.



Figure 3.3 The estimated track of Ty Ulysses during its passage within the PRB on Nov 12. Estimated Typhoon eye entry and exit in the PRB were 0200H and 0600H of Nov 12, respectively.

Estimated damage to Agriculture and Infrastructure at around (Philippine) ₱ 1.39 B (Reg. 3) and ₱ 1.87 B (Reg. 3); for Casualties: Dead – 101; Injured – 85; Missing – 10 for Regions I, II, III, CALABARZON, V, CAR, & NCR (NDRRMC Situational Report No. 29 dated January 13, 2021)

Observations reported by some PAGASA synoptic stations within PRB during the event: PAGASA Clark synoptic station in Angeles, Pampanga - minimum pressure of 985.2 hPa (2100H UTC, Nov 11), maximum winds of 23 mps and a max 24-hr rainfall of 87.6 mm. PAGASA CLSU synoptic station in Muñoz, NE reported minimum pressure of 990.4 hPa, maximum winds of 20 mps (NNE, 2000 UTC) and max 24-hr rainfall of 24.8 mm.⁵

⁵ Info provided by M. Esguerra, CMO, Clark synop; and R. Manuel, CMO, CLSU Synop

4.0 Basin hydrological aspects during Ty Ulysses

4.1 Basin rainfall

The rains associated with Ty Ulysses over the PRB were mainly those that occurred on November 11 to 12. Moderate to heavy and at times intense rains (between 15 to 30 mm/hr) were mostly concentrated in the evening of November 11 until the following day, November 12.

Table 1.0 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

Table 1.1 Pampanga River Basin observed 24-hr (met day) rainfall in millimeters for the period November 11 and 12, 2020.

Stations	November 11	November 12	Maximum one hour observed rainfall	Time (LST) / Day of maximum 1-hr RR for the period November 11 to 12
Muñoz	27	12	6	1700H / 12
Sapang Buho	74	24	15	2100H / 11
Gabaldon	306	157	60	0100H / 12
Zaragoza	56	10	13	0400H / 12
Mayapyap (NIA-UPRIIS)	79	13	22	1600H / 10
Peñaranda	67	11	10	0200H / 12
Calaanan	132	59	24	0100H / 12
Palali	90	2	14	0600H / 12
San Isidro	61	40	23	0900H / 12
Arayat	100	14	26	0700H / 12
Candaba	77	13	19	0700H / 12
Sibul Spring	126	10	18	0100H / 12
Sulipan	191	24	63	0400H / 12
San Rafael	206	18	66	0400H / 12

Table 1.2 Allied sub-basin of Pasac-Guagua River system 24-hr (met day) RR in millimeters for the period November 11 and 12, 2020.

Stations	November 11	November 12	Maximum one hour observed rainfall	Time (LST) / Day of maximum 1-hr RR for the period November 11 to 12
Sasmuan	111	25	40	0500H / 12
Mexico	98	18	29	0500H / 12
Porac	83	39	33	0500H / 12
PRFFWC	115	20	38.2	0500H / 12

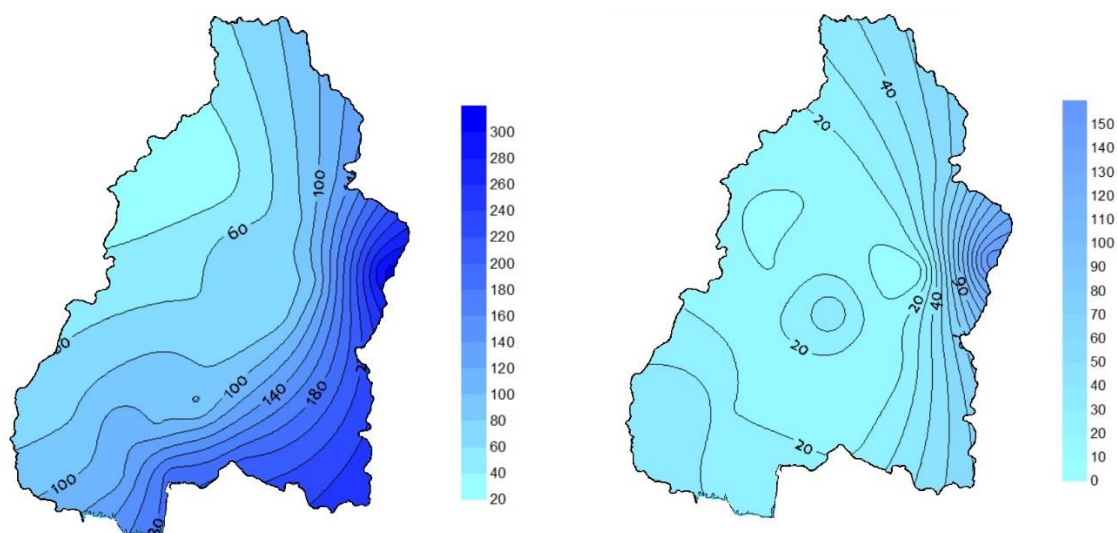


Figure 4.0 The 24-hour met day isohyets for Nov 11 (top left) and Nov 12 (top right) during the passage of Typhoon Ulysses over the PRB.

4.2 River stages at PRFFWC forecasting points

PAMPANGA RIVER BASIN ASSESSMENT LEVELS (meters)			
color code	YELLOW	ORANGE	RED
STATION	ALERT	ALARM	CRITICAL
Sapang Buho	3.70	4.50	6.50
Mayapyap			
Zaragoza	2.50	3.50	4.50
Penaranda			4.00 *
San Isidro	3.20	4.50	6.00
Arayat	5.00	6.00	8.50
Candaba	3.00	4.50	5.00
Mexico			3.00 *
Sasmuan			3.00
Sulipan	2.60	3.20	3.80

* Based on past observations from various flood events (still to be validated)

RIVER RATE (AVERAGE) in meters			
PERIOD	SLOW	GRADUAL	RAPID
1-hour	< 0.3	0.3 - 1.0	> 1.0
3-hour	< 0.6	0.6 - 1.4	> 1.4
6-hour	< 0.9	0.9 - 1.9	> 1.9
12-hour	< 1.6	1.6 - 2.9	> 2.9
24-hour	< 3.0	3.0 - 5.0	> 5.0

Figure 4.1 (top R) The PRB assessment levels that were used during event Ulysses.

Figure 4.2 (above) A qualitative description for river rates in meters per specific period.

Table 2.0 Time / Day of Station's Flood Assessment Gauge Heights were reached

Station Point	Alert Level	Alarm Level	Critical Level	Remarks
Sapang Buho	(3.70 m) Before 0400H of Nov 12	(4.50 m) Before 0500H of Nov 12	(6.50 m) Was not reached	Peak WL was 5.89 m (56.084 m AMSL) attained at around 1600H of Nov 12
Mayapyap	(Station has yet to be reinstalled)			
Zaragoza	(2.50 m) Around 1200H of Nov 12	(3.50 m) Before 1300H of Nov 13	(4.50 m) Not reached	WL crested, as per telemetry records, at 3.67 m (13.883 m AMSL) attained at 2000H, Nov 14
Peñaranda	No assigned assessment levels at the moment			Maximum telemetry reading was 4.02 m (22.316 m based on a TBM) reached around 0500H of Nov 12
San Isidro	(3.20 m)	(4.50 m)	(6.00 m)	Station remains down due to the rehabilitation of the bridge where the WL sensor is attached

