Department of Public Works and Highways
Flood Control Management Cluster

GROUP ON EARTH OBSERVATIONS

Global Centre of Excellence for Water Hazard and Risk Management
ICHARM
International Centre for Water Hazard and Risk Management under the auspices of UNESCO

Flood Mitigation in Philippines

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Project Director

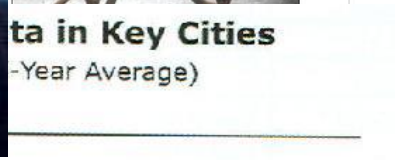
Outline of Presentation

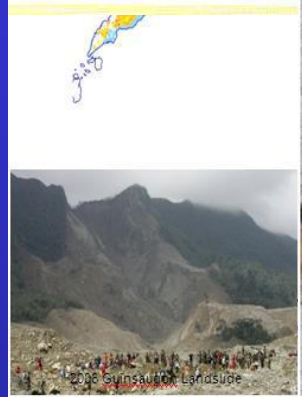
1. Flooding Scenario in the Philippines
   - Why is Metro Manila and Surrounding Areas Perennially Flooded?
   - 2009 Typhoon Ondoy Metro Manila Flooding
2. Policy Direction / Framework
   - World Bank Proposed Projects
   - Mangahan Floodway
   - Paranaque Spillway
   - Laguna Lakeshore Ringdike Project
   - Marikina Dam
3. Actions / Challengers to Mitigate Flooding
   - Completed and On-going Initiatives

The Philippines

Water-Related Disaster Dat

- 7, 107 islands
- Land Area : 298,170 km^2
- Population : 105 Million
- Annual rainfall : 2,400 mm
- 92.5% of disasters caused by typhoons
- Ranked 1st in the world: vulnerability to typhoons
- Ranked 3rd in 2012 World Risk Index Report





Flood Risk Index

Philippine Flood Risk Index Basic Concept

$$Philippine\ Flood\ Risk\ Index\ (PFRI_c)$$

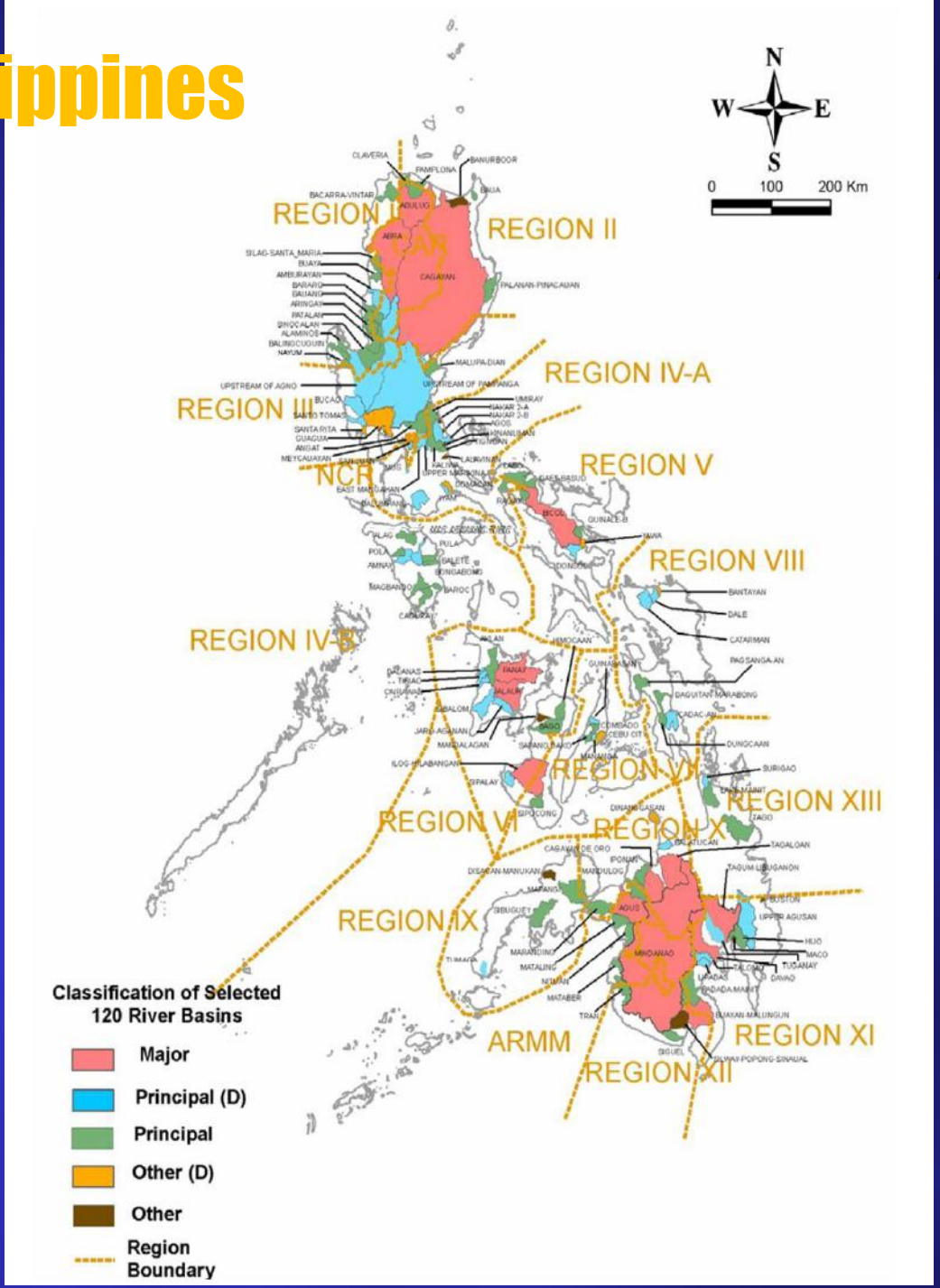
$$PFRI_c = \frac{Hazard \times Exposure \times Basic\ Vulnerability}{Capacity\ (Soft\ Countermeasures + Hard\ Countermeasures)}$$

[Five (5) Sub-Indices]

1. Hazard Index (H)
2. Exposure Index (E)
3. Basic Vulnerability (V)
4. Capacity (Soft Countermeasures) (CS)
5. Capacity (Hard Countermeasures) (CH)

River Basins in the Philippines

- **18 Major River Basins**
  - Catchment Area > 1,400 km^2
- **421 Principal River Basins**
  - Catchment Area > 40 km^2
  - With intense rainfall:
    - ✓ overflowing of waterways
    - ✓ inundation and deposition of sediment in flood plains
    - ✓ extensive flood damages often result.



$ 208 Million (CY 1970-2010 Damage to Economy Data)

$ 168 Million lost annually

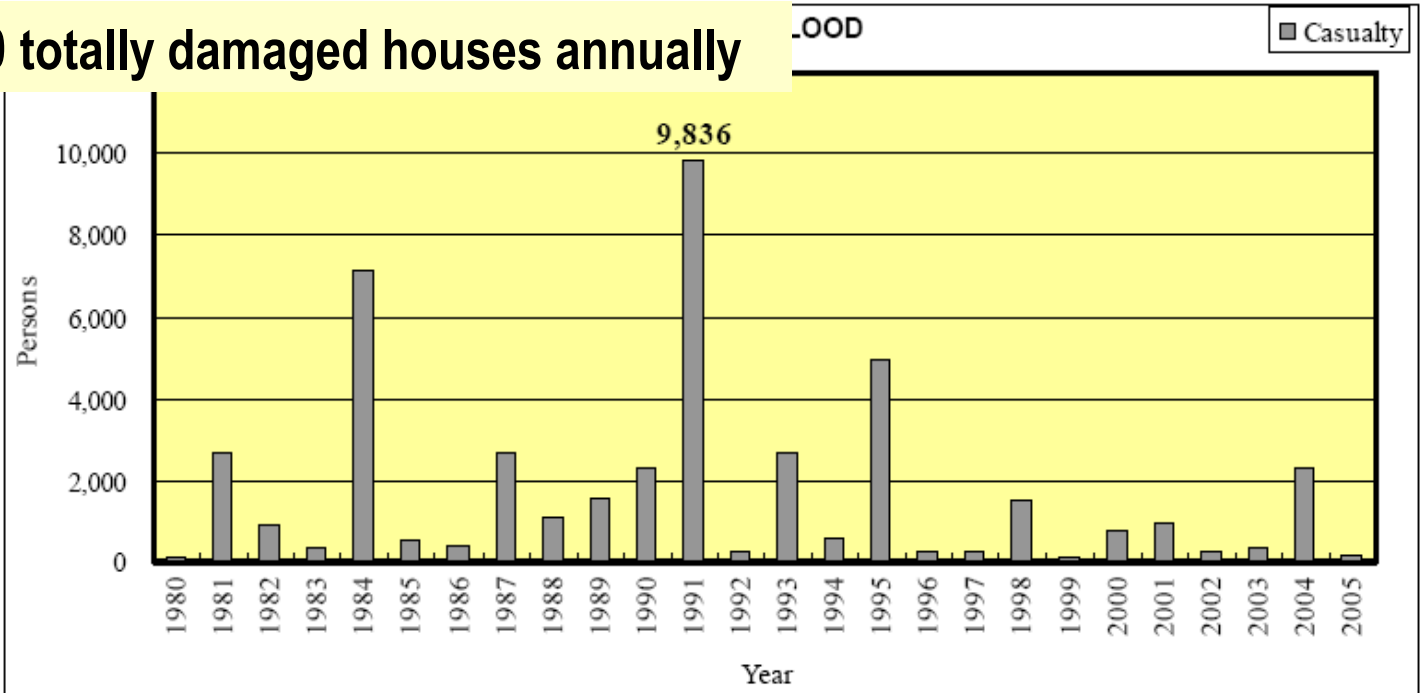
700 persons killed annually

2.8 M people affected annually

77,000 totally damaged houses annually

Table Recorded Annual Flood Damages in the Philippines

Year	Population Affected		Causalities			House Damaged		Damage Value* ($ million)
	Families	Persons	Dead	Missing	Injured	Totally	Partially	
							1,101	30.66
							9,251	26.52
1982	266,476	1,569,017	337	223	347	84,027	97,485	36.54
			126	168	28	29,892	85,072	10.90
			1,979	4,426	732	310,646	313,391	8.67
1985	318,106	1,643,142	211	300	17	8,204	211,151	0.6
			171	43	155	3,162	14,595	38.29
			1,020	213	1,455	180,550	344,416	182.56
1988	1,173,994	6,081,572	429	195	468	134,344	585,732	180.73
			382	89	1,088	56,473	184,584	93.63
			676	262	1,392	223,535	636,742	244.02
1991	150,894	759,335	**5,201**	**4,278**	**357**	15,458	83,664	1.54



