Flood Hazard Analysis by RRI Model
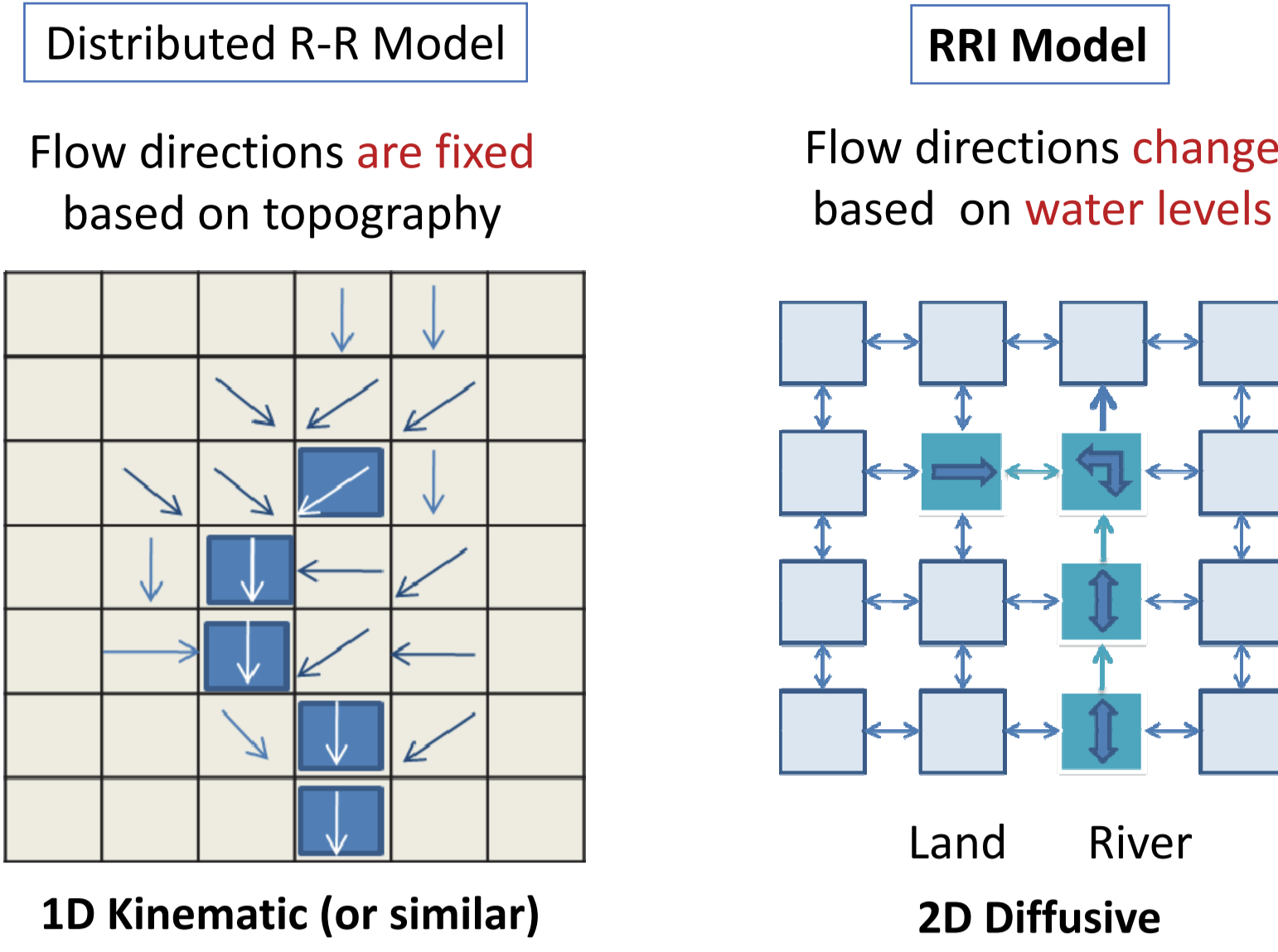
Rainfall-Runoff-Inundation (RRI) Model

Input
- Rainfall
- DEM
- Land Cover
- Cross Sec.