Arayat	(5.00 m) Before 2000H of Nov 11 & 0800H of Nov 12	(6.00 m) Before 1000H of Nov 12	(8.50 m) Around 0300H of Nov 13	WL crested, as per telemetry records, at 8.81 m (8.887 m AMSL) attained before 0600H of Nov 14
Candaba	(3.00 m) Prior to the event, WL was already above alert level	(4.50 m) Around 1300H of Nov 12	(5.00 m) Before 2100H of Nov 12	Swamp water level crested at 6.34 m (6.186 m AMSL) on 0800H, Nov 14 and remained at this level until 1600H of the same day before it receded very slowly
Mexico	No assigned assessment levels at the moment (no river overflowing during Ty. Ulysses)			Maximum WL based on telemetry readings was 2.27 m (8.203 m as per TBM) and was attained on 1100H of Nov 12
Sasmuan	No assigned assessment levels at the moment (no river overflowing during Ty. Ulysses)			Guagua River at Sasmuan station crested, as per telemetry records, at 2.81 m (1.411 m AMSL) attained on 2200H of Nov 12
Sulipan	(2.60 m) About 0300H of Nov 12	(3.20 m) Before 1300H of Nov 12	(3.80 m) At 1800H of Nov 14	Maximum WL based on telemetry observation was 3.99 m (3.928 m AMSL) attained around 12 noon of Nov 15.
<i>Note: Elevation of "0" of staff gages were based on surveys undertaken on August 2009.</i> <i>TBM – Temporary Bench Mark</i>				

4.3 Tides

Table 3.0. High Tide (highest for the day) from Nov 11 to 17, 2020

Day	Time	Height (m)
Nov 11	5:15 am	0.96
Nov 12	8:58 pm	0.75
Nov 13	8:57 pm	0.86
Nov 14	9:08 pm	0.99
Nov 15	9:30 pm	1.11
Nov 16	11:52 am	0.57
Nov 17	1:30 pm	0.46

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

Tides during the event were moderately high and may have partly obstructed river flows towards Manila Bay coinciding with the flood event recession phase particularly on November 14 and 15. Further, several riverside areas along the Pampanga River, mainly in the towns of Macabebe, Masantol, Apalit, Hagonoy, and Calumpit, have already been experiencing floods due to the recurring tides prior to Ty Ulysses. This situation usually last for several weeks in a lot of the said areas as standing floodwaters. The tidal effects in the basin can sometimes reached further upstream up to Arayat during low flow conditions of the Pampanga River. There were no storm surges reported in the coastal towns of PRB during Ty Ulysses.

4.4 Dam structures / releases

Pantabangan and Angat Dams are the two major hydraulic structures within PRB. The former is situated in the province of Nueva Ecija at the North Northeast end of PRB. Angat, on the other hand, is situated at the Southeast end of the PRB in the town of Norzagaray, Bulacan.

Pantabangan Dam did not open its gates during Ty. Ulysses' passage over PRB. Dam reservoir elevation was still way below the rule curve at that time. Some irrigation dams within the NIA-UPRIIS area, however, have reservoir spills during the event. Atate Dam in Palayan City reached a peak outflow of around 1,500 cumecs on November 13. The PENRIS (Peñaranda River Irrigation System), in contrast, had a relatively smaller peak spill of about 370 cumecs.⁶

Angat Dam opened its gate at around 1500H LST of November 12 as its reservoir elevation was already more than a meter above its Normal High Water Level of 212.0 meters and was still rising steadily. The maximum discharge spill reached 447 cumecs at around 1600H LST of November 13. Dam gates closed on 1700H LST of November 15. 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 very much smaller than Angat Dam. Bustos Dam is located around 38 kms downstream of Ipo and serves chiefly as an irrigation reservoir. During the flood event, Ipo Dam opened its initial radial gates in the afternoon of November 11 as its reservoir elevation rose above its threshold of 101.0 meters. Peak spill discharge reached more than 1,300 cumecs in the morning (0400H LST) of November 12. This activity continued with a slow reduction in its spill discharge lasting until the morning of November 16. Subsequently, in simultaneous activity with Ipo, Bustos Dam deflated its three rubber dams and opened several sluice gates to reach a peak discharge reaching 2,520 cumecs in the morning (0600H LST) of November 12. In the afternoon (1400H LST) of November 21 all the three rubber gates were inflated back.⁷



Figure 4.3 (top L) View of Bustos Dam taken on Nov 12 and (top R) during normal situations (pictures courtesy of Bustos MDRMO)

⁶ NIA-UPRIIS information on Major Flow Points for November 2020

⁷ Dam Q info were provided by Bulacan PDRMO

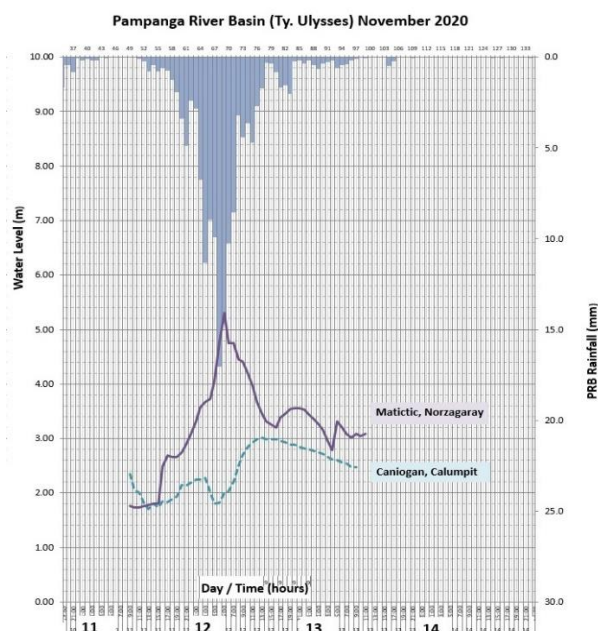


Figure 4.4 (Left) Hydrographs of Angat River at Matictic, Norzagaray and in Bagbag River in Caniogan, Calumpit during Ty. Ulysses event (0900H LST, Nov 11 to 0900H LST, Nov 13); Angat River in Matictic crested at 0500H LST, Nov 12 almost coinciding with the maximum basin RR of PRB while Bagbag River in Caniogan peaked at around 1300H LST, Nov 12. Figure 4.5 (Top picture) The reference staff gage for Bagbag River in Caniogan, Calumpit. (pic shared by MDRRMO-Calumpit)

5.0 Basin hydrological situation during Ty Ulysses

Typhoon Ulysses affected the PRB starting on the evening of November 11. Reports from various LGUs mostly on the eastern side of the basin initially experienced strong winds. Tropical Cyclone associated winds brought down a lot of trees and several infrastructures as these winds persisted for several hours. Hydrological related effects similarly started in the late hours of November 11 with moderate to heavy and at times intense rains mostly on the eastern sections of the basin. Gabaldon RR station had a significant 9-hour period of continuous heavy to intense rainfall (from 2000H LST, Nov 11 until 0400H LST, Nov 12).

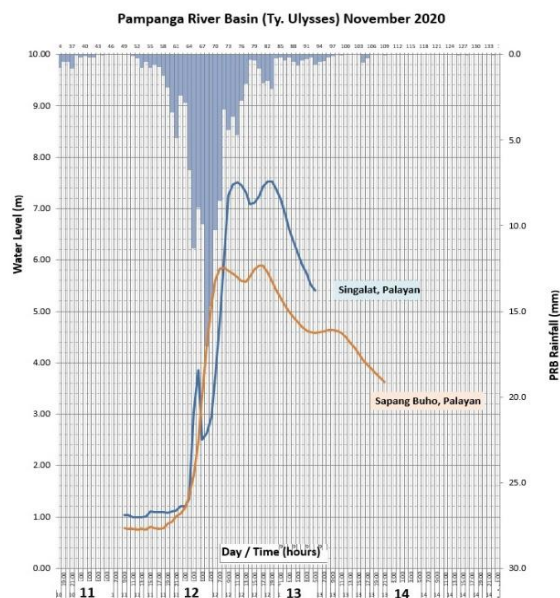


Figure 5.0 Event hydrographs of Pampanga River at Singalat (blue) and Sapang Buho (orange) both in Palayan City, NE. Singalat is roughly 12 kms D/S of Sapang Buho station.