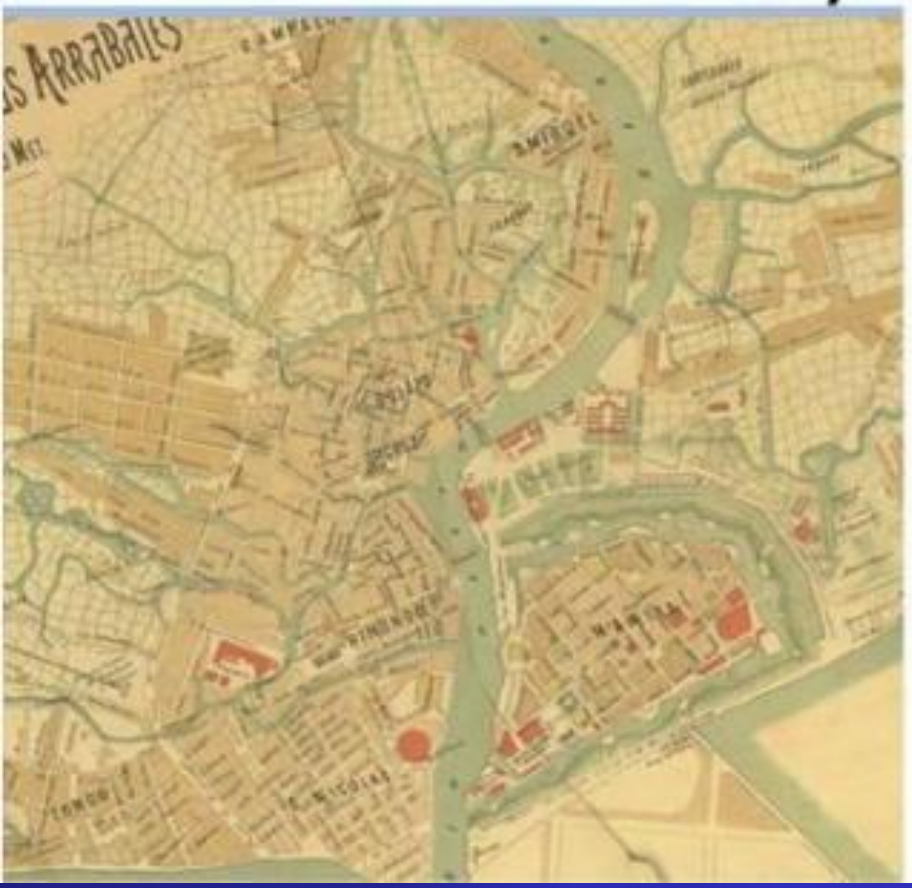
Recent Mega Flood Disasters

Philippine Destructive Typhoons
in the last 10 years (2006-2016)

RANK	NAME OF TYPHOON	DATE	DEATHS	COST IN DAMAGE ($)
1	Typhoon Haiyan	Nov. 6-8, 2013	7,041	$1.98B
2	Typhoon Pablo	Dec. 2-12, 2012	1,900	$930M
3	Typhoon Ketsana	Sept. 26-29, 2009	956	$430M
4	Typhoon Washi	Dec. 16-18, 2011	1,257	$35M
5	Typhoon Frank	June 18-22, 2008	557	$296M
6	Typhoon Milenyo	Sept.25-26, 2006	213	$147M
7	Typhoon Reming	Nov.30, 2006	1,479	$26.66M
8	Typhoon Violeta / Winnie	Nov.22-Dec.3, 2004	1,232	$178M
9	Typhoon Washi	Dec. 16-18, 2011	1,257	$35M
10	Typhoon Koppu	Oct. 19, 2015	12	$3.96M

Source: NDRRMC Website

WHY IS THE FLOOD PROBLEM IN MANILA SO HUGE?



LOOK BACK ON FLOOD CAUSE

- **Occurrence of extreme rainfall amount and intensity.**

  (According to PAGASA the 24-hr rainfall of 455mm recorded from 8am Saturday to 8am Sunday at the Science Garden in Quezon City is equivalent to a return period of more than 100 years.)

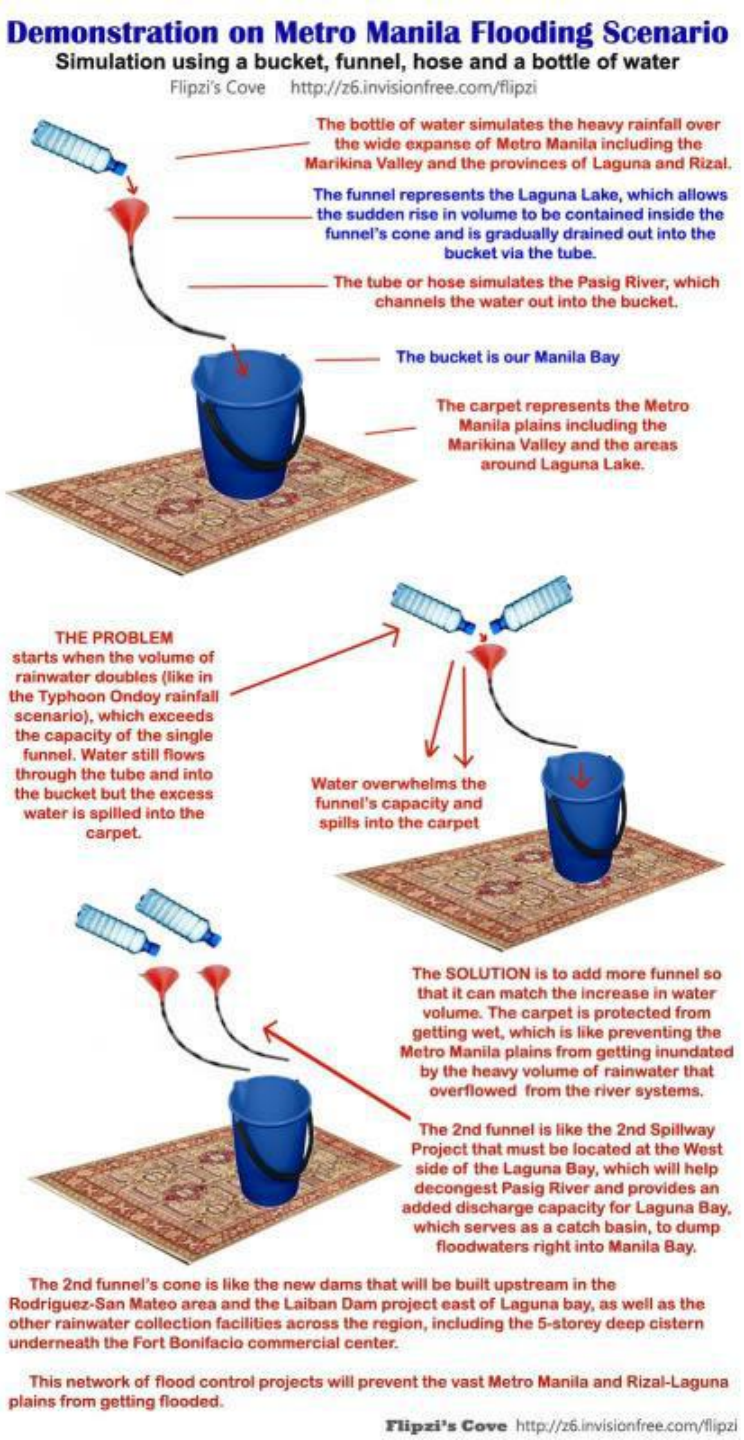
- **Existing river channels do not have the capacity to contain extreme discharge**

  (Pasig River has a present flow capacity of 500m^3/s, Marikina River with a 900m^3/s, and in Cainta, Antipolo, Angono & Taytay with 22m^3/s each)

- **Existing Internal drainage systems in Metro Manila cannot contain the unusual runoff** *(JICA Study on the Drainage Improvement in the Core Area of Metropolitan Manila, March 2005)*

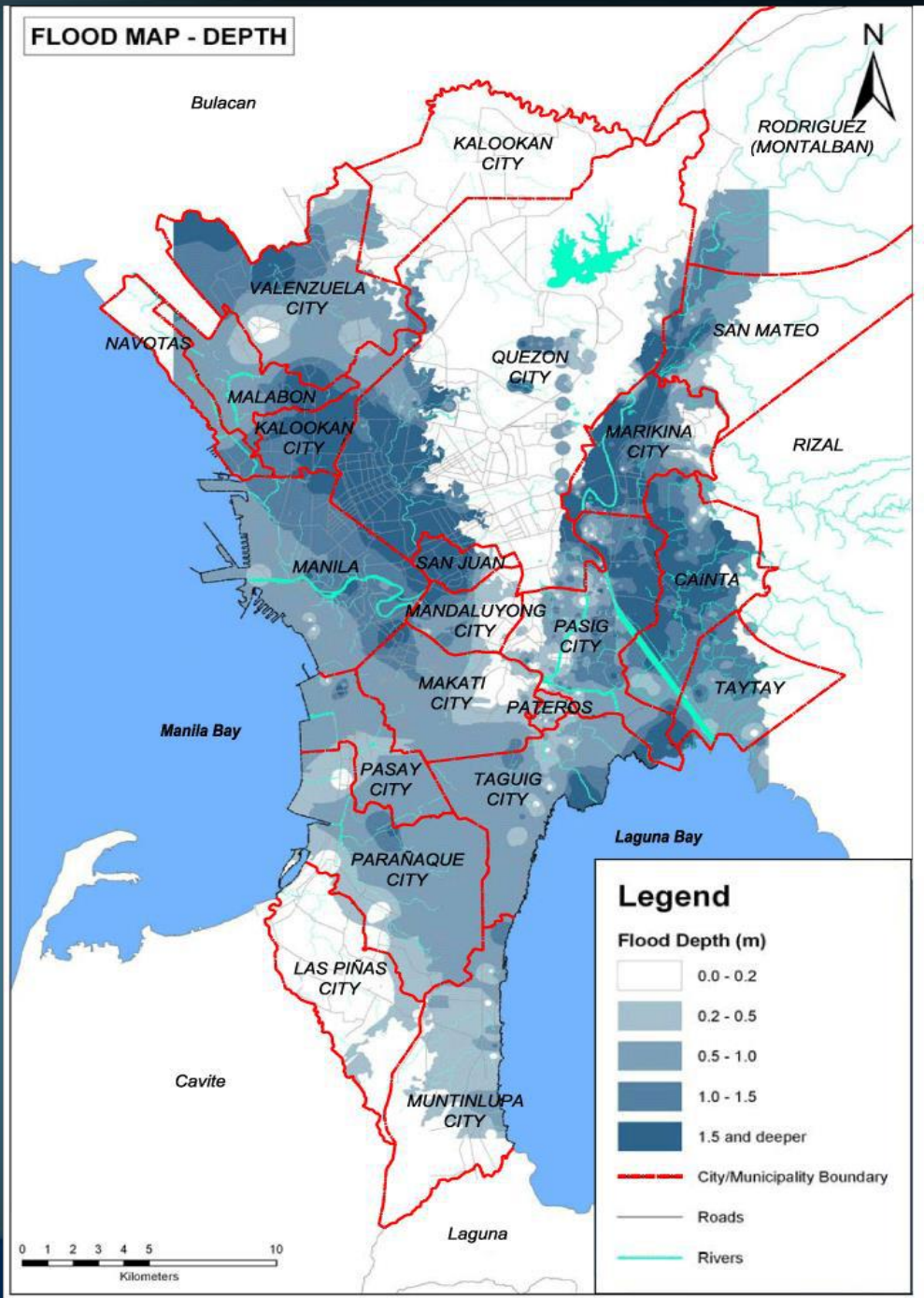
  (Old drainage system constructed in 1975 already 70% silted; the runoff coefficient varies from 0.4-0.5. At present, due to rapid urbanization, the runoff coefficient was significantly increased.)