Subsurface + Surface Vertical Infiltration

1D Diffusion in River

2D Diffusion on Land

Output
- Discharge
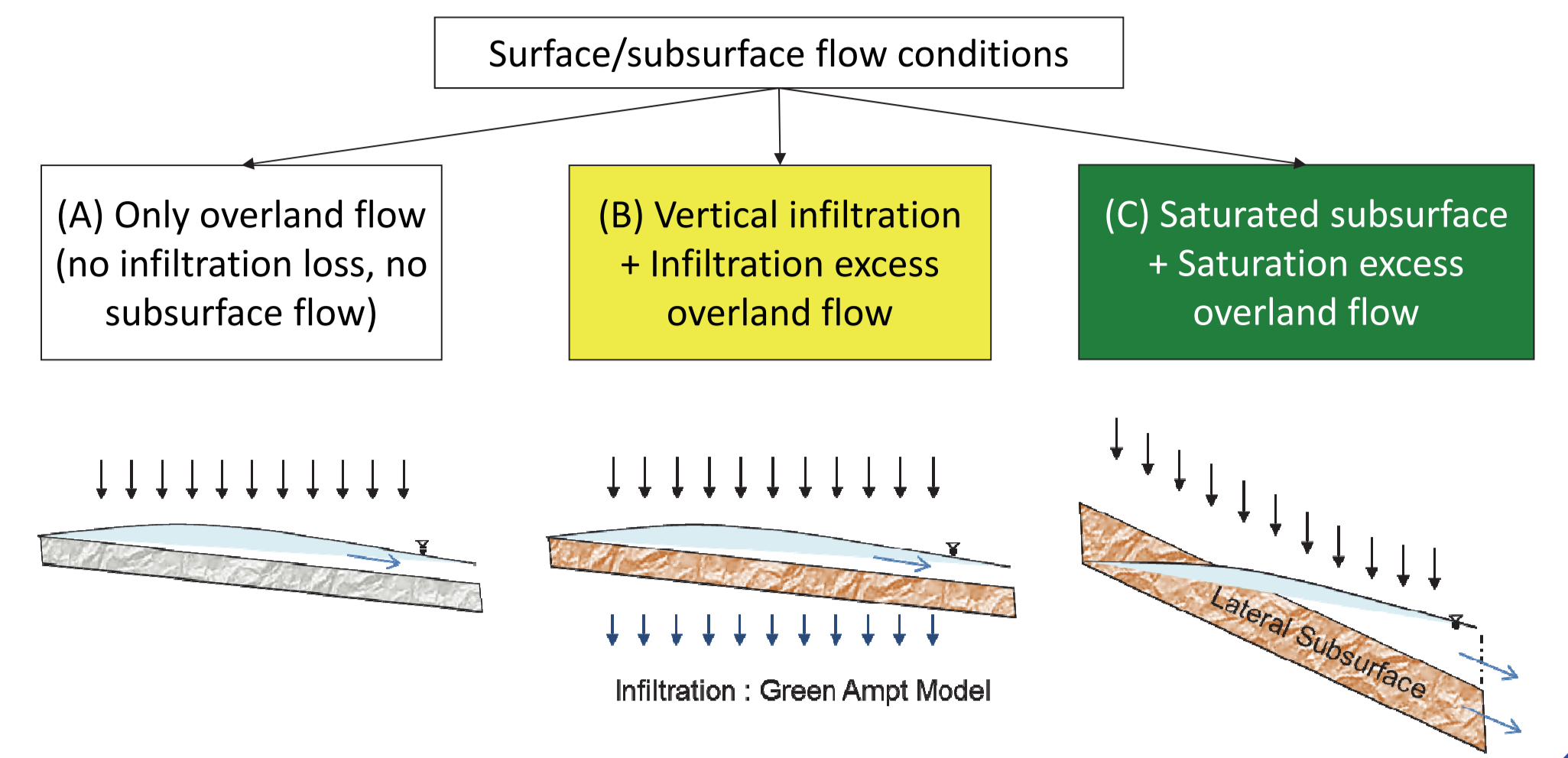- W. Level
- Inundation
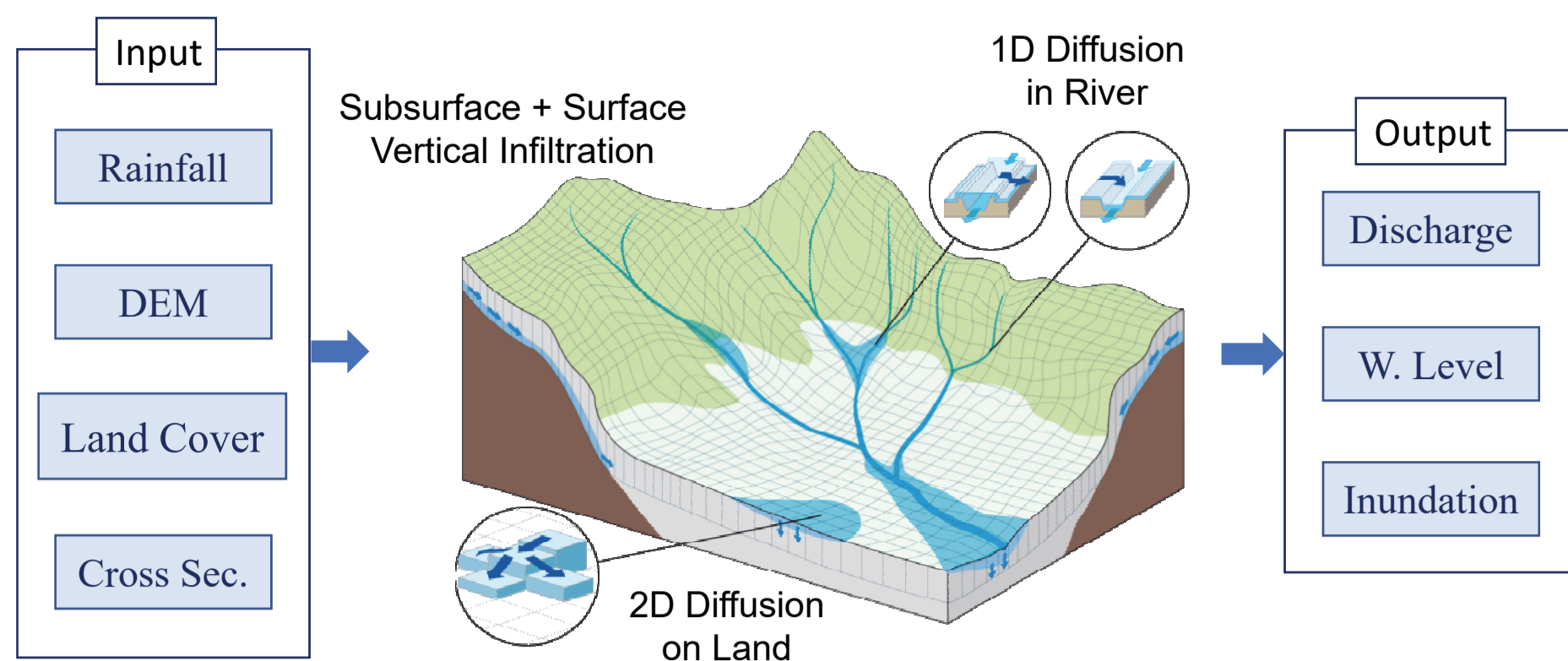
- This two-dimensional model is capable of simulating rainfall-runoff and flood inundation simultaneously.
- The model deals with slopes and river channels separately.
- At a grid cell in which a river channel is located, the model assumes that both slope and river are positioned within the same grid cell.

