



# LiDAR Data Application in Hazard Assessment and Mapping: Region IVB and Laguna, Philippines

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# Outline of Presentation

- **Introduction**

- Philippines experience on flooding associated with typhoons and extreme rainfall events
- Agency responsible for disaster prevention and mitigation
- Brief background about PHIL-LiDAR program

- **Objectives** (program and project)

- **Methodology** (data processing, validation and flood modeling)

- **Results** (initial outputs for selected river basins)

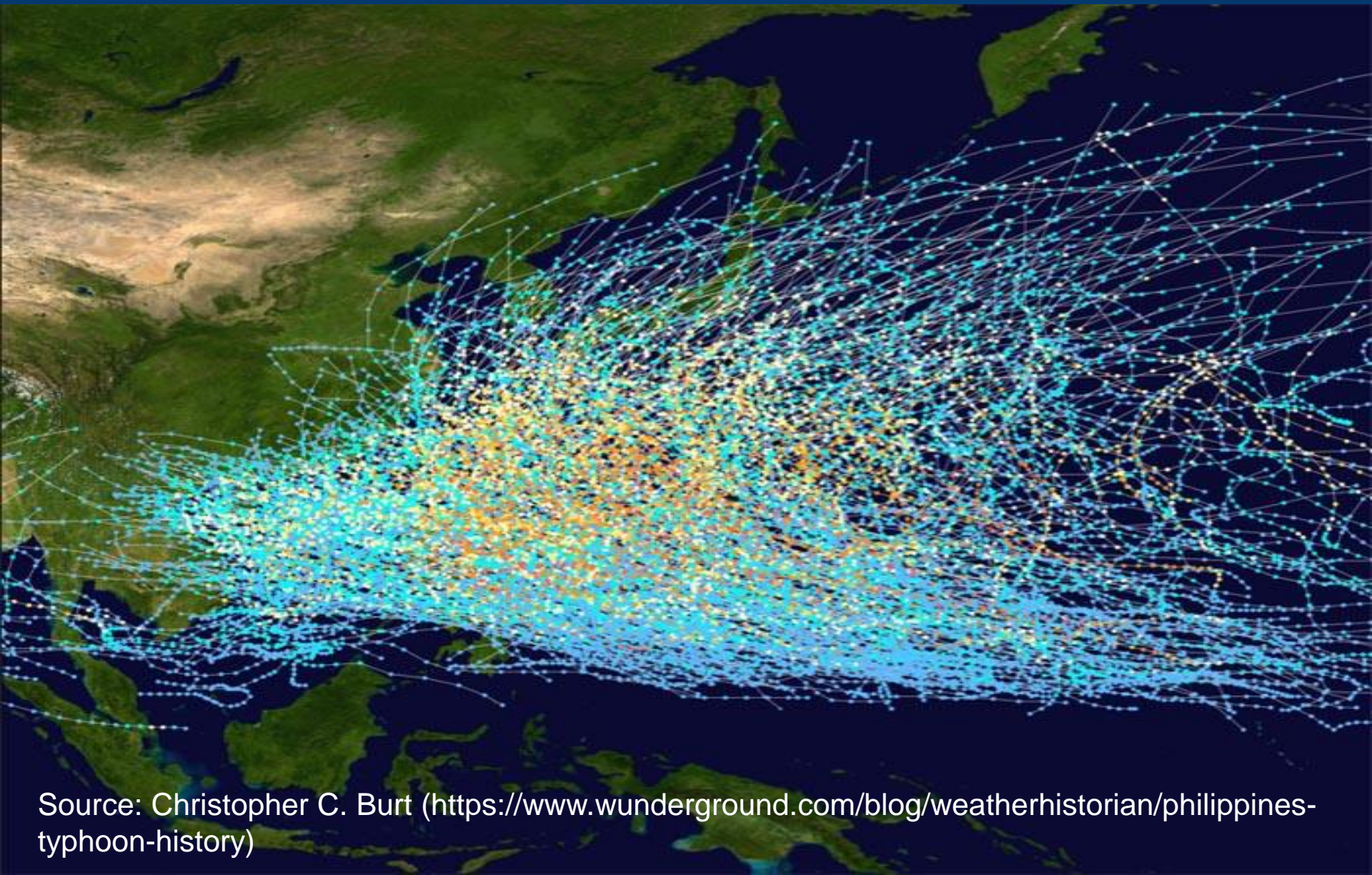
- **Concluding remarks**

- **Acknowledgments**





# INTRODUCTION



Source: Christopher C. Burt (<https://www.wunderground.com/blog/weatherhistorian/philippines-typhoon-history>)



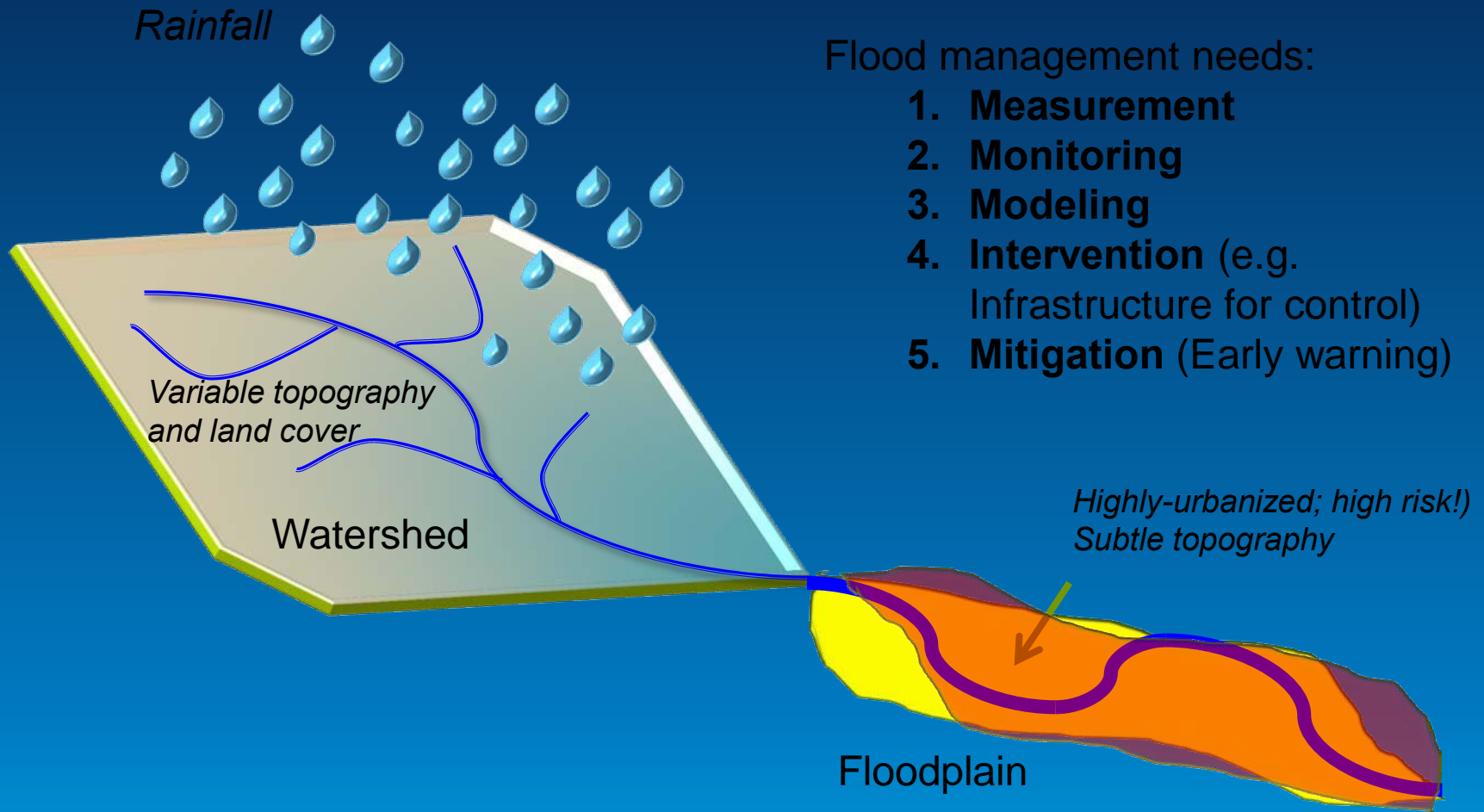
# Are we helping build resilient communities?



*Orchids Subdivision located at the river mouth (estuary) of Mandulog River, Iligan City in Mindanao after typhoon Sendong Dec 2011 In "Washi"*