- **Existing internal drainage systems are clogged up by 70% due to indiscriminate throwing of garbage.**



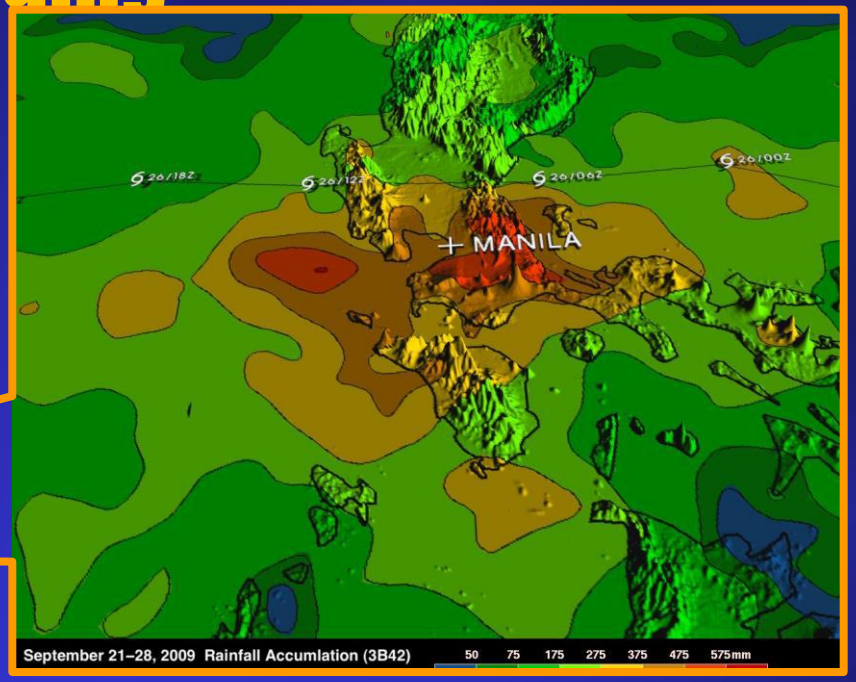
FLOOD CONDITIONS IN METRO MANILA DURING TYPHOON KETSANA IN 2009

Flood Condition by Ondoy in Pasig Marikina River Area



2009 Metro Manila Flooding

Typhoon Ketsana (26 Sept 2009)



- Tropical Rainfall Measuring Mission (TRMM) / NASA – Multi Satellite Precipitation Analysis (MPA) showed Typhoon 'Ketsana' poured 575mm of rainfall (6hr Rainfall)

- Monthly ave. (November) rainfall in manila was poured over in 1 day.

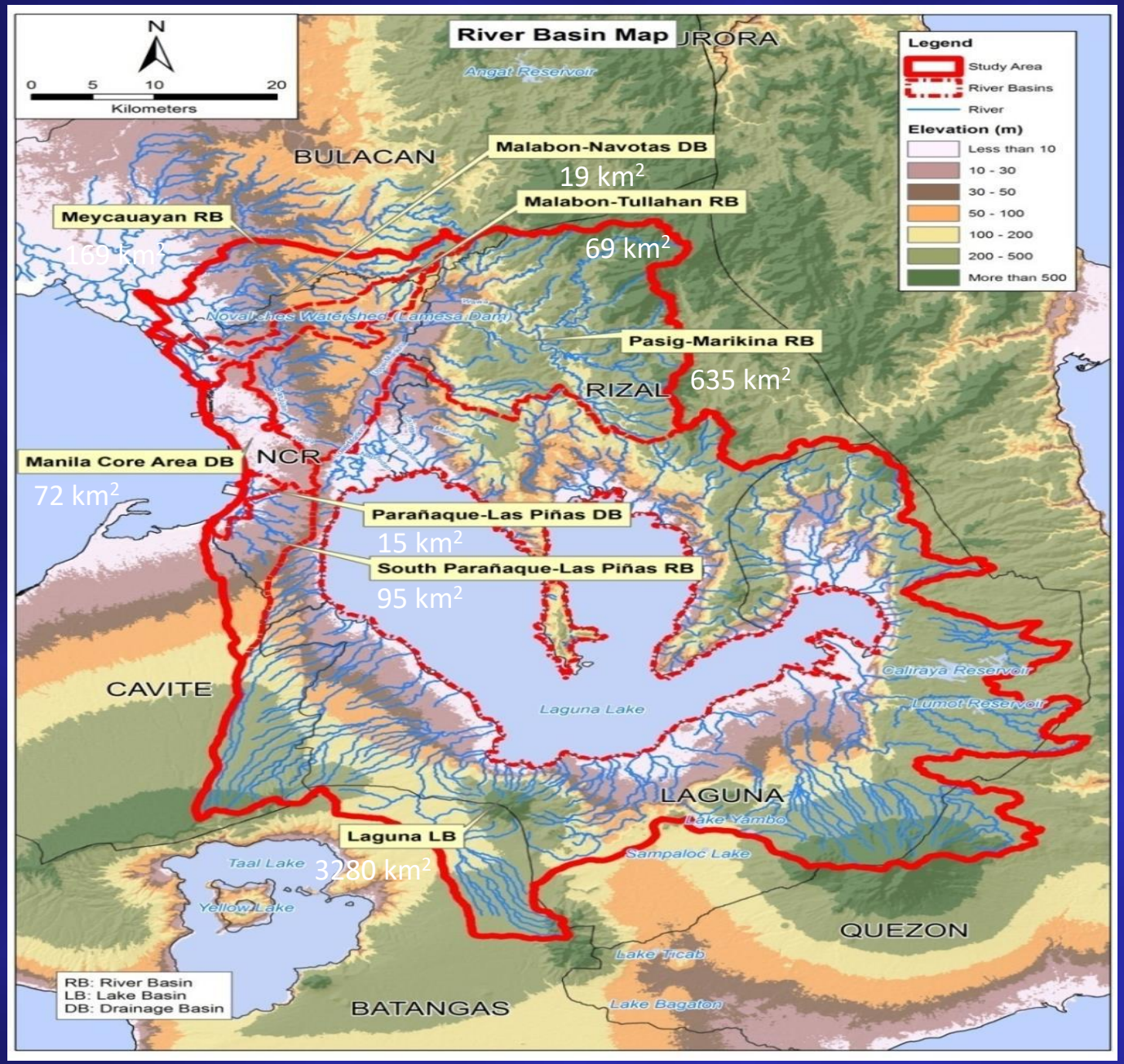
2009 Metro Manila Flooding

Typhoon Ketsana (26 Sept 2009)

- **Affected** — **9.3 million**
- **Casualty** — **1,000 people dead**
- **Damage** — **2.7% of GDP**

MASTER PLAN FOR FLOOD MANAGEMENT IN METRO MANILA AND SURROUNDING AREAS

Master Plan for Flood Management in Metro Manila and Surrounding Areas



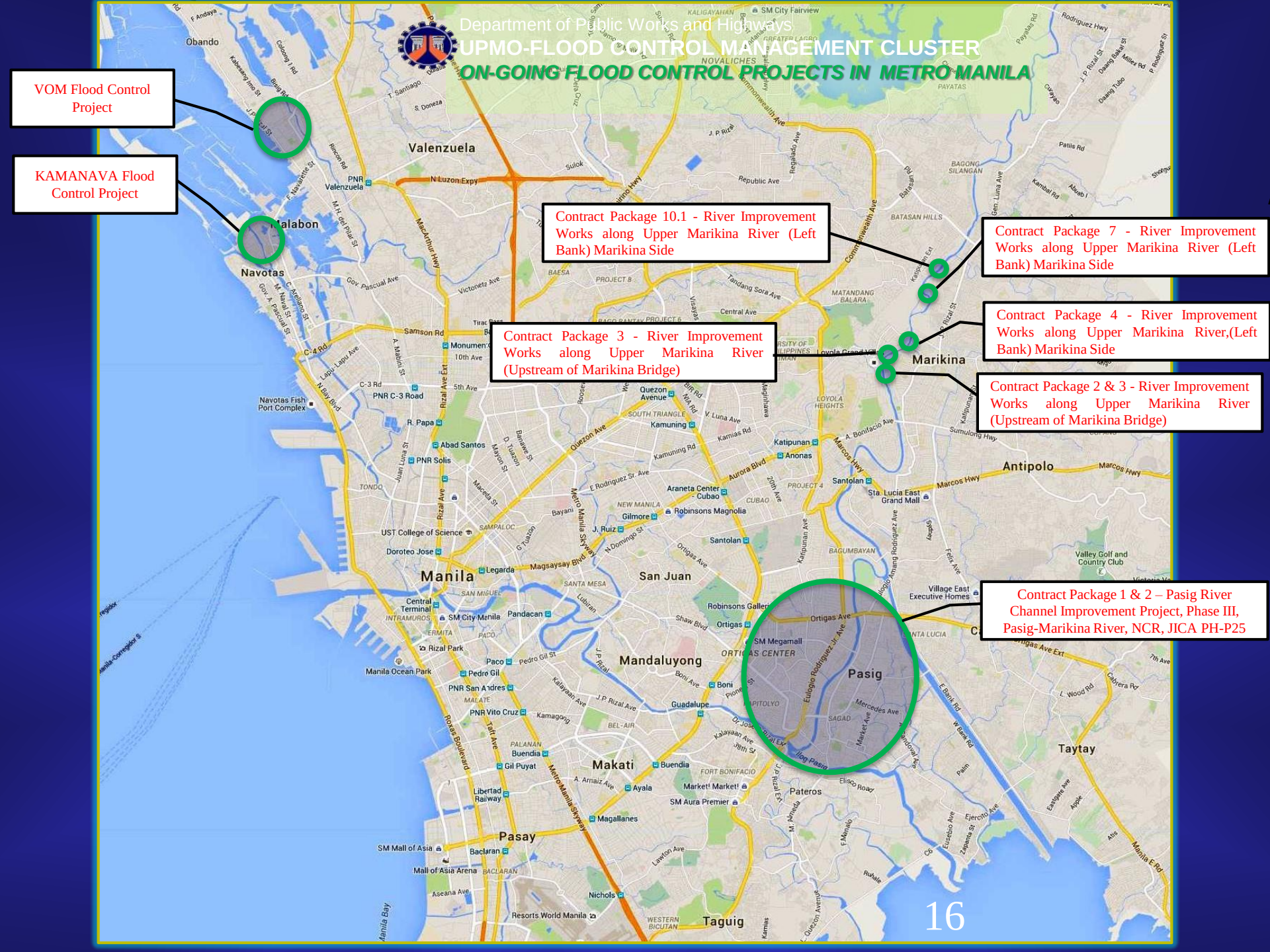
Based on river basins: Pasig-Marikina River Basin and Laguna Lake Basin.