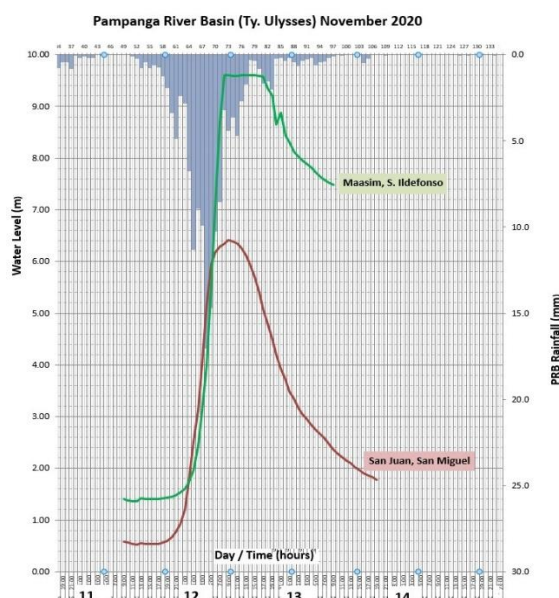


Figure 5.1 Event hydrographs of San Miguel River in San Juan, San Miguel (red) and Maasim River in San Ildefonso (green). Flattening of curve for Maasim River suggests a horizontal spread of floodwaters in the area.

Around early morning of November 12, upper Pampanga River at Sapang Buho in Palayan registered rapid rise from a normal level to Alarm level or more than 1.7m in just 3 hours. Similar rapid rises in the river channels of Peñaranda, San Miguel and Maasim Rivers were observed at almost the same period. These rivers have their sources coming from the western slopes of the Sierra Madre Range. By 0500H LST portions of the Maharlika Highway along the towns of San Ildefonso (Bgys. Maasim & Garlang) and in San Miguel (Bgy. Camias) were rendered impassable to most types of vehicles for several hours due to overflowing of portions of San Miguel and Maasim Rivers. Likewise, during the said period floods were also reported in several riverside barangays of Palayan City and almost simultaneously with those reported in some areas from Cabanatuan City down to Gapan City.



Figures 5.2 (top L) View of Maasim River as seen from the Maasim Bridge taken a month after Ty. Ulysses; Figure 5.3 (top R) San Miguel River at San Juan, San Miguel (stock picture taken on Nov 2014)

Heavy to intense rains were observed at the South and Southwest part of PRB between the period 0200H LST to 0700H LST of November 12 as Ty Ulysses trekked across the basin. Before midday of November 12 middle main Pampanga River had a slow to gradual increase as river stage in Arayat reached Alert WL of 5.0 m by 0900H LST and by 1100H LST was already above Alarm WL of 6.0 m. The Candaba swamp was already above Alert WL prior to Ty Ulysses. Alarm WL of 4.5 m in Candaba swamp was reached just after midday and by night time had exceeded Critical WL of 5.0 m.

Lower main Pampanga River at Sulipan reached Alert WL of 2.6 m in the early morning of November 12 (Assessment levels for Sulipan station was adjusted in the early part year of 2020). Alarm WL of 3.2 m was later reach in the afternoon of the same day. However, before night time, there were already floods reported in the Calumpit. The town of Hagonoy had likewise reported a start of floods as early as in the afternoon of Nov 12. Floods were also reported at low-lying riverside areas along the Angat River particularly in the towns adjacent to the said river: Norzagaray, Angat, Bustos, Baliuag, San Rafael, Pulilan, Plaridel, and including the towns of Calumpit, Hagonoy and Paombong.

Fluvial floods in the upper main Pampanga River lasted only throughout the day of November 12. Remnants of floodwaters from combined effects of fluvial and accumulated rains (pluvial) persisted for a few more days. On the other hand, floods in the Candaba swamp area remained from several days to more than a week. Floods at lower sections of Pampanga River persisted for less than a week.

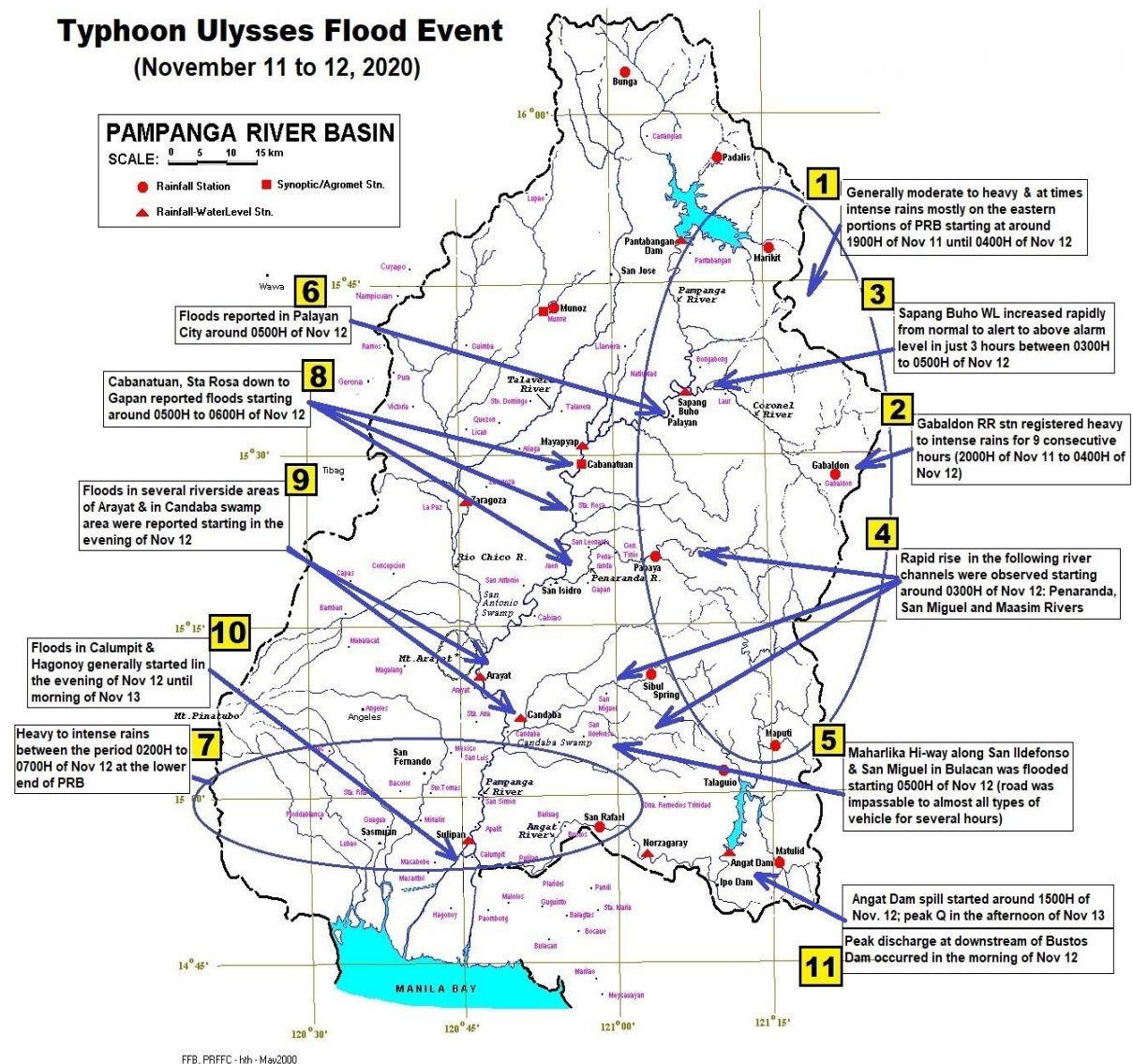


Figure 5.4 The estimated flood episode timeline during the passage of Ty Ulysses across the PRB from the period November 11-12, 2020.

Flood depths in the Candaba swamp varied from 1 meter to more than 4 meters. At least 14 towns were affected by floods and covering some 135 barangays in the Province of Pampanga (Pampanga PDRPMC Report on Ty Ulysses). Bulacan had a total of 158 barangays affected, however, these total includes those outside the PRB. Flood depths for most of the areas within the PRB had inundation ranging from 0.5 meters to as high as 4 meters (as per RDRPMC-3 SITREPS re: Effects of Ty Ulysses in Central Luzon). For the Province of Nueva Ecija and from reports provided by a few LGUs in the province, some of the towns that have been affected by floodwaters included Gabaldon, Palayan City, Cabanatuan City, Gapan City, Sta. Rosa, and Jaen.