# Spatial Framework for Flood Analysis



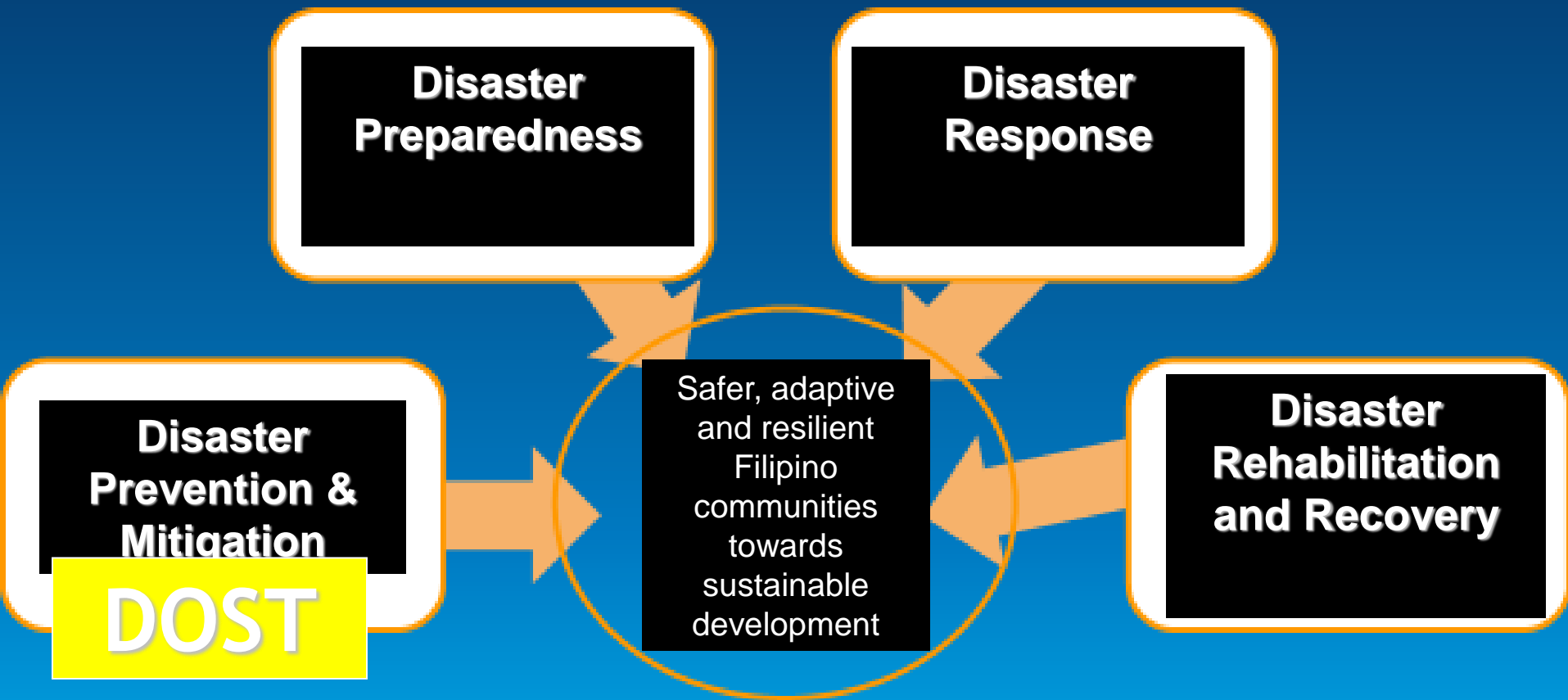
Flood management needs:

1. **Measurement**
2. **Monitoring**
3. **Modeling**
4. **Intervention** (e.g. Infrastructure for control)
5. **Mitigation** (Early warning)

COMMON NEED: Accurate, reliable and up-to-date Spatial DATA



# **DOST** as Overall Responsible Agency for Disaster Prevention & Mitigation



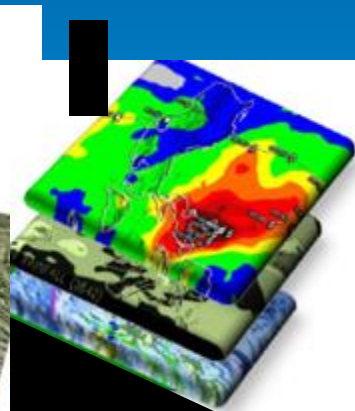
**NDRRMP Four Thematic Areas leading to the attainment of the country's overall DRRM vision (NDRRMP, 2011)**



# Strategies in Support to DOST Outcomes

**Outcome 8: SCIENCE-BASED WEATHER INFORMATION AND CLIMATE CHANGE SCENARIOS WITH ASSOCIATED IMPACT ASSESSMENTS THAT SHALL ENABLE CONCERNED AGENCIES TO DEVELOP APPROPRIATE MITIGATION STRATEGIES FOR A DISASTER AND CLIMATE CHANGE RESILIENT PHILIPPINES**

- Provide NGAs and the public with timely warnings and information on weather and climate change scenarios using state of the art technologies, best practices and tools



# DOST DIRECTED RESEARCHES IN CY 2014

DREAM Phase 1 Outputs

Nationwide Hazard  
Mapping using LIDAR  
(PHIL-LiDAR-1)  
(P1.5 B – 3 years)

Philippine Resources  
Inventory using LIDAR  
(PHIL-LIDAR-2)  
(P900M – 3 years)

Climate Change Adaptation and Disaster  
Risk Reduction (CCA-DRR) Funds in 2014



# Implementing Agencies

## Luzon

UP Diliman

UP Baguio

Central Luzon  
State University

Isabela State  
University

UP Los Baños

Mapua / MIT

Ateneo de Naga

## Visayas

UP Cebu

University of San  
Carlos

Visayas State  
University

## Mindanao

Caraga State  
University

Central Mindanao  
University

MSU-IIT

UP Mindanao

Ateneo de  
Zamboanga

# PROGRAM OBJECTIVES

1. To process data (LIDAR, bathy, SAR) of selected rivers in the MIMAROPA and Laguna from the Phil-LIDAR 1 of UP-Diliman for processing using various software
2. To gather field data for purposes of calibration and validation of hydrologic models
3. To generate and calibrate hydrologic and flood models for each river basin
4. To produce and validate flood hazard maps



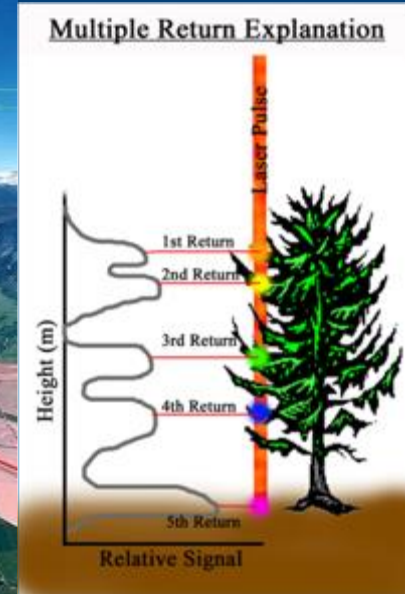
# EXPECTED OUTPUTS

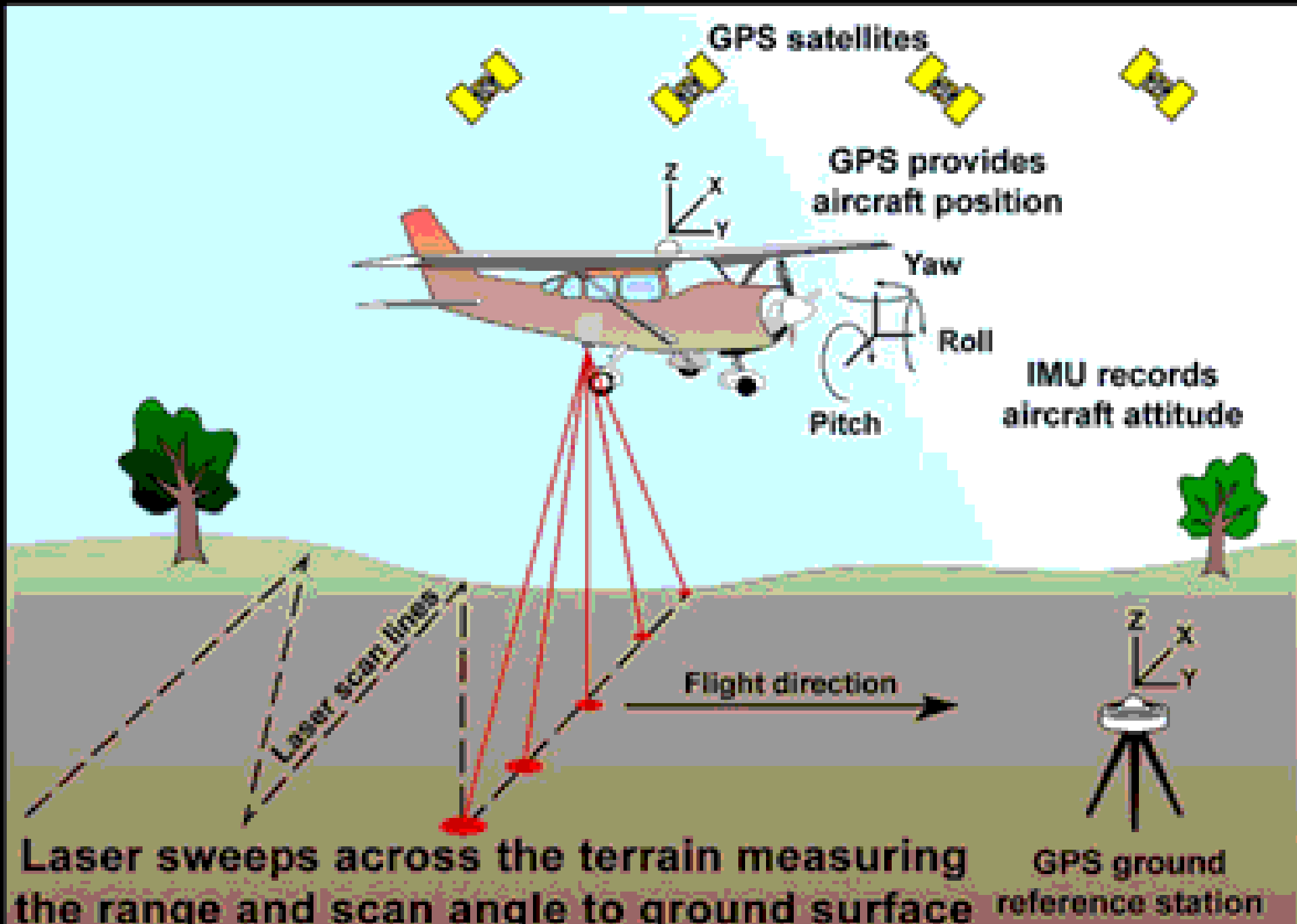
1. **52 river basins with processed DEMs and features extracted**
2. **52 river basins with flow data (base and event); bridge cross-section; flood depth validation data gathered**
3. **52 of calibrated hydrologic and flood inundation model and real time flood inundation model (note: dependent on the availability of AWLS and rain gauges)**
4. **52 flood Inundation and Hazard Maps from various rainfall return period and real time flood inundation map generated**



# Light Detection and Ranging or LiDAR

- The LiDAR sends out a scanning laser beam from the aircraft, which is reflected back to the sensor by the earth's surface and the features on it
- The time this takes is used to calculate the exact distance from the aircraft
- Using airborne LiDAR, it is possible to map all the upstanding features in the landscape





