Application of Rainfall-runoff-inundation (RRI) Model to the Pampanga River Basin

Hilton Hernando (PRFFWC)

Hilario 'Larry" Esperanza (ARFFWC)

Philippine Atmospheric, Geophysical & Astronomical Services Administration (PAGASA)

Presentation Outline

➤ **Brief on Pampanga River Basin**

➤ **Pampanga River Flood Forecasting & Warning System (PRFFWS)**

➤ **Event: Typhoon "Pedring" (Nesat) – September 2011 and Southwest Monsoon of August 2012**

➤ **RRI Model as applied to PRB event/s**

  ➤ **Calibration - Sept 2011**

  ➤ **Validation - August 2012**

➤ **Way Forward Programs (Challenges, Priorities & Opportunities…other related activities)**
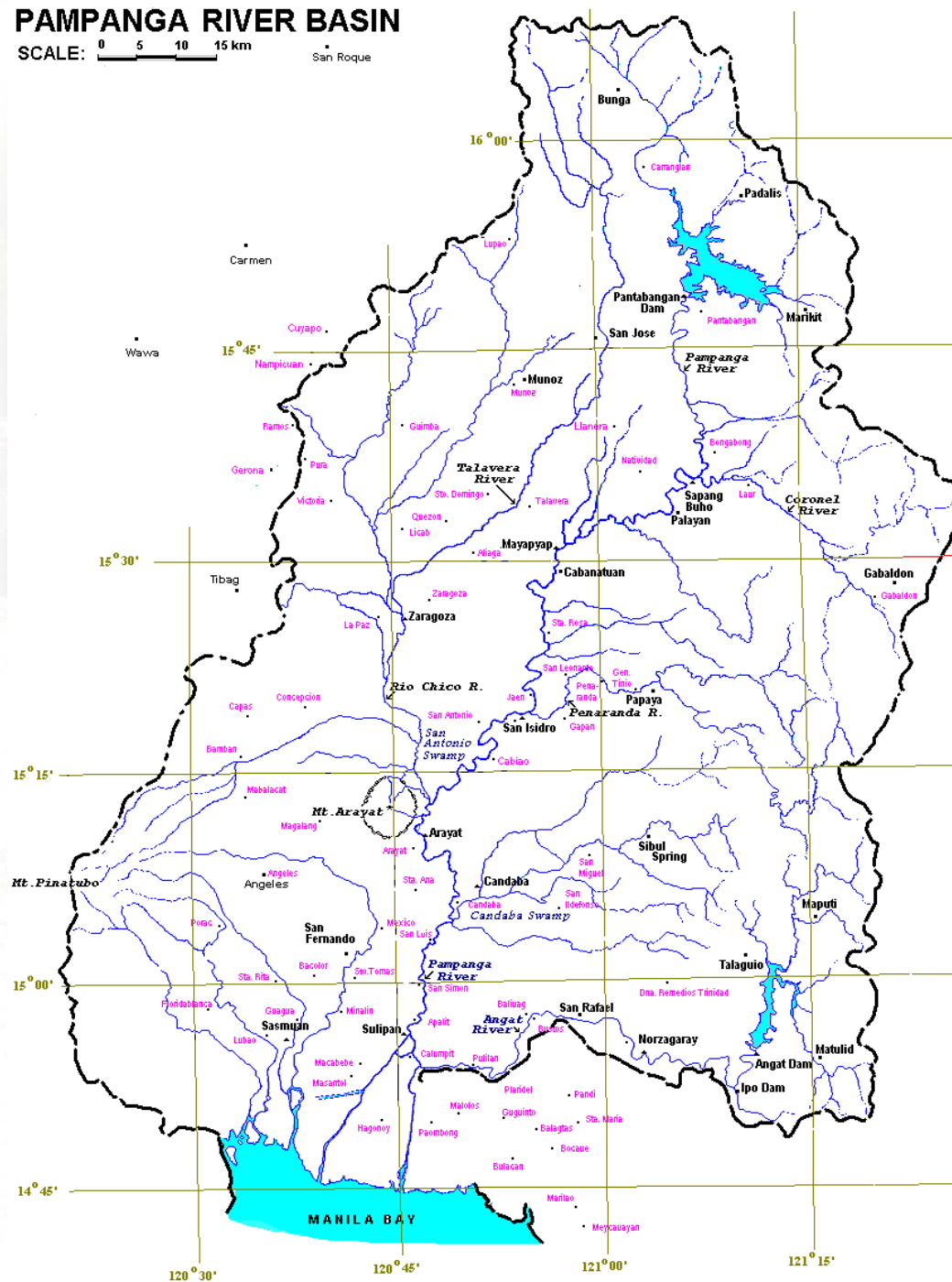
➤ **Other matters**

Cagayan River Basin

Agno River Basin

Pampanga River Basin

Bicol River Basin

The
**PAMPANGA
RIVER BASIN**

PRFFWC
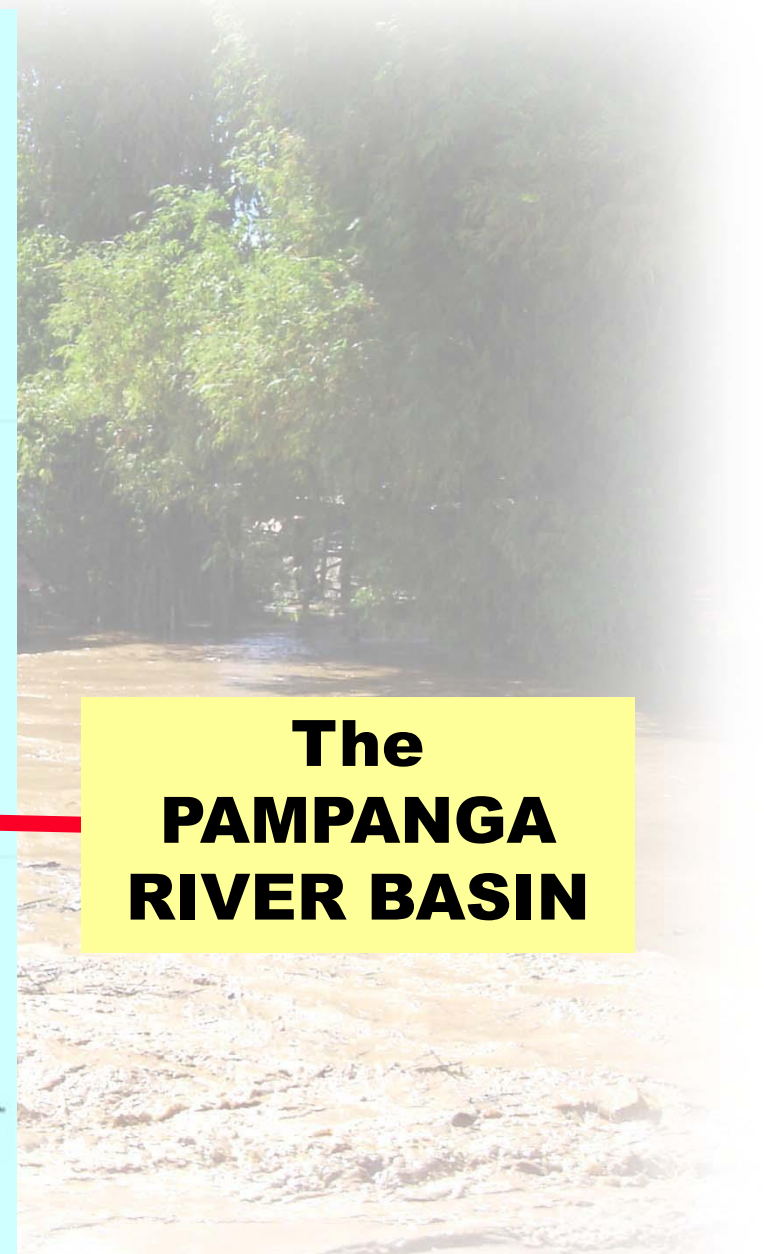
Provinces within the PAMPANGA RIVER BASIN
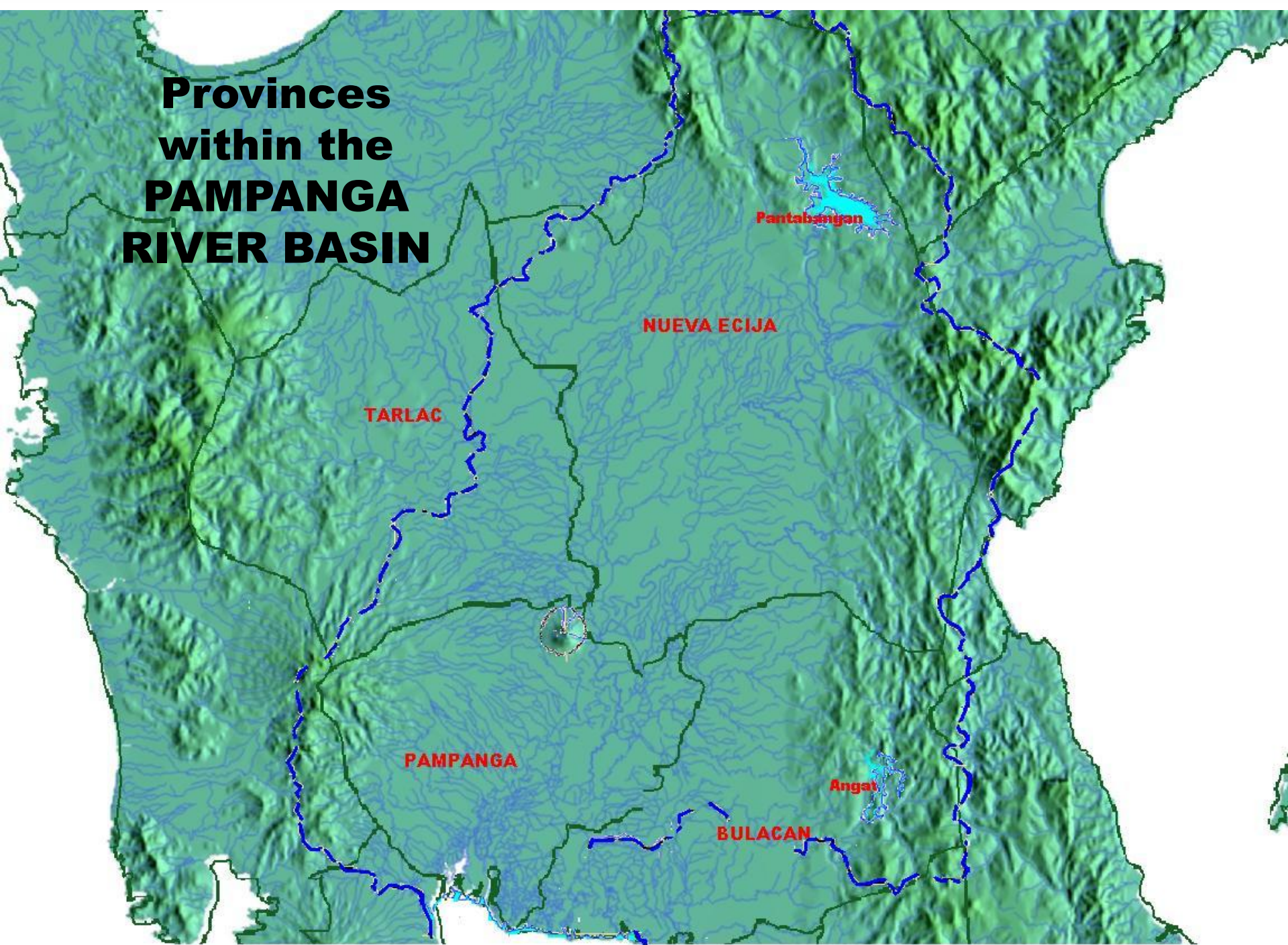
PAMPANGA RIVER BASIN

SCALE: 0 5 10 15 km

PRB:

About 90 towns and 7 cities within the basin area.
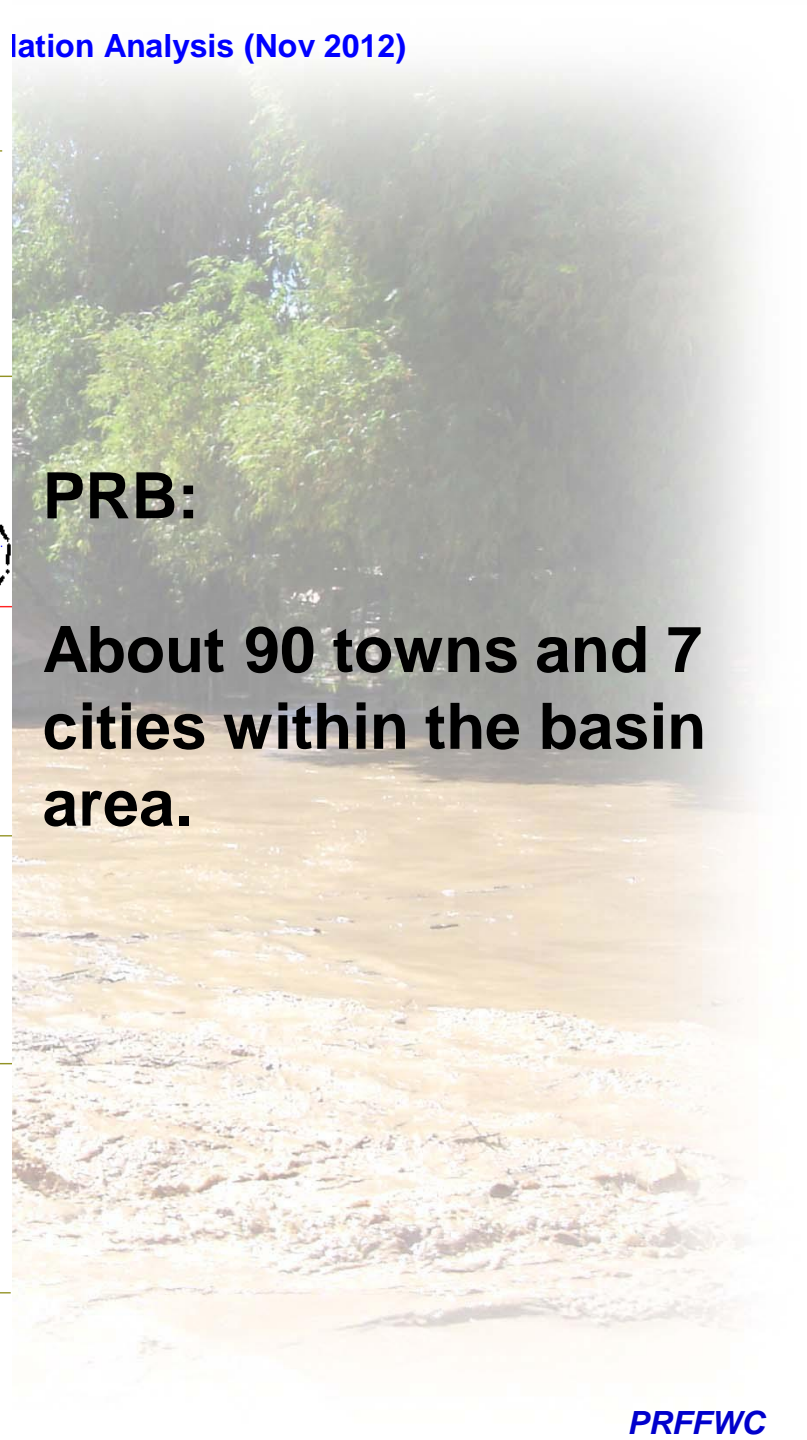
PAMPANGA RIVER Basin
MAIN TRIBUTARIES

CARRANGLAN RIVER

PANTABANGAN RIVER

TALAVERA RIVER

MURCON RIVER

ILOG BALIWAG RIVER

DIGMALA RIVER

PAMPANGA RIVER BASIN

CORONEL RIVER

CABU RIVER

Minatula River

TABUATING RIVER

CAAGASAN RIVER

Tambo River

SIU RIVER

PEÑARANDA RIVER

QUITANGUIL RIVER

BULO RIVER

GARLANG RIVER

RIO CHICO RIVER

MAASIM RIVER

PAMPANGA RIVER

ANGAT RIVER

Manila Bay

⭐ MANILA

PRFFWC

PAMPANGA RIVER Basin
Flood Structures
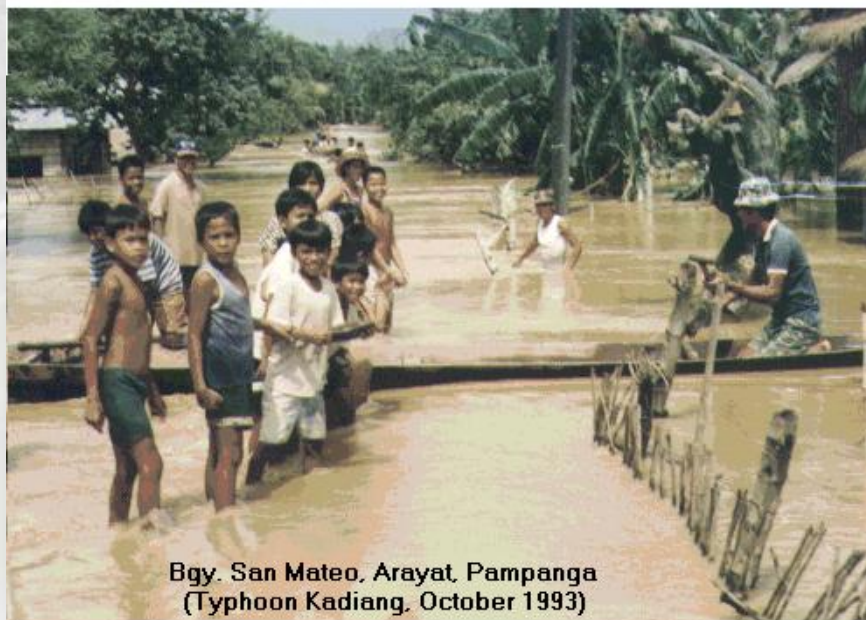
PRFFWC
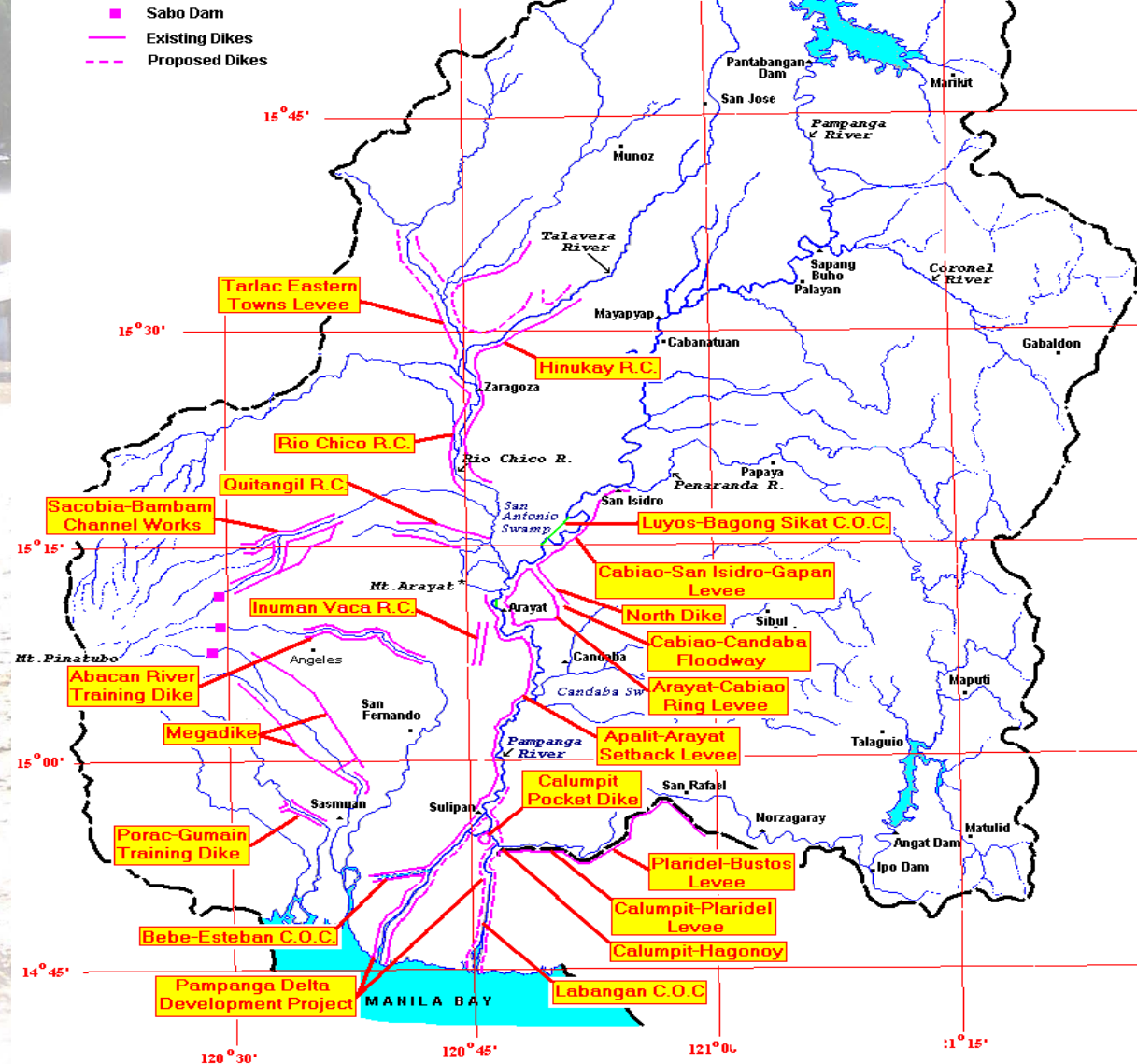
PAMPANGA RIVER BASIN: THE NEED FOR FFWS