Ty Ulysses' flood regime in the PRB was a case of rains falling mostly on the eastern side of the basin with floodwaters all coming down towards the middle and lower plains of the basin. In contrast with other flood events, Ulysses was a relatively short-lived event for the PRB. It is also worth noting that the allied sub-basin of Pasac-Guagua river system, which is on the southwest end of the basin, was not much affected by fluvial floods during Ulysses' passage over the area.

PAMPANGA RIVER BASIN

SCALE: 0 5 10 15 km

San Roque

LEGEND:

-  less than 5 bgy's affected
-  less than 10 bgy's affected
-  10 or more bgy's affected
-  below 0.5 m depth
-  between 0.5 to 1.0 m depth
-  more than 1.0 m depth

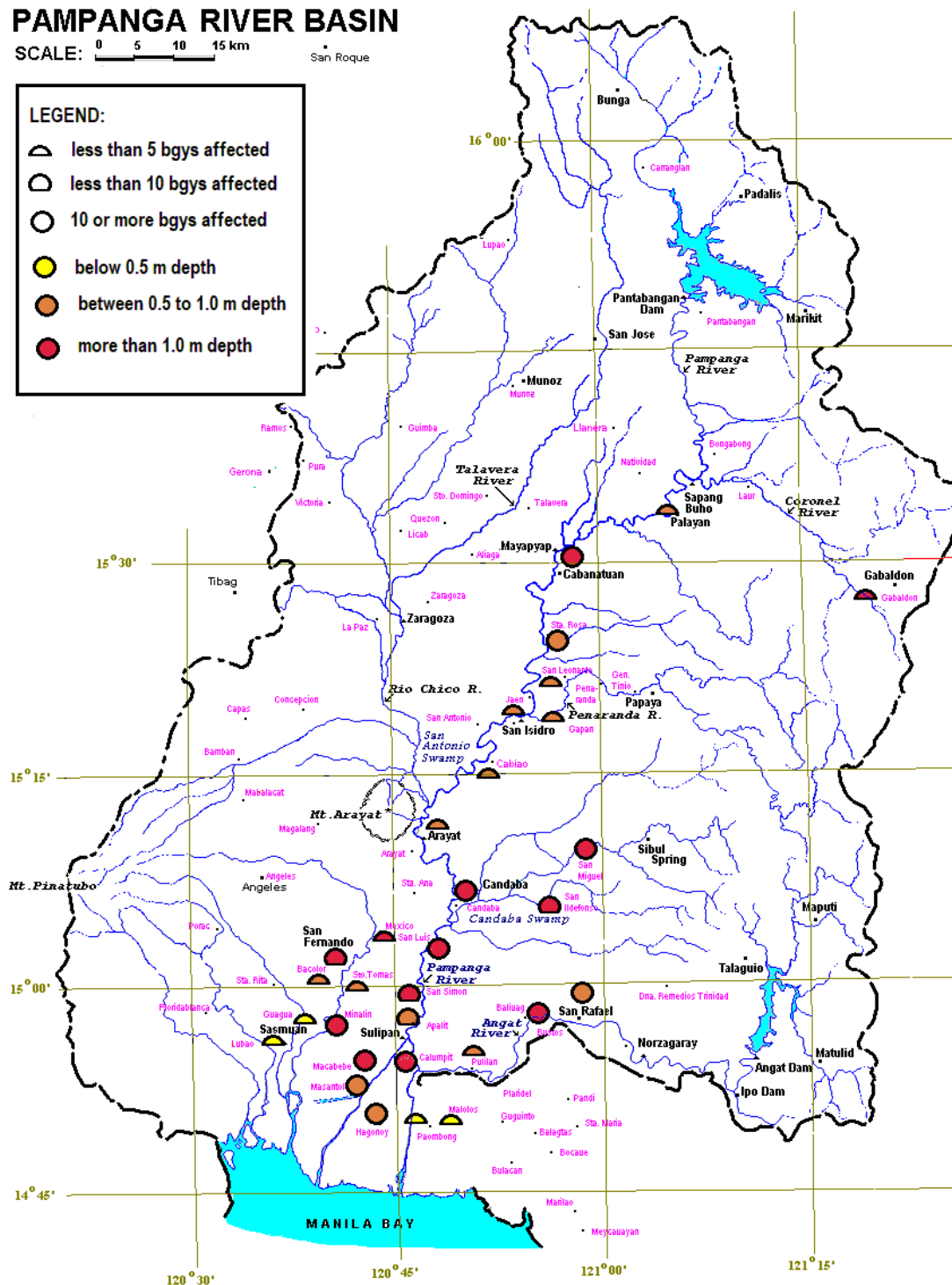



Figure 5.5 The estimated spot flooding map as per range of barangays affected and maximum flood depth reported in the respective towns during passage of Ty Ulysses across the PRB. Consolidated flooded area based on reports provided by various DRRM entities within the basin.

6.0 Flood Forecasting & Warning activities during Ty. Ulysses

The initial flood information issued by the PRFFWC was a Flood Advisory (#1) released in the afternoon (1430H LST) of November 10. The information was more than 24 hours prior to Ulysses' effects in the PRB. FA # 1 included a scenario map of the possible immediate hazards likely to affect the various municipalities within the basin. The information focused on the event affecting the basin starting in the morning of November 12. FA #2 was issued in the morning (0530H LST) of November 11. Changes in the movement of Ulysses prompted the PRFFWC to adjust the hazards likely to affect the basin scenario starting in the afternoon of November 11. However, 12 hours later in the issuance of its FA #3 the center further adjusted Ulysses' effects on the basin to start by nighttime of November 11.



Republic of the Philippines
DEPARTMENT OF SCIENCE AND TECHNOLOGY
Philippine Atmospheric, Geophysical and Astronomical Services
Administration (PAGASA)

PAMPANGA RIVER BASIN FLOOD FORECASTING & WARNING CENTER (PRFFWC)
DMGC, Bgy. Mainpils, City of San Fernando, Pampanga 2000, Tel. (045) 455-1701; CP: 0999 336 6416

FLOOD ADVISORY # 1

PAMPANGA RIVER BASIN & ALLIED RIVERS
ISSUED AT 2:30 PM, 10 November 2020
(NEXT ADVISORY WILL BE ISSUED AT 5:00 AM TOMORROW UNLESS THERE IS AN INTERVENING ADVISORY OR AN INITIAL FLOOD BULLETIN TO BE ISSUED)

PRESENT BASIN HYDROLOGICAL SITUATION:

AS OF 1:00 PM TODAY, MAIN PAMPANGA RIVER AND ITS TRIBUTARIES ARE MOSTLY BELOW THEIR RESPECTIVE ALERT LEVELS AND IN A SLOW DECREASING TREND. CANDABA SWAMP STILL REMAINS ABOVE ALERT LEVEL COMING FROM PREVIOUS FLOOD EVENT.

ON THE OTHER HAND, RIVERS AND TRIBUTARIES WITHIN THE PASAC-GUAGUA SUB-BASIN ARE ALL BELOW THEIR RESPECTIVE ALERT LEVELS AND WILL LIKELY TO REMAIN WITHIN THEIR BANKFUL CAPACITY UNTIL TOMORROW.