Sayama, T. et al.: Rainfall-Runoff-Inundation Analysis of Pakistan Flood 2010 at the Kabul River Basin, Hydrological Sciences Journal, 57(2), pp. 298-312, 2012.
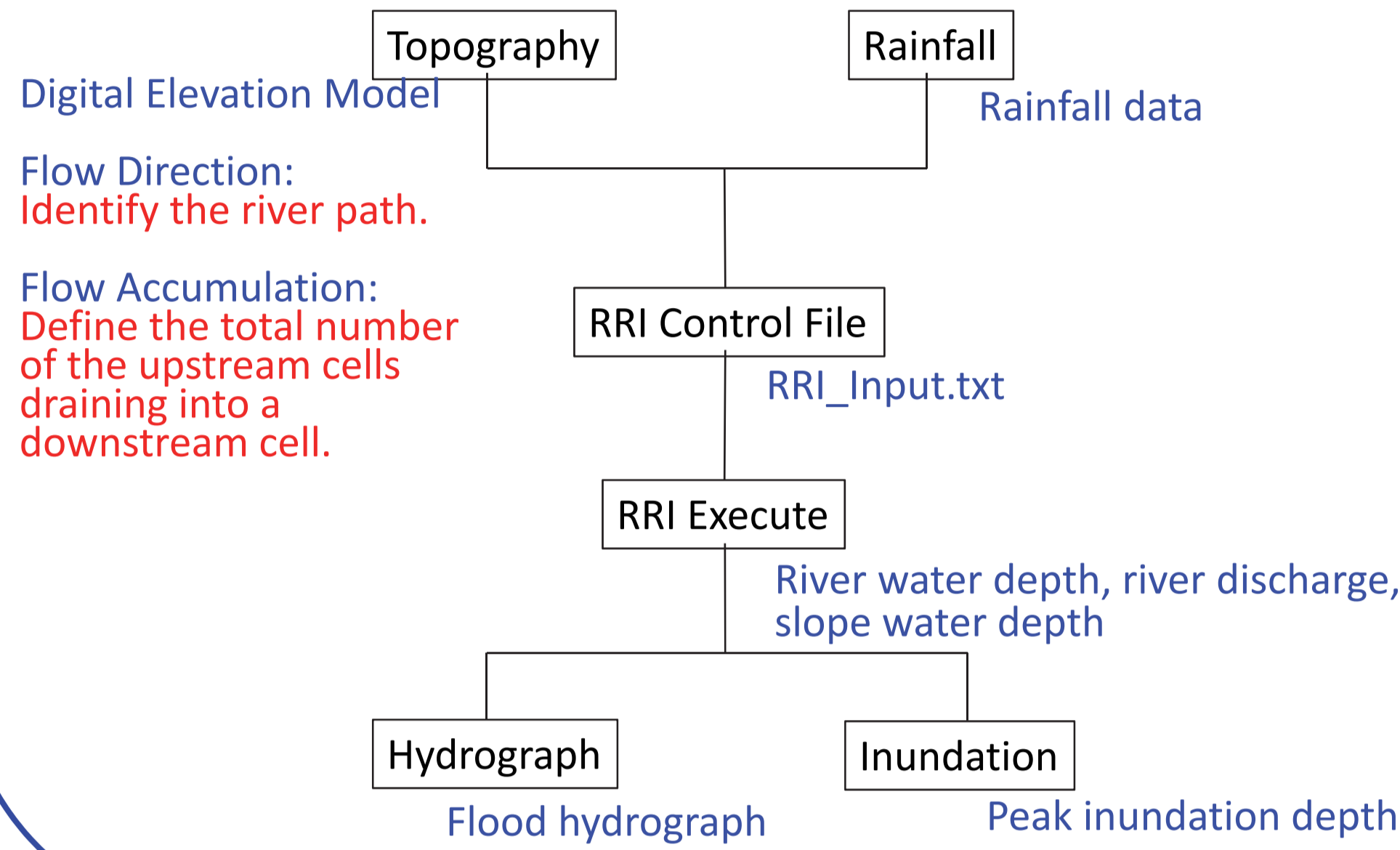
Main difference between typical distributed R-R models and RRI