➤ **At least 1 flooding a year**

➤ **Frequency of TC: about 5 in 3 years**

➤ **Very pronounced SW monsoon**

➤ **Relatively low elevation / flat terrain**

➤ **Narrow (some sections) and silted waterways**

➤ **Flood prone area: about 2,200 km^2 (Pampanga) & 400 km^2 (Pasac-Guagua)**

➤ **2 Swamp areas – Candaba & San Antonio**

➤ **2 major Dam structures – Angat & Pantabangan**

➤ **(Reported) slow sinking of the Pampanga Delta**

FLOOD SITUATION within PRB

Swirling Floodwaters in Candaba, Pampanga (T.Kadiang, Oct.1993)

Bgy. San Mateo, Arayat, Pampanga
(Typhoon Kadiang, October 1993)

FFB, PRFFWC - hth - Nov.1993

Top:
Poblacion, Hagonoy,
Bulacan
(T.Kadiang, Oct.1993)

Left:
Bgy. San Anton,
San Leonardo,
Nueva Ecija
(T.Kadiang, Oct.1993)

PRFFWC

River overflowing…

Cabiao - Aug 2004
PRFFWC-hth

Some flashy tributaries

Floods from Dam releases

Other flooding issues within the basin: Coastal Floods (due to high tide)

Hagonoy High Tide
June 05, 2008

PRFFWC-hth

The Pampanga River Basin Flood Forecasting & Warning Center (PRBFFWC)

A non-structural flood mitigating measure
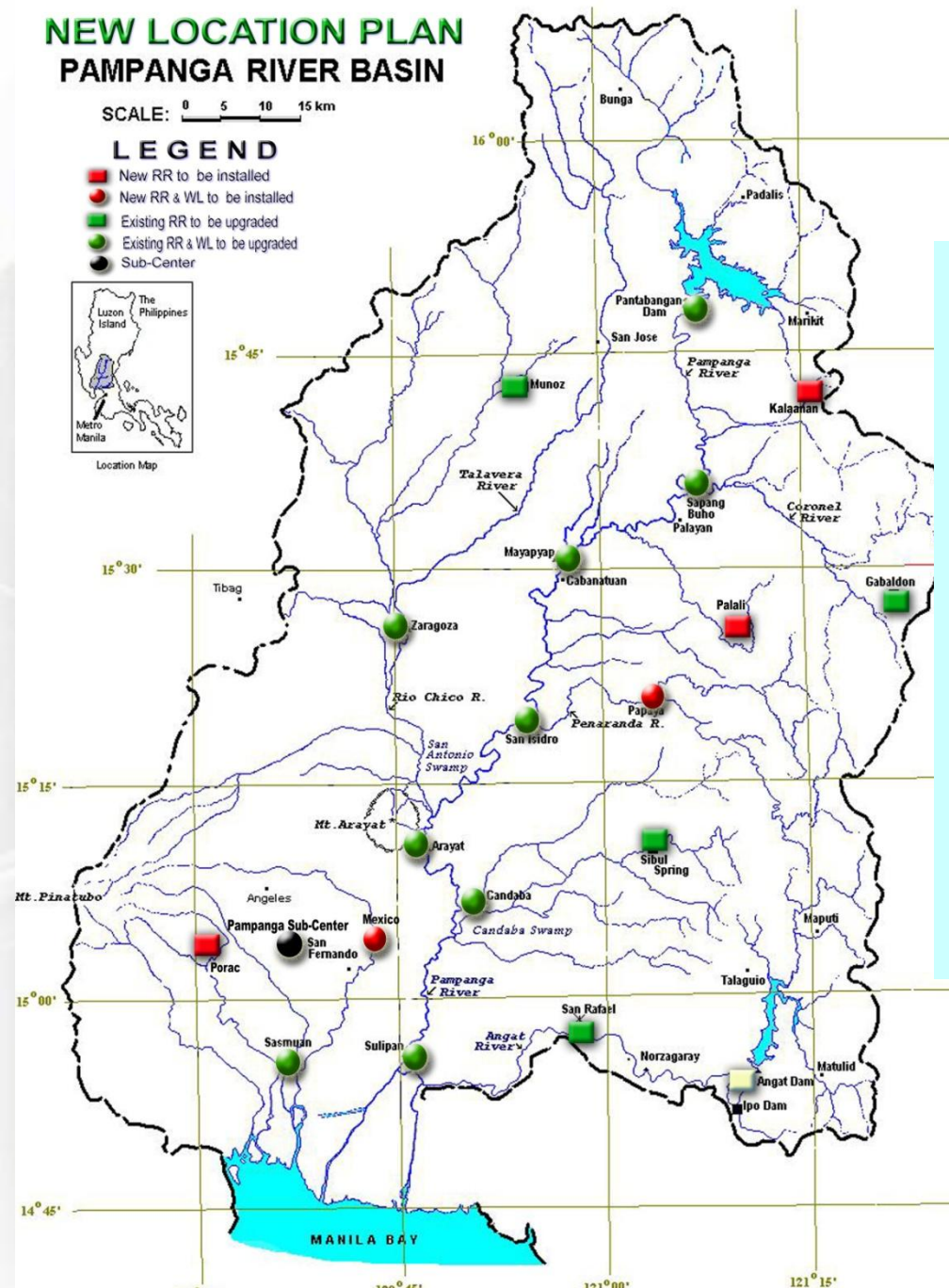
NEW LOCATION PLAN
PAMPANGA RIVER BASIN

SCALE: 0 5 10 15 km

LEGEND
- ■ New RR to be installed
- ● New RR & WL to be installed
- ■ Existing RR to be upgraded
- ● Existing RR & WL to be upgraded
- ● Sub-Center

Location Map

d Inundation Analysis (Nov 2012)

PRFFWC

- **1973**
- **March 19, 2009**
- **18 RR & 10 WL stns**
- **Monitoring Ctr in SFDO**
- **Telemetry system**
- **FFWSDO thru FFWS, Q.C. – MOC**
- **Operational 24 / 7**
- **5 personnel**

Pampanga River Flood Forecasting & Warning System

PRFFWC

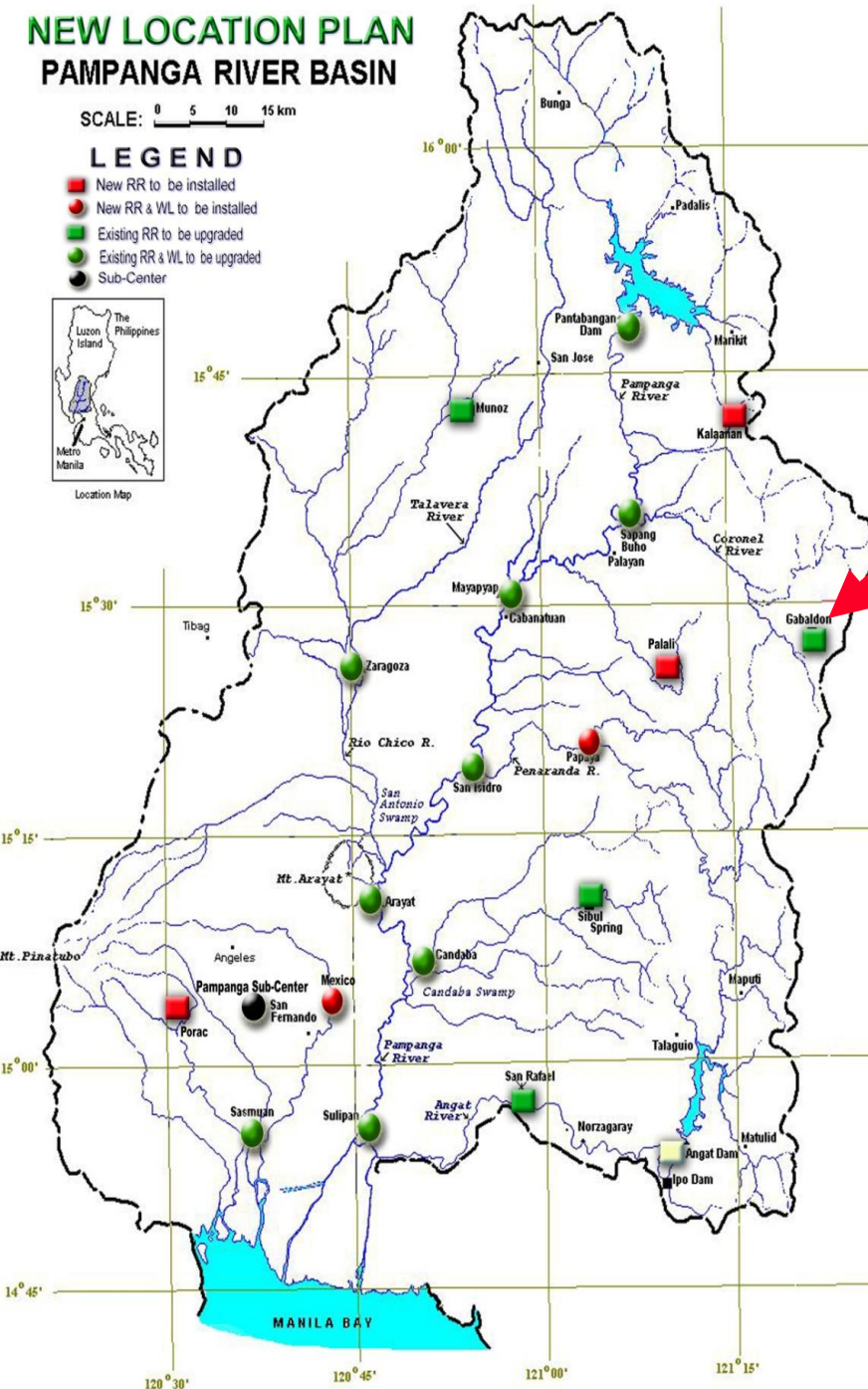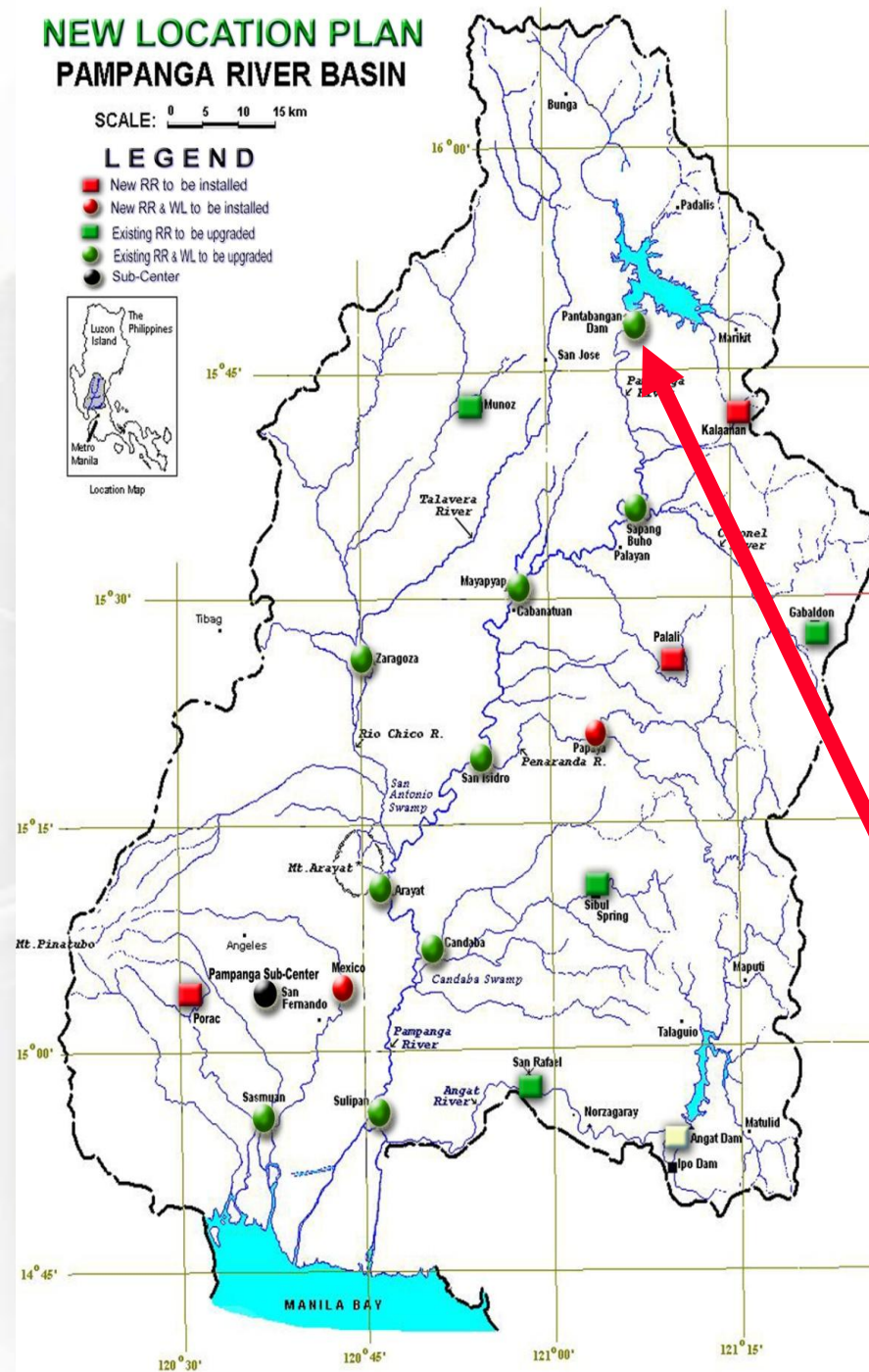NEW LOCATION PLAN
PAMPANGA RIVER BASIN

SCALE: 0 5 10 15 km

LEGEND
■ New RR to be installed
● New RR & WL to be installed
■ Existing RR to be upgraded
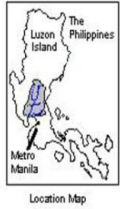● Existing RR & WL to be upgraded
● Sub-Center

Upstream rainfall station in Gabaldon, N.E. (Coronel River) – (Eastside)

PRFFWC

NEW LOCATION PLAN
PAMPANGA RIVER BASIN

SCALE: 0   5   10   15 km

LEGEND
- 🟥 New RR to be installed
- 🔴 New RR & WL to be installed
- 🟩 Existing RR to be upgraded
- 🟢 Existing RR & WL to be upgraded
- ⚫ Sub-Center

On the upper side (Northeast), Pampanga River starts at Pantabangan Dam

PRFFWC

NEW LOCATION PLAN
PAMPANGA RIVER BASIN

SCALE: 0 5 10 15 km

LEGEND
- New RR to be installed
- New RR & WL to be installed
- Existing RR to be upgraded
- Existing RR & WL to be upgraded
- Sub-Center
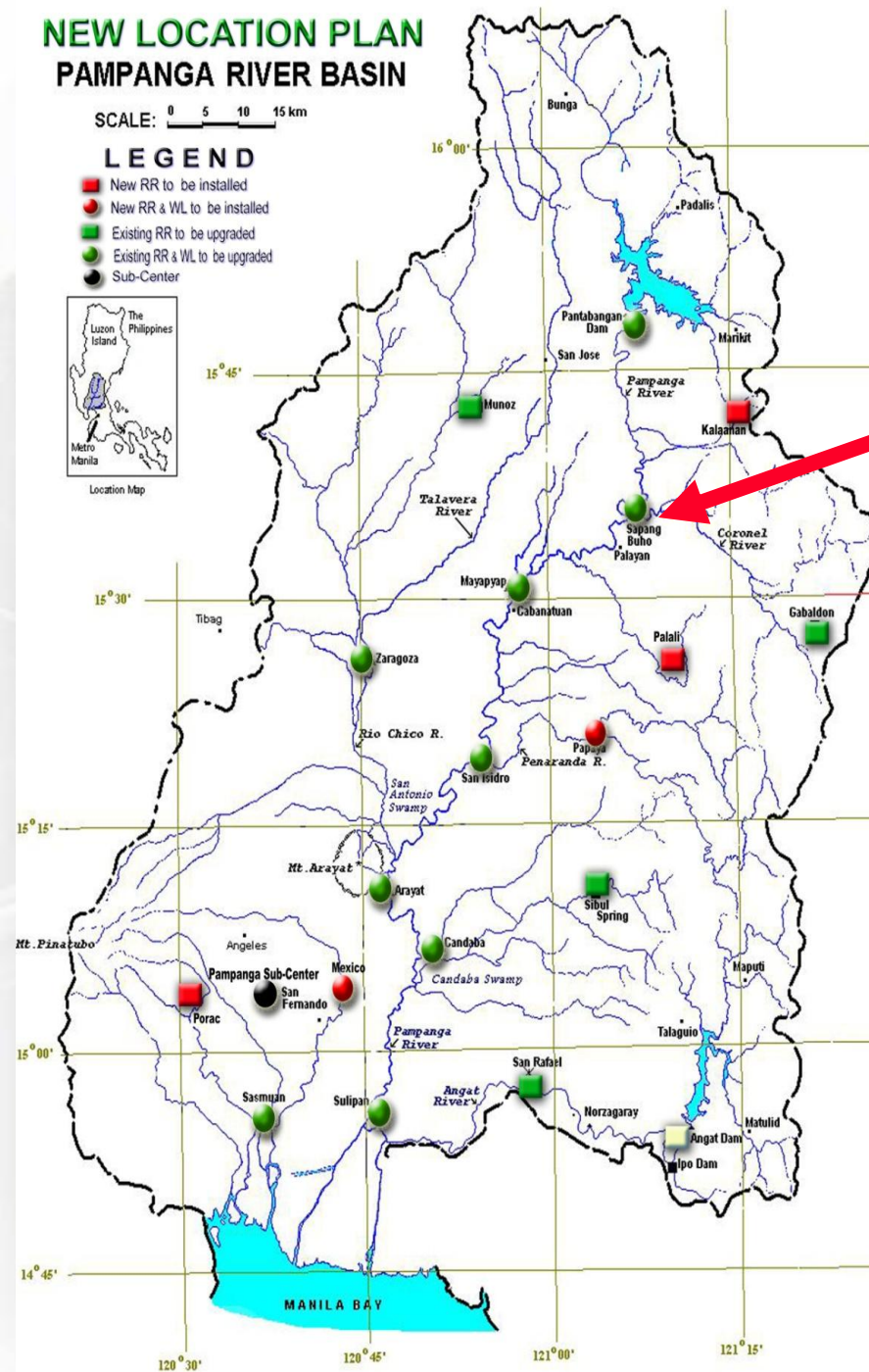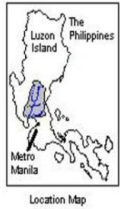
on Floc *Calaanan Rainfall station (Digmala watershed)*

03/23/2009

NEW LOCATION PLAN
PAMPANGA RIVER BASIN

Coronel River joins with Pampanga River before Sapang Buho station

PRFFWC

Sapang Buho RR-WL station @ 2009

03/24/2009

RFFWC

NEW LOCATION PLAN
PAMPANGA RIVER BASIN

on Flood Inu...

Pampanga River at Mayapyap stn.