Source: <http://lidarnews.com/articles/lidar-system-accuracy/>

# Aircrafts used in LiDAR operations

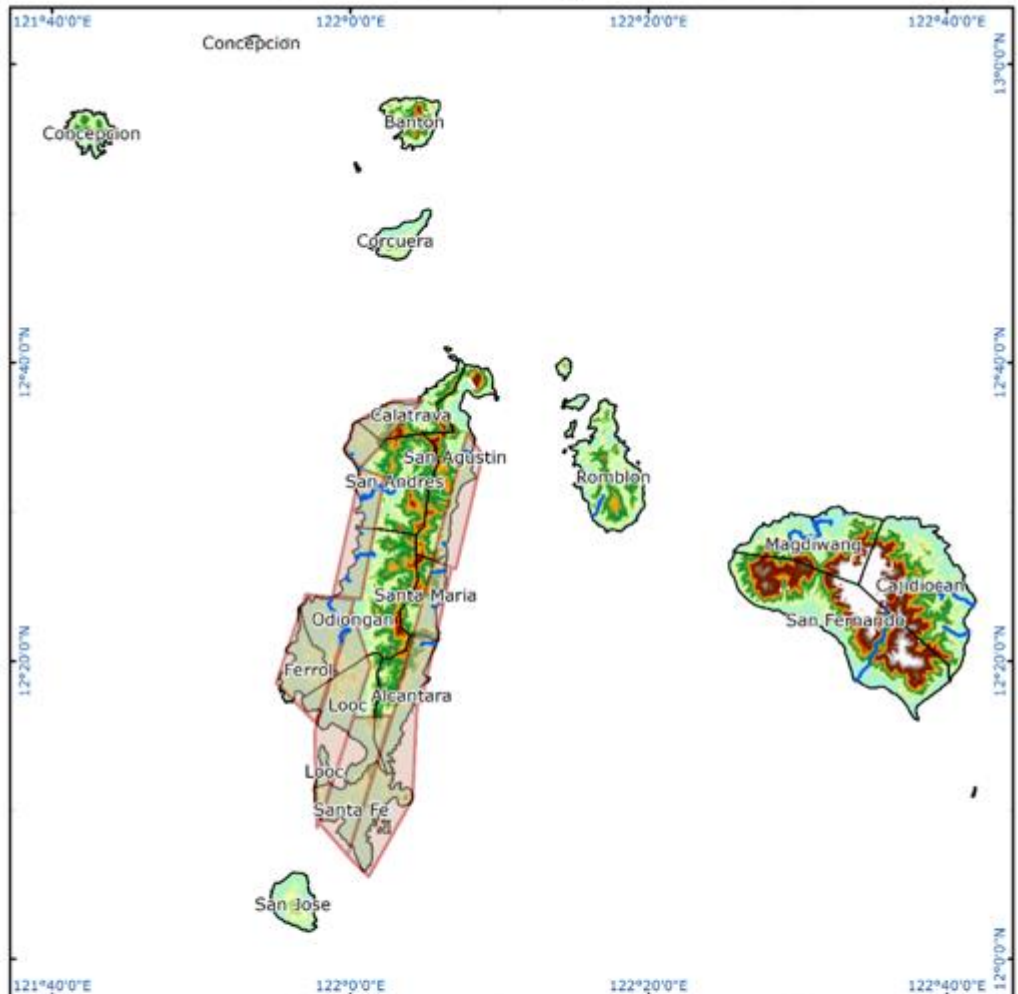


*DREAM Rapid Topographic LIDAR System was deployed to Davao to capture topographic data over Compostela last Jan 15 due to typhoon Pablo; deployed to Tacloban on 21 January for topographic and bathymetric mapping*





# Romblon Flight Plan



**Data Sources**

Romblon DEM	.....	ASTER DEM
Municipal Boundary	.....	www.philgis.org
Stream Network	.....	www.openstreetmap.org

**Coordinate System**  
WGS 1984 UTM Zone 51N

**Datum**  
WGS 1984

**Projection**  
Transverse mercator

**Legend**

- Stream Network
- RML Flight Plans
- Municipal Boundary

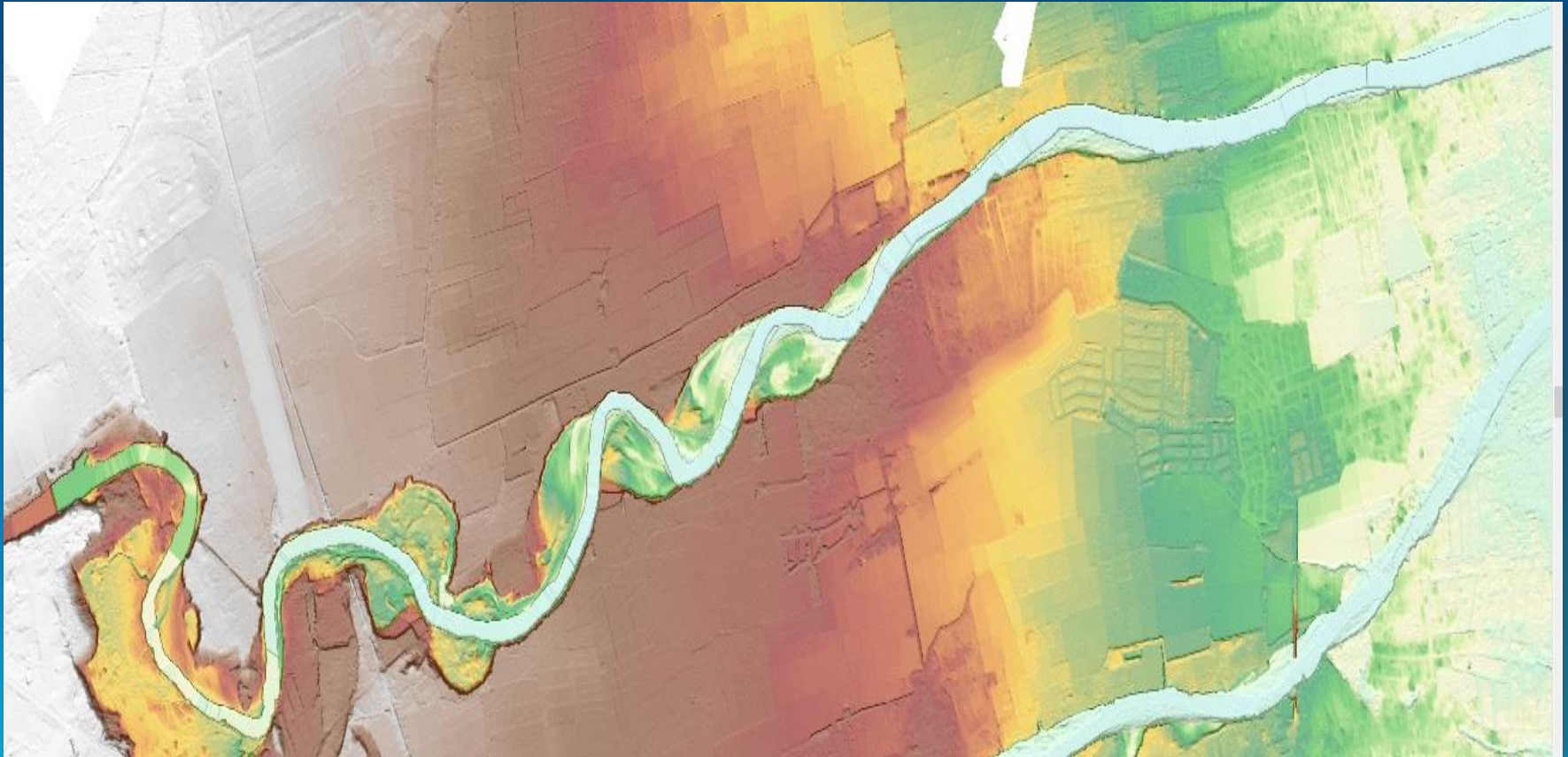
**Romblon ASTER (30m)**

**Value**

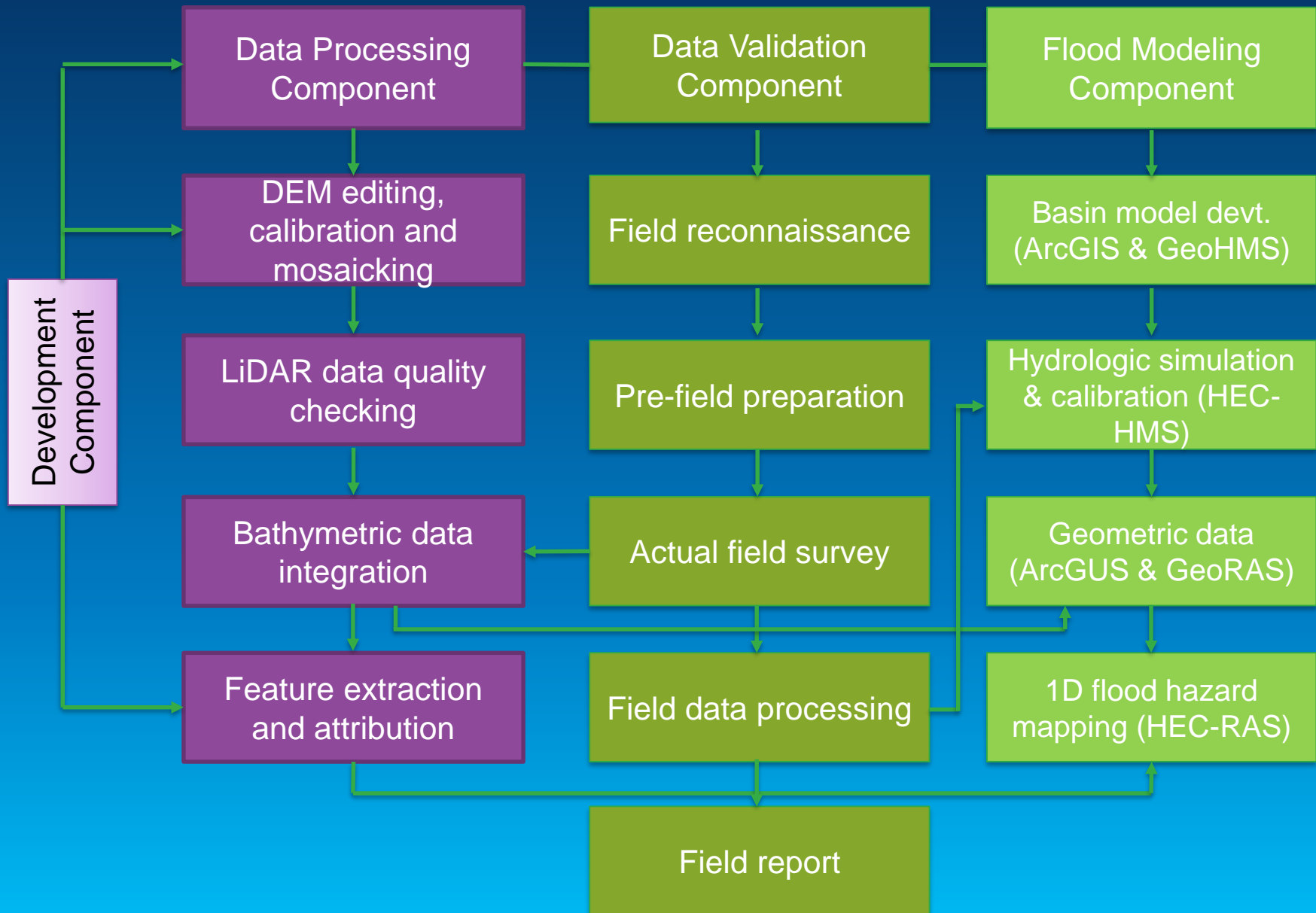
High : 6397  
Low : -8

# OBJECTIVE

Develop 1D-flood hazard map of selected river basins in Oriental Mindoro, Philippines.