Distributed R-R Model
Flow directions are fixed based on topography

1D Kinematic (or similar)

RRI Model
Flow directions change based on water levels

Land   River
2D Diffusive

Three Conditions of Surface/Subsurface Flows

Surface/subsurface flow conditions

(A) Only overland flow (no infiltration loss, no subsurface flow)

(B) Vertical infiltration + Infiltration excess overland flow

(C) Saturated subsurface + Saturation excess overland flow

Infiltration : Green Ampt Model

Lateral Subsurface

Key Steps in RRI Modeling

Topography — Digital Elevation Model

Flow Direction: Identify the river path.

Flow Accumulation: Define the total number of the upstream cells draining into a downstream cell.

Rainfall — Rainfall data

RRI Control File — RRI_Input.txt

RRI Execute — River water depth, river discharge, slope water depth

Hydrograph — Flood hydrograph

Inundation — Peak inundation depth

Case study in Pampanga River Basin, Philippines

Outline of the basin

China   Japan
Myanmar
Philippines
Indonesia
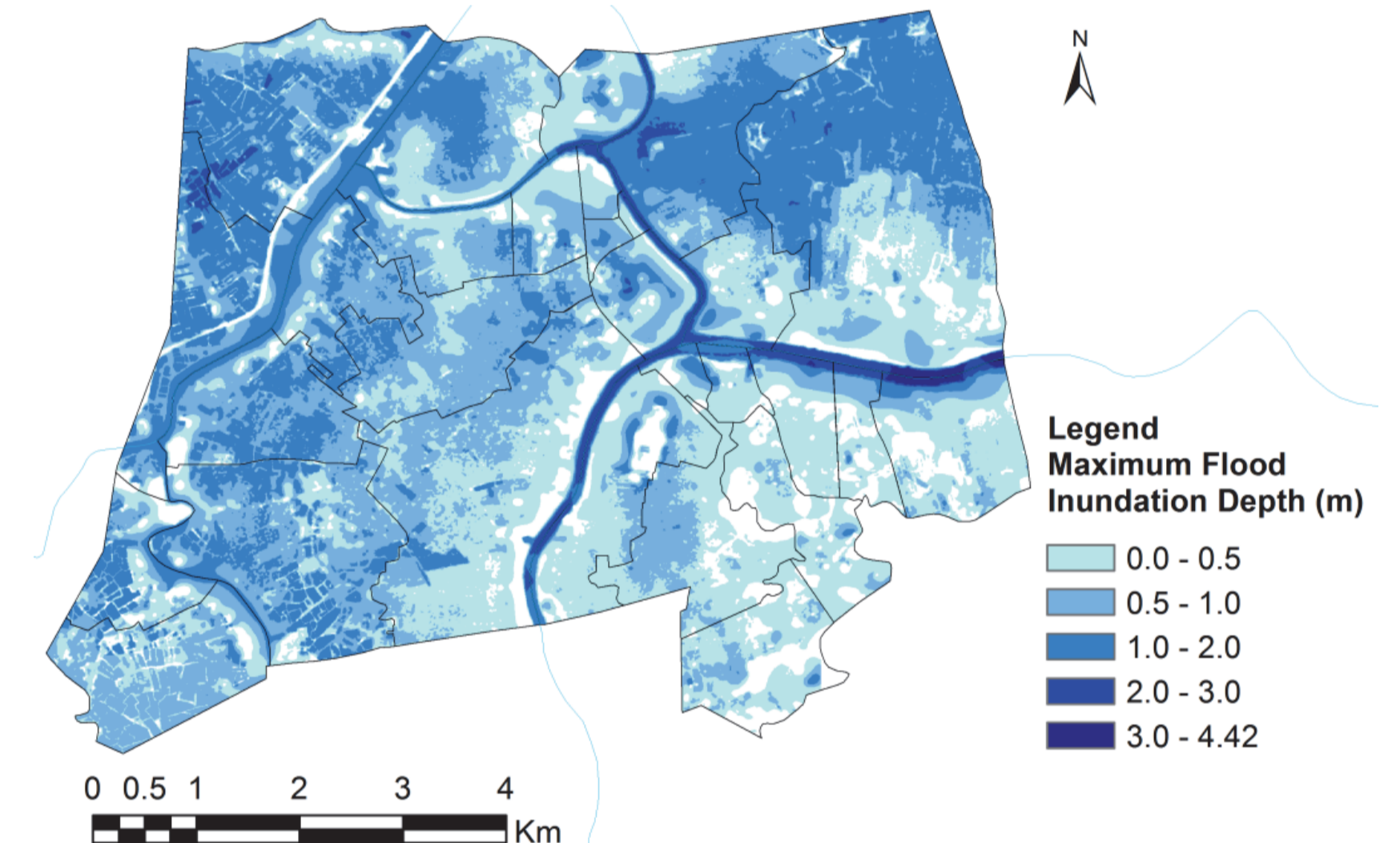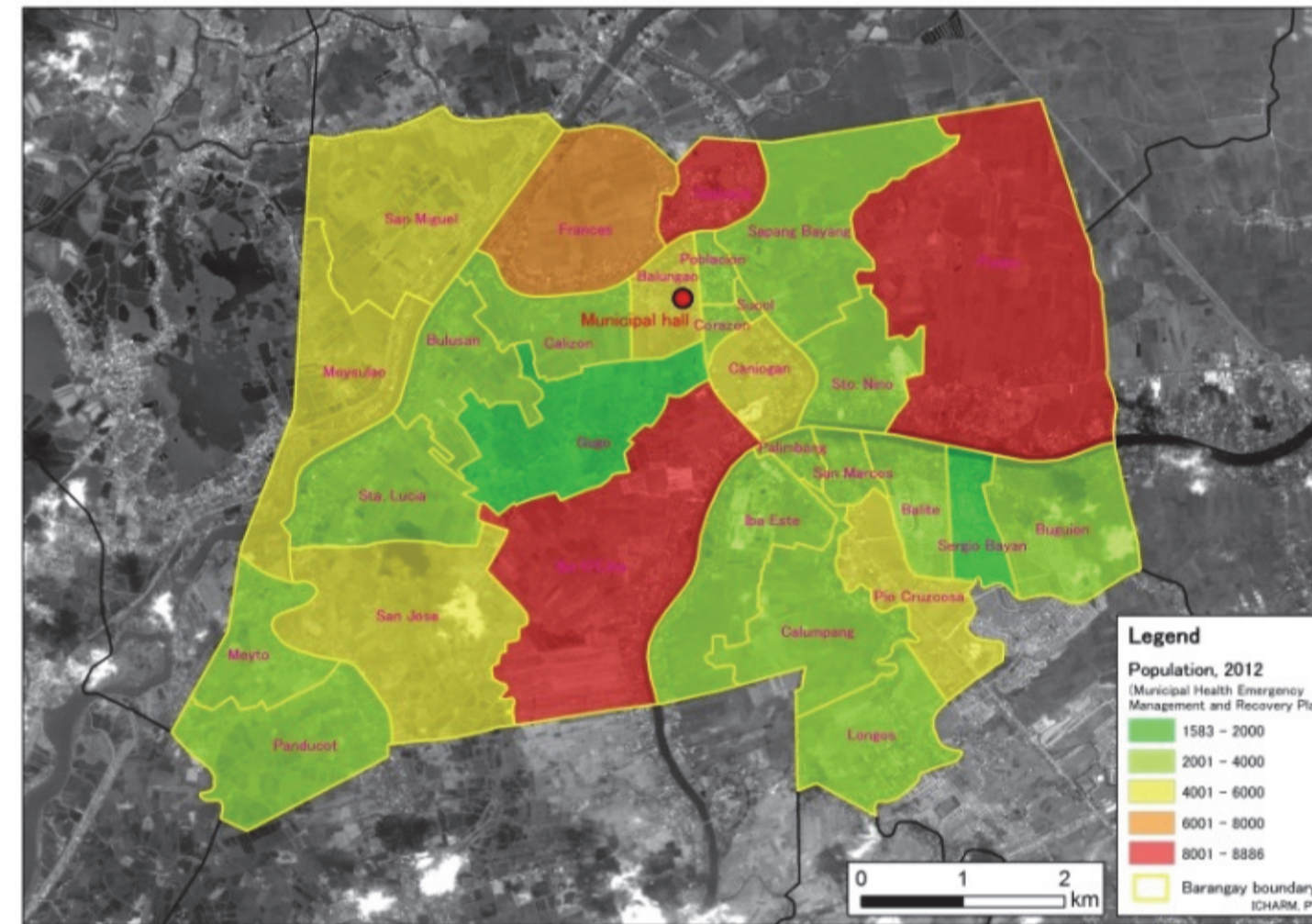
Forth largest river basin in the Philippines