- As per latest update, Tropical Storm "Ulysses" has a high chance of crossing landmass at the south of the Pampanga River Basin by Thursday morning (12 Nov) until Friday (13 Nov).
- In anticipation of this scenario, main Pampanga River, its major tributaries and secondary streams particularly starting from the eastern sections of the basin are likely to increase significantly during and after the Tropical Cyclone's passage.
- For now, isolated rainshowers / thunderstorms are likely to be experienced over the Pampanga River Basin within the next 24 hours
- Hazards likely to affect areas within the basin:
 - Possible rain-induced landslides and flash floods at western slopes of Sierra Madre Mountains particularly the Eastern parts of Nueva Ecija (Gabaldon, Laur, Bongabon, Rizal, Llanera, Pantabangan, Carranglan, San Jose city Palayan City, Gen. Tinio and other immediate adjacent towns); Eastern Bulacan Area (San Miguel, San Ildefonso, San Rafael, DRT, Norzagaray, Angat); Pampanga Area (Arayat, Magalang, Porac, Mabalacat, Angeles City, Floridablanca); Tarlac Area (Bamban, Capas)
 - Riverine flooding (Fluvial) and accumulation / ponding of rainwater (pluvial) – all waterways starting at the eastern sections of the basin
 - Secondary related Hazards: Riverbank erosions, possible failure of river structures, prolonged flooding, merging of river floods with high tide; storm surges at the coastal areas of Pampanga (Masantol & Macabebe) and Bulacan (Hagonoy, Paombong & Malolos) provinces within the basin

For awareness, preparedness and mitigation purposes, the public and the Local Disaster Risk Reduction and Management Councils (LDRRMCs) within the Pampanga River Basin are advised to start undertaking additional preparations and precautionary measures to mitigate the adverse immediate impacts of the possible hazards associated with Tropical Storm Ulysses within their area of concern; to continue monitoring for updates particularly Thunderstorm Advisories / Heavy Rainfall Warnings issued by PAGASA Regional Services Divisions (NCR-PRSD); and the Latest Severe Weather Bulletins issued by the Weather Division of PAGASA.

PRFFWC: HTH / RFD / JCL

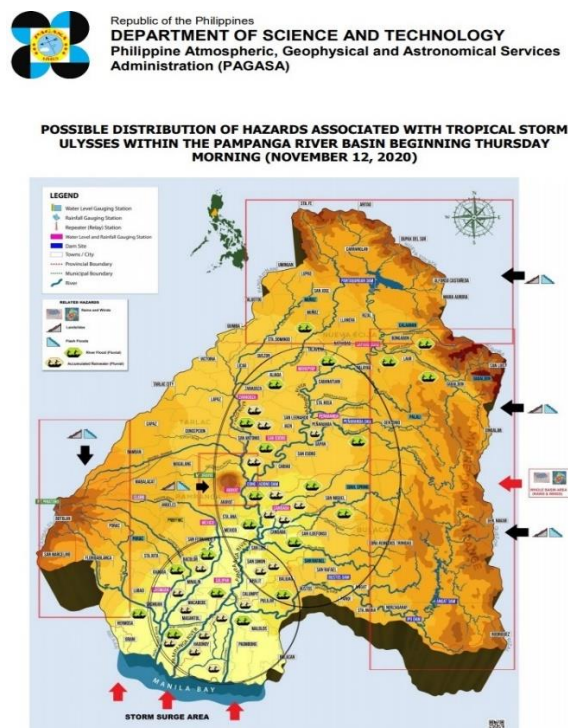


Figure 6.0 (top L) Flood Advisory #1 issued at 1430H LST of Nov 10; Figure 6.1 (top R) The accompanying map for FA #1 with indicated possible hazards per area that may likely affect the PRB during Ty Ulysses passage.

In the afternoon of November 11, a few hours prior to Ulysses' passage over PRB, the PRFFWC system went down. Problems in the San Rafael Repeater station resulted in data transmission downtimes from all its telemetry stations. This lasted for some 27 hours (1600H LST, Nov 11 to 1900H LST, Nov 12). During the said period PRFFWC had to manually gather, collate and analyze patches of information from various sources, from synop stations, several LGUs, and from its only part-time observer in Sulipan station. The transmission problem covered 4 flood information issuances (FA # 3 up to FB #3)

The initial Flood Bulletin (#1) was issued in the morning (0530H LST) of November 12. As reports of progressing floodwaters from the upstream of PRB were received, the PRFFWC immediately issued an intermediate bulletin (FB #2) at 1230H LST. Subsequent FBs afterwards were issued between 0500H LST to 0530H LST and between 1700H LST to 1730H LST until its final FB issuance in the afternoon of November 17. A total of 3 FAs and 13 FBs were issued for the event. Information were provided to various recipients through uploading in the center's website (prffwc.synthasite.com), sharing via e-mail, and posting in the center's Facebook and Twitter accounts. It was during Ty Ulysses that PRFFWC

started sharing a localized version (in Filipino) of its Flood Bulletins which started at FB #10 (0530H LST of November 16). This was in response to the requests of netizens who have been following the center's Facebook and Twitter accounts.

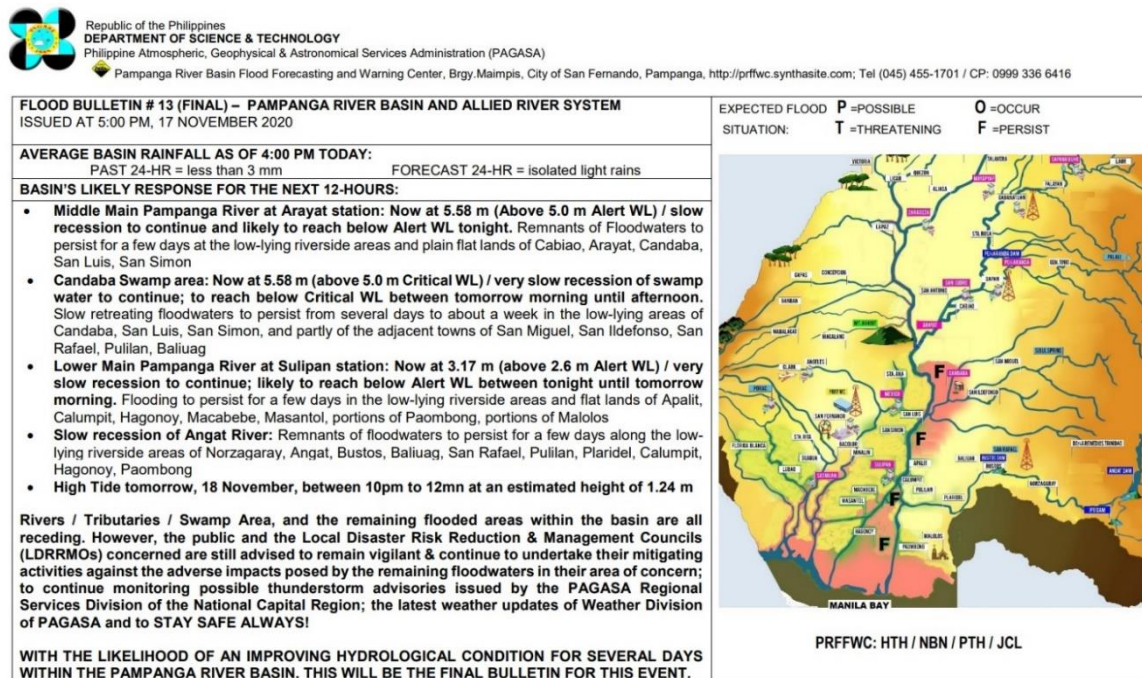


Figure 6.2 The Final Flood Bulletin (# 13) issued by PRFFWC at 1700H LST, Nov 17.