Total area: 4,354 km²

Total Population: 17.1 M

Boundary of Study Area and the River Basins

ON-GOING FLOOD CONTROL PROJECTS IN METRO MANILA



Metro Manila Flood Control Project-West of Mangahan Floodway

Components

- Lakeshore Dike: 10.8 km long including 1 bridge (150 m) from Lower Bicutan to Mangahan Floodway
- Bridge: 1 site (Napindan; 150 m)
- Parapet Wall: 5.16 km in total along Napindan River Banks
- Floodgates: 8 sites
- Pumping Stations: 4 sites (Total Capacity ; 36 m^3/s)
- Regulation Ponds: 4 sites (at each pumping station)

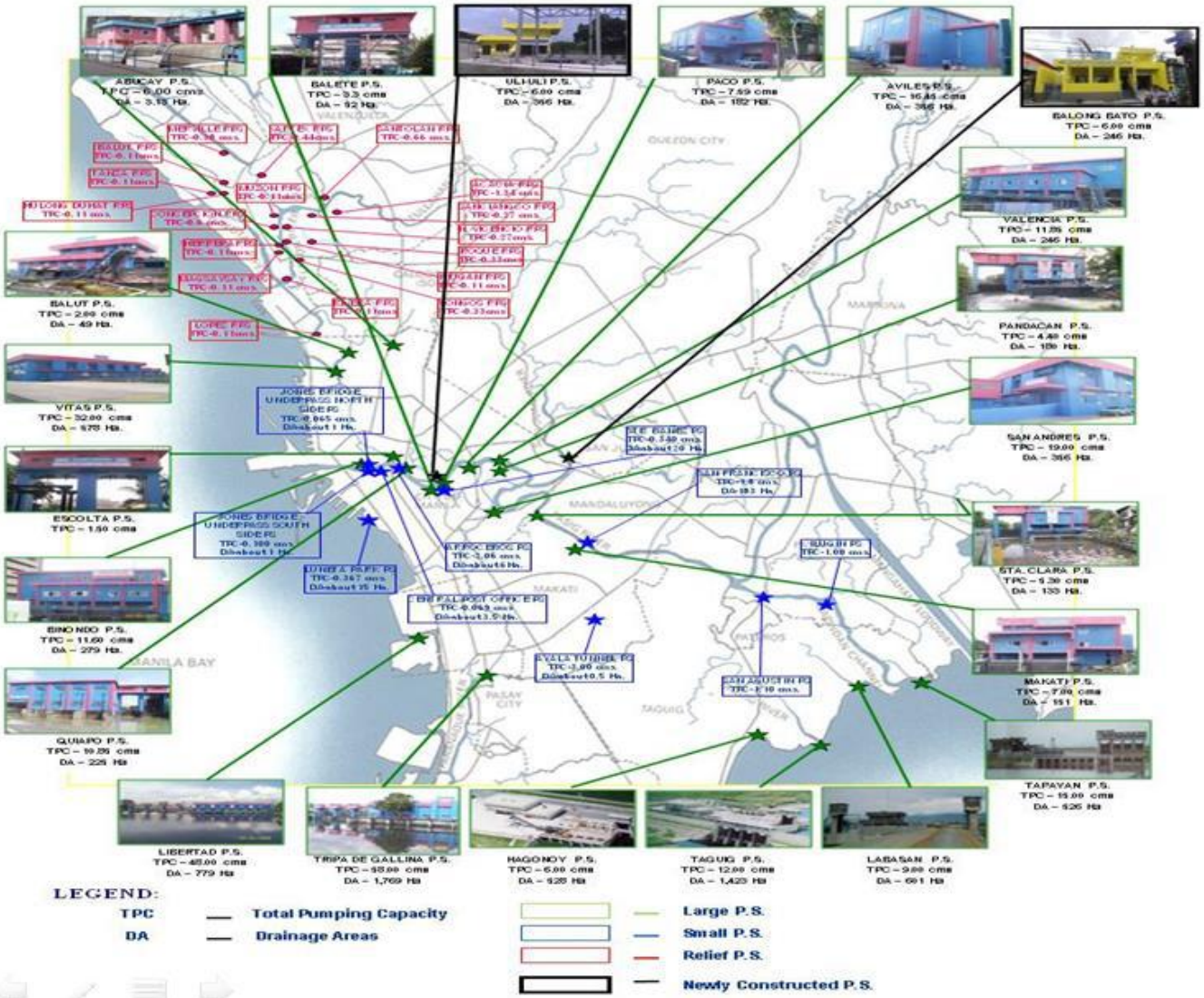
Proposed Marikina Control Gate Structure

Pasig Marikina Channel Improvement Project

Department of Public Works and Highways

UPMO-FLOOD CONTROL MANAGEMENT CLUSTER

LOCATION MAP OF PUMPING STATIONS IN METRO MANILA



FUNCTIONS:

TO PUMP OUT WATER FROM ESTERO SIDES INTO RIVERS AND BAYS IN ORDER TO CREATE RETARDING RESERVOIR/ STORAGE AREA FOR LOCAL RUNOFF DURING HEAVY RAINFALL.

AREA SERVED: 5,385 hectares

CATEGORIES:

LARGE PS	22
SMALL PS	12
RELIEF PS	18
TOTAL	52

Policy Direction / Framework

DPWH Efforts to Mitigate Flooding in Metro Manila

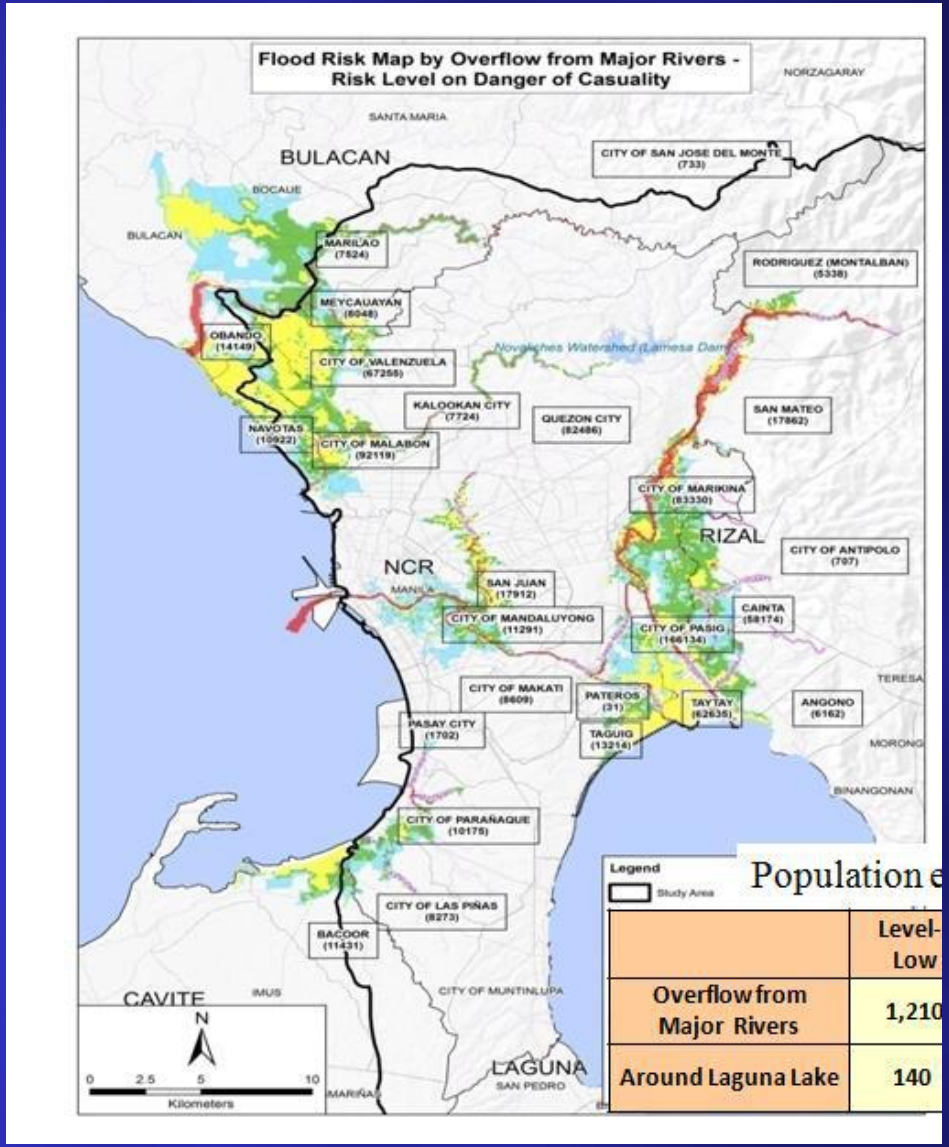
1. Flood Management Master Plan for Manila