# METHODOLOGY



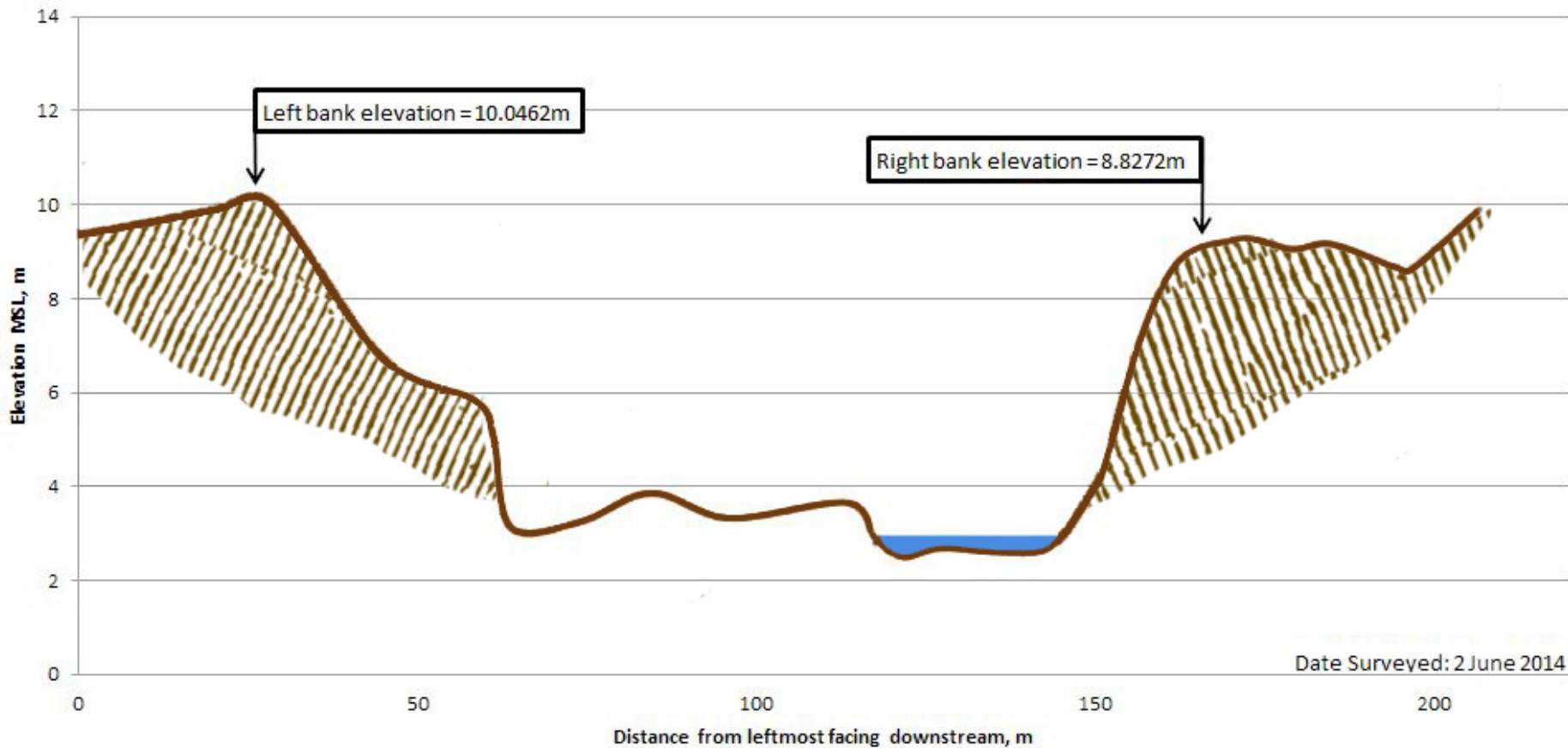




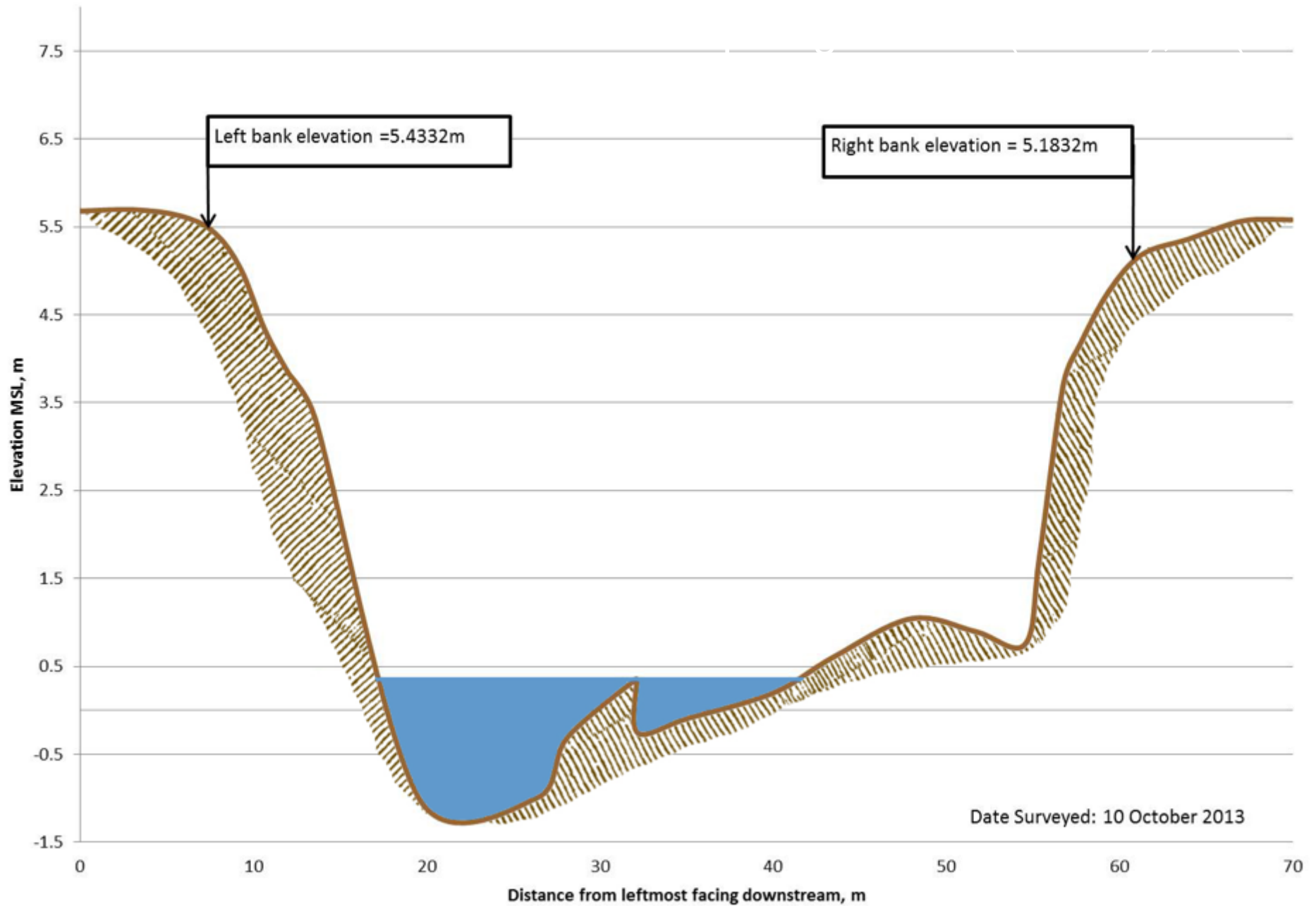


# RESULTS

## Balete Bridge Cross-Section



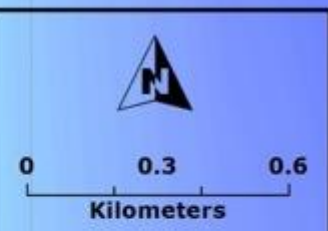
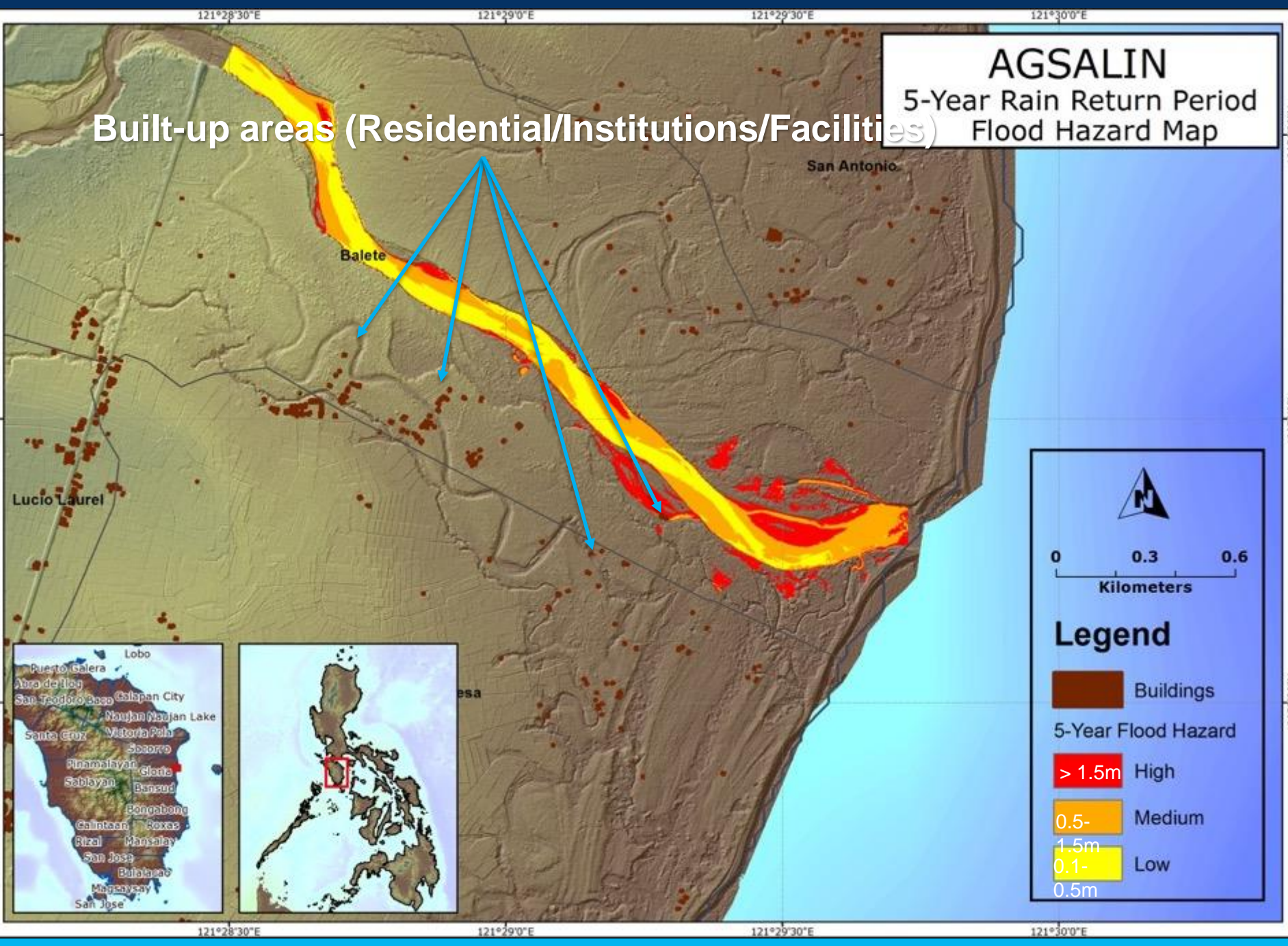
# Sumagui Bridge Cross-Section



Built-up areas (Residential/Institutions/Facilities)

# AGSALIN

## 5-Year Rain Return Period Flood Hazard Map



### Legend

- Buildings