PRFFWC

NEW LOCATION PLAN
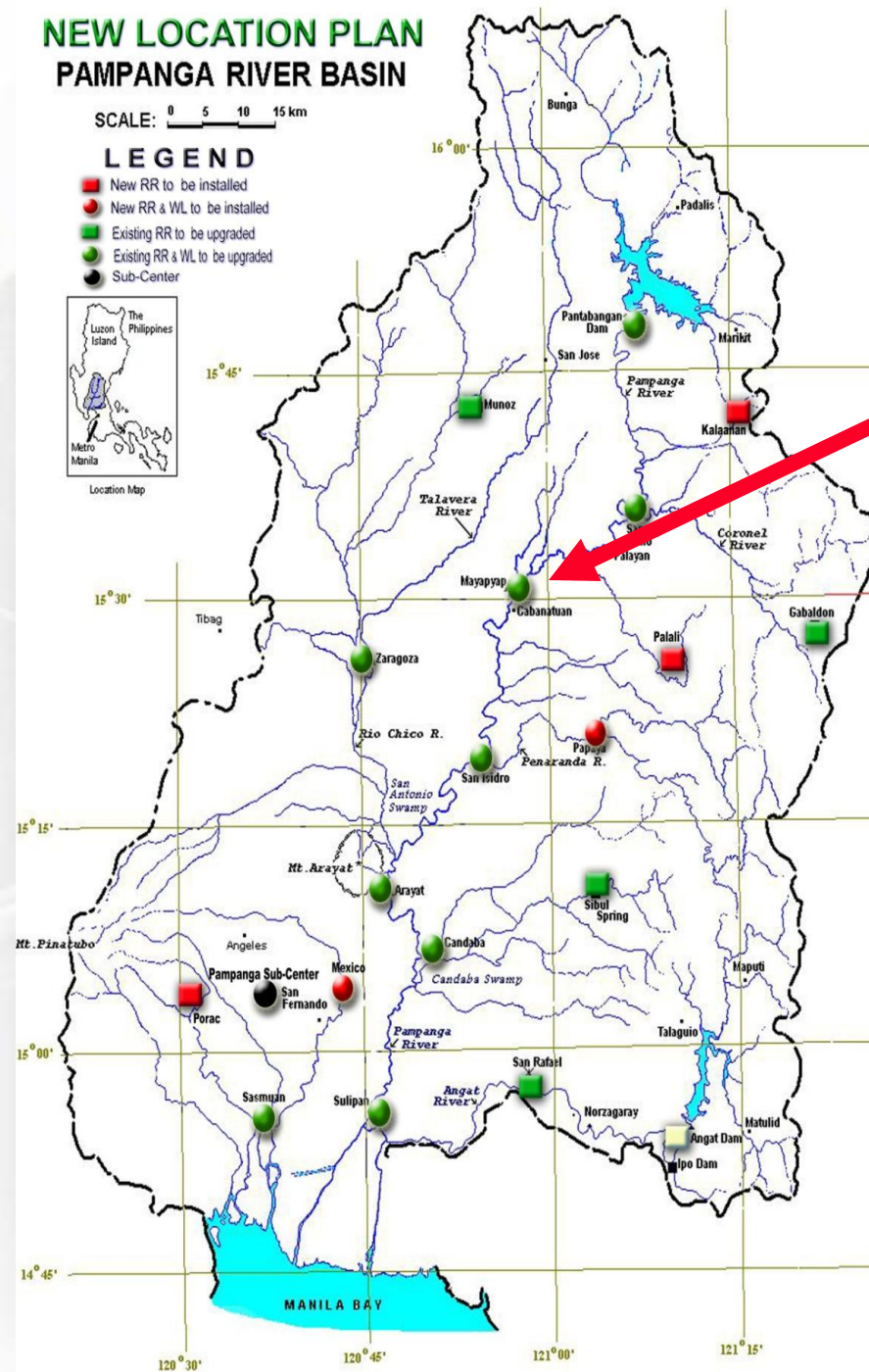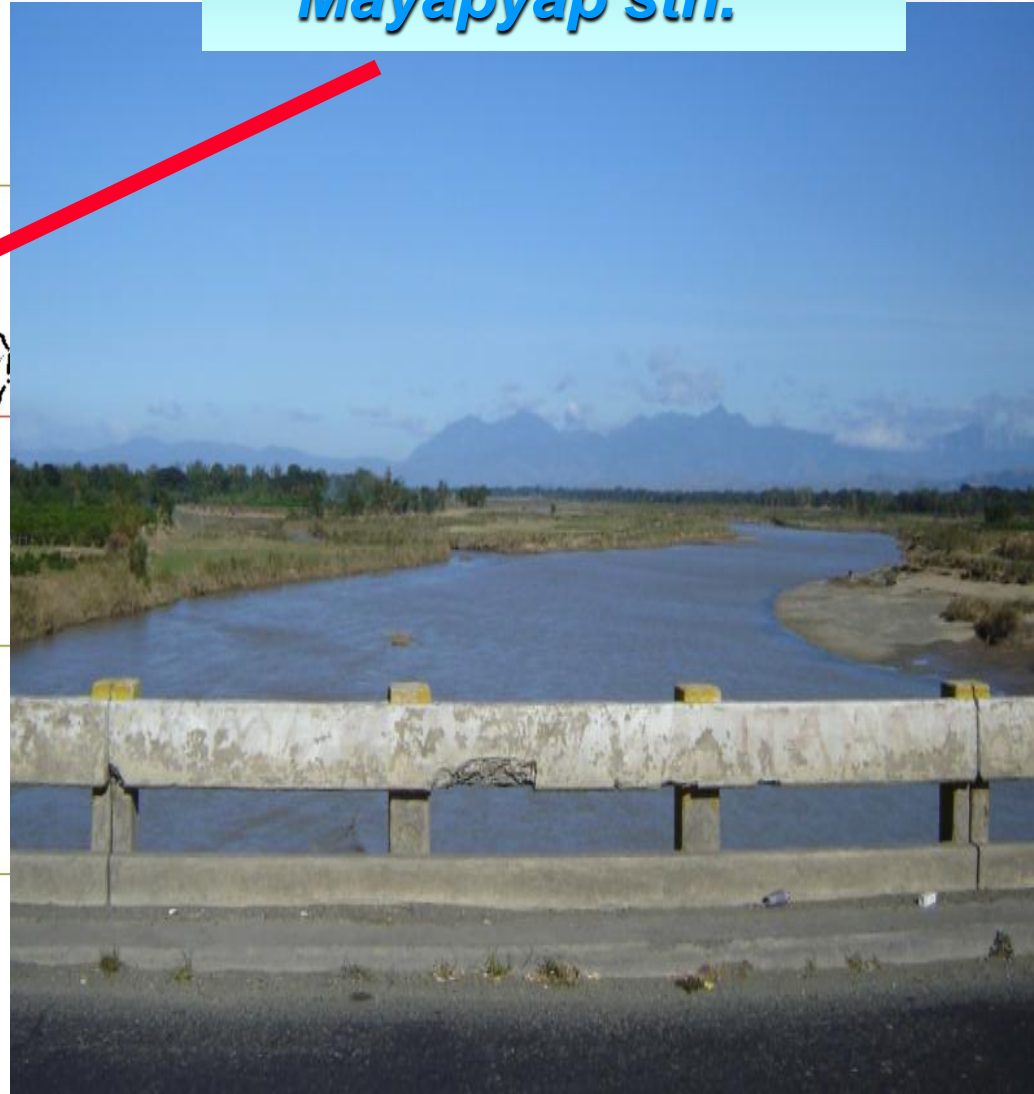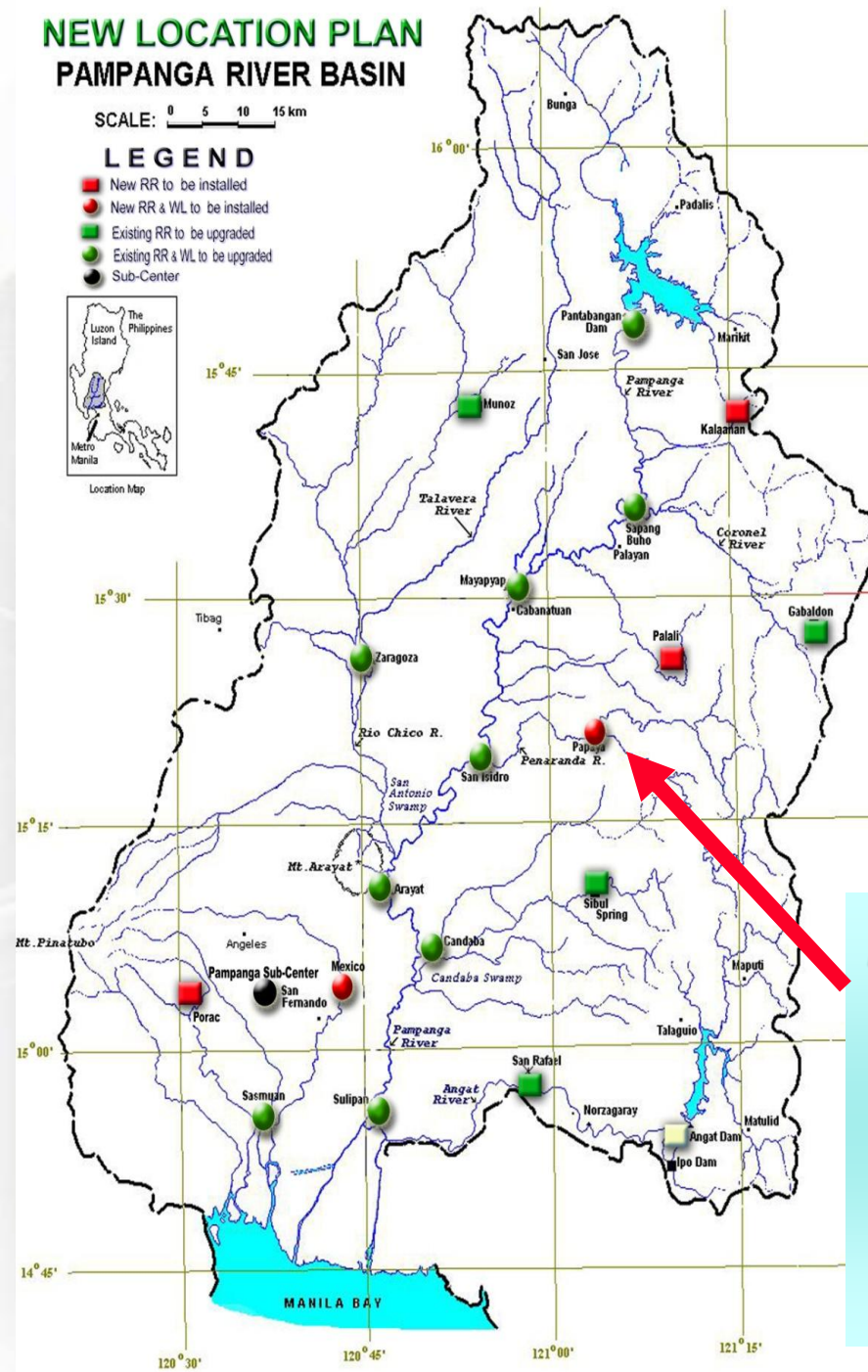**PAMPANGA RIVER BASIN**

SCALE: 0 5 10 15 km

LEGEND
- 🟥 New RR to be installed
- 🔴 New RR & WL to be installed
- 🟩 Existing RR to be upgraded
- 🟢 Existing RR & WL to be upgraded
- ⚫ Sub-Center

Location Map

Penaranda River (East area) joins Pampanga R. before San isidro

NEW LOCATION PLAN
PAMPANGA RIVER BASIN

on Flood Inundation Analysis (Nov 2012)

Pampanga River at San Isidro

03/24/2009

PRFFWC

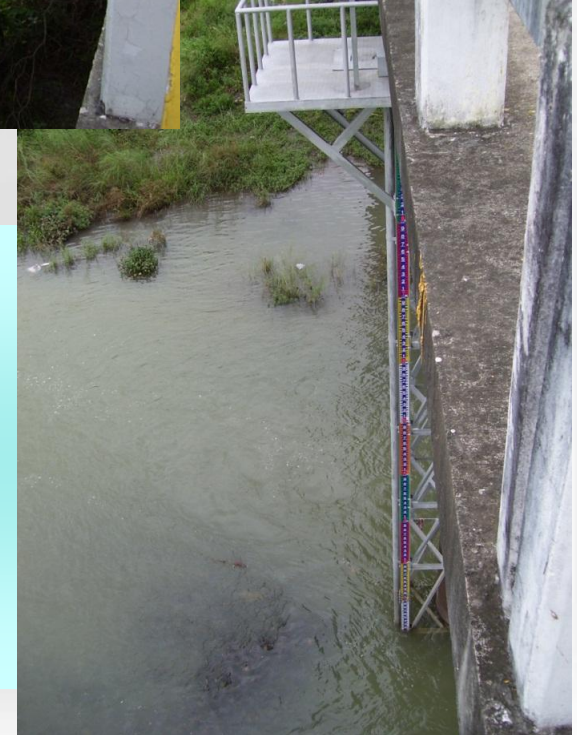# NEW LOCATION PLAN
PAMPANGA RIVER BASIN

SCALE: 0 5 10 15 km

LEGEND

- 🟥 New RR to be installed
- 🔴 New RR & WL to be installed
- 🟩 Existing RR to be upgraded
- 🟢 Existing RR & WL to be upgraded
- ⚫ Sub-Center

Location Map

The Philippines
Luzon Island
Metro Manila

Rio Chico River at the NW part of the basin

NEW LOCATION PLAN
PAMPANGA RIVER BASIN

Pampanga river at Arayat

NEW LOCATION PLAN
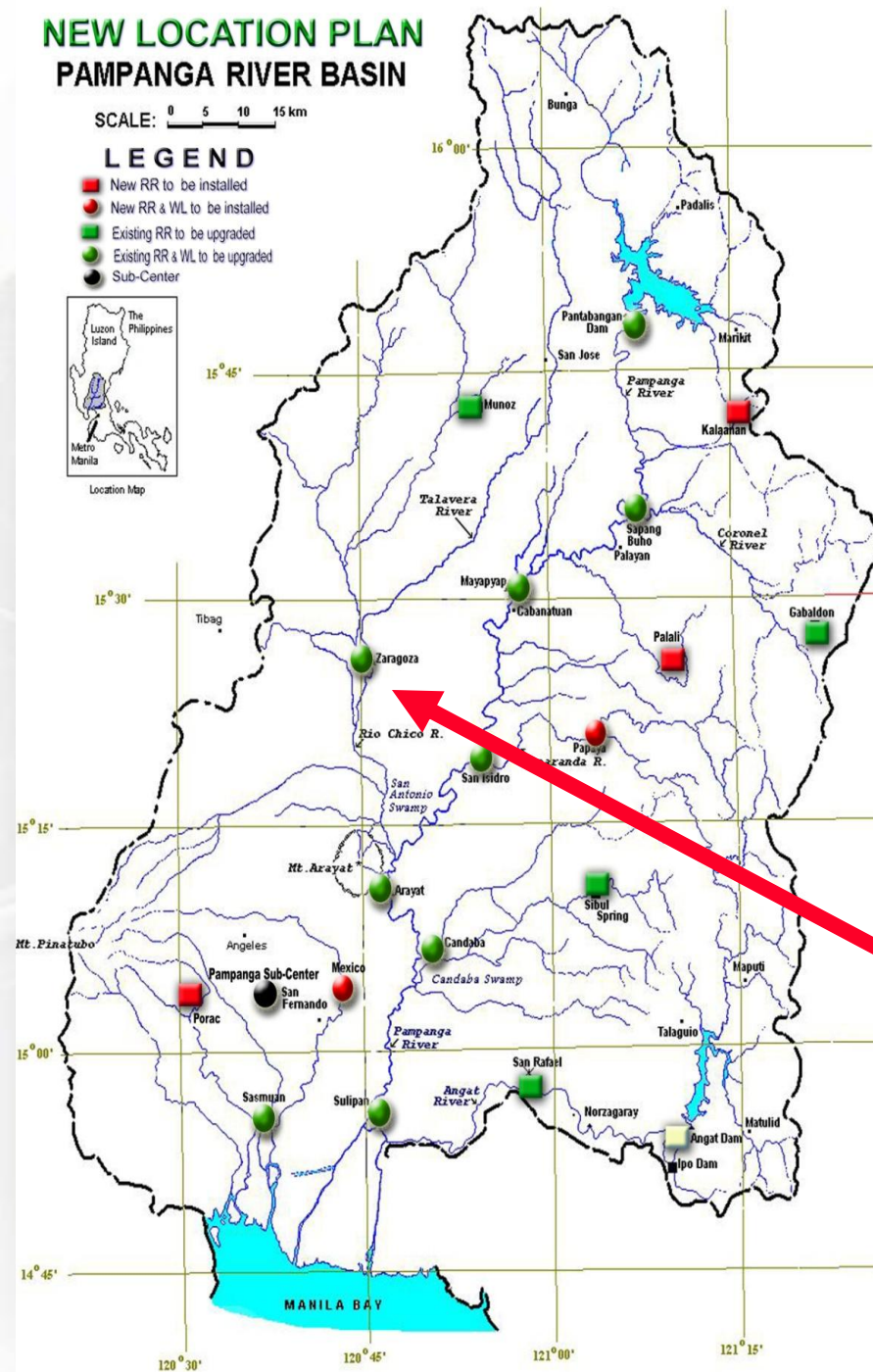## PAMPANGA RIVER BASIN

SCALE: 0 5 10 15 km

LEGEND
- ■ New RR to be installed
- ● New RR & WL to be installed
- ■ Existing RR to be upgraded
- ● Existing RR & WL to be upgraded
- ⬤ Sub-Center

Location Map

Candaba swamp area

Candaba station

Candaba at flood season

NEW LOCATION PLAN
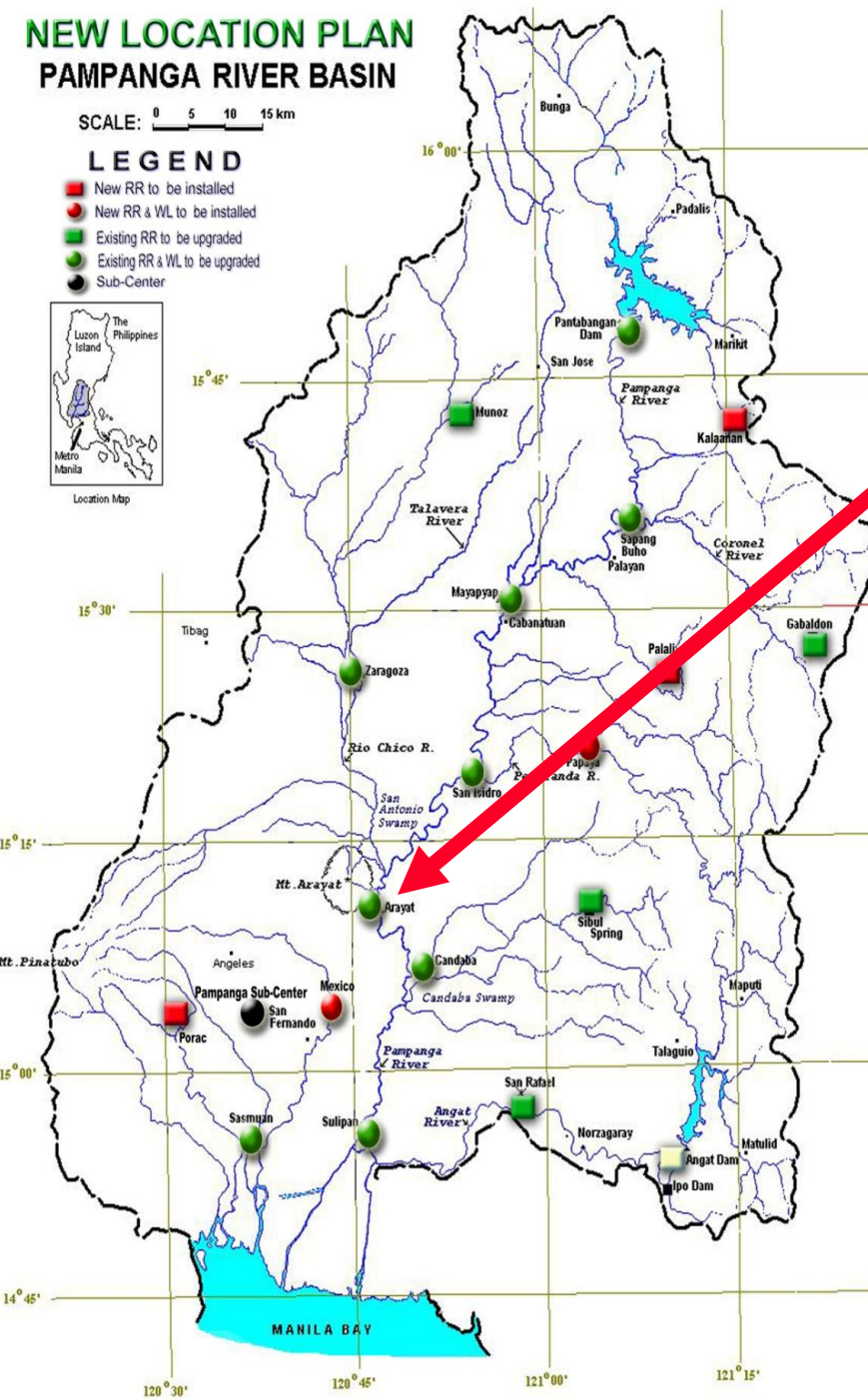## PAMPANGA RIVER BASIN

SCALE: 0 5 10 15 km

LEGEND
- ■ New RR to be installed
- ● New RR & WL to be installed
- ■ Existing RR to be upgraded
- ● Existing RR & WL to be upgraded
- ● Sub-Center