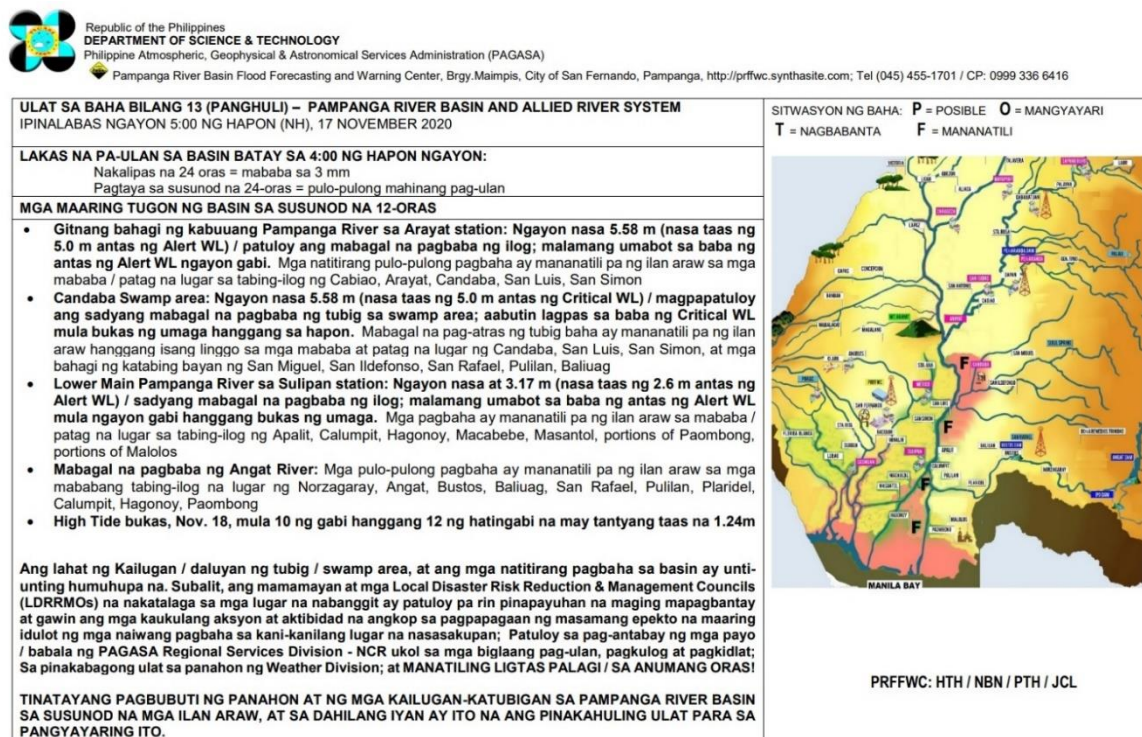


Figure 6.3 The Final Flood Bulletin (# 13) in Filipino.

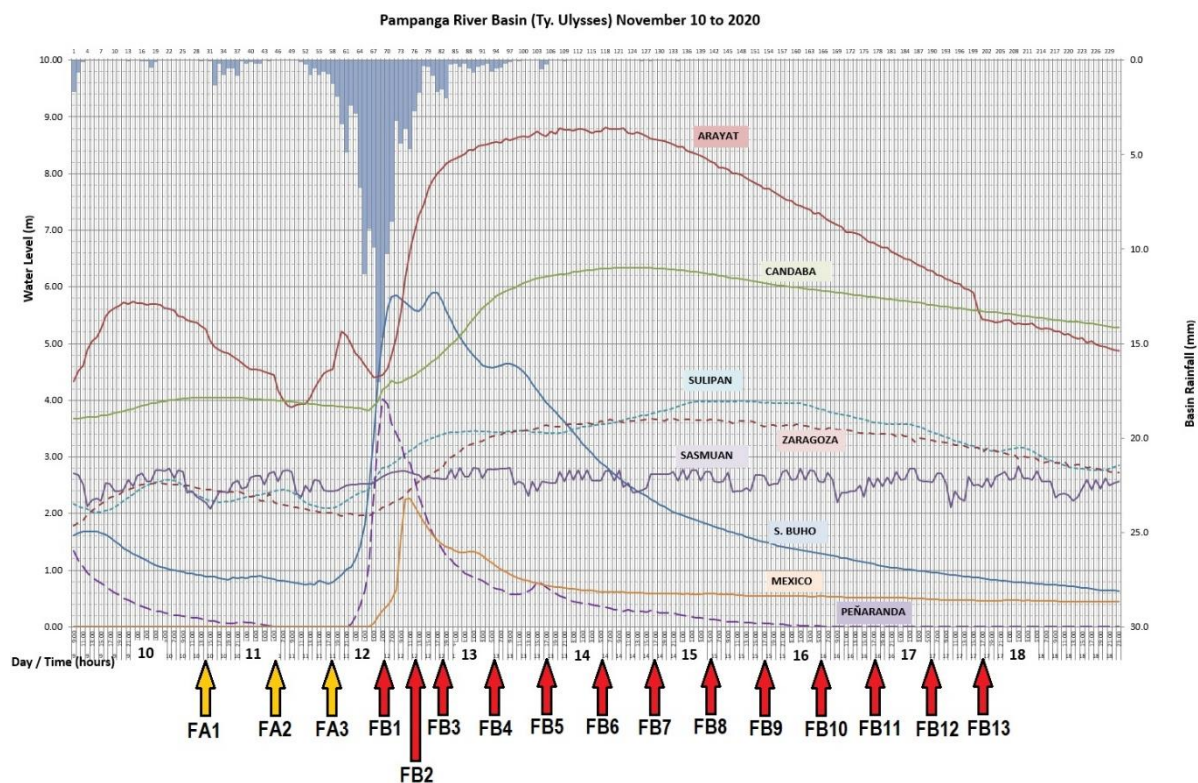


Figure 6.4 The figure above shows the basin hyetograph (average basin rainfall vs. time) and hydrographs (river heights vs. time) at various forecasting points during Ty Ulysses and the corresponding issuances of FAs and FBs, from November 10 to 17. The PRFFWC was able to issue an initial warning with a lead time of more than 24 hours prior to the initial impact of rainfall and rise of river stages at various forecasting points within the basin.

In the issuance of its final flood bulletin, middle and lower sections of the basin were still above alert levels (Based on Arayat & Sulipan station WL) though continuously receding and Candaba swamp was still above critical level. This situation was undertaken because of the relatively long period for flood to totally diminish at some areas within the basin particularly at Candaba swamp area; slow recession of Pampanga River at the downstream sections may be due to its already shallow and silted waterways and tidal effects.

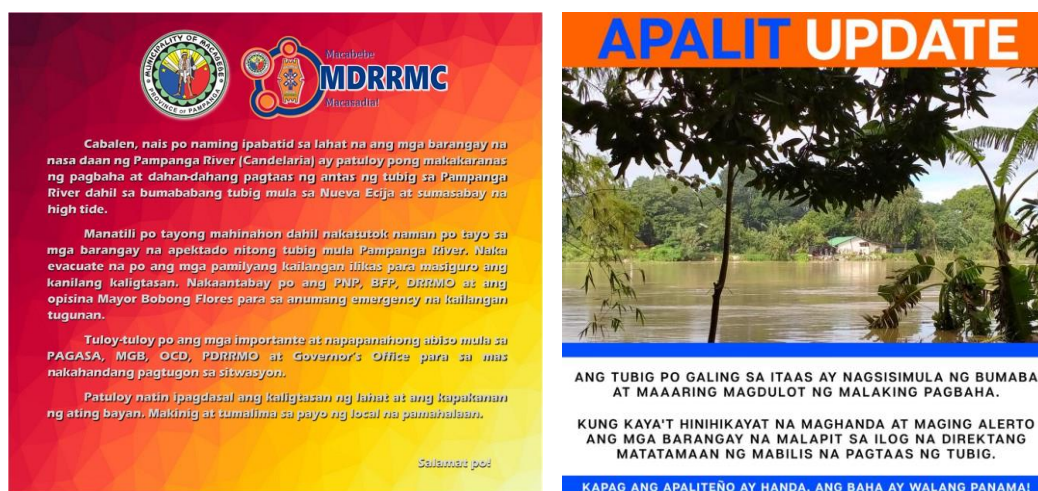


Figure 6.5 Some information disseminated by several MDRRMOs in their respective social media accounts (Facebook) during the event following the issuances of flood information by the PRFFWC. (Top L) Macabebe MDRRMC and (Top R) Apalit Municipality.

7.0 Highlights of Ty Ulysses in pictures



Figure 7.0 Strong typhoon intensity winds were the immediate damaging effects of Ty Ulysses in CL. (Top to bottom & L to R) Gen. Tinio in NE (by Gen. Tinio MDRRMO); fallen electric post, damaged house & fallen trees in Masantol, Magalang, Sto. Tomas & in Sta. Ana, respectively, all in Pampanga (shared by Pampanga PDRRMO).