- Prioritize the construction of flood structures in highly flood prone areas

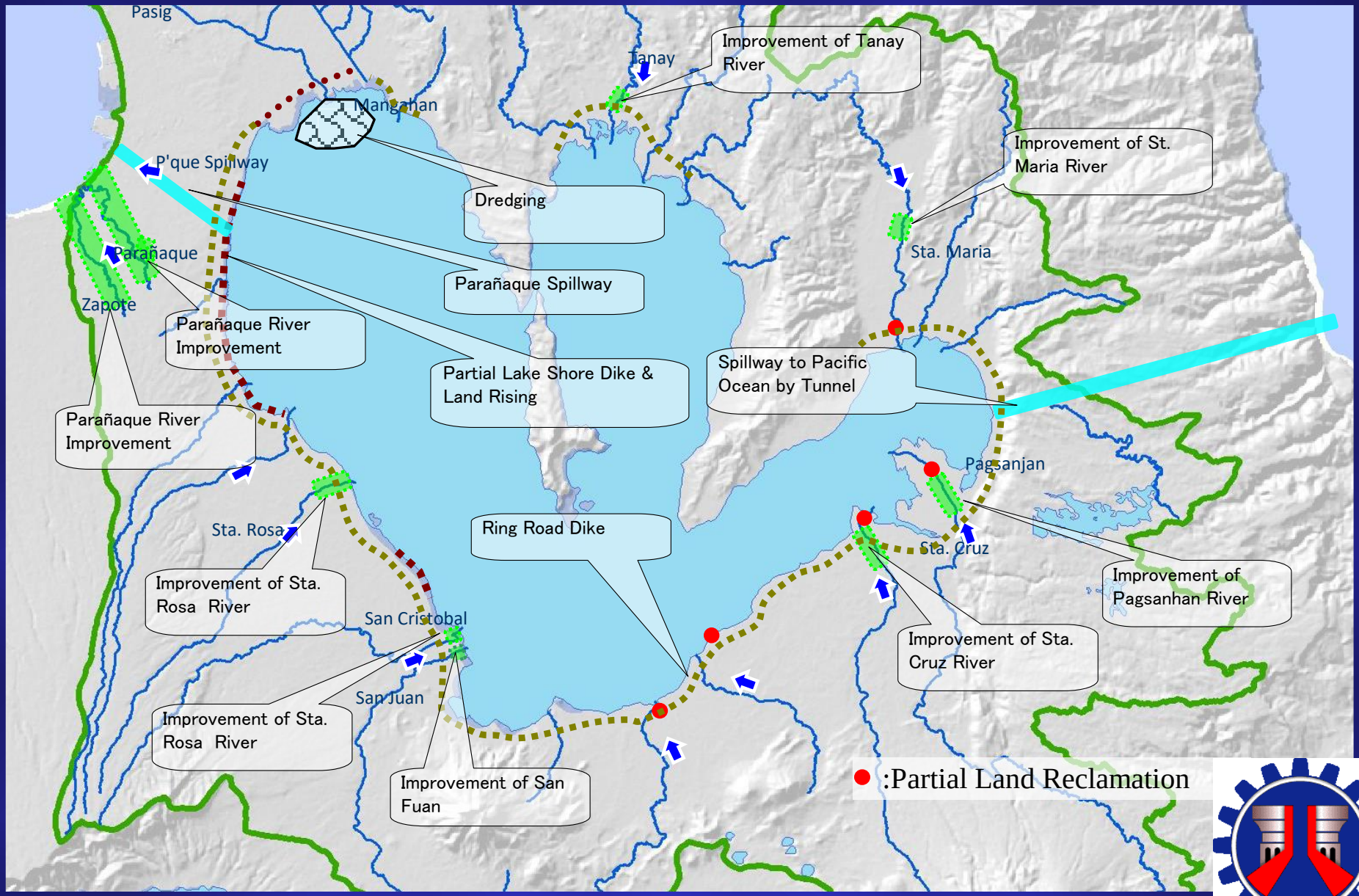
- Bureau of Design Upgrades on Flood Control and Drainage Standards

a) Min. flood return periods of drainage pipes (15 yr flood); esteros/creeks (15 yr flood);

b) principal and major rivers (50 yr flood).

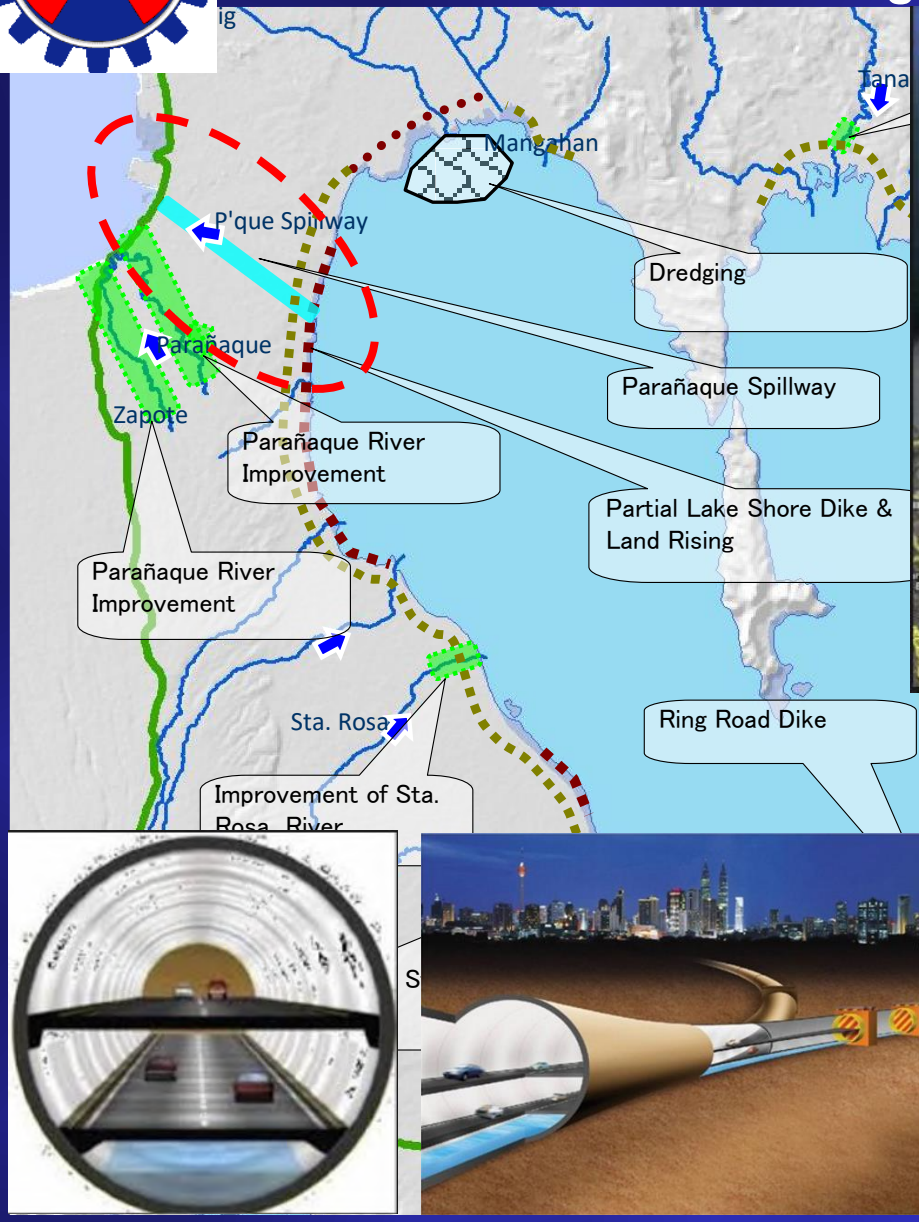


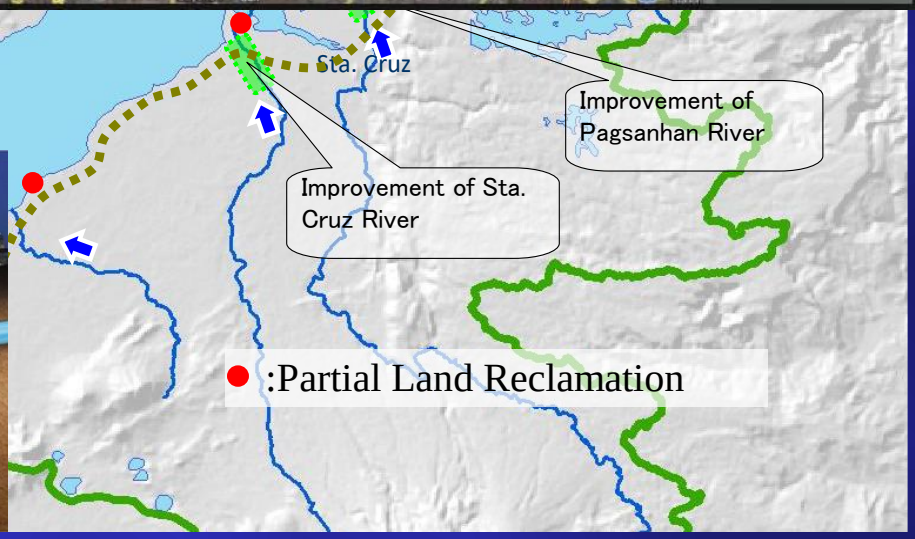
Laguna Lakeshore: Long Flood Control Projects



Paranaque Underground Tunnel

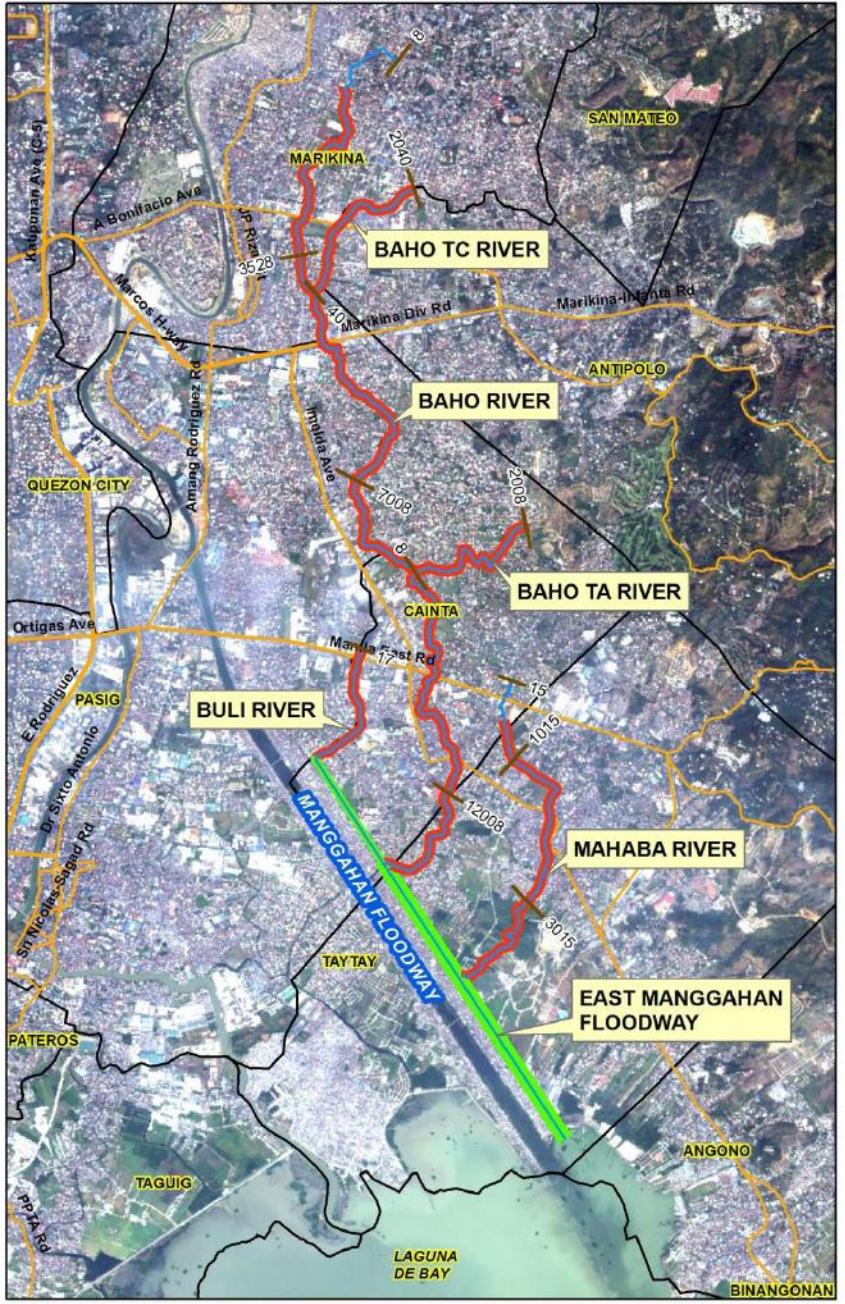
DPWH Efforts to Mitigate Flooding in Metro Manila