Sulipan station
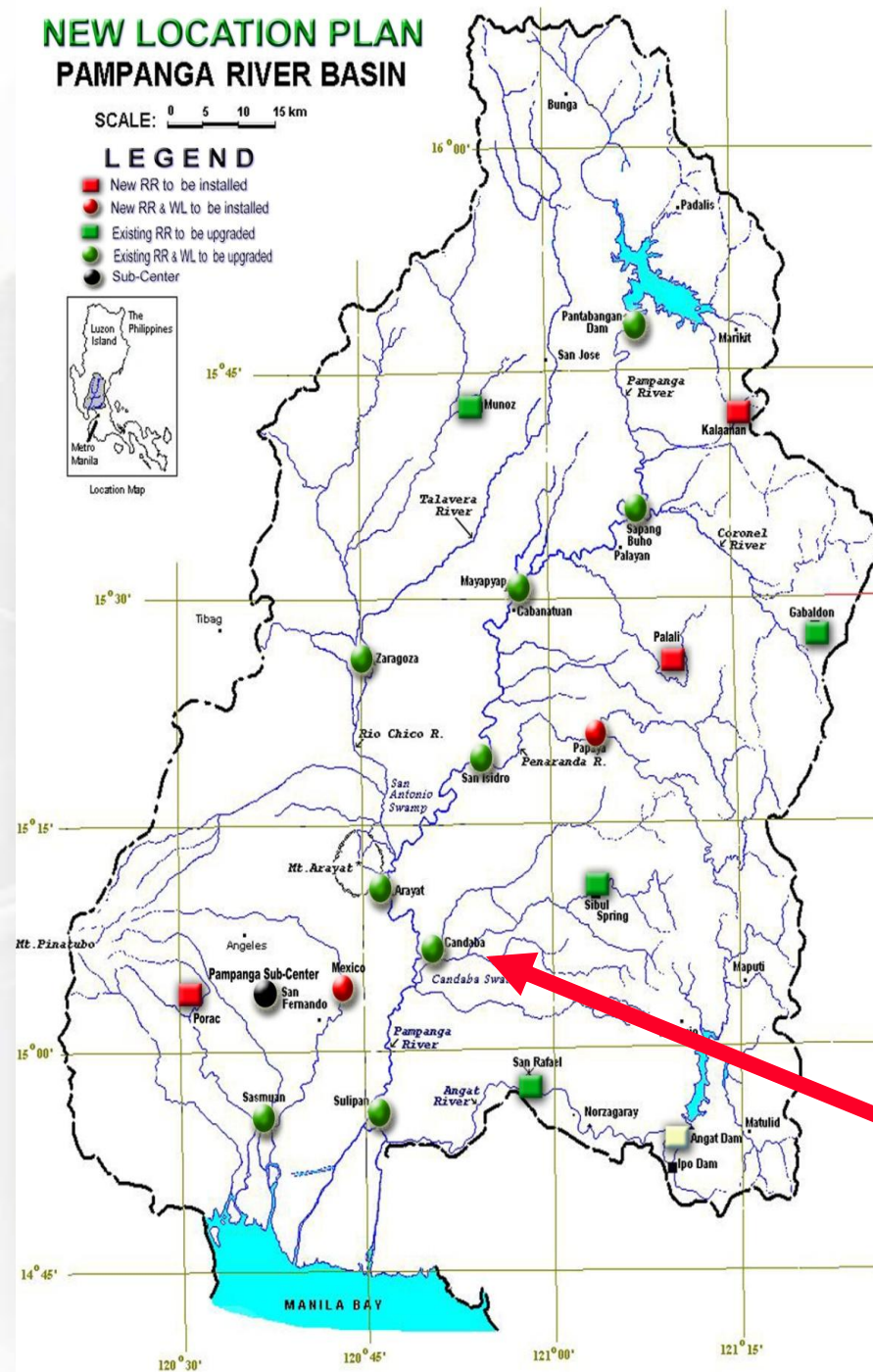
NEW LOCATION PLAN
PAMPANGA RIVER BASIN

SCALE: 0 5 10 15 km

LEGEND
- New RR to be installed
- New RR & WL to be installed
- Existing RR to be upgraded
- Existing RR & WL to be upgraded
- Sub-Center

Location Map

on Flood Inundation Analysis (Nov 2012)

Mexico stn.
(Abacan River)

PRFFWC®
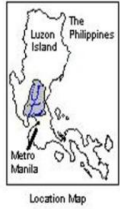
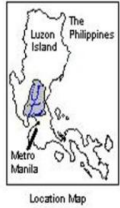**Sasmuan stn. (Pasac-Guagua River System)**
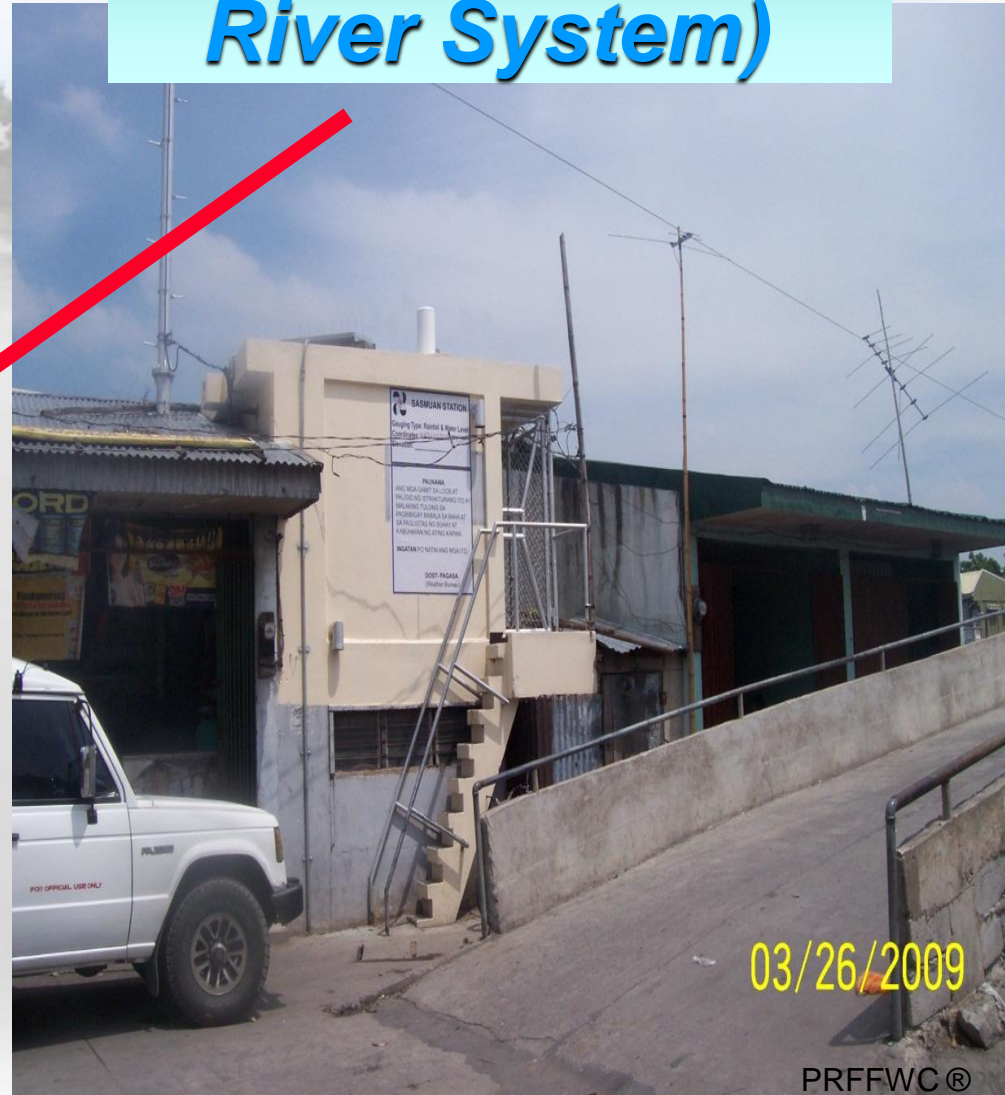
NEW LOCATION PLAN
PAMPANGA RIVER BASIN

SCALE: 0 5 10 15 km

LEGEND
- New RR to be installed
- New RR & WL to be installed
- Existing RR to be upgraded
- Existing RR & WL to be upgraded
- Sub-Center

Location Map

03/26/2009

PRFFWC ®

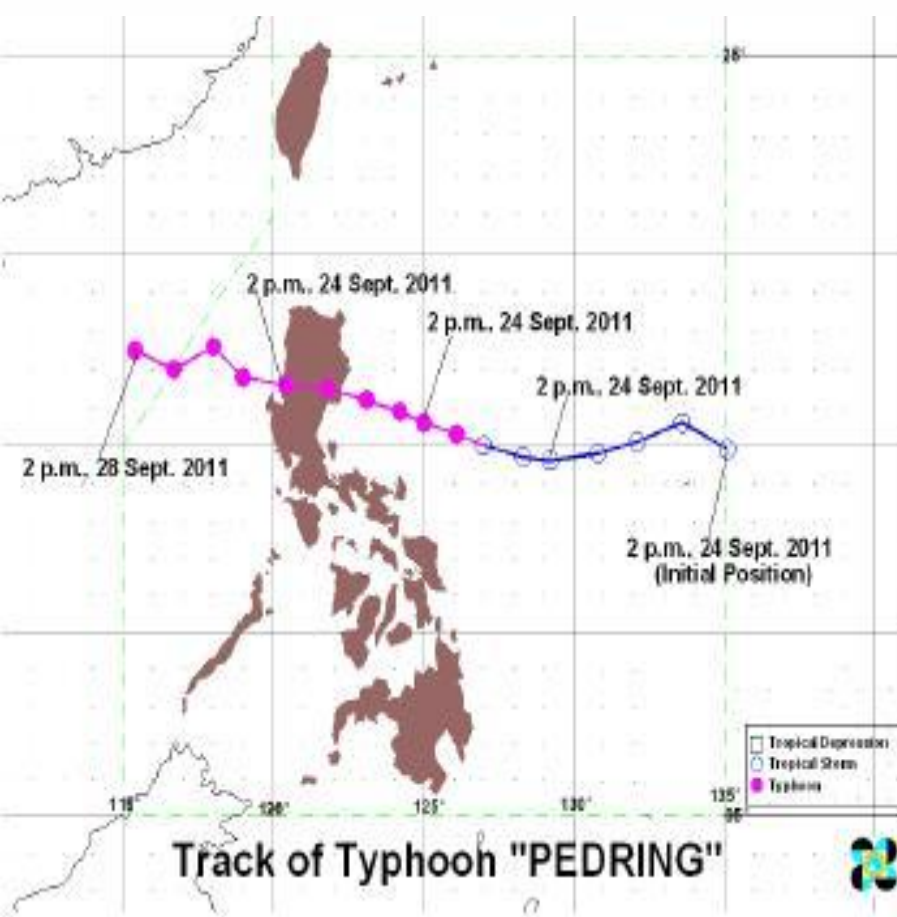# Event: Typhoon "Pedring" (Nesat) – September 2011

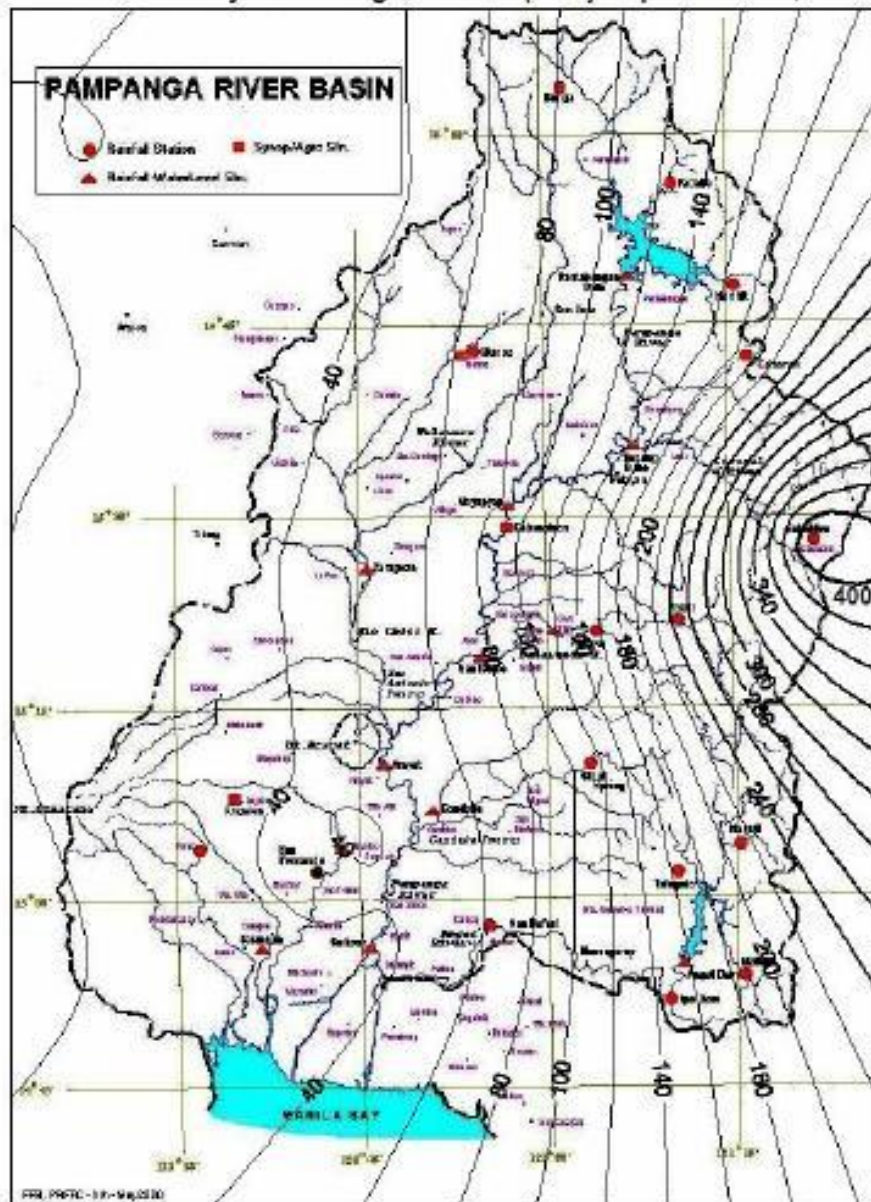Figure 3.0 Track of Typhoon "Pedring" during its course within the PAR (Sept 24 to 28).[4]

Figure 3.1 The enhanced IR satellite image of "Pedring" as of 0432H (LST), September 27, 2011 as it made landfall over at the Isabela-Aurora boundary.
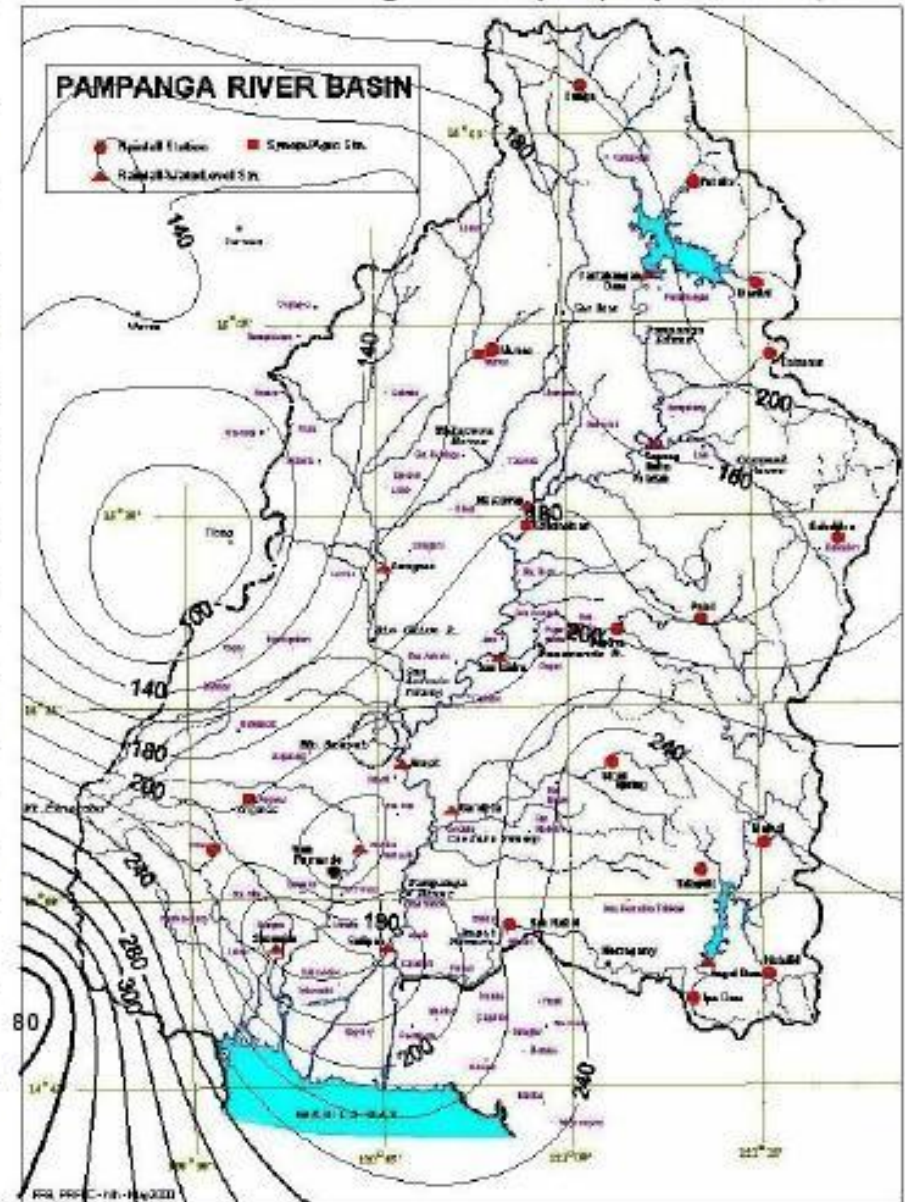
Typhoon "Pedring" (Nesat)

Figure 4.2 The 24-hour met-day (meteorological day) isohyets for September 26 (top left) and September 27 (top right) during the passage of Typhoon "Pedring".
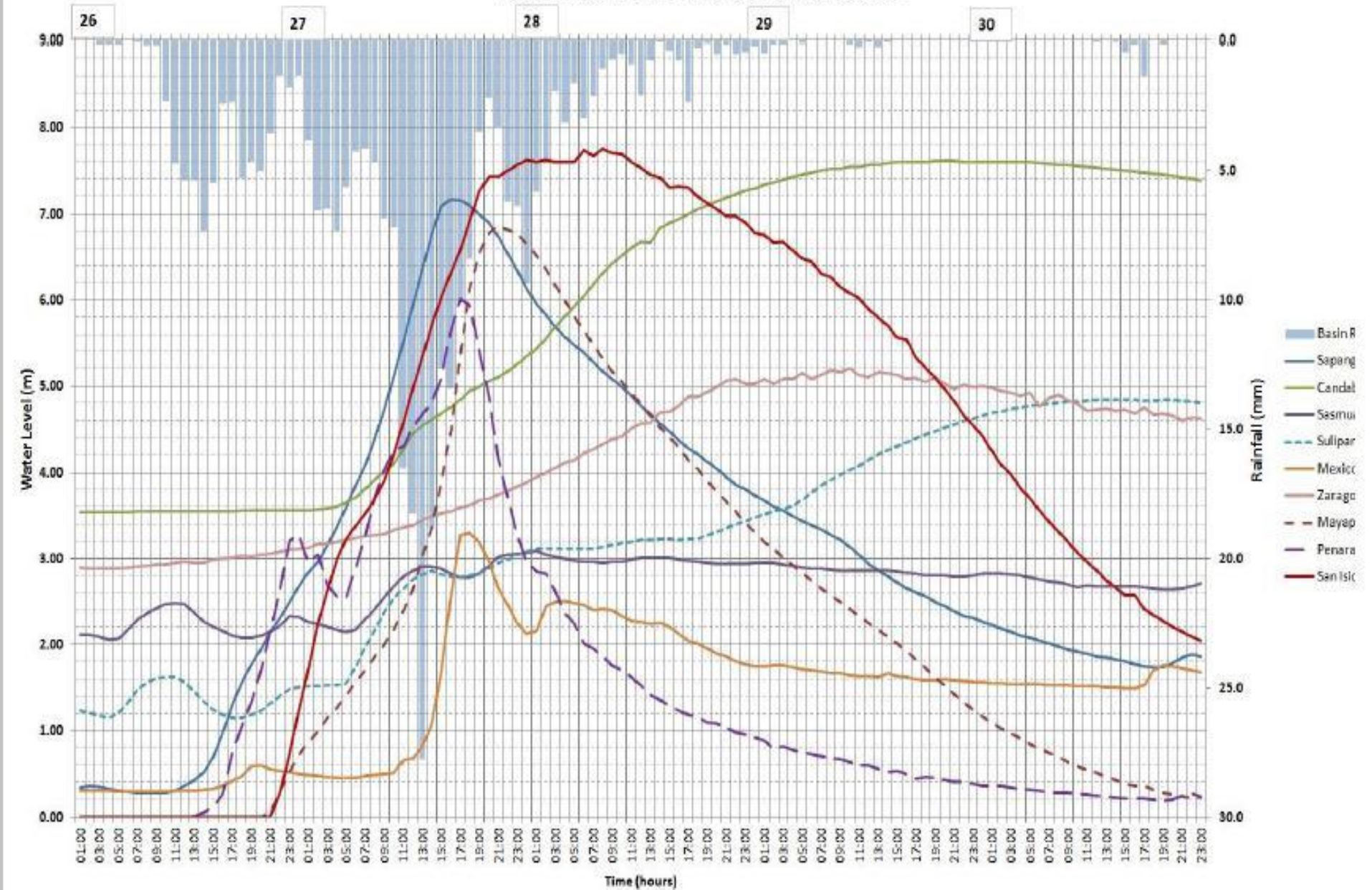
Figure 5.0 Hyetograph (mean basin rainfall) and hydrographs at various forecasting points within the basin covering the period from September 26 to October 30 during event "Pedring".
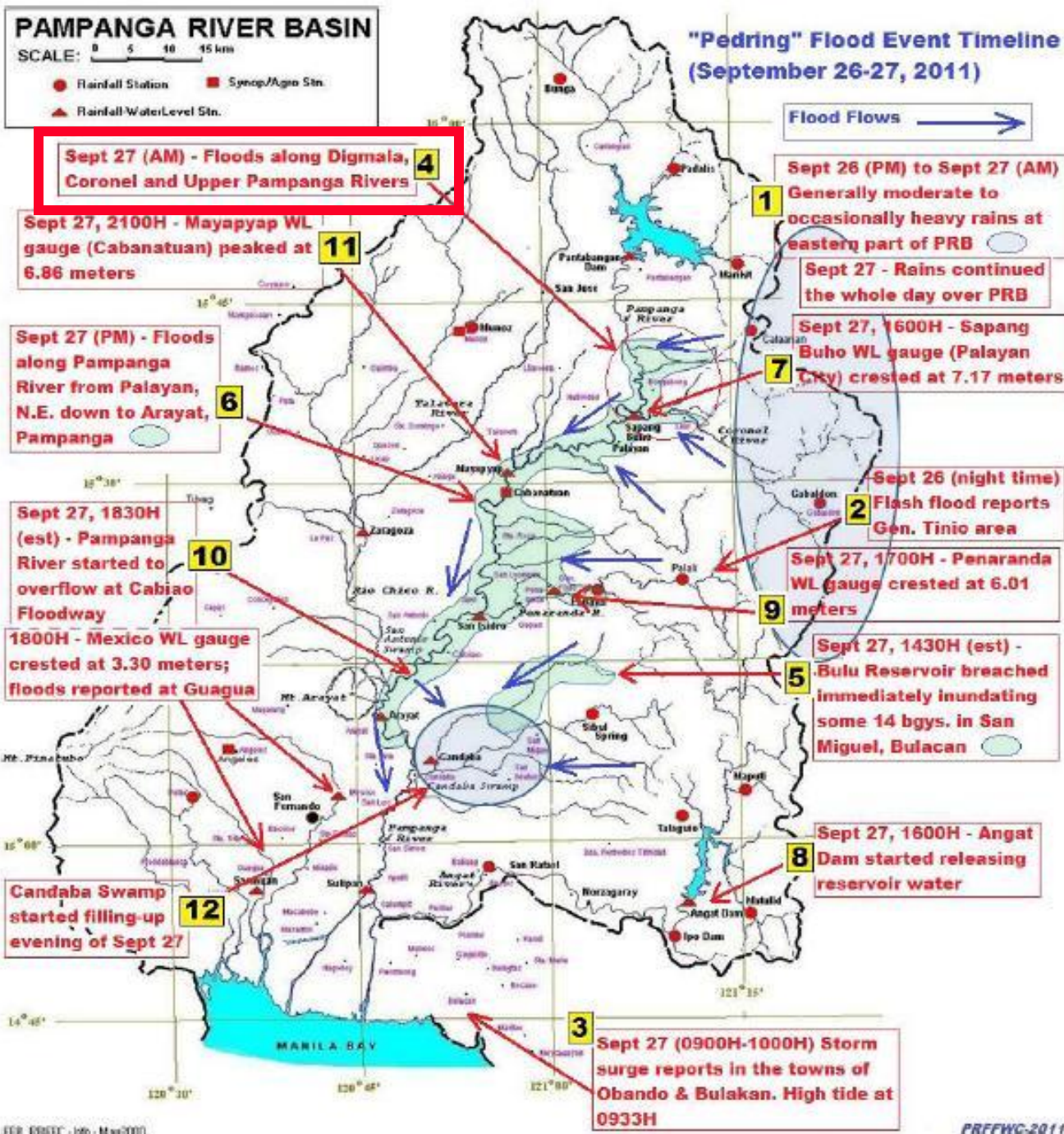
Figure 6.0 "Pedring" flood event timeline map from September 26 to 27, 2011.