Figure 7.1 (Top L to R) Dupinga River in Gabaldon taken around 1230H of Nov 12 and Coronel River at Bgy. South Poblacion, Gabaldon at around 1200H of Nov 12. (pictures courtesy of Gabaldon MDRRMO / MENRO)

Left picture shows Dupinga River (taken from the same view as in top left picture) in Gabaldon taken almost a month after Ty Ulysses' passage across CL.



Figure 7.2 (L to R) Pampanga River as seen from Valdefuente Bridge in Cabanatuan City (pic by Cabanatuan CDRRMO) and Pampanga River as seen from Sta. Rosa Bridge in Sta. Rosa, N.E. (pic by Sta. Rosa MDRRMO) in the morning of November 12 and November 13, respectively.



Figure 7.3 (top L) A view of Peñaranda River from the Gapan-San Leonardo Bridge left bank side taken at 1133H of Nov 12. Left bank of the river is Bgy. San Vicente of Gapan City which was around half-meter flooded. (source: Gapan CDRRM); (top R) A view of the right bank side of Peñaranda River taken from the Gapan-San Leonardo Bridge during normal dry situation.

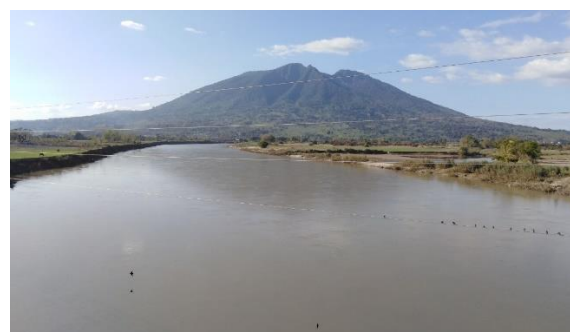


Figure 7.4 (top L) Pampanga River at Arayat on a slow recession phase taken on Nov 14 (pic by Arayat MDRRMO). Pampanga River at Arayat station peaked around 0600H of Nov 14. (top R) Pampanga River at Arayat during normal situation (picture taken more than a week after passage of Ty Ulysses across PRB)

(Left picture) Barangay Candating taken on Nov 14 with about a meter of floodwater (pic by a barangay resident).



Figure 7.5 (top L) The Candaba-San Miguel Road (Dukma) taken around 1515H, Oct 27 (Event: TC Quinta), almost 2 weeks prior to Ty Ulysses. Candaba telemetry station staff gage at 5.63m. (top R) The same road at around 1140H of Nov 17 from a CCTV footage of the area (CCTV pic courtesy of Bulacan PDRRMO) with Candaba WL telemetry station reading at 5.62m.



Figure 7.6 (L-R) Bgy. San Agustin taken around 0930H, Nov 13 (0.5 to 3.0 m of floodwaters) and Bgy. Gulap 1500H, Nov 14 in Candaba (0.5 to 1.3m of floodwaters). WL gage reading at Candaba Telemetry station was 5.95m and 6.34m at 0900H, Nov 13 and 1500H, Nov 14, respectively. (pictures by Candaba MDRRMO)



Figure 7.7 (top L to R) San Miguel Public Market area and at Maharlika Highway in Bgy. Camias taken on Nov 12 (pics by San Miguel MDRRMO)



Figure 7.8 (top L to R & bottom) Maharlika Highway at Bgys Garlang and Maasim in San Ildefonso, Bulacan around 0600H of Nov 12 with floodwaters ranging from 0.5 to 1.5 meters. The highway along this stretch was impassable to almost all types of vehicles for several hours on that day. Residents stuck in their houses along the highway were rescued by the San Ildefonso MDRMO team. (info & pictures courtesy of San Ildefonso MDRMO)



Figure 7.9 (top L) Overflowing Creek going to Maasim River at Bgy. Maasim, San Rafael, Bulacan taken at around 0500H-0600H of Nov 12; floodwaters started around 0300H to 0400H of Nov 12 and totally subsided before midday of the same day; overflowed waters reached from 1.0 to 1.5 meters above the road. (top R) Same creek during normal flow situations. (pictures provided by Mr. L. Rodriguez)



Figure 7.10 (top L) Flooding at Bgy. Diliman II, San Rafael, Bulacan around early morning of Nov 12; flood started around 0300H of Nov 12 and totally subsided before midday of the same day with flood depth ranging from 1.0 to 1.5 meters. (top R) The Diliman II Bypass Bridge during normal situation (see blue arrow for reference of the area). (info and pictures by Mr. L. Rodriguez)



Figure 7.11 (top L) Bgy. Balagtas-BMA, San Rafael, Bulacan: floods started around 0200H of Nov 12 with maximum floodwater depth of almost 1.0 meter; floods started subsiding around 1300H on the same day. (top R) Bgy. Tambubong in San Rafael, Bulacan: floods started between 0600H-0700H of Nov 12 and started subsiding before midday of Nov 12 with floodwater depth of around 0.3 meters at road level. (info and pictures by Mr. L. Rodriguez)



Figure 7.12 (top L) A view of flooded Tumana in Bgy. Tanawan, Bustos during the effects of Ty Ulysses and (top R) a view of the same area during normal situations. Bustos MDRRMO reported 10 barangays flooded as per effects of Ty. Ulysses with floodwaters starting before midnight of Nov 11 and subsided by afternoon of Nov 13. (information and pictures courtesy of Bustos MDRRMO)



Figure 7.13 (top L) A view of Angat River after the passage of Ty Ulysses and (top R) the same river during normal situations. (pictures courtesy of Bustos MDRRMO)



Figure 7.14 Frances Elementary School in Calumpit, Bulacan on Nov 12 (top L) and on Nov 14 (top R). (pictures shared by Ms. P. Censon)



Figure 7.15 The town of Calumpit in Bulacan was one of the hardest hit by floods during Ty. Ulysses. (Top pics from L to R): The Calumpit-Hagonoy Road in Bgy. Balungao with max depth of 1.0m (0645H, Nov 14); 2 pics of Bgy. Gatbuca at 0843H, Nov 12 and at 0634H, Nov 13; a view of Bgy. Meysulao in the morning of Nov 14.



(Bottom pics from L-R): The Calumpit-Hagonoy Road in Bgy. Sta. Lucia with at least 0.5m of floodwaters (1535H, Nov 15); and Bgy. Iba-O-Este with at least 0.5m flood depth (morning of Nov 13). (all pictures were shared by Calumpit MDRMO as per their 4th Q MPOC Meeting Presentation)



Figure 7.16 Another Bulacan town that was heavily affected by Ty Ulysses flood episode was Hagonoy. Around 11 Barangays were reported to have been flooded in the town with flood depths ranging from 0.3 to 1.0m. (Top L-R): Bgy. San Juan on Nov 13 & Nov 14; Bgy. Palapat on Nov 14. (Bottom L-R) Bgy Tampok on Nov 14 and Bgy. San Isidro on Nov 15. (Information & pictures were shared by Hagonoy MDRMO)



Figure 7.17 One of the towns affected by flood in the Pampanga Delta area was the town of Masantol. As per MDRMO report, about 26 barangays were underwater with flood depths ranging from 0.3 to almost a meter. Floodwaters were aggravated by the recurring high tide which lasted for almost 2 weeks in the area. (information & pics shared by Masantol MDRMO)

8.0 Event comparison

Ty Ulysses may have been the worst flood event that occurred in the PRB for the year 2020 but compared with other past events its flood episode was still relatively lower from the other events. A comparison of the peak WL registered in respective streamgaging points of the PRFFWC for some of the events that affected the PRB are given below:

Table 4.0 Peak Water Level attained at respective streamgaging stations as per various flood events in the PRB