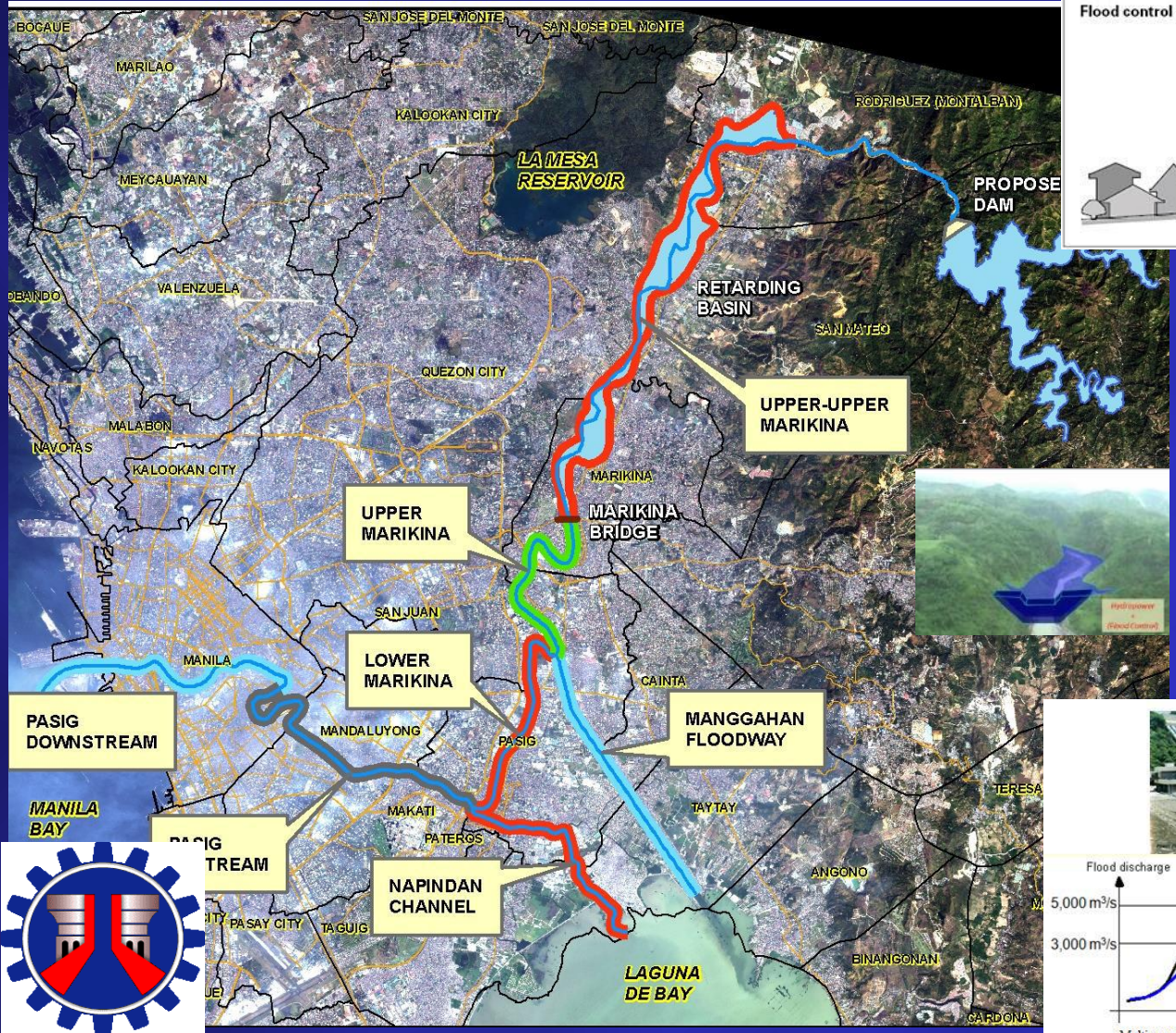
East Mangahan Floodway

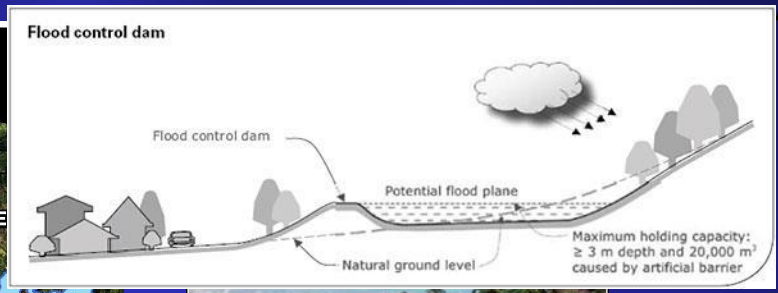
Including Improvement of Inflow Rivers

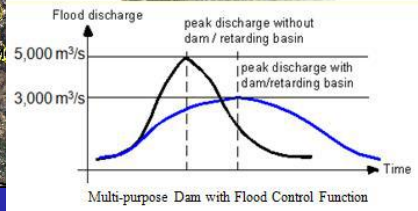


Marikina Dam

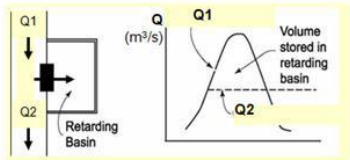
DPWH Efforts to Mitigate Flooding in Metro Manila