PAMPANGA RIVER BASIN

SCALE: 0 5 10 15 km

● Rainfall Station   ■ Synop/Agro Stn.
▲ Rainfall/WaterLevel Stn.

"Pedring" Flood Event Timeline (September 26-27, 2011)

Flood Flows →

4 Sept 27 (AM) - Floods along Digmala, Coronel and Upper Pampanga Rivers

11 Sept 27, 2100H - Mayapyap WL gauge (Cabanatuan) peaked at 6.86 meters

6 Sept 27 (PM) - Floods along Pampanga River from Palayan, N.E. down to Arayat, Pampanga

10 Sept 27, 1830H (est) - Pampanga River started to overflow at Cabiao Floodway

1800H - Mexico WL gauge crested at 3.30 meters; floods reported at Guagua

12 Candaba Swamp started filling-up evening of Sept 27

1 Sept 26 (PM) to Sept 27 (AM) Generally moderate to occasionally heavy rains at eastern part of PRB

Sept 27 - Rains continued the whole day over PRB

7 Sept 27, 1600H - Sapang Buho WL gauge (Palayan City) crested at 7.17 meters

2 Sept 26 (night time) Flash flood reports Gen. Tinio area

9 Sept 27, 1700H - Penaranda WL gauge crested at 6.01 meters

5 Sept 27, 1430H (est) - Bulu Reservoir breached immediately inundating some 14 bgys. in San Miguel, Bulacan

8 Sept 27, 1600H - Angat Dam started releasing reservoir water

3 Sept 27 (0900H-1000H) Storm surge reports in the towns of Obando & Bulakan. High tide at 0933H

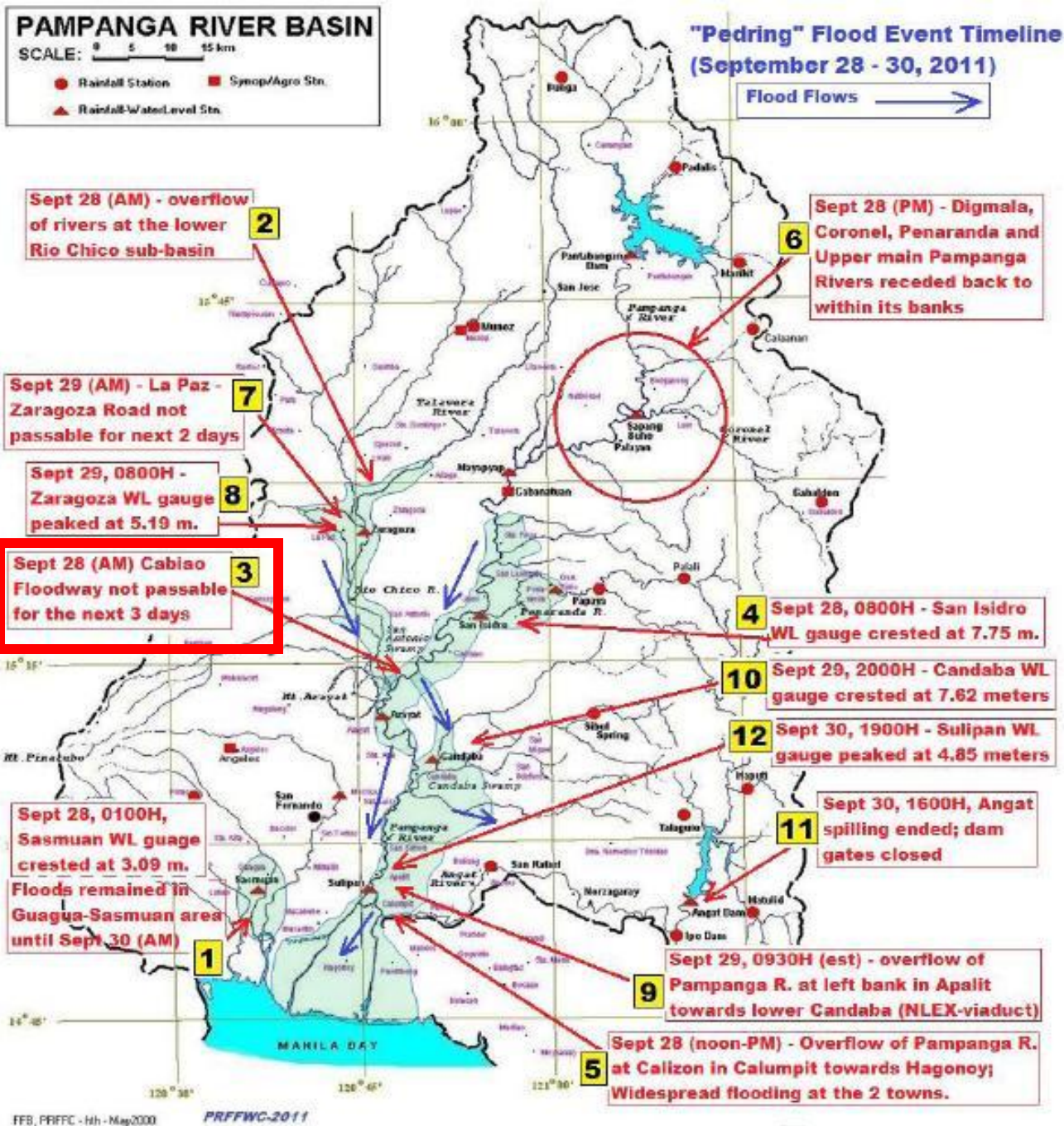FFB, PRFFC - Inth - May2000

PRFFWC-2011

PRFFWC

Figure 6.1 "Pedring" flood event timeline map from September 28 to 30, 2011.
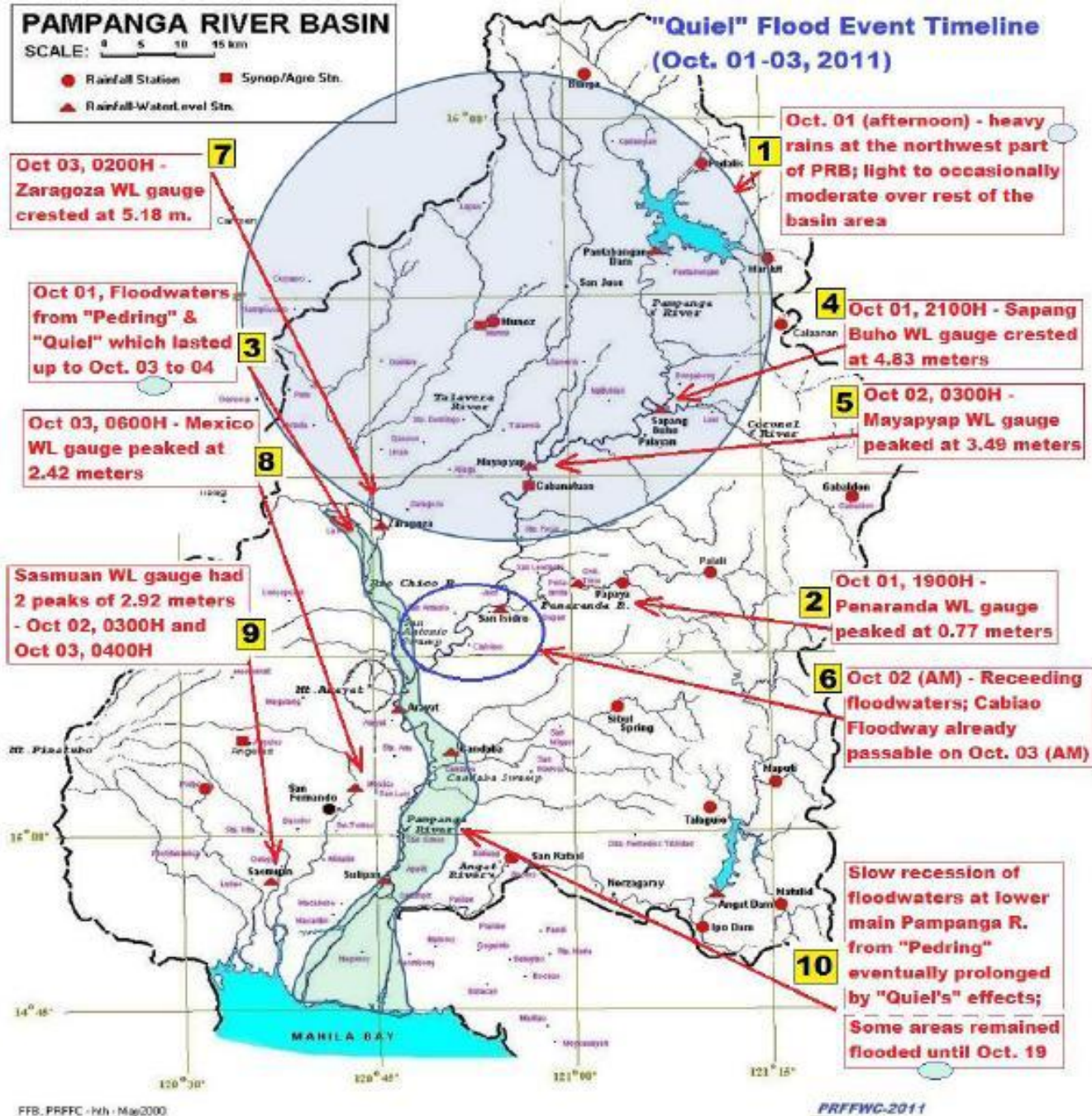
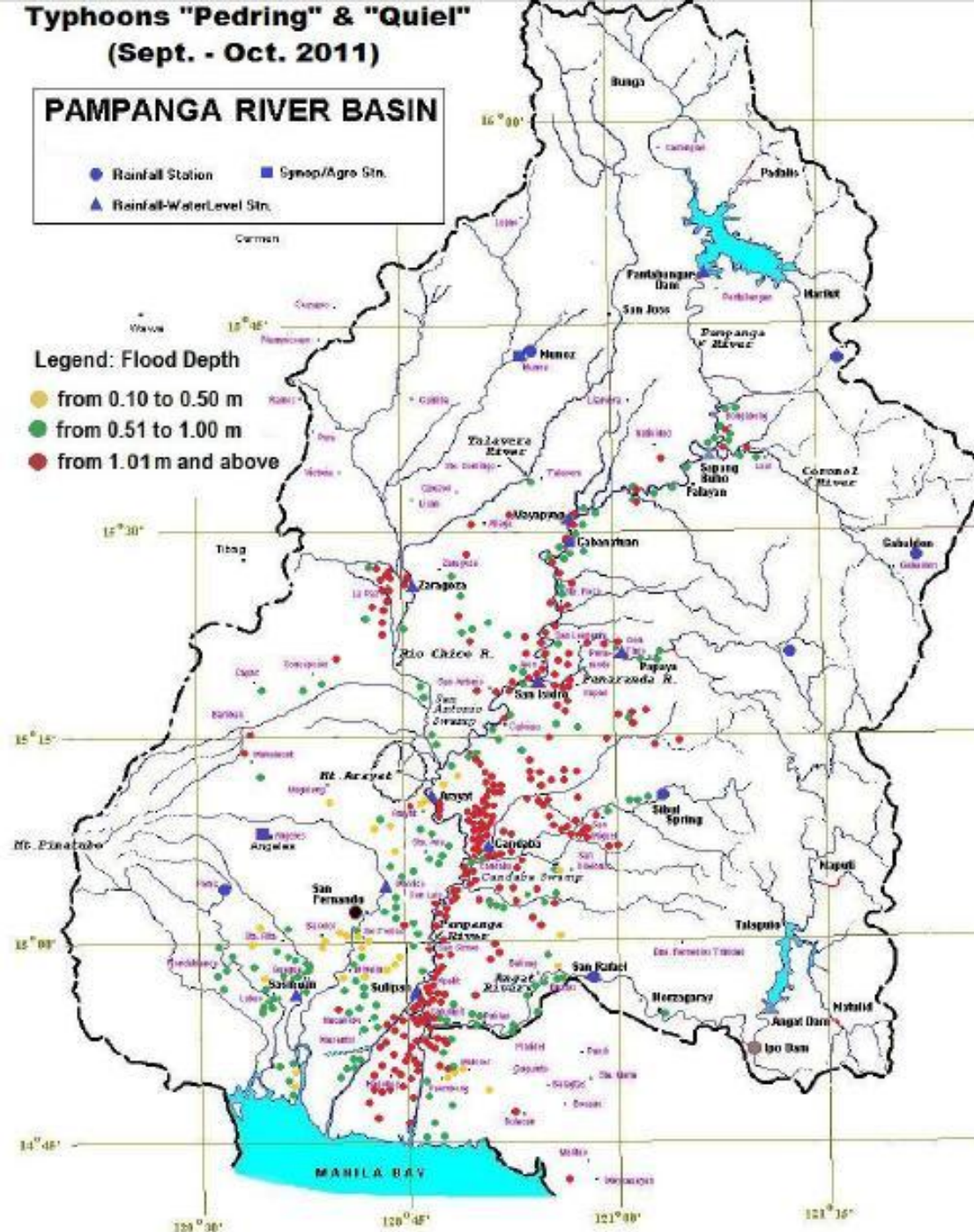Figure 6.2 "Quiel" flood event timeline map from October 01 to 03, 2011.

PRFFWC

Typhoons "Pedring" & "Quiel"
(Sept. - Oct. 2011)

PAMPANGA RIVER BASIN

PRFFWC

NLEX (Viaduct)
September 29, 2011

on Analysis (Nov 2012)

Typhoon Pedring (Sept 2011)

Calumpit, Bulacan
September 30, 2011

ocd-3

PRFFWC

Typhoon Pedring (Sept 2011)

Typhoon Pedring (Sept 2011)

Bgy. San Jose, San Simon, Pampanga (Sept. 29, 2011)

San Simon LGU

Bgy. Sta. Cruz, San Luis, Pampanga (Sept. 2011)

San Luis LGU

Villa Luz Subd., Mabini, Cabanatuan, Nueva Ecija (1038H, 28 Sept. 2011)

PDRRMO-N.E./prffwc

Bgy. San Vicente, Jaen, N.E. (0600H, Sept. 28, 2011) MSWD, Jaen

PRFFWC

Typhoon Pedring (Sept 2011)
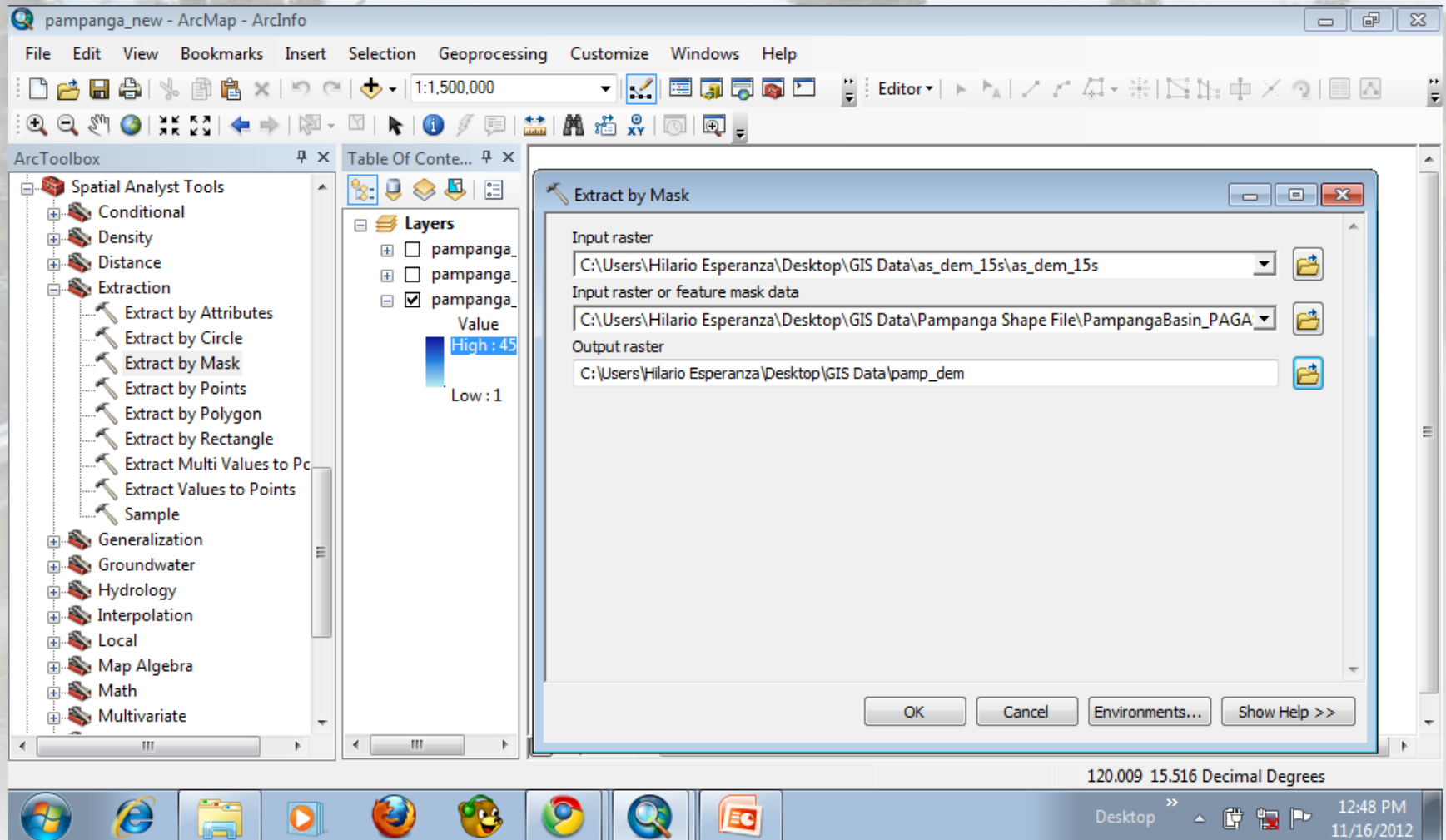

La Paz - Zaragoza Road

MEO, La paz

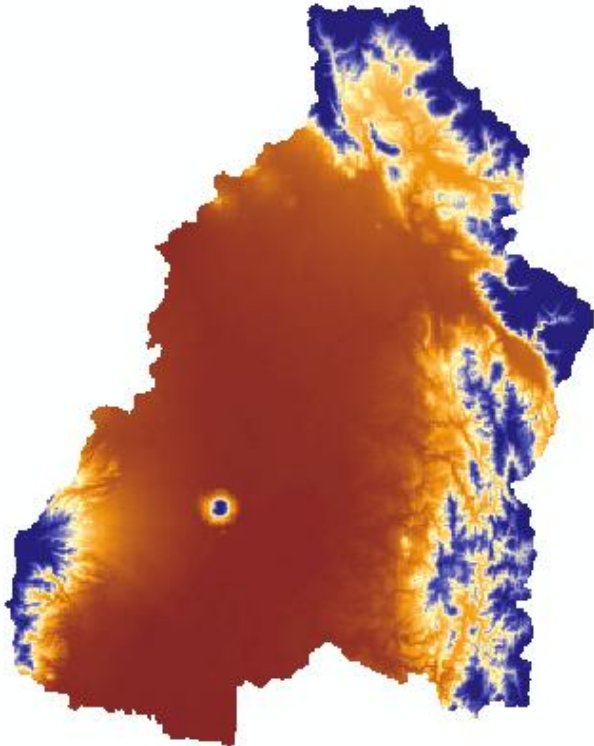# RRI calibration: PRB September 2011 flood event