Catchment Area: 10,434 km²
River Length: 260 km
Average Annual Rainfall: 2155mm/year
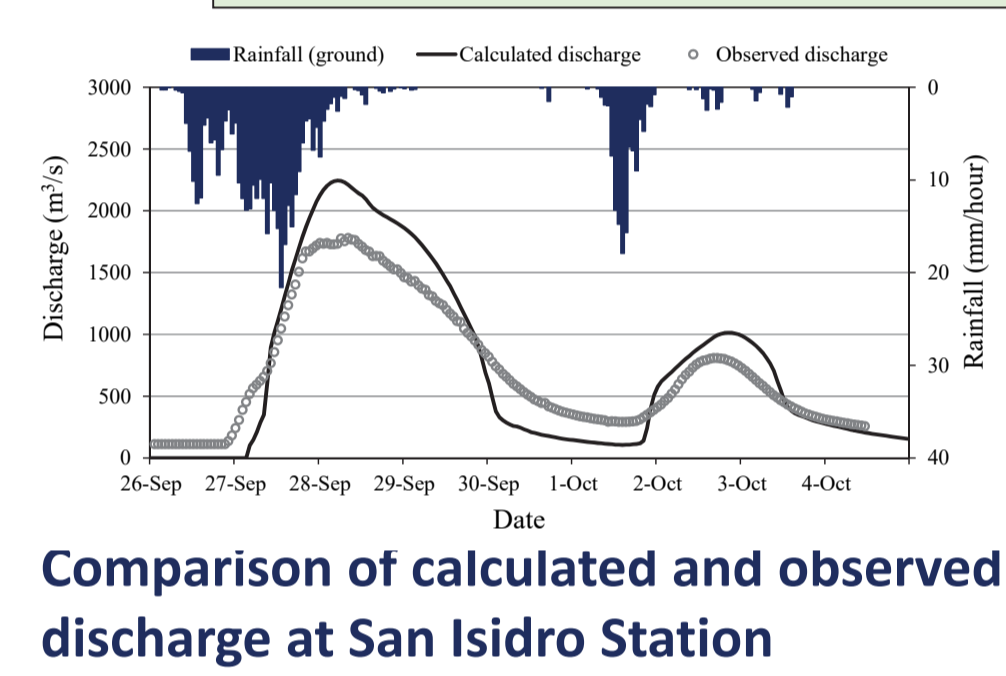Population: 5.8 million
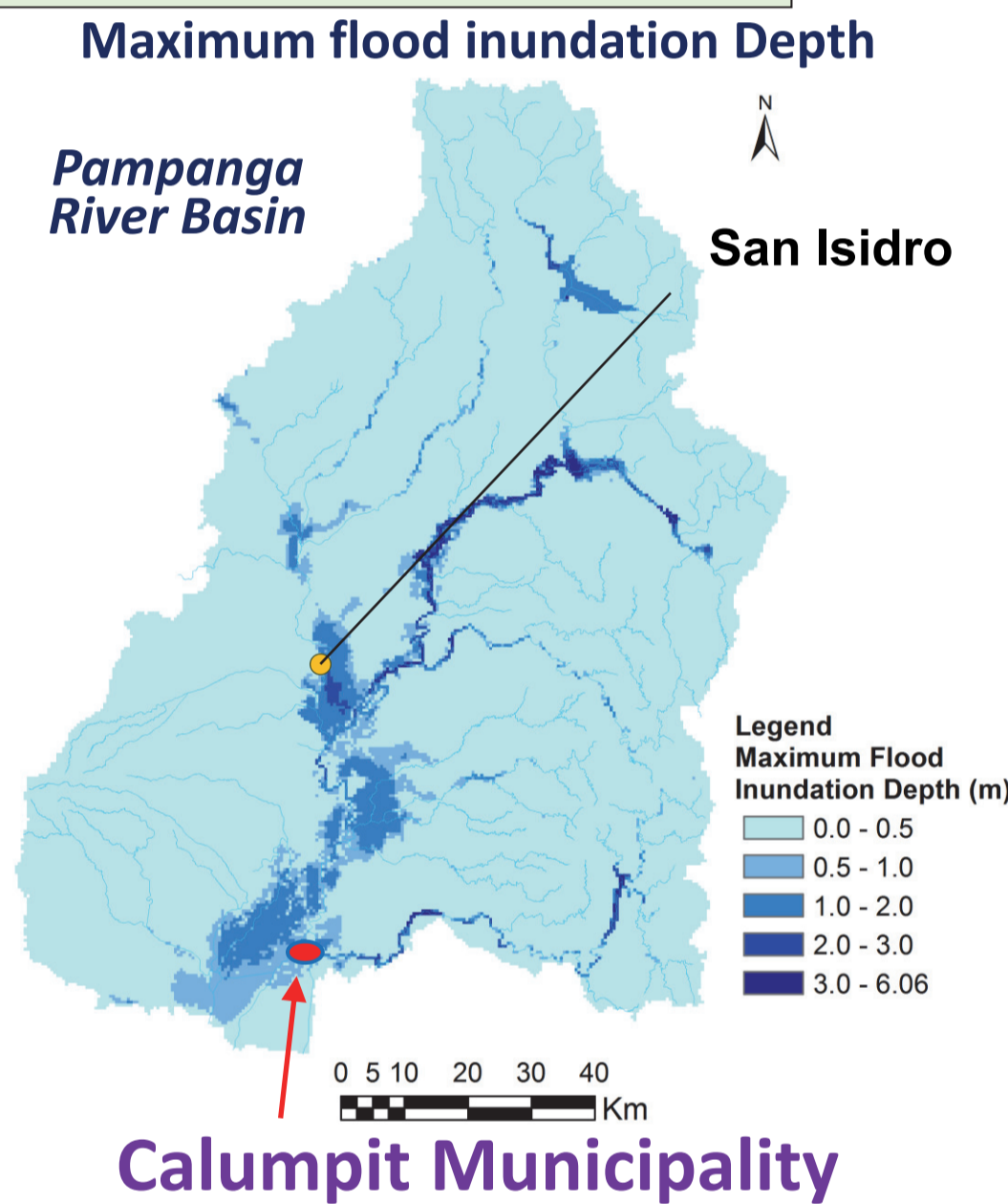Population Density: 460 persons/km²