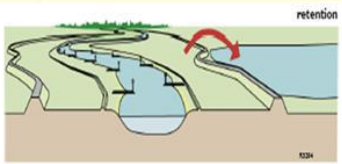






Multi-purpose Dam with Flood Control Function

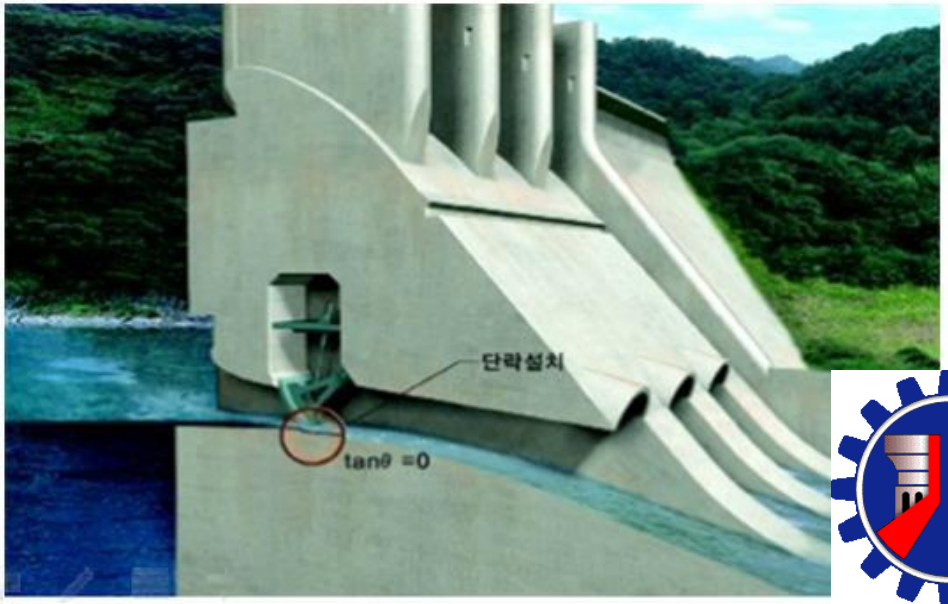


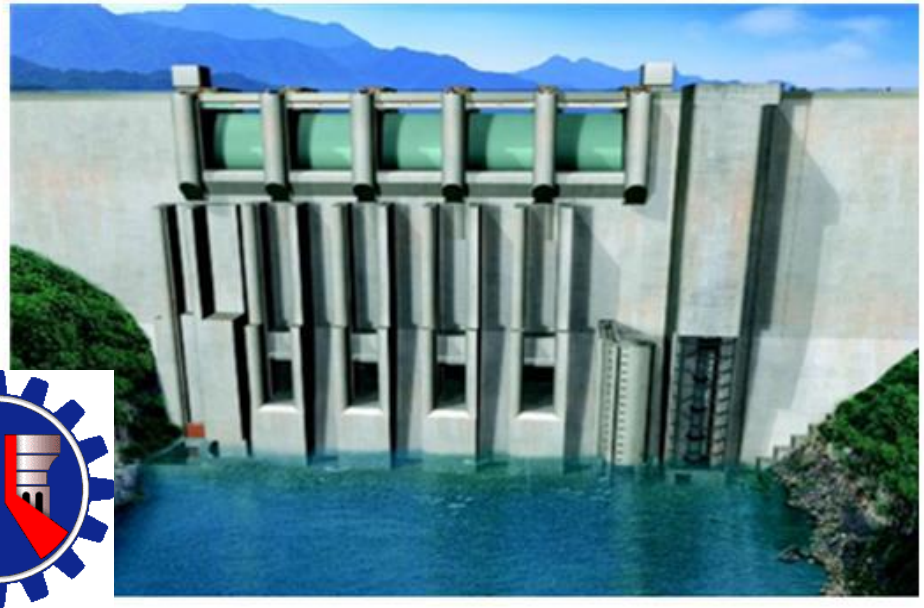


Retarding Basin

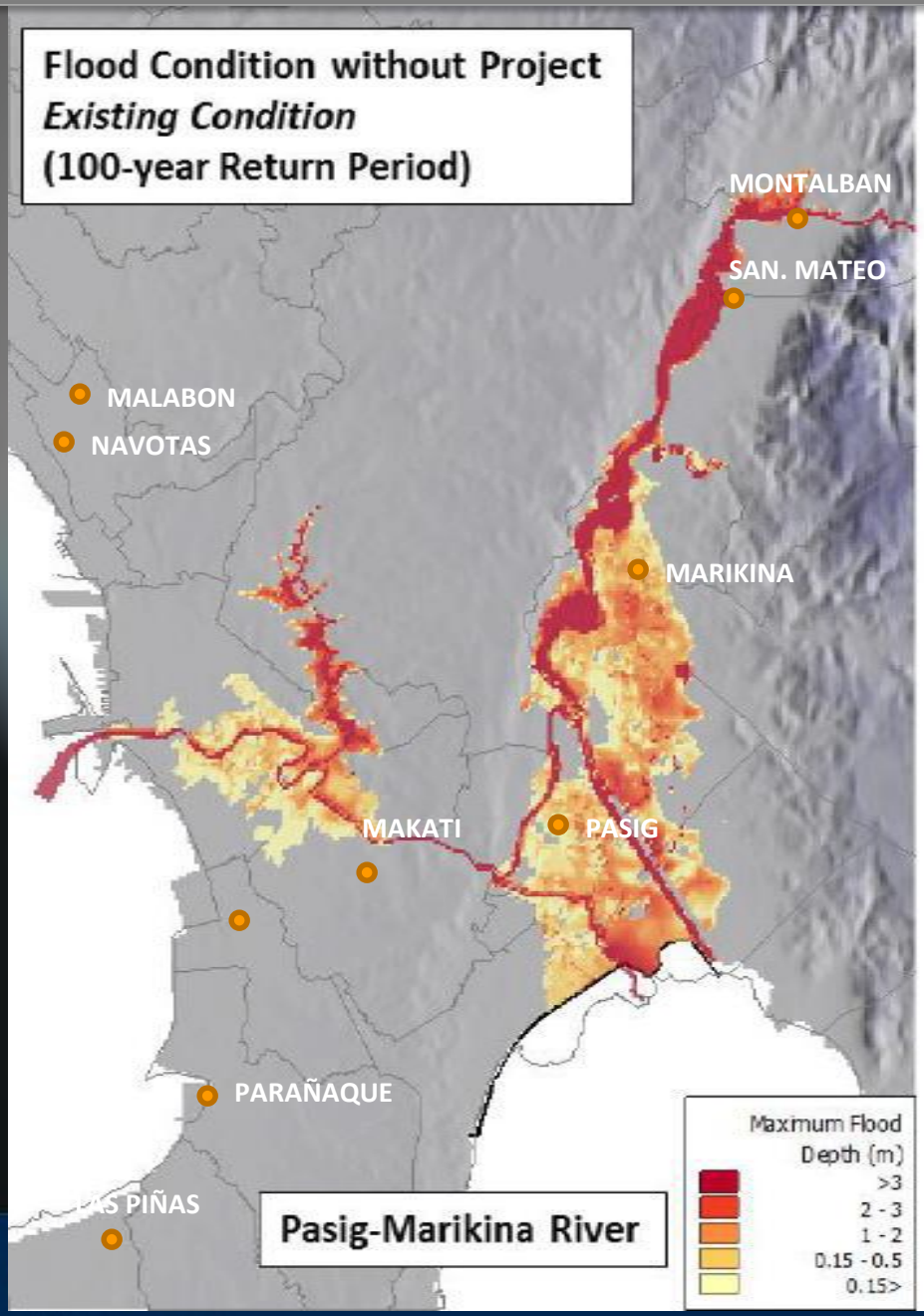
Marikina Dam

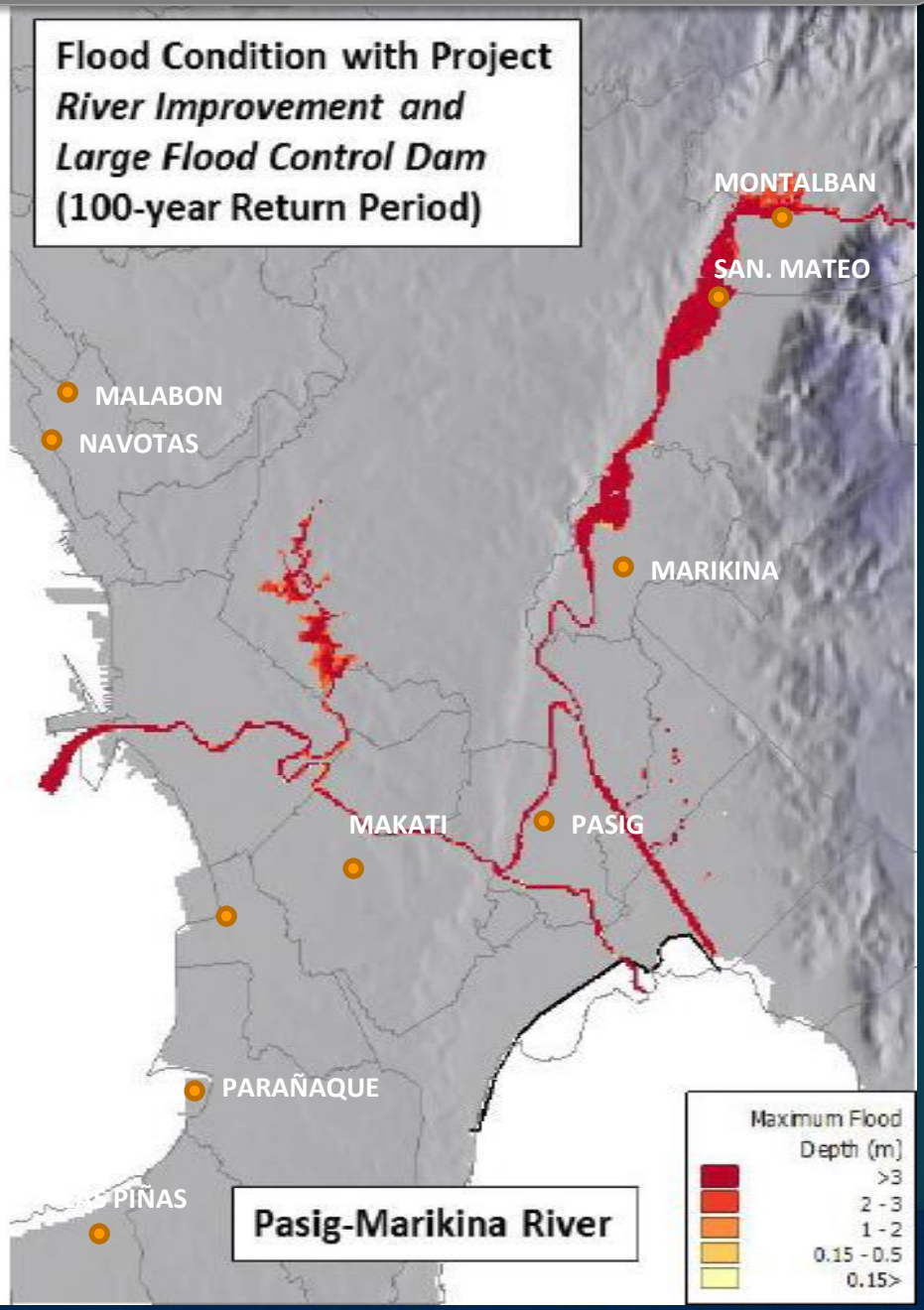
FEASIBILITY STUDY AND DETAILED ENGINEERING DESIGN OF THE PROPOSED UPPER MARIKINA DAM, GREATER METRO MANILA AREA FLOOD MANAGEMENT PROJECT





Comparison of Flood Condition in the Pasig-Marikina River Basin



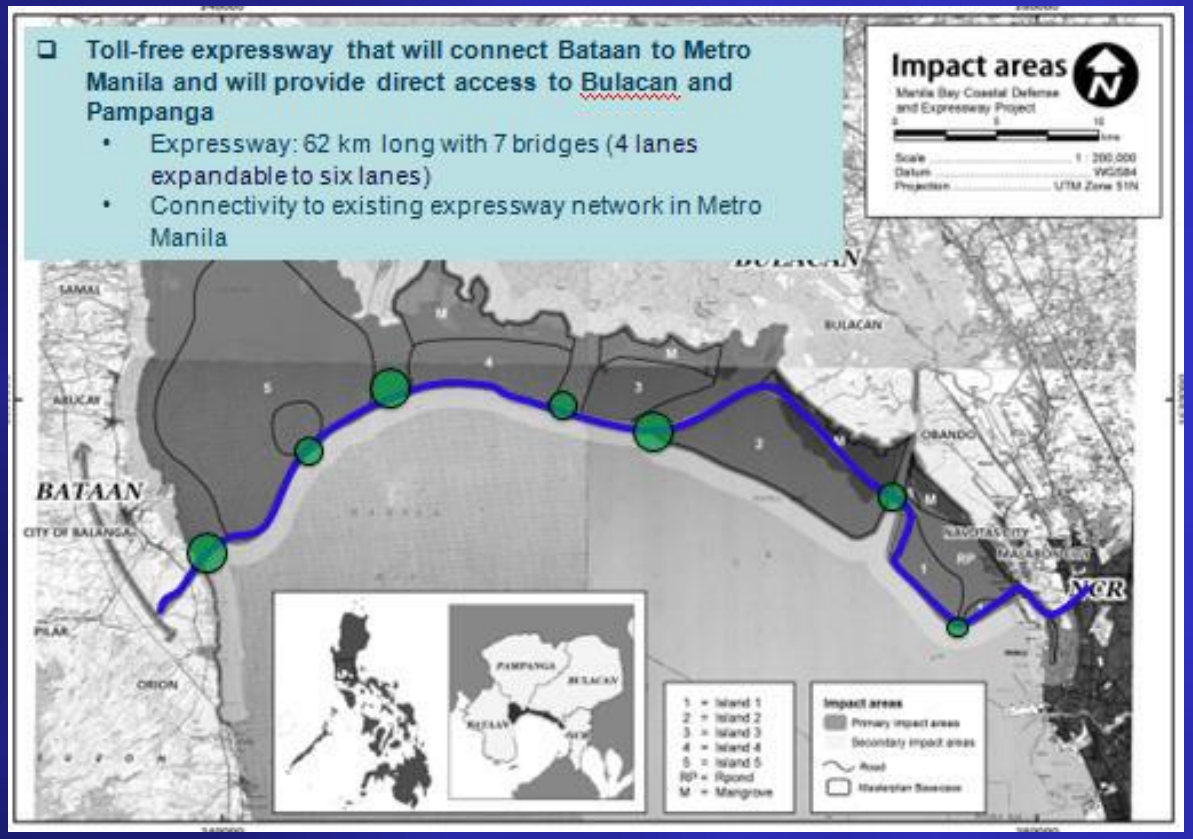


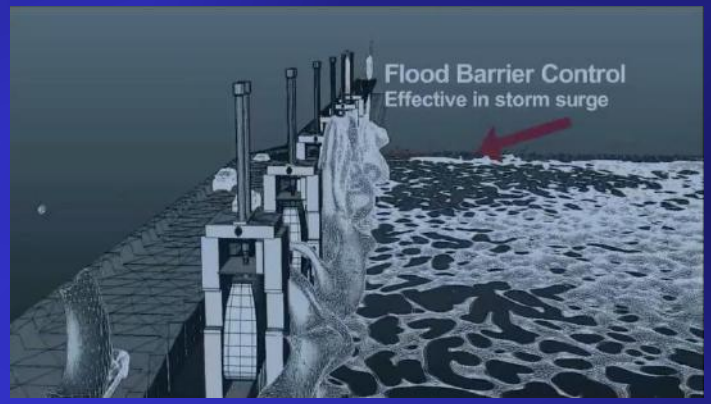
Policy Direction / Framework

DPWH Efforts to Mitigate Flooding in Metro Manila

4. Coastal Flood Defense and Sea Barrier

Metro Manila flood proofing thru flood gates and coastal sea barrier for protection against coastal flooding and storm surge