ARCGIS PROGRAM:

- DOWNLOAD THE HYDROSHEDS DATA
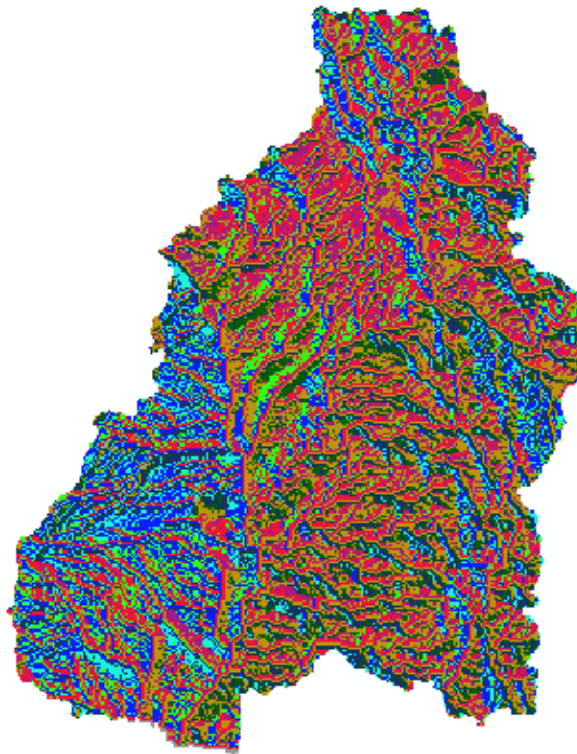
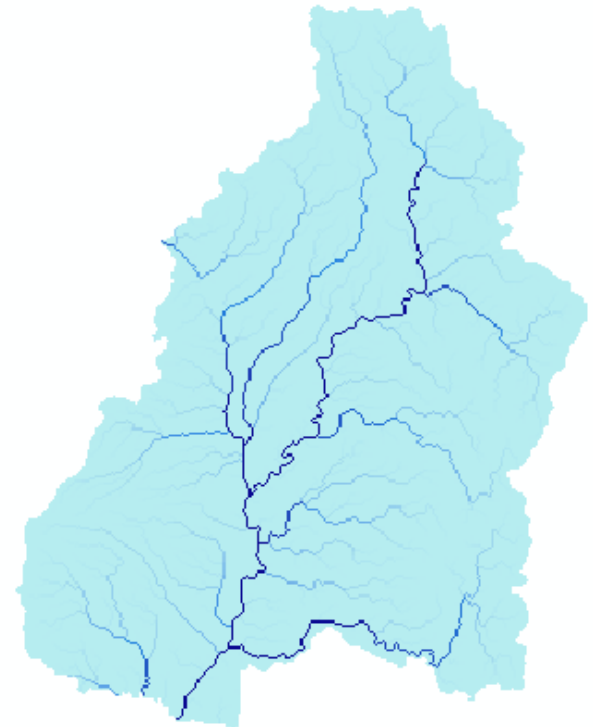- EXTRACT USING MASK TO MAKE A RASTER FILE

ARCGIS PROGRAM:
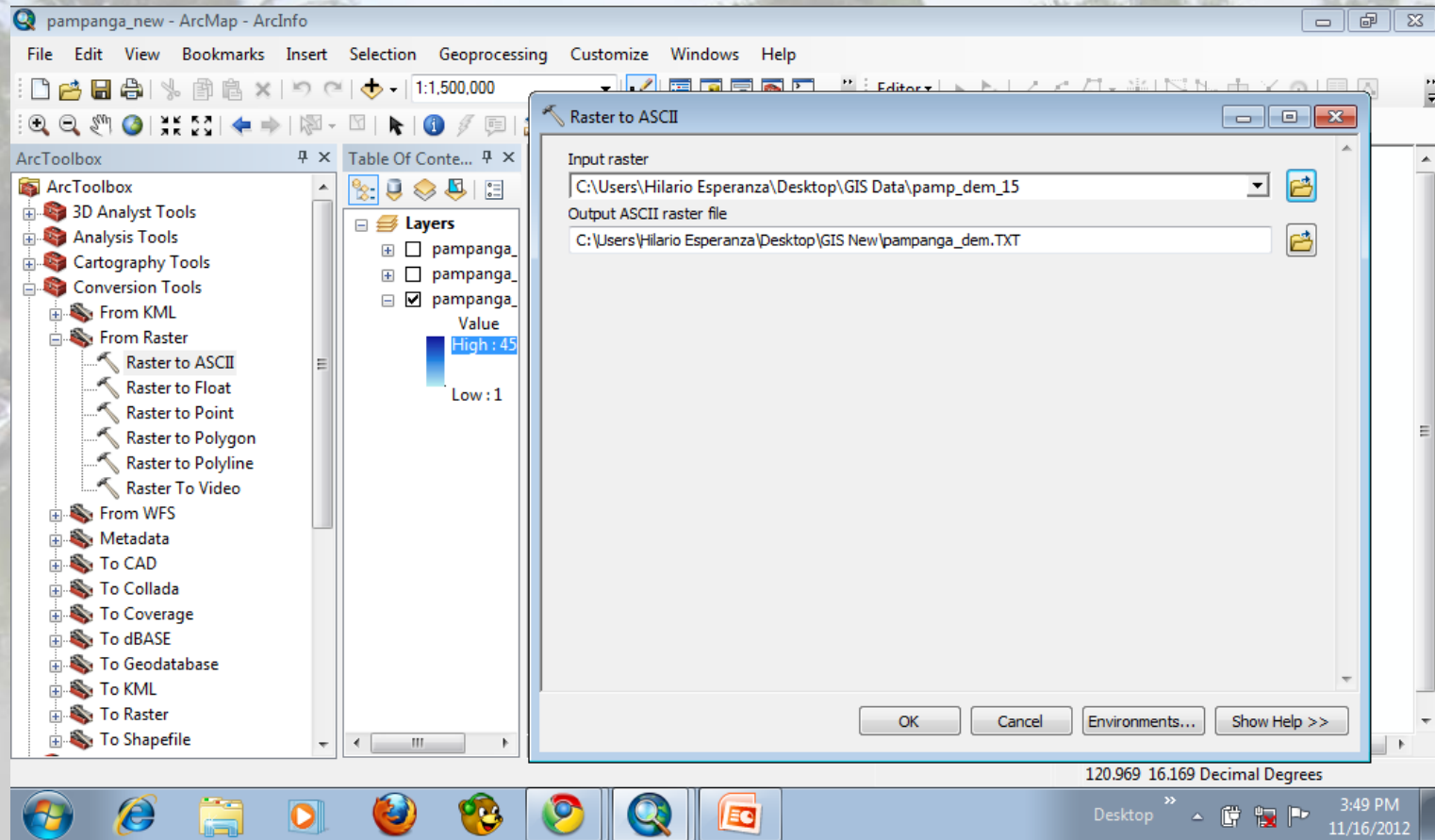
* THE RESULT RASTER FILE OF PAMPANGA
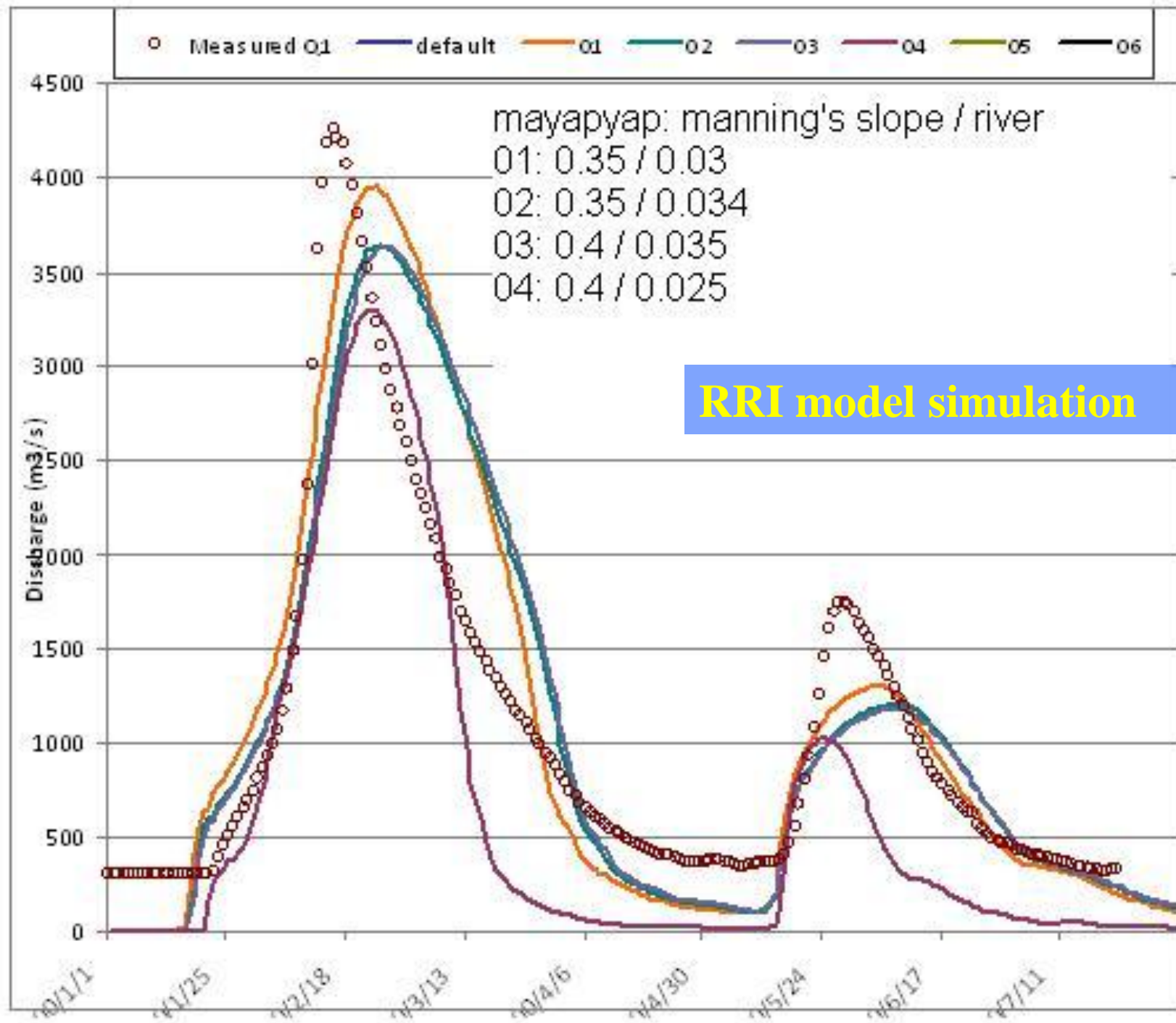

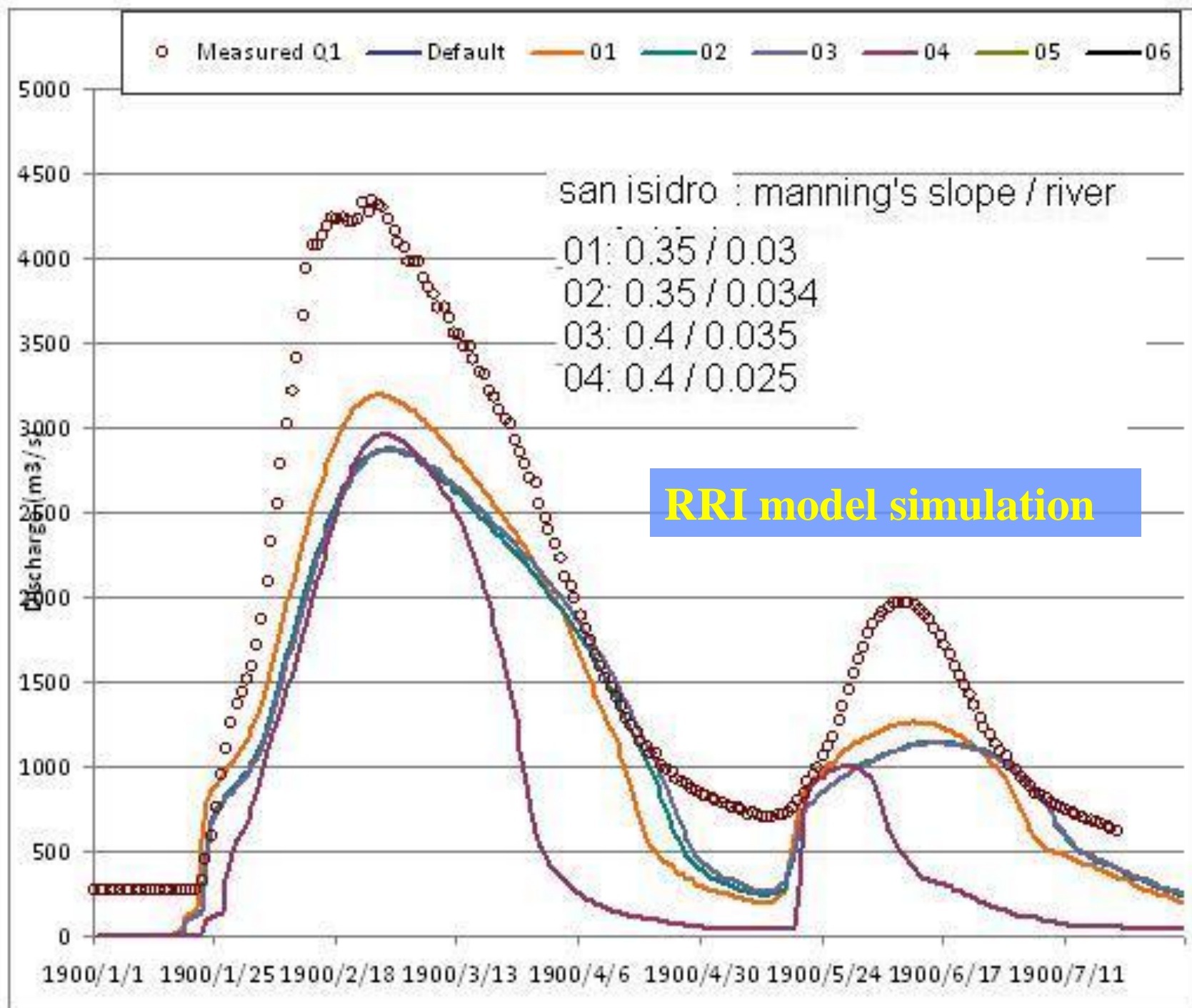PAMPANGA DEM

PAMPANGA DIR

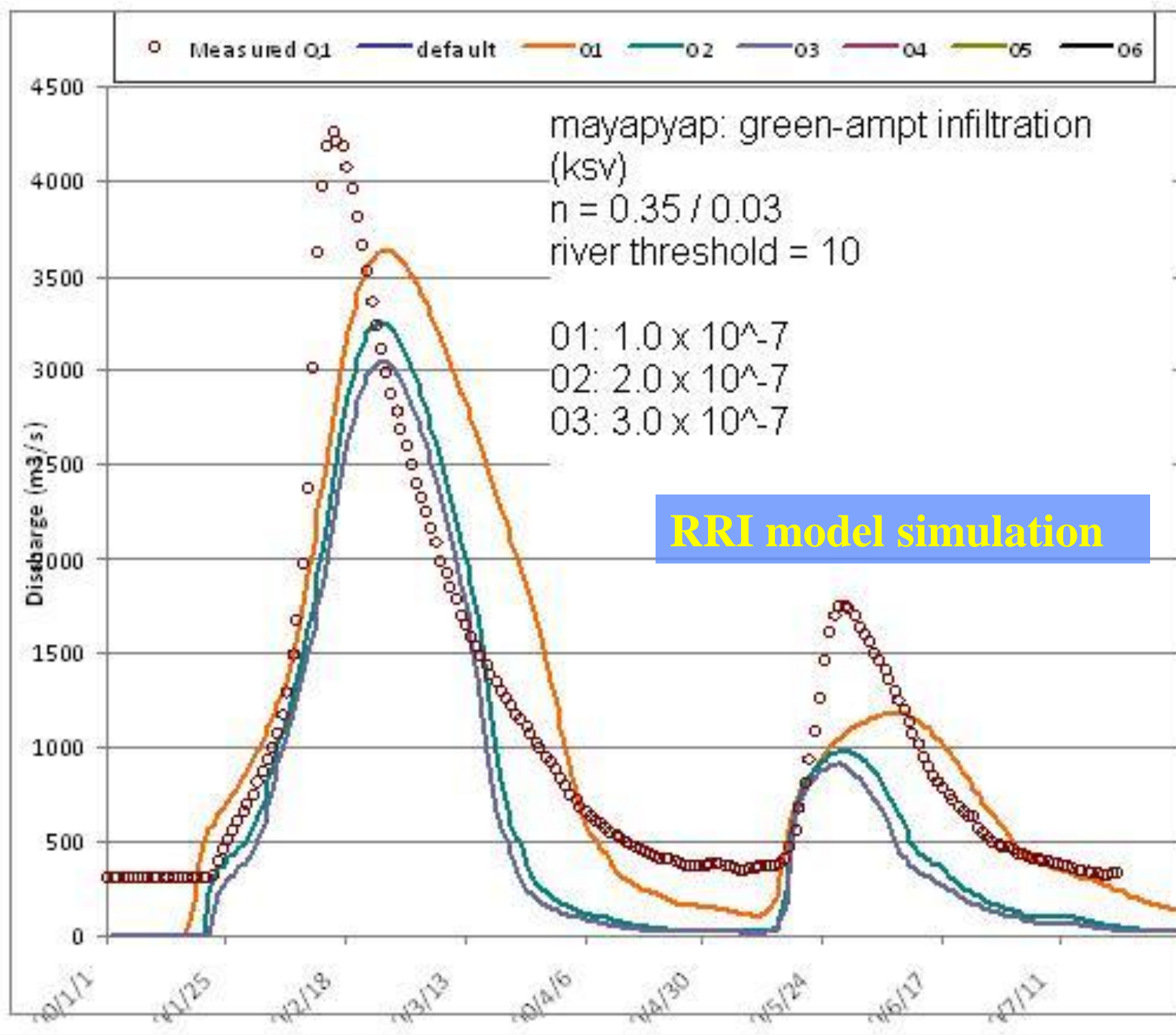PAMPANGA ACC

RASTER FILE TO ASCII FILE

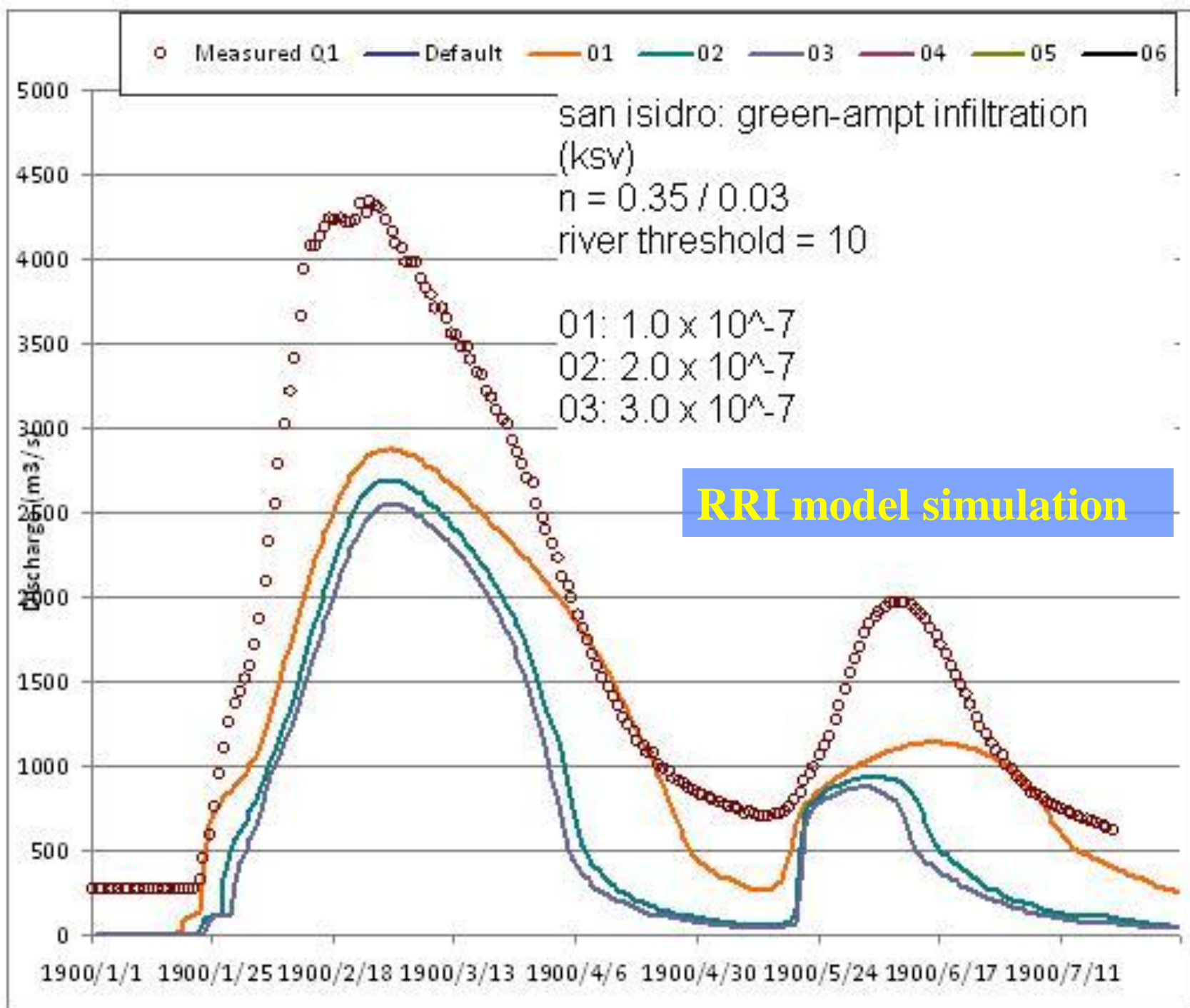- **AT THE ARCTOOL BOX USING THE CONVERSION TOOLS WE CONVERT THE RASTER FILE TO ASCII FILE**