- 5-Year Flood Hazard
  - > 1.5m High
  - 0.5-1.5m Medium
  - 0.1-0.5m Low

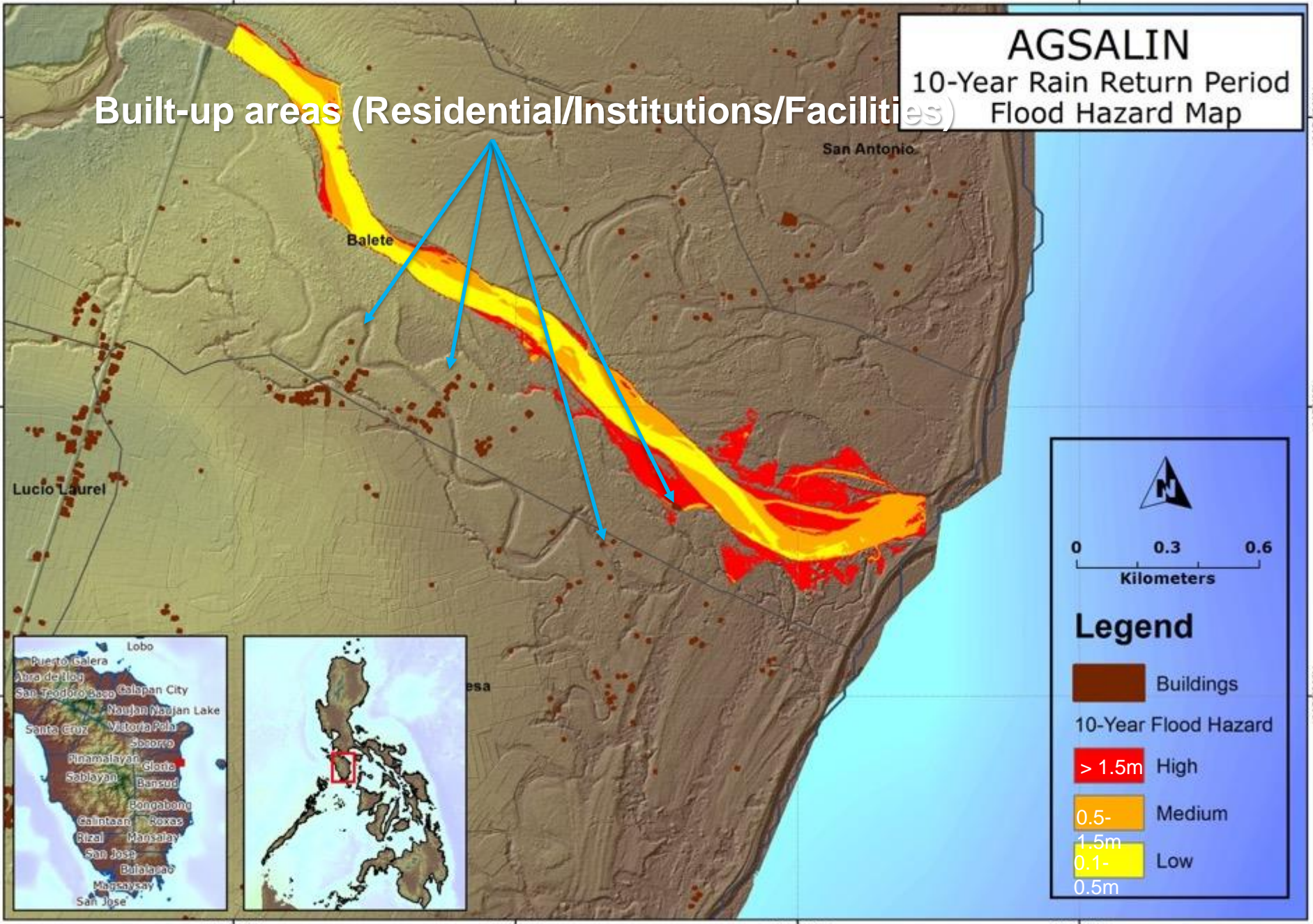




Built-up areas (Residential/Institutions/Facilities)

# AGSALIN

## 10-Year Rain Return Period Flood Hazard Map





121°28'30"E

121°29'0"E

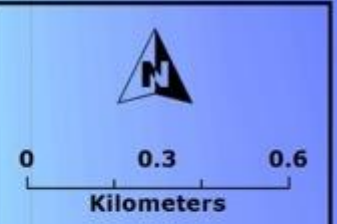
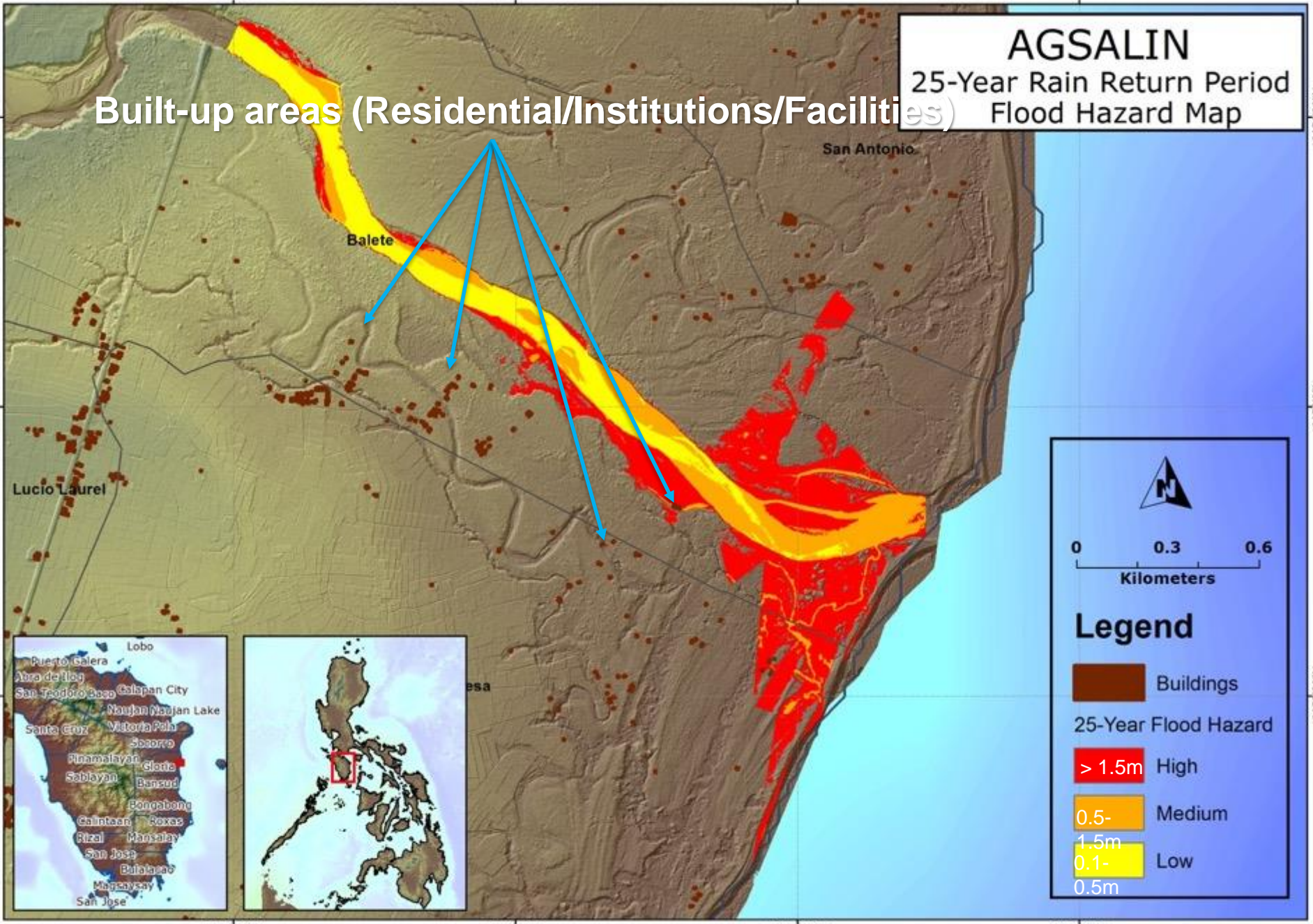
121°29'30"E