Issues and Challenges

Efforts to Mitigate Flood Disasters

Pursuing Integrated Flood Management

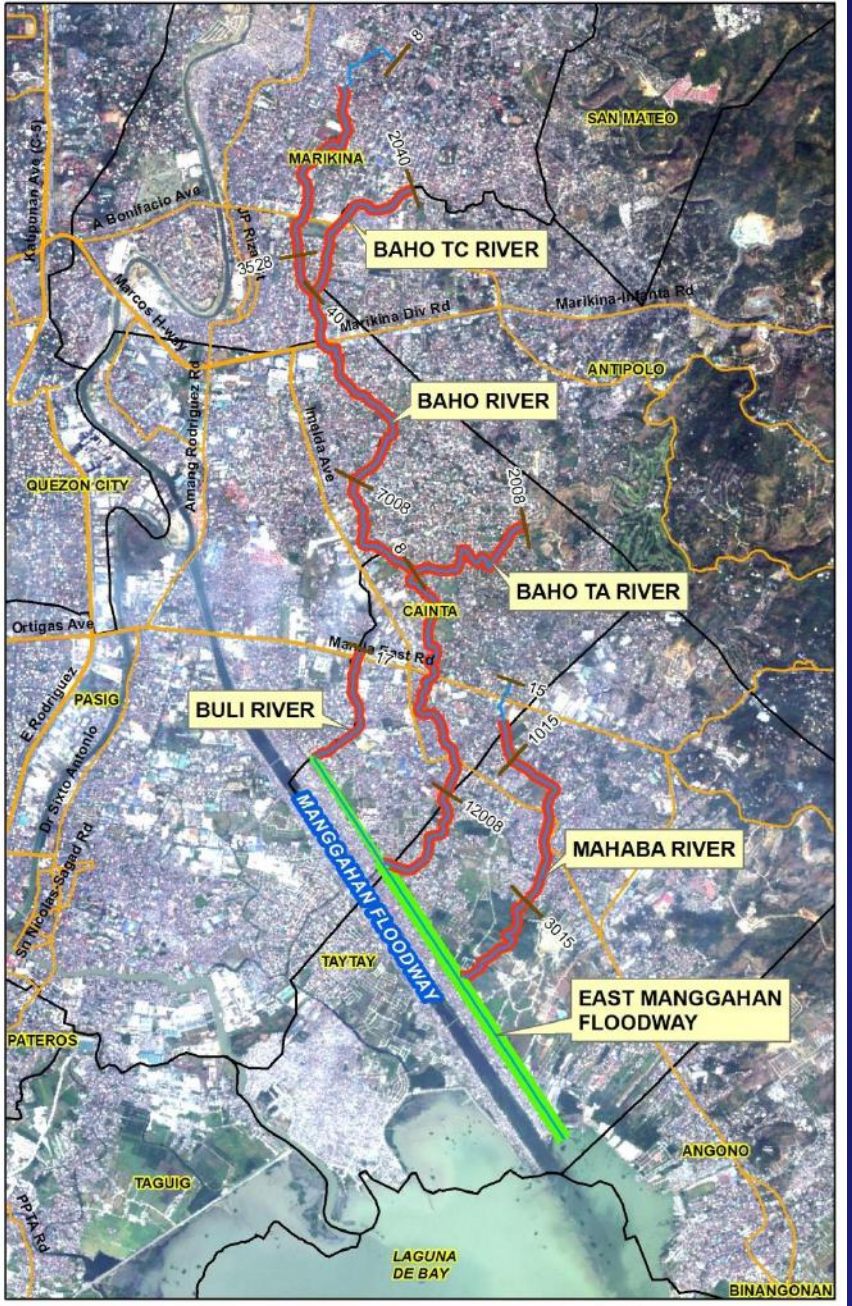
Hazard Map – Development of flood inundation map, pre-and-post flood disaster, that shows flood prone areas, no built-zones (no habitation zones) that reflects the old-cadastral river boundary

CDO Flood Hazard Map, Post-Sendong, 2012

Bottlenecking of CDO river at Ysalina Bridge

Issues and Challenges

Relocation of Informal Settler Families



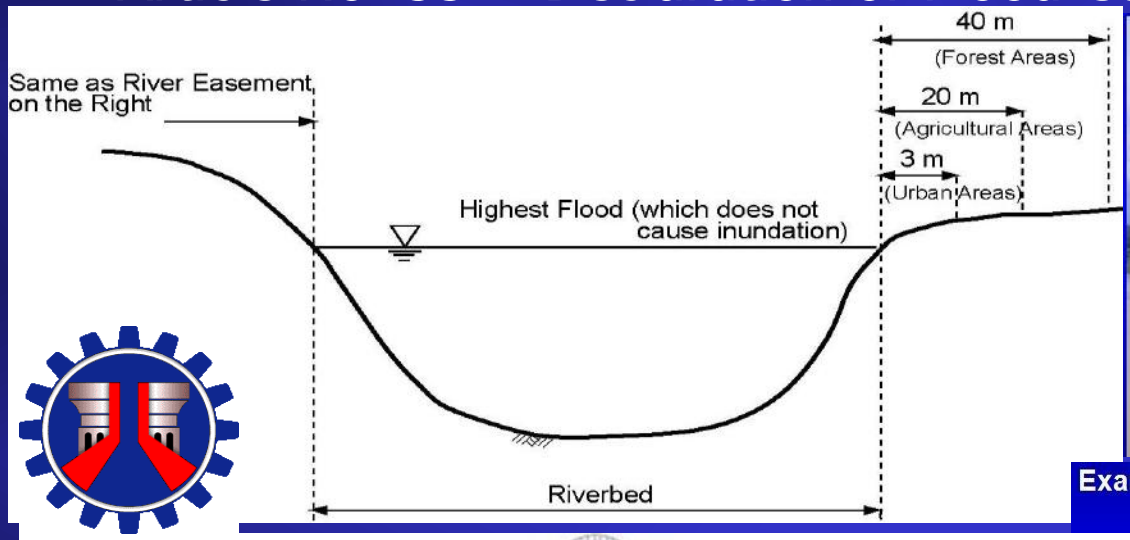
Issues and Challenges

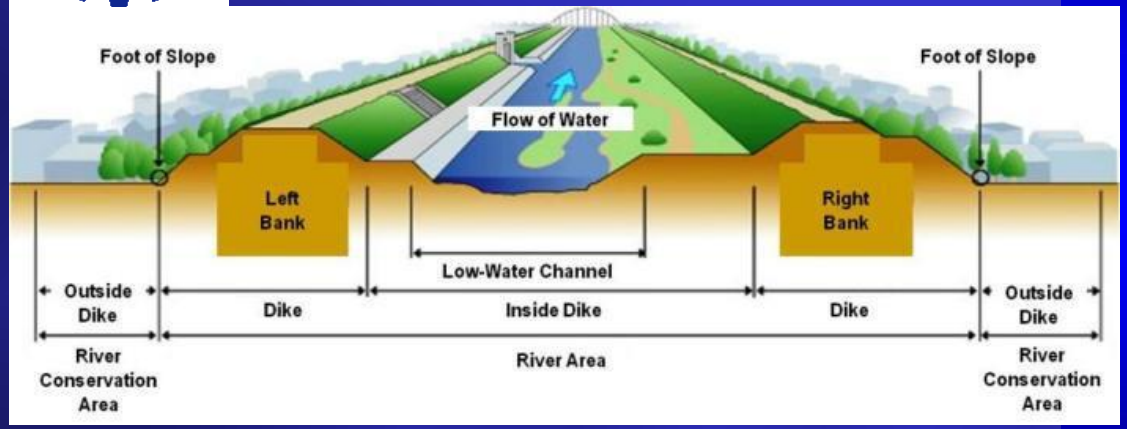
Efforts to Mitigate Flood Disasters

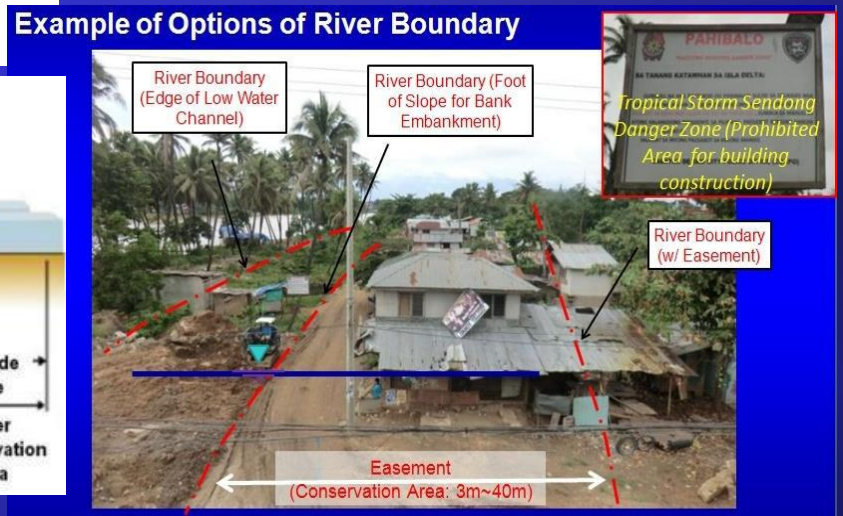
Enforcement of PD 1067 / RA10752

Article No. 51 - Designation of River Easements

Article No. 53 - Declaration of Flood Control Areas (No Build Zones)







Completed and On-going Initiatives

DPWH Efforts to Mitigate Flooding in Metro Manila

Completed and Ongoing Flood Control Projects

Pasig – Marikina River Improvement

Ormoc Flood Mitigation Project

Anilao Slit-Type Sabo Dam

Pinatubo Groundsills

Camiguin Sabo Dam

KAMANAVA Flood Control Project