RRI Model Simulation for 2011 September Flood

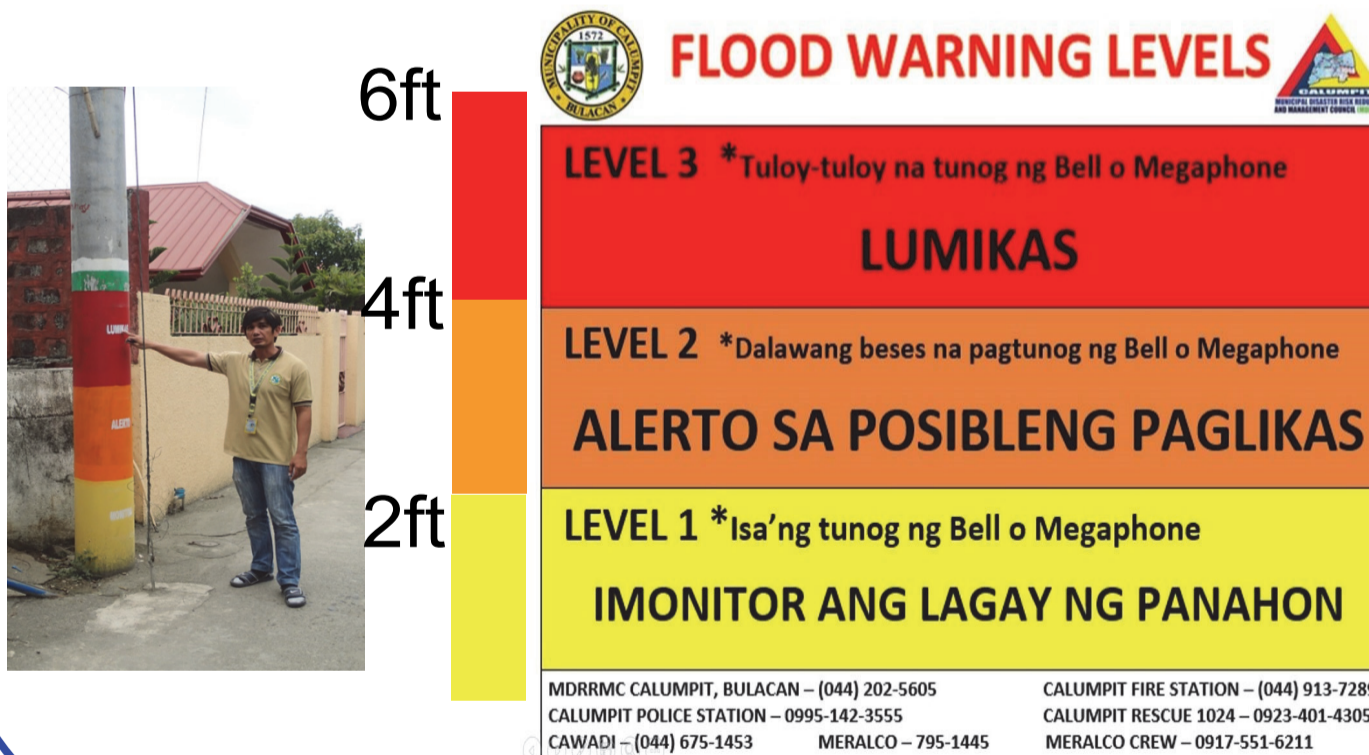**Comparison of calculated and observed discharge at San Isidro Station**

Interferometric Synthetic Aperture Radar (IfSAR) Data, provided by National Mapping and Resource Information Authority (NAMRIA), Philippines, are used in the calculation.
Based on statistical analysis using rainfall data at 17 telemetric stations, the return period is approximately 28.3 years.