121°30'0"E





Built-up areas (Residential/Institutions/Facilities)

# AGSALIN

## 25-Year Rain Return Period Flood Hazard Map



### Legend

-  Buildings
- 25-Year Flood Hazard**
-  > 1.5m High
-  0.5-1.5m Medium
-  0.1-0.5m Low

121°28'30"E

121°29'0"E

121°29'30"E

121°30'0"E

12°56'30"N  
12°56'0"N  
12°55'30"N  
12°55'0"N

121°28'30"E  
121°29'0"E  
121°29'30"E  
121°30'0"E



121°28'30"E

121°29'0"E

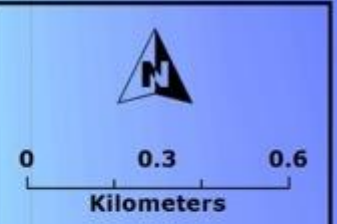
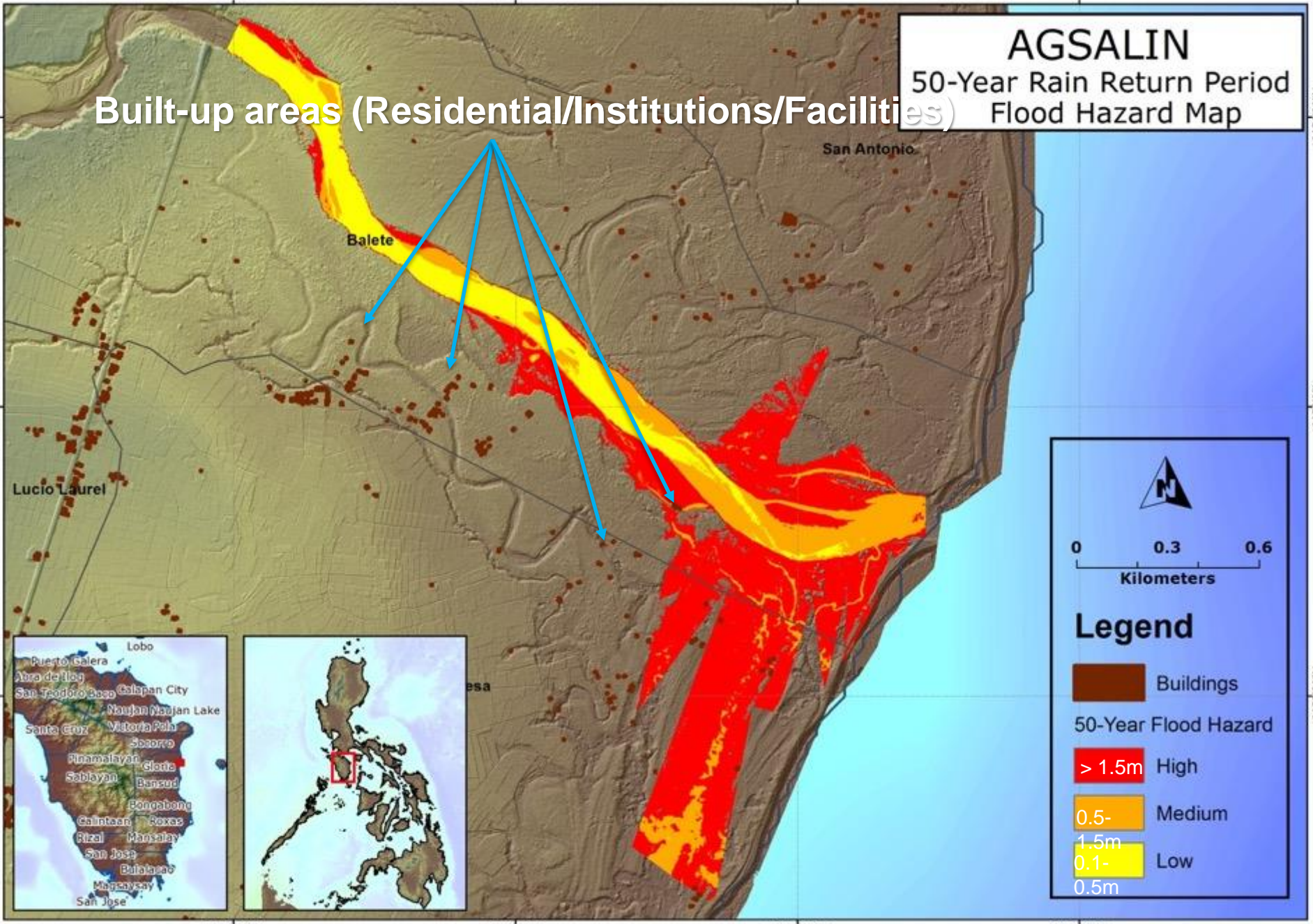
121°29'30"E

121°30'0"E




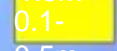
Built-up areas (Residential/Institutions/Facilities)

# AGSALIN

## 50-Year Rain Return Period Flood Hazard Map



### Legend

-  Buildings
- 50-Year Flood Hazard**
-  > 1.5m High
-  0.5-1.5m Medium
-  0.1-0.5m Low

121°28'30"E

121°29'0"E

121°29'30"E

121°30'0"E

12°56'30"N

12°56'0"N

12°55'30"N

12°55'0"N

121°28'30"E

121°29'0"E

121°29'30"E

121°30'0"E



121°28'30"E

121°29'0"E

121°29'30"E

121°30'0"E

Built-up areas (Residential/Institutions/Facilities)

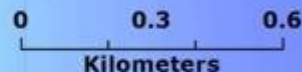
# AGSALIN

## 100-Year Rain Return Period Flood Hazard Map




San Antonio

Balete

Lucio Laurel



### Legend

-  Buildings
- > 1.5m** High
-  0.5-1.5m Medium
-  0.1-0.5m Low



121°28'30"E

121°29'0"E

121°29'30"E

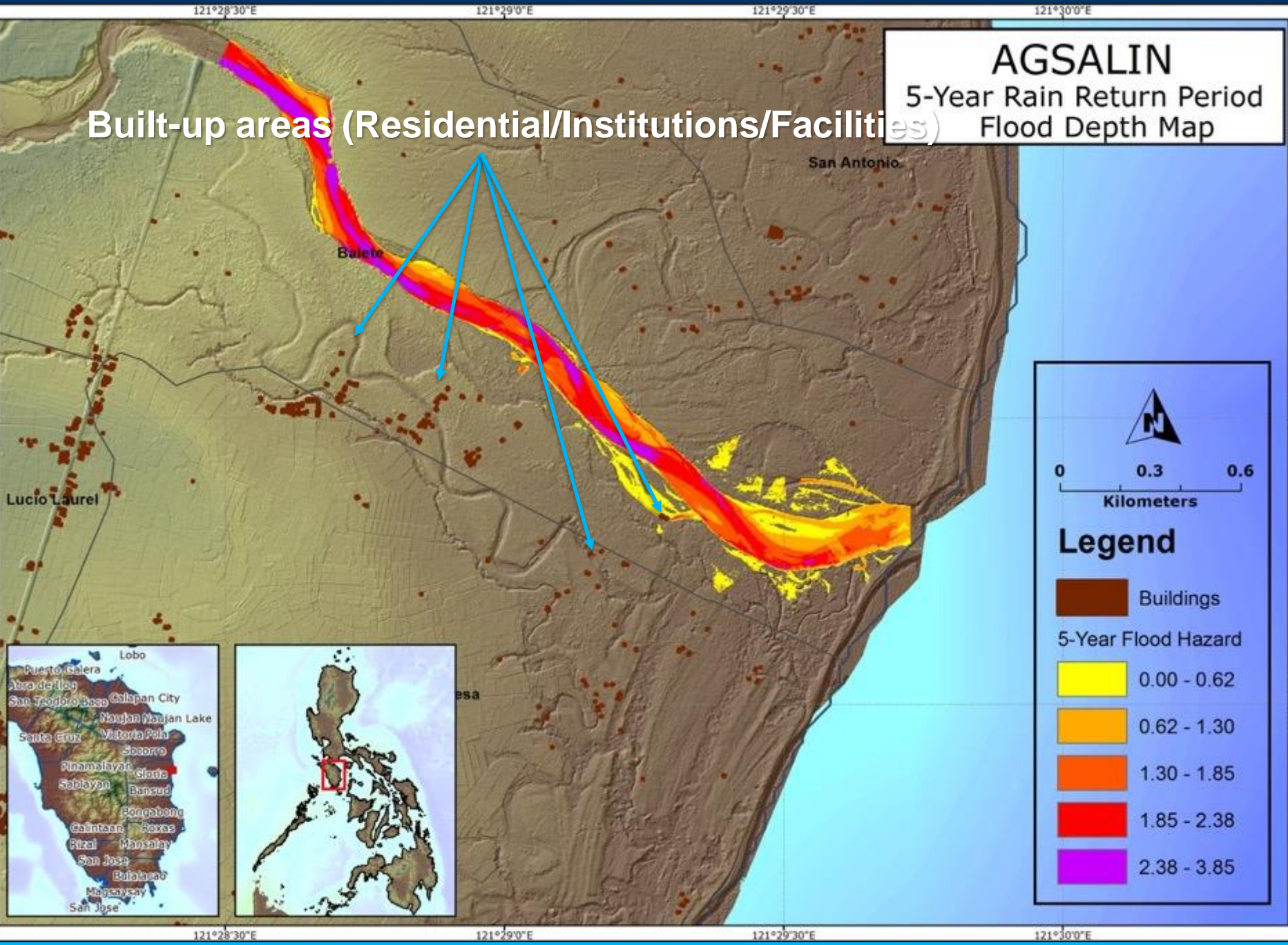
121°30'0"E



Built-up areas (Residential/Institutions/Facilities)