Event	Sapang Buho	Mayayap	Zaragoza	Pefaranda	San Isidro	Arayat	Candaba	Sulipan	Mexico	Sasmuan	Remarks
Ty Kadiang (Sept-Oct. 1993)	6.30 (SG)	6.18 (SG)	15.9 (SG)		7.65 (SG)	9.81 (SG)	7.6 (SG)	4.91 (SG)			
Ty Loleng (Oct. 1998)	7.15 (est)	6.50 (est)	15.76		7.38	9.47	6.62	4.87			2-day event ave. basin RR: 131 mm
TD Winnie-Ty Yoyong (Nov.-Dec. 2004)	7.60 (est)	7.18	13.63		7.16 (est)	9.42 (est)	6.96	3.97			1-day event ave. basin RR: 77 mm
Ty Marce-SW (Aug. 2004)	5.45	5.06	15.39		6.70	10.03	7.38	4.39		2.06 (est)	2-day event ave. basin RR: 114 mm
TS Ondoy (Sept. 2009)	3.38	1.72	14.14	3.93	3.89	8.35	6.40	3.29	2.81	3.03	2-day event ave. basin RR: 72 mm
Ty Pepeng (Oct. 2009)	6.29	5.46	15.68	2.79	6.46	9.66	7.02	4.03	4.03	2.73	2-day event ave. basin RR: 53 mm
TS Falcon-SW (June 2011)	3.47	2.57	14.88	2.56	4.08	8.37	6.24	2.80	2.72	3.22	
Ty Pedring (Sept.-Oct. 2011)	7.17	6.86	15.40	6.01	7.75	10.6 (FM)	7.62	4.85	3.30	3.09	2-day event ave. basin RR: 146 mm
SW of August 2012	1.67	0.6	4.64	1.68	3.29	9.24	6.93	3.17	3.46	3.17	2-day event ave. basin RR: 97 mm
TS Maring-SW (Aug. 2013)	1.36		4.31	1.08	1.46	8.39	6.30	3.26	2.61	3.06	
Ty Lando** (Oct. 2015)	8.08	7.30 (FM)	4.19	7.72	8.23	10.03	7.13	4.29	1.57	2.00	2-day event ave. basin RR: 112 mm
Ty Nona / Frontal System (Dec. 2015)	6.84		5.22	5.72	7.80	9.98	6.94	4.13	1.62	2.13	2-day event ave. basin RR: 142 mm
Ty Ulysses (Nov 2020)	5.89		3.67	4.02		8.81	6.34	3.99	2.27	2.83	2-day event ave. basin RR: 70 mm

Note: ** - based on a 10-minute telemetry observation; blue shaded events are associated with enhanced SW monsoon; blanks indicate station either did not yet exist or station's telemetry system was down / out of order during that time; light orange shaded values +10.213; (FM) – levels were based on available flood marks only; (SG) – staff gage reading.

9.0 General analyses and effects of Ty Ulysses in the PRB

- Typhoon Ulysses crossed the PRB starting late night of Nov 11 and exited before midday of Nov 12;
- Prior to Ty Ulysses, the PRB already experienced 5 related tropical disturbances in a span of less than a month: SW monsoon as enhanced by TC Nika (Oct 11-13), TC Ofel (Oct 14-16), TC Pepito (Oct 19-23), TC Quinta (Oct 25-30), and TC Rolly (Oct 30 to Nov 03). These series of disturbances can be associated with the prevailing enhanced La Niña in the last quarter period of 2020;
- Typhoon intensity winds initially affected the eastern sections of the PRB starting in the evening of Nov 11 and lasted before midday of Nov 12;
- Moderate to heavy and at times Intense rains were mostly recorded over the eastern portions of the PRB starting just after midnight of Nov 11 until early morning of Nov 12;
- Gabaldon RR station had a significant 9-hour period of continuous heavy to intense rainfall (from 2000H LST Nov 11 until 0400H LST Nov 12) or a total of 250 mm for the said period.
- Most of the rivers / tributaries coming from the east (e.g. Coronel, Peñaranda, San Miguel, Maasim, Angat Rivers had rapid rises starting just after midnight of Nov 11 until early morning of Nov 12 (6 to 7 hours);
- The rapid rise of rivers from the east happened immediately after the moderate to heavy and at times intense rains associated with the passage of Ty. Ulysses;
- Flashfloods were reported along Maharlika Highway (at San Ildefonso & San Miguel in Bulacan) due to the overflowing of Maasim and San Miguel Rivers. The highway was impassable to all types of land vehicles starting 0500H of Nov 12 and persisted for 2-3 hours;
- Major tributaries Coronel, Peñaranda and Angat Rivers, all coming from the eastside of PRB, likewise rose rapidly in the early morning of Nov 12 coinciding with the peak rainfall over at this part of the basin;
- Ty Ulysses was a relatively short-lived TC event that caused fluvial floods in the riverside and low-lying areas along Pampanga River;
- Fluvial floods lasted for 1 to 2 days mostly at the mid to downstream sections of Pampanga River. However, remnants of floodwaters from combined river overflowing and ponded rainwater took more than a week before subsiding completely;
- The Candaba swamp was still above alert level prior to Ty Ulysses;
- As usual, the Candaba swamp and Pampanga Delta areas along Pampanga River (Pampanga & Bulacan Provinces) were the ones heavily affected by floods during the event; These areas were already partially flooded even before the arrival of Ty Ulysses;
- The flood episode of Ty Ulysses and other recent flood events in year 2020 had some specific effects in the present hydrological dynamics of PRB as follows:

 - - Rains in Gabaldon will be felt in Sapang Buho WL in Palayan within 4 to 6 hours
 - - flow from Sapang Buho to Arayat, assuming no significant inflow from Penaranda River, will take about 10 to 12 hours
 - - flow from Arayat to Sulipan, assuming no significant tidal effects and inflow from Angat River, will take 10 to 14 hours
 - - Arayat WL at almost 8.0 meters will already affect 2 to 3 houses in Bgy. Candating, Arayat
 - - Sulipan WL at about 3.0 meters will almost be at road level with portions of the Calumpit-Hagonoy Road at Bgys. Calizon-Bulusan area

- - *Candaba WL at just above 5 meters will have the Candaba-Baliuag Road in Bgy. San Agustin already impassable to many types of land vehicles; and at about 5.5 meters will have the Candaba-San Miguel Road at Dukma impassable to all types of land vehicles*
 - Angat, Ipo and Bustos Dams all released reservoir water during Ty Ulysses; Likewise, some irrigation dams (e.g. Atate and PENRIS) in Nueva Ecija (NIA-UPRIIS area) had their gates opened as well;
 - Pampanga Province reported 14 towns affected by floods (from Pampanga PDRRMO Terminal Report on Ty Ulysses); Bulacan Province had about 12 towns within the PRB and Nueva Ecija around 11 towns affected by floods (based on reports gathered and from the post-flood survey conducted);
 - The PRFFWC issued 3 FAs and 13 FBs from the period Nov 10 to 17. First issuance (FA #1) was more than 24 hours ahead of the Tropical Cyclone's passage over the PRB. Final FB (# 13) was issued with several areas, mostly at the downstream stretch of Pampanga River including Candaba swamp area still underwater (remnants of floodwaters);
 - Floods due to Ty Ulysses may be the worst for year 2020 but it is still way below par of the other PRB flood events such as the events in 2004, 2011, 2012, and 2015;
 - Finally, and for the record, Ty Ulysses may not be one of the worst floods that affected the PRB but it may be one of the worst events that happened while the Philippines was still in pandemic state (due to COVID19).
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Resource Entities:

1. Office of Civil Defense Reg. 3 / Regional Disaster Risk Reduction & Management Council 3
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7. Gabaldon MENRO / MDRRMO (NE)
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14. San Leonardo MDRRMO (NE)
15. Jaen MDRRMO (NE)
16. Zaragoza MDRRMO (NE)
17. San Rafael MDRRMO (Bul)
18. San Ildefonso MDRRMO (Bul)
19. San Miguel MDRRMO (Bul)
20. Bustos MDRRMO (Bul)
21. Calumpit MDRRMO (Bul)
22. Hagonoy MDRRMO (Bul)
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