Maximum flood inundation Depth

Pampanga River Basin
San Isidro

Legend Maximum Flood Inundation Depth (m)
0.0 - 0.5
0.5 - 1.0
1.0 - 2.0
2.0 - 3.0
3.0 - 6.06

Calumpit Municipality

Calumpit Municipality
Number of Barangays (Communities): 29

Legend Population, 2012

Legend Maximum Flood Inundation Depth (m)
0.0 - 0.5
0.5 - 1.0
1.0 - 2.0
2.0 - 3.0
3.0 - 4.42

Colors of Safety Markers

- About 193 water-level markers (electric poles) are installed in Calumpit.
- Each electric pole is color-coded with yellow, orange, and red every 2 ft to provide a guide for evacuation.
- Each marker has a designated contact person to report water levels to MDRRMO (Municipal Disaster Risk Reduction and Management Office).

FLOOD WARNING LEVELS

6ft

LEVEL 3 *Tuloy-tuloy na tunog ng Bell o Megaphone
LUMIKAS

4ft

LEVEL 2 *Dalawang beses na pagtunog ng Bell o Megaphone
ALERTO SA POSIBLENG PAGLIKAS

2ft

LEVEL 1 *Isa'ng tunog ng Bell o Megaphone
IMONITOR ANG LAGAY NG PANAHON

MDRRMC CALUMPIT, BULACAN – (044) 202-5605   CALUMPIT FIRE STATION – (044) 913-7289
CALUMPIT POLICE STATION – 0995-142-3555   CALUMPIT RESCUE 1024 – 0923-465-4305
CAWACO – (044) 675-1453   MERALCO – 795-1445   MERALCO CREW – 0917-551-6231

Timeline Scenario (Inundation Chart)

Colors of Safety	Flood Case	<Legend> < 2ft (<0.3048m)	< 4ft (<1.2192 m)	> 4ft (>1.2192m)	Inundation depth (m)										
		Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9	Day10	Day11			
Purok 1	Ordinary flood (10yrs return period)	0.00	0.00	0.00	0.00	0.71	0.90	0.98	1.00	0.93	0.85	0.74	0.35	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High flood (30yrs return period)	0.00	0.00	0.00	0.00	0.84	1.02	1.16	1.21	1.21	1.20	1.17	1.14	1.08	0.96	0.81	0.69	0.58	0.47	0.00	0.22	0.00
	Extreme flood (100yrs return period)	0.00	0.00	0.00	0.44	0.93	1.22	1.38	1.43	1.47	1.50	1.51	1.50	1.45	1.42	1.34	1.25	1.12	1.05	1.00	0.92	0.83
	2011 Pedring and Quiel	0.00	0.00	0.00	0.00	0.83	1.01	1.15	1.20	1.20	1.19	1.16	1.13	1.12	1.15	1.16	1.17	1.13	1.10	1.05	0.99	0.87
Purok 2	Ordinary flood (10yrs return period)	0.00	0.00	0.00	0.00	0.00	0.57	0.62	0.63	0.61	0.57	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High flood (30yrs return period)	0.00	0.00	0.00	0.00	0.51	0.63	0.71	0.75	0.75	0.75	0.73	0.70	0.68	0.64	0.57	0.50	0.43	0.35	0.00	0.00	0.00
	Extreme flood (100yrs return period)	0.00	0.00	0.00	0.23	0.58	0.79	0.93	0.97	1.01	1.04	1.06	1.05	1.02	0.98	0.92	0.84	0.74	0.68	0.65	0.61	0.57
	2011 Pedring and Quiel	0.00	0.00	0.00	0.00	0.55	0.67	0.75	0.78	0.78	0.78	0.77	0.75	0.74	0.75	0.77	0.78	0.76	0.74	0.71	0.69	0.64

The flood inundation depths calculated by RRI model at the locations of the colors of safety markers are presented in the table at 12-hr intervals daily. The colors used to paint the cells in the table correspond to the ones on the safety markers.

Ordinary Flood: floods that occur quite frequently but the damage will not be very serious.
High Flood: floods that occur less frequently than ordinary floods (i.e., equivalent to the Typhoon Pedring flood) but the damage is likely to be greater.
Extreme Flood: floods that rarely occur but the damage will be very serious.

Discussion at Barangay

Discussion with MDRRMO

Discussion with local residents (January, 2016)

Explanation to municipal mayor (January, 2016)

Discussion on revision of the Barangay DRR and Management Plan (February, 2016)

Final Workshop at Municipality on Feb. 17, 2016

Certificate of Appreciation

Republic of the Philippines
Province of Bulacan
Municipality of Calumpit
OFFICE OF THE MUNICIPAL MAYOR

CERTIFICATE OF APPRECIATION

presented to

INTERNATIONAL CENTRE FOR WATER HAZARD AND RISK MANAGEMENT (ICHARM), under the auspices of UNESCO, PUBLIC WORKS RESEARCH INSTITUTE (PWRI), JAPAN

in grateful recognition of your efforts in conducting a research project for flood risk assessment and pre-disaster recovery planning within the Municipality of Calumpit which resulted to increased awareness and preparedness of our barangays on disaster risk management.

We are truly grateful for your support and commitment.

Given this 18th day of February, 2016, coinciding with the Workshop on Evidence-based Flood Contingency Planning held in Luxent Hotel, Quezon City, Philippines.

HON. JESSIE P. DE JESUS, DMD
MUNICIPAL MAYOR