# AGSALIN

## 5-Year Rain Return Period Flood Depth Map



0 0.3 0.6  
Kilometers

### Legend

- Buildings
- 5-Year Flood Hazard
- 0.00 - 0.62
- 0.62 - 1.30
- 1.30 - 1.85
- 1.85 - 2.38
- 2.38 - 3.85



121°28'30"E

121°29'0"E

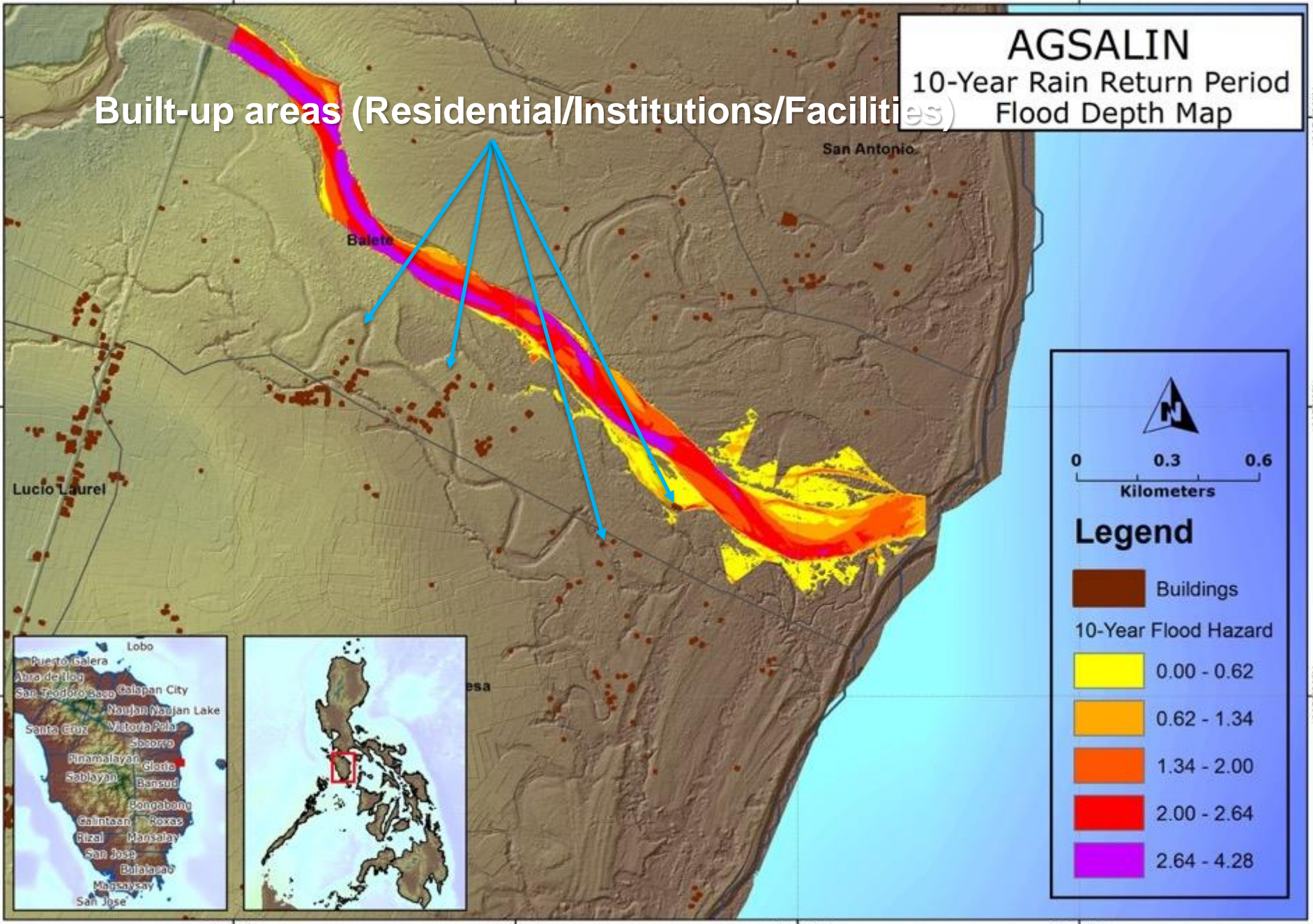
121°29'30"E

121°30'0"E

Built-up areas (Residential/Institutions/Facilities)

# AGSALIN

## 10-Year Rain Return Period Flood Depth Map



121°28'30"E

121°29'0"E

121°29'30"E

121°30'0"E



### Legend

-  Buildings
- 10-Year Flood Hazard**
-  0.00 - 0.62
-  0.62 - 1.34
-  1.34 - 2.00
-  2.00 - 2.64
-  2.64 - 4.28

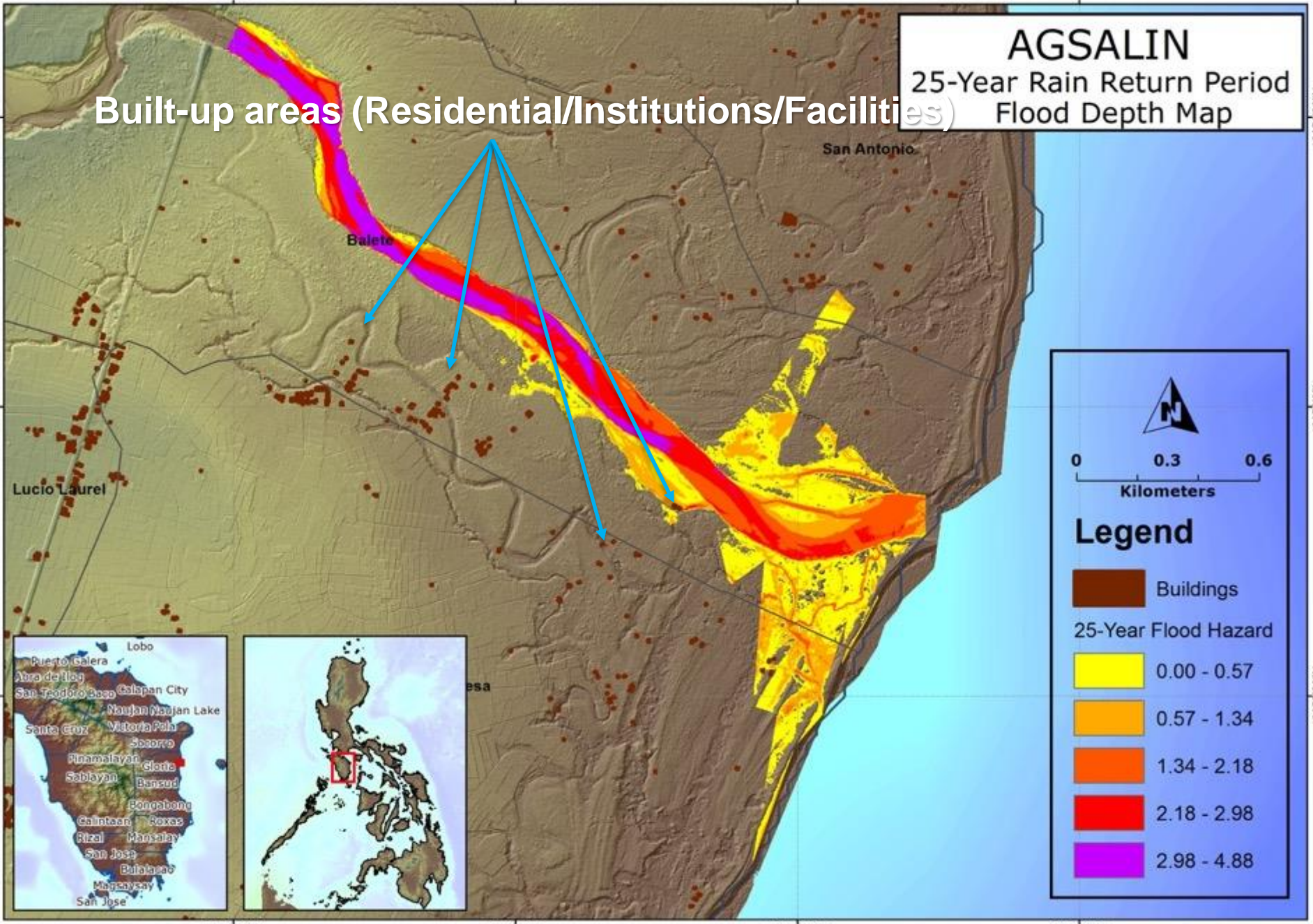


121°28'30"E 121°29'0"E 121°29'30"E 121°30'0"E

Built-up areas (Residential/Institutions/Facilities)

# AGSALIN

25-Year Rain Return Period  
Flood Depth Map



## Legend

-  Buildings
- 25-Year Flood Hazard**
-  0.00 - 0.57
-  0.57 - 1.34
-  1.34 - 2.18
-  2.18 - 2.98
-  2.98 - 4.88

121°28'30"E 121°29'0"E 121°29'30"E 121°30'0"E

12°55'30"N  
12°55'00"N  
12°54'30"N

121°28'30"E  
121°29'0"E  
121°29'30"E  
121°30'0"E



121°28'30"E

121°29'0"E

121°29'30"E

121°30'0"E

Built-up areas (Residential/Institutions/Facilities)

# AGSALIN

50-Year Rain Return Period  
Flood Depth Map

San Antonio

Bailete

Lucio Laurel



## Legend

-  Buildings
- 50-Year Flood Hazard**
-  0.00 - 0.61
-  0.61 - 1.36
-  1.36 - 2.28
-  2.28 - 3.22
-  3.22 - 5.32