OUTPUT FILE: PAMPANGA.TXT (DEM, ACC, DIR)
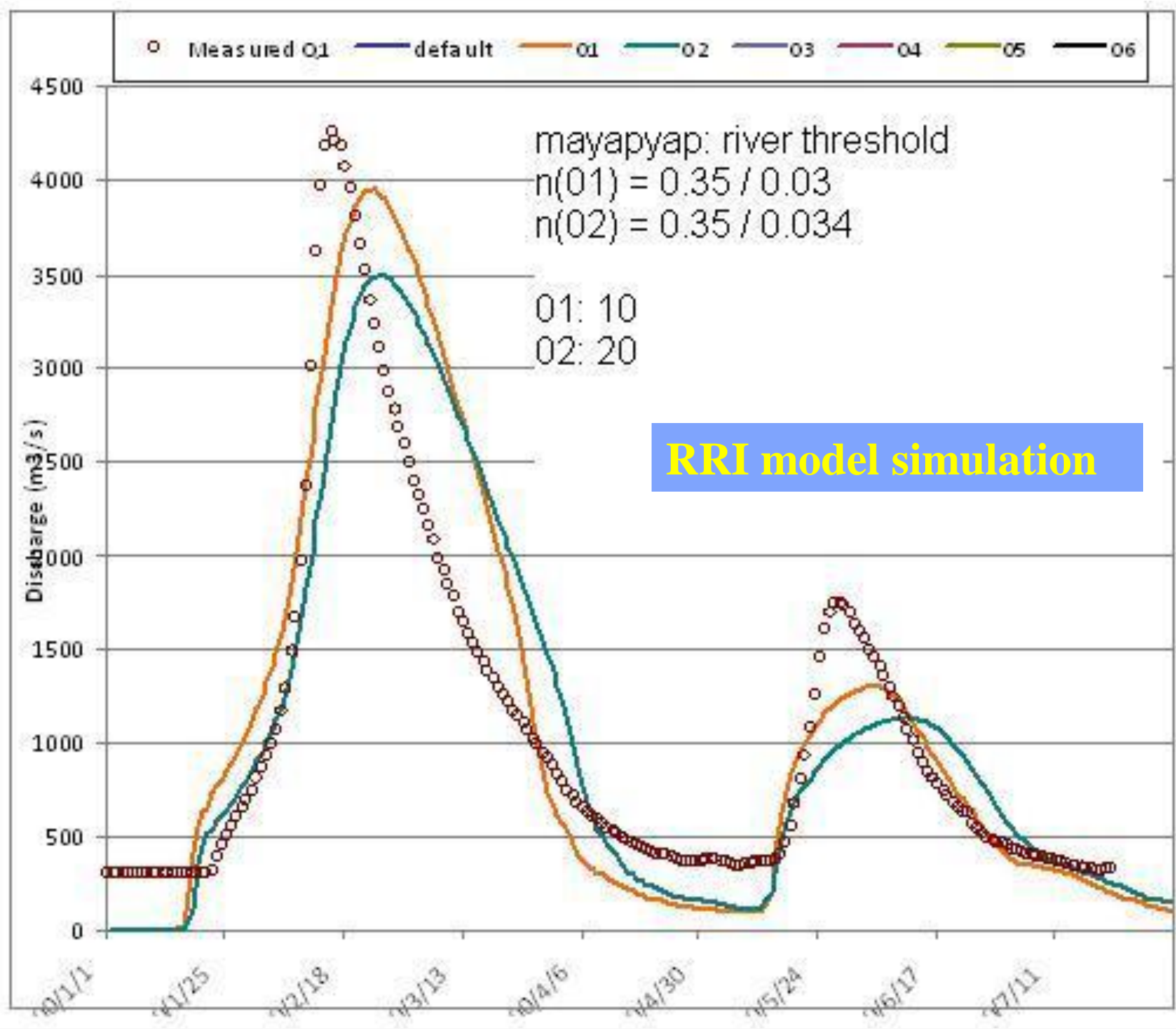
RRI model simulation

mayapyap: manning's slope / river
01: 0.35 / 0.03
02: 0.35 / 0.034
03: 0.4 / 0.035
04: 0.4 / 0.025

RFFWC

san isidro : manning's slope / river

01: 0.35 / 0.03
02: 0.35 / 0.034
03: 0.4 / 0.035
04: 0.4 / 0.025

RRI model simulation

FWC

RRI model simulation

san isidro: green-ampt infiltration (ksv)
n = 0.35 / 0.03
river threshold = 10

01: 1.0 x 10^-7
02: 2.0 x 10^-7
03: 3.0 x 10^-7

RRI model simulation

Legend: Measured Q1, Default, 01, 02, 03, 04, 05, 06

FWC

mayapyap: river threshold
n(01) = 0.35 / 0.03
n(02) = 0.35 / 0.034

01: 10
02: 20

RRI model simulation

FFWC

san isidro river threshold
n(01) = 0.35 / 0.03
n(02) = 0.35 / 0.034

01: 10
02: 20
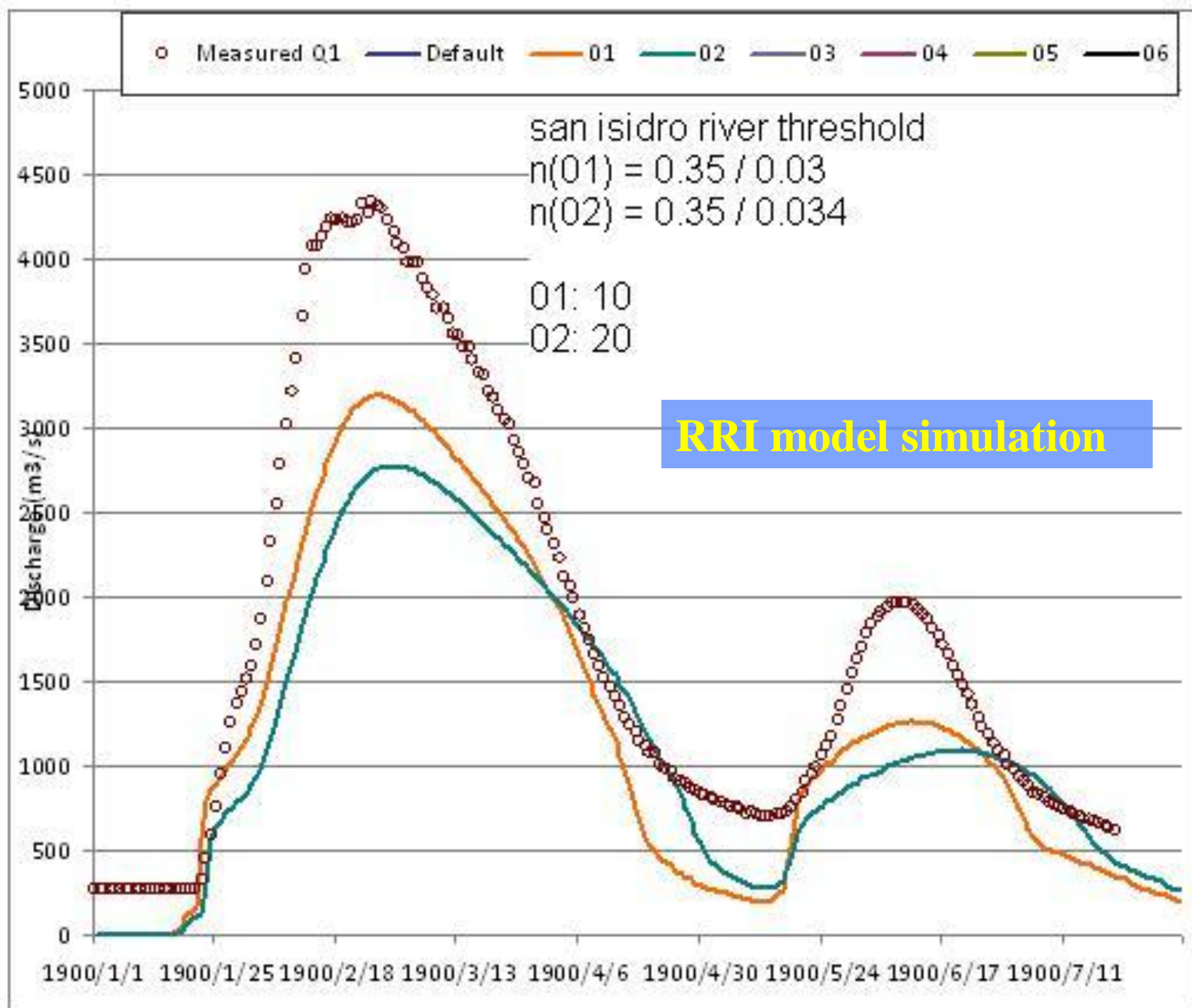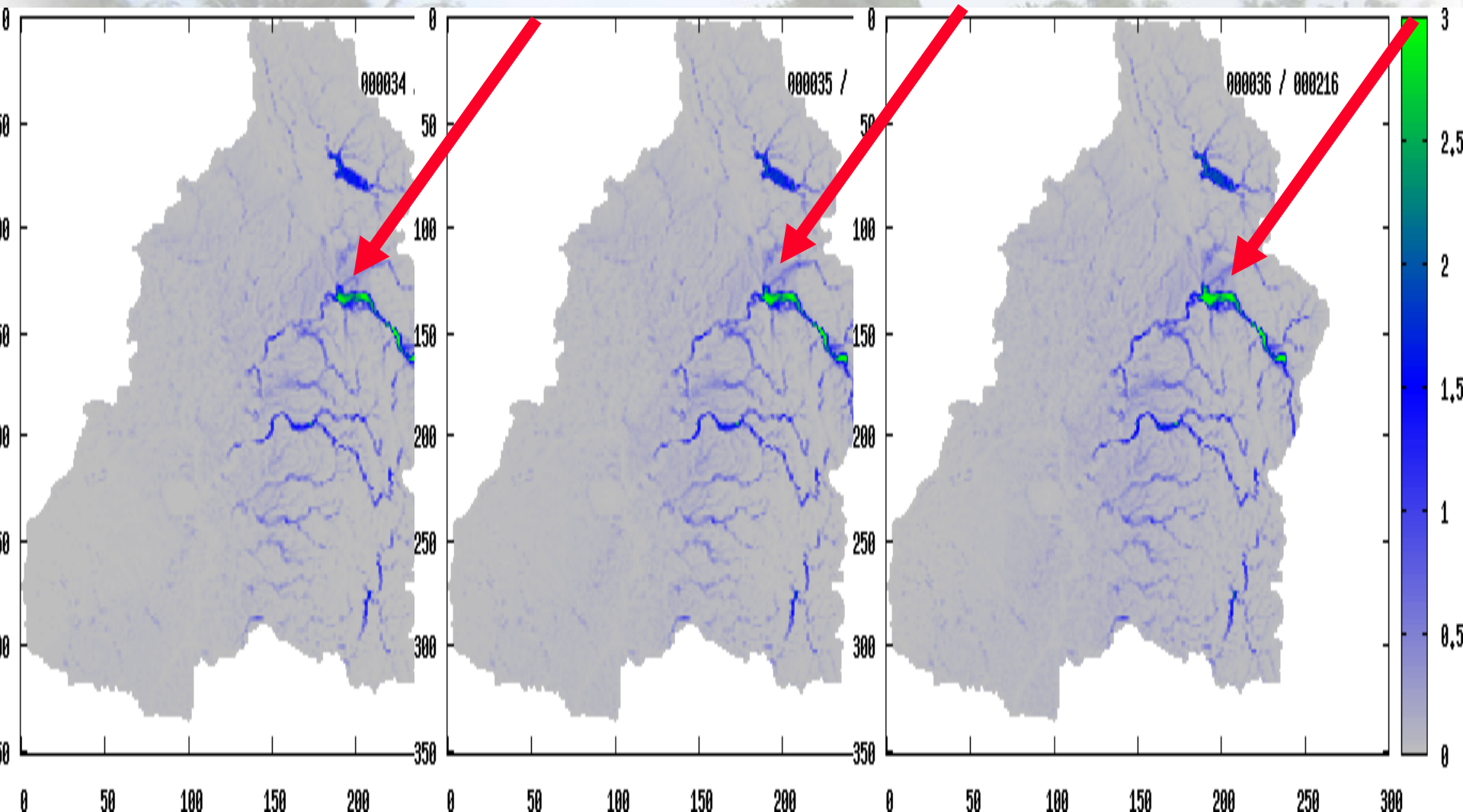
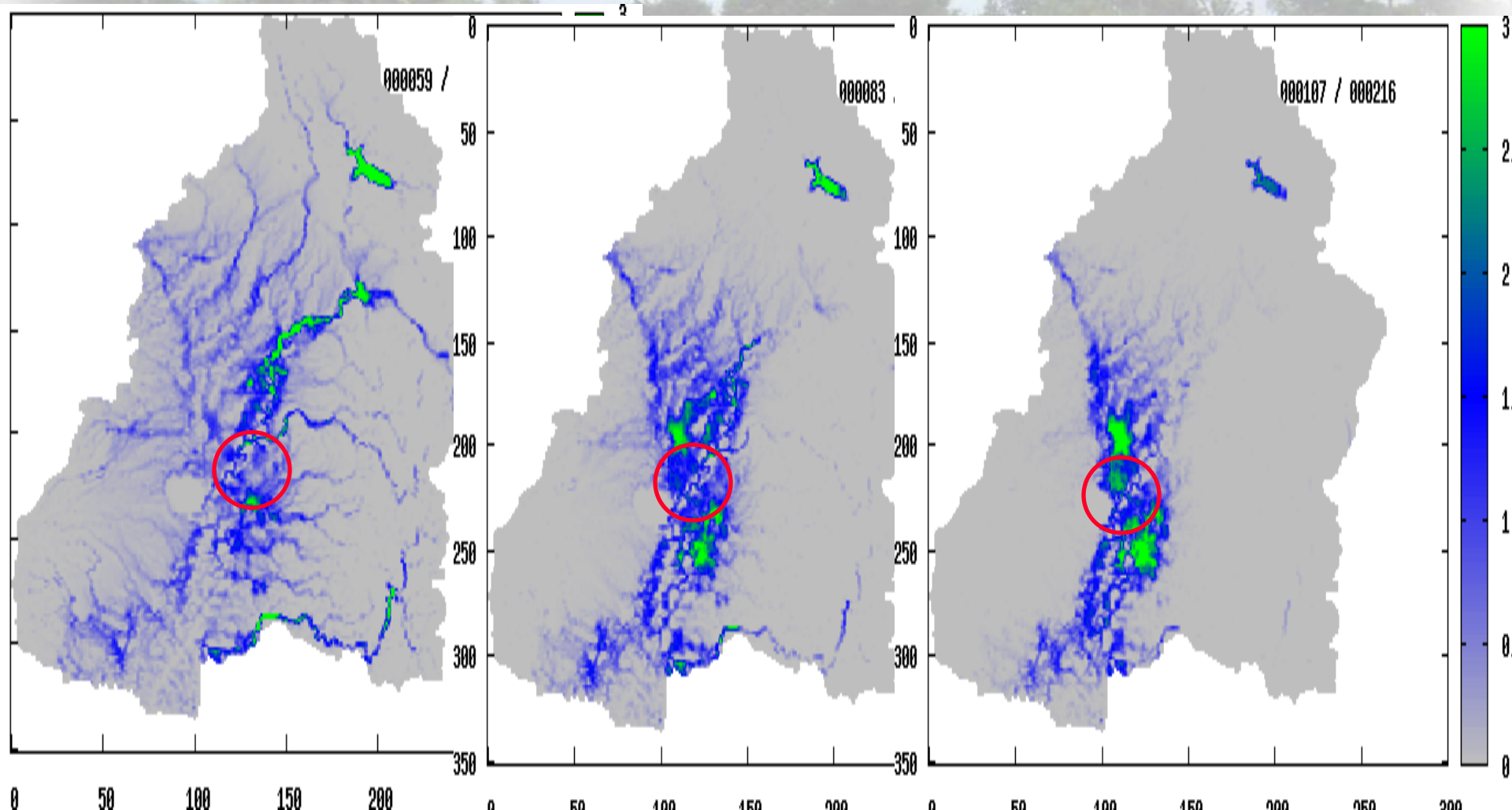**RRI model simulation**

FWC

Some comparative results

Flood started at around 0900H – 1000H, Sept. 27, 2012 at Digmala – Coronel rivers
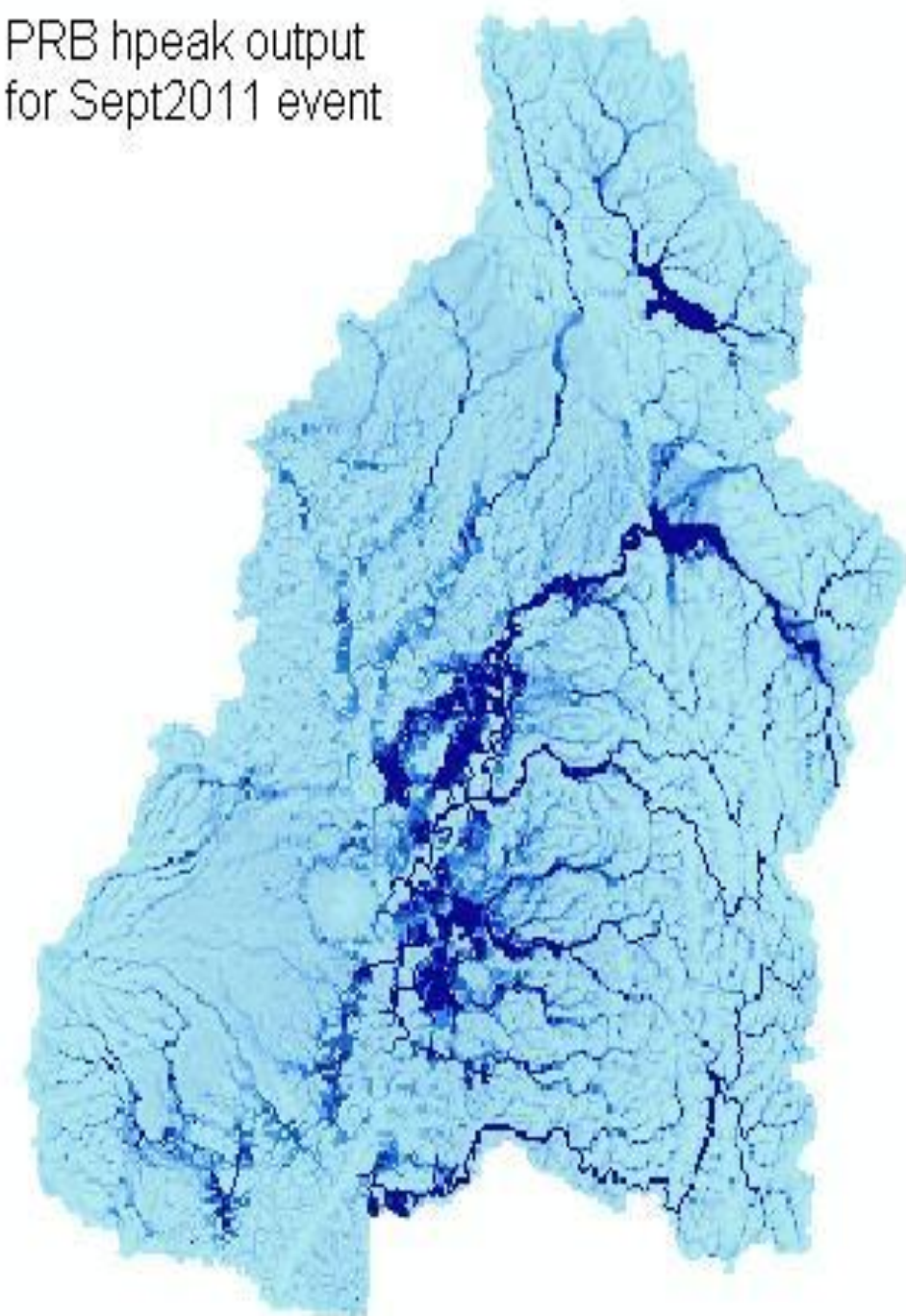
Some comparative results