121°28'30"E

121°29'0"E

121°29'30"E

121°30'0"E

12°56'30"N  
12°56'0"N  
12°55'30"N

121°28'30"E  
121°29'0"E  
121°29'30"E  
121°30'0"E

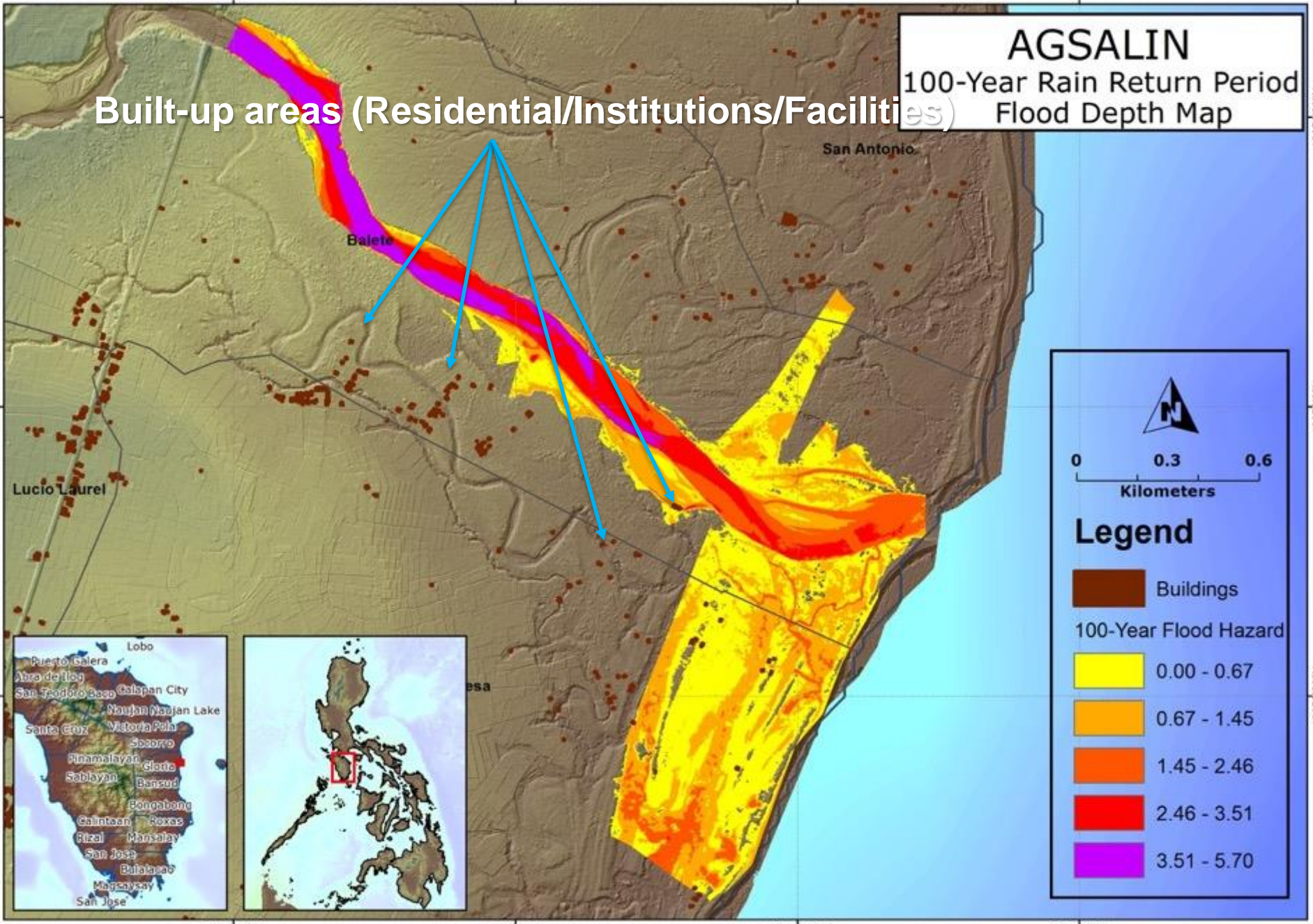


121°28'30"E 121°29'0"E 121°29'30"E 121°30'0"E

Built-up areas (Residential/Institutions/Facilities)

# AGSALIN

100-Year Rain Return Period  
Flood Depth Map



121°28'30"E 121°29'0"E 121°29'30"E 121°30'0"E

12°55'30"N  
12°55'00"N  
12°54'30"N

121°28'30"E  
121°29'0"E  
121°29'30"E  
121°30'0"E



**Legend**

	Buildings
100-Year Flood Hazard	
	0.00 - 0.67
	0.67 - 1.45
	1.45 - 2.46
	2.46 - 3.51
	3.51 - 5.70



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

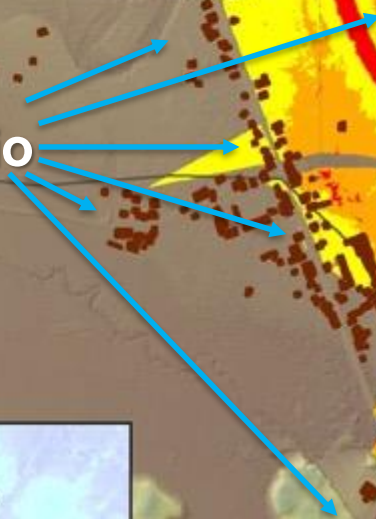
# SUMAGUI

## 5-Year Rain Return Period Flood Hazard Map




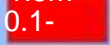
Villa Pag-Asa

Sumagui

Built-up areas  
(Residential/Institutions/Facilities)



### Legend

-  Buildings
- 5-Year Flood Hazard
-  > 1.5m Low
-  0.5-1.5m Medium
-  0.1-0.5m High



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

12°48'0"N

12°48'0"N

12°47'30"N

12°47'30"N



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

# SUMAGUI

## 10-Year Rain Return Period Flood Hazard Map




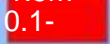
Villa Pag-Asa

Sumagui

Built-up areas  
(Residential/Institutions/Facilities)



### Legend

-  Buildings
- 10-Year Flood Hazard
-  > 1.5m Low
-  0.5-1.5m Medium
-  0.1-0.5m High



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

12°48'0"N

12°48'0"N

12°47'30"N

12°47'30"N



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

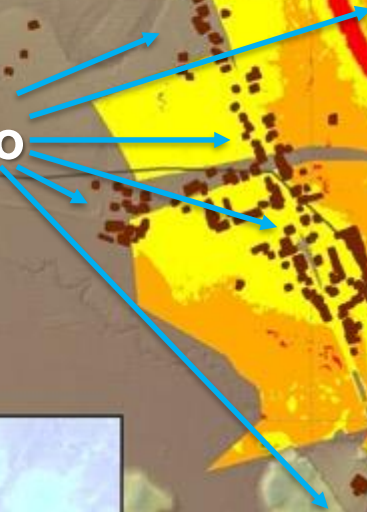
# SUMAGUI

## 25-Year Rain Return Period Flood Hazard Map




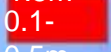
Villa Pag-Asa

Sumagui

Built-up areas  
(Residential/Institutions/Facilities)



### Legend

-  Buildings
- 25-Year Flood Hazard
-  > 1.5m Low
-  0.5-1.5m Medium
-  0.1-0.5m High



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

12°48'0"N

12°48'0"N

12°47'30"N

12°47'30"N



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

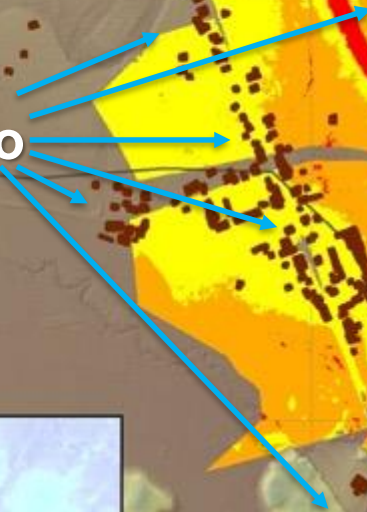
# SUMAGUI

## 50-Year Rain Return Period Flood Hazard Map




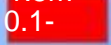
Villa Pag-Asa

Sumagui

Built-up areas  
(Residential/Institutions/Facilities)



### Legend

-  Buildings
- 50-Year Flood Hazard
  -  > 1.5m Low
  -  0.5-1.5m Medium
  -  0.1-0.5m High



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

12°48'0"N

12°48'0"N

12°47'30"N

12°47'30"N



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

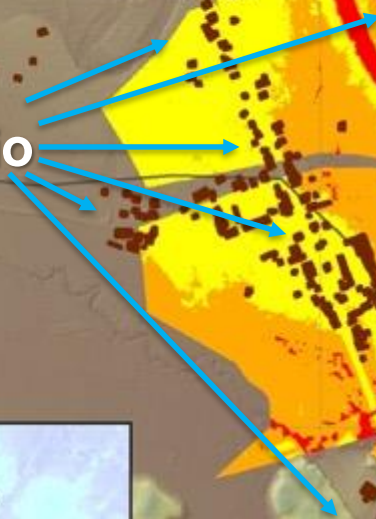
# SUMAGUI

## 100-Year Rain Return Period Flood Hazard Map


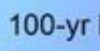


Villa Pag-Asa

Sumagui

Built-up areas  
(Residential/Institutions/Facilities)



### Legend

-  Buildings
- 100-yr Flood Hazard
-  > 1.5m Low
-  0.5-1.5m Medium
-  0.1-0.5m High



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

12°48'0"N

12°48'0"N

12°47'30"N

12°47'30"N



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

# SUMAGUI

## 5-Year Rain Return Period Flood Depth Map

Villa Pag-Asa

Sumagui

Built-up areas  
(Residential/Institutions/Facilities)



### Legend



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

12°48'0"N

12°48'0"N

12°47'30"N

12°47'30"N



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

# SUMAGUI

## 10-Year Rain Return Period Flood Depth Map


Villa Pag-Asa

Sumagui

Built-up areas  
(Residential/Institutions/Facilities)



### Legend

-  Buildings
- 10-Year Flood Depth**
-  0.00 - 0.91
-  0.91 - 1.59
-  1.59 - 2.25
-  2.249 - 3.14
-  3.14 - 5.41



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

12°48'0"N

12°48'0"N

12°47'30"N

12°47'30"N



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

# SUMAGUI

## 25-Year Rain Return Period Flood Depth