Cabiao Floodway not passable starting around 11AM of 28 Sept and for the next 3 - 4 days

Cabiao flooway road at Bgy. San Vicente, Cabiao (N.E.) during Pampanga River's spill-over at the area. The said road was not passable for about 4-days during the event period.
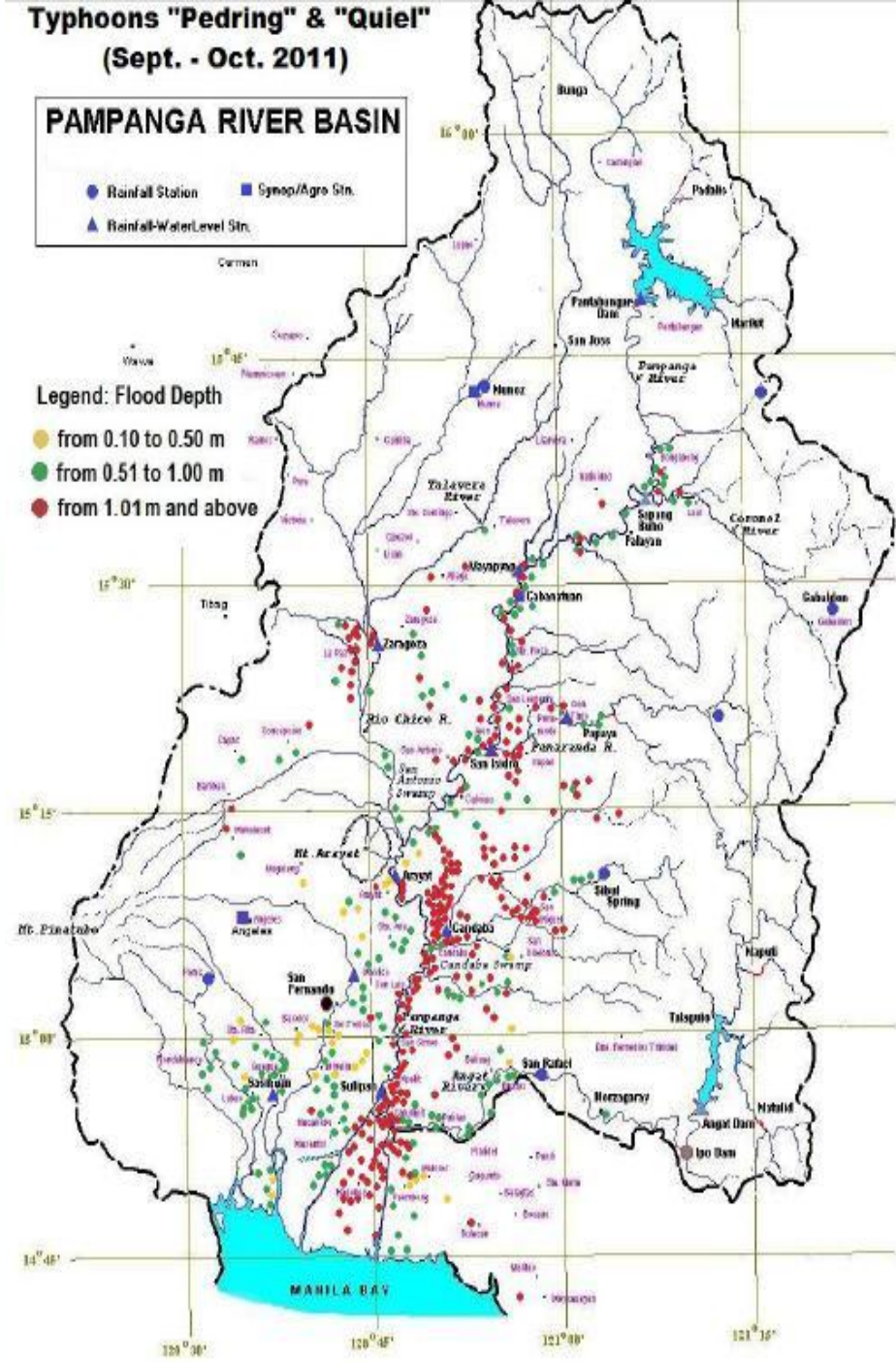
PRB hpeak output for Sept2011 event

Typhoons "Pedring" & "Quiel" (Sept. - Oct. 2011)

PAMPANGA RIVER BASIN

- Rainfall Station
- Synop/Agro Stn.
- Rainfall-WaterLevel Stn.

Legend: Flood Depth
- from 0.10 to 0.50 m
- from 0.51 to 1.00 m
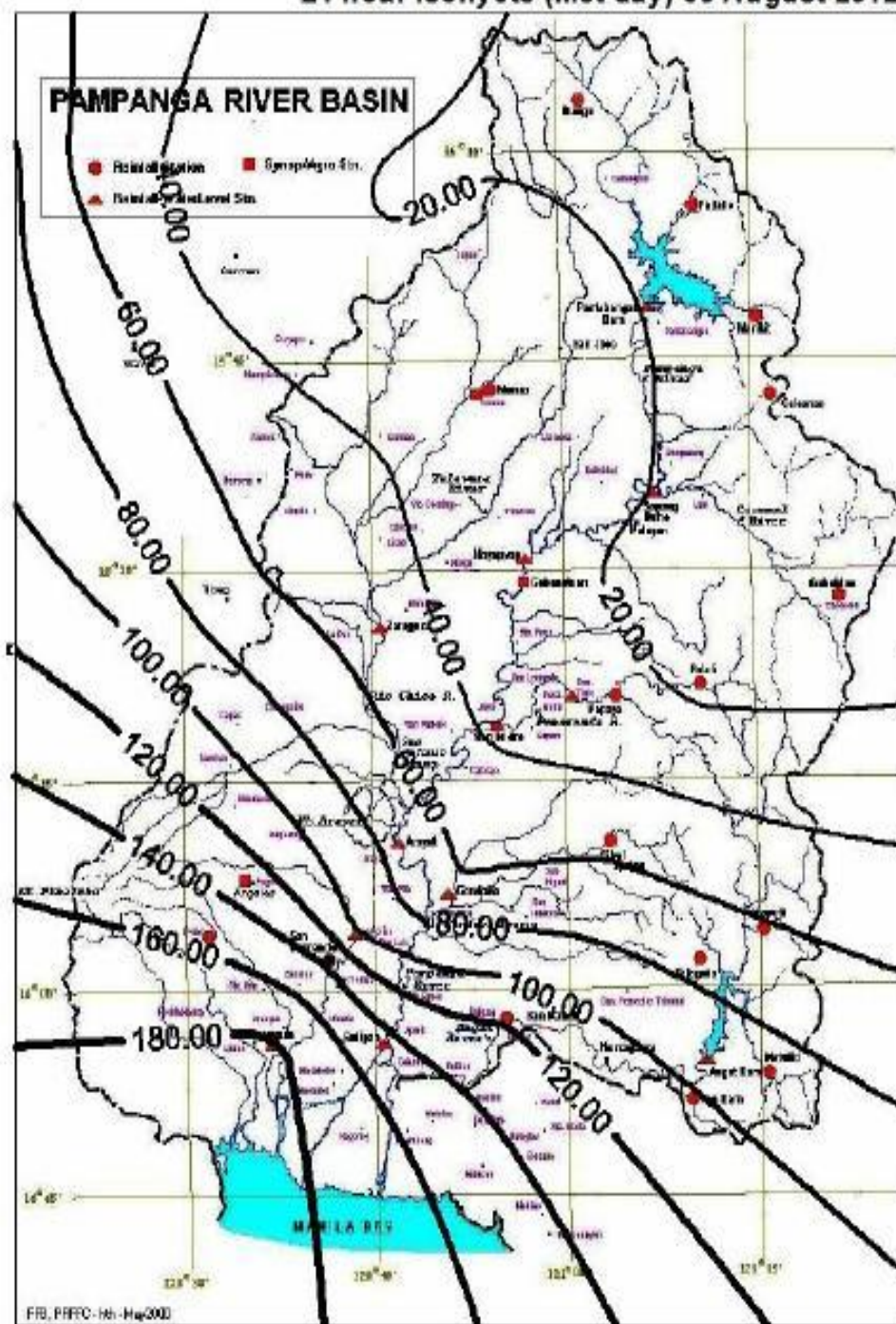- from 1.01 m and above

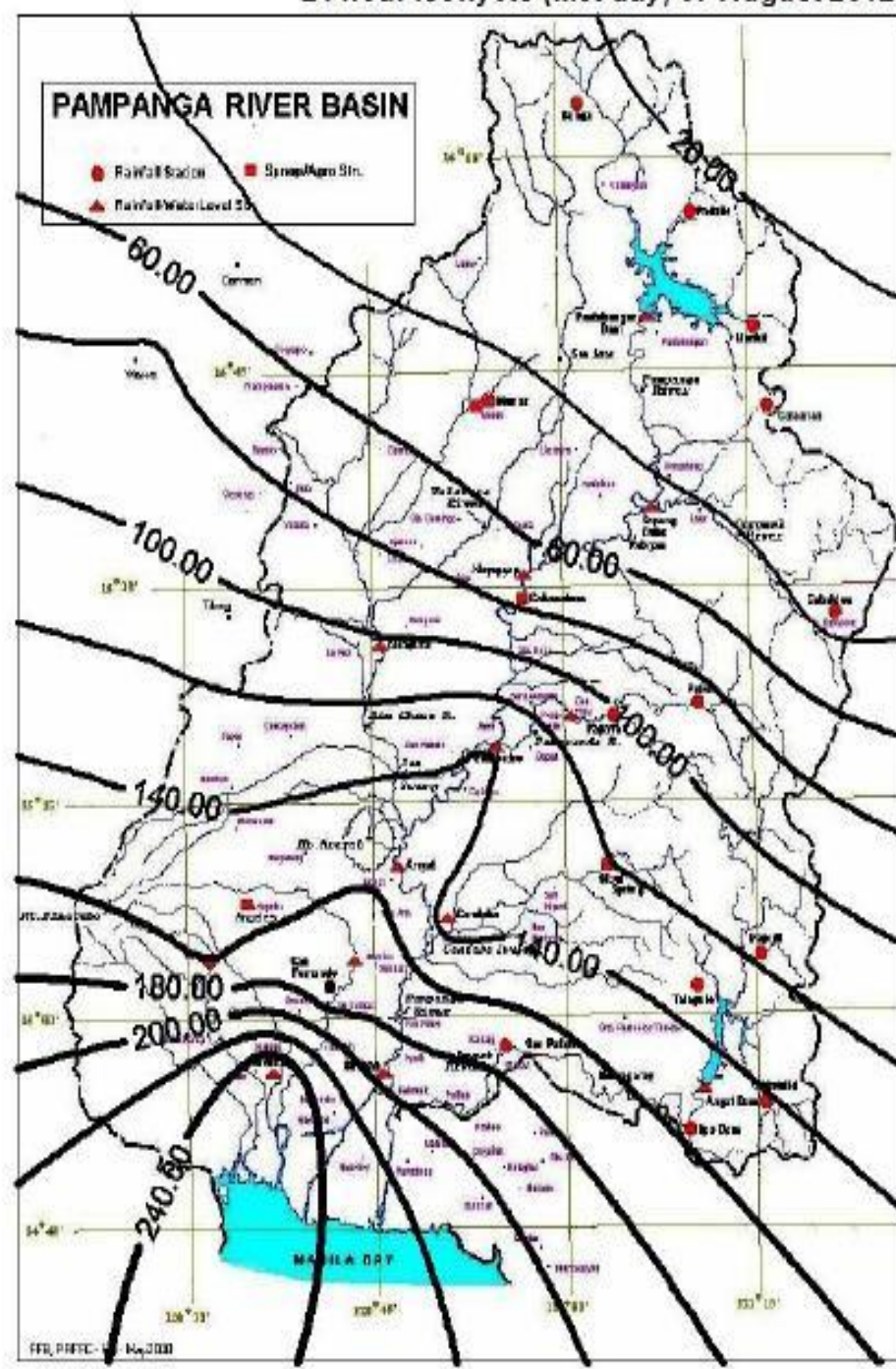# Event: Southwest Monsoon – August 2012

Figure 1.0 Satellite Images (above) showing the monsoons rains affecting the western parts of Luzon,
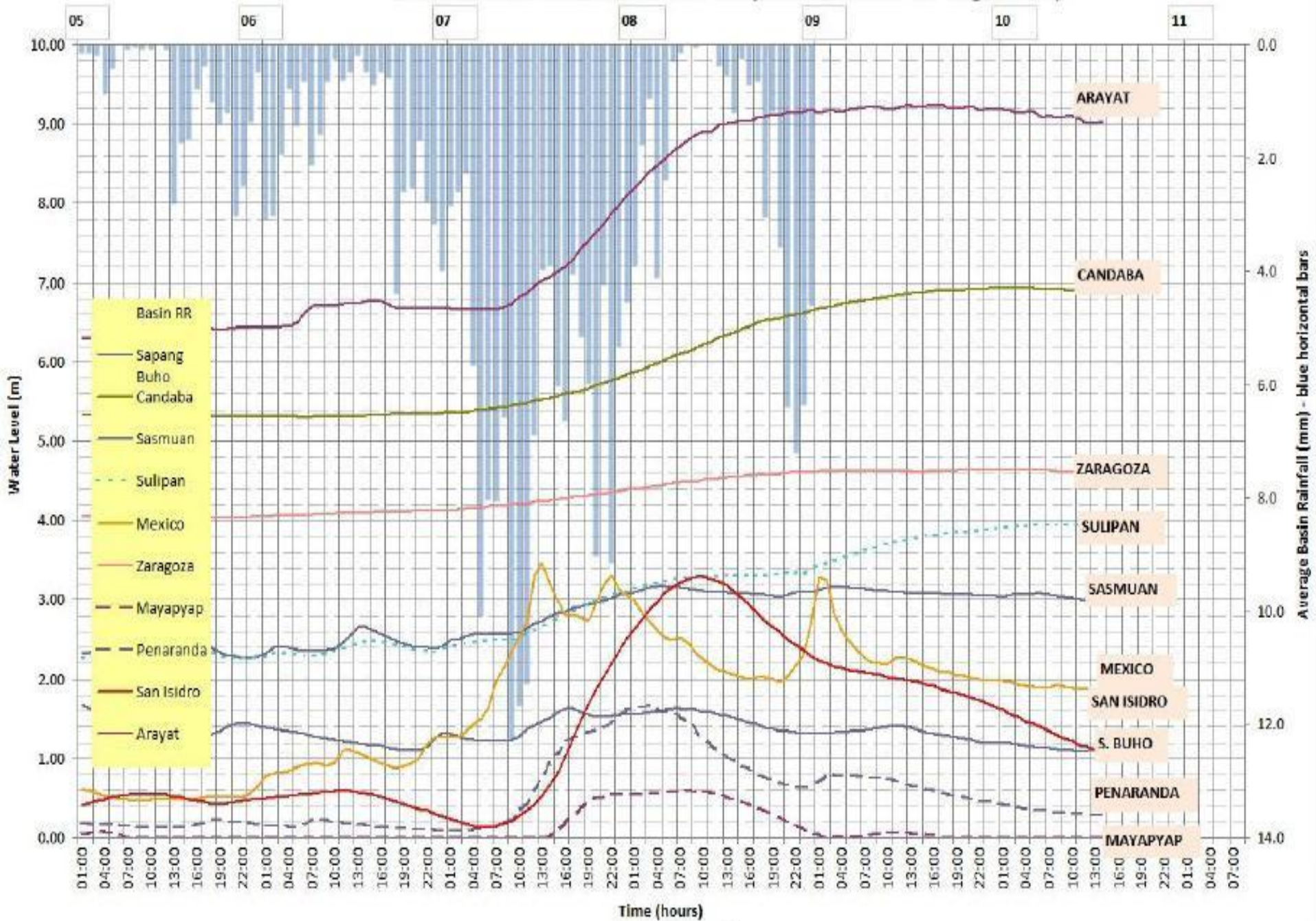
24 hour isohyets (Met day) 06 August 2012
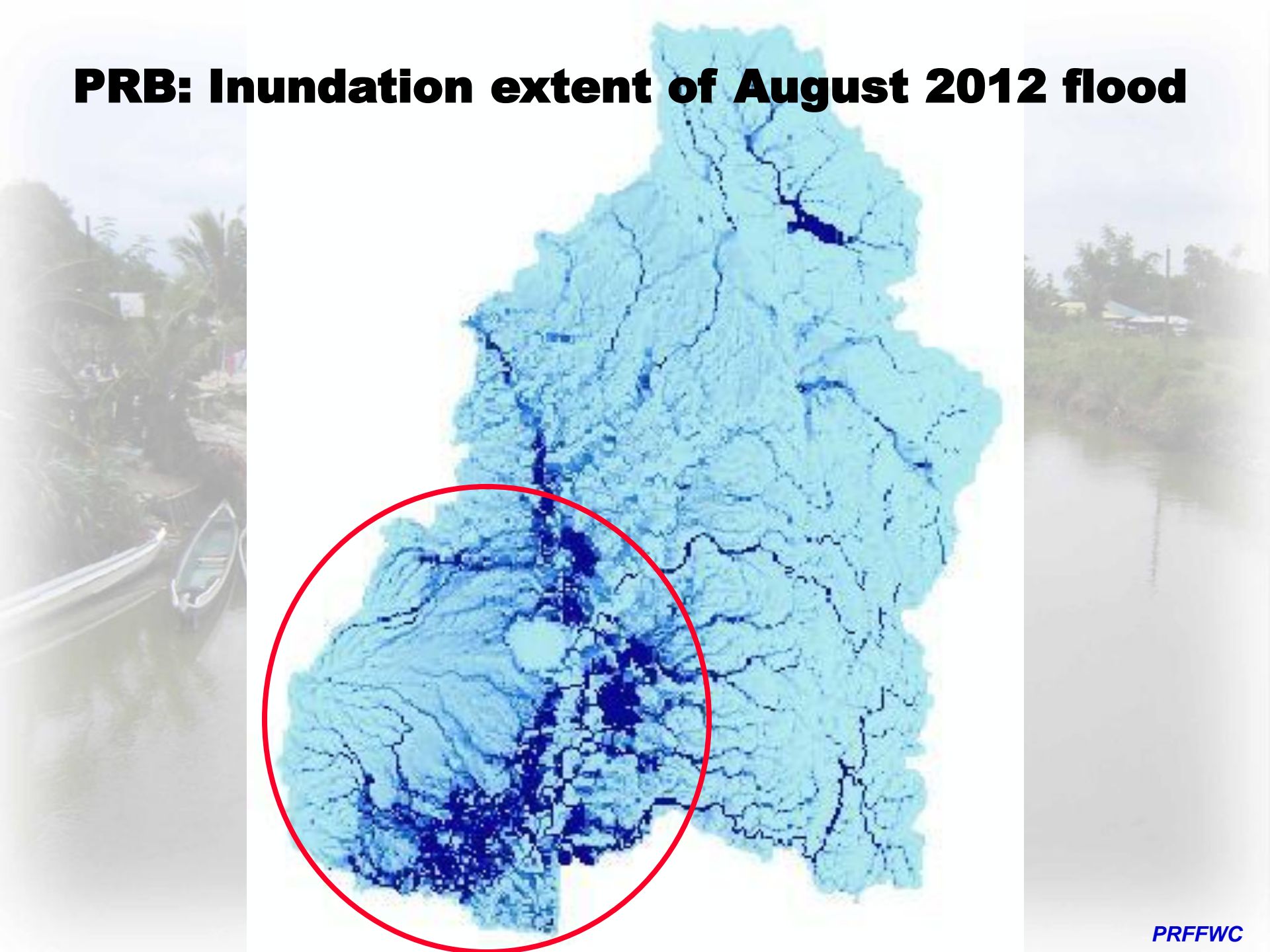
24 hour isohyets (Met day) 07 August 2012

WATER LEVELS & BASIN RAINFALL for PRB (Southwest Monsoon - August 2012)

RRI validation: PRB August 2012 flood event

PRB: Inundation extent of August 2012 flood

Way forward Programs:
Challenges, Priorities & Opportunities…other related activities

Way forward activities (for now)...

➢ **Technical report on the application of RRI in the PRB (Sept 2011 & Aug 2012 events)**

➢ **Echo seminar to basin personnel**

➢ **RRI basic operational application procedural suite for Philippine situation**

➢ **Application of RRI model**

  ➢ **In the PRB (future flood events) – forecasting mode**

  ➢ **Agno River Basin**

  ➢ **Other Basins in the Philippines (if possible)**

➢ **Enhancement of Parameters – grouped into similar events**

Thank you very much for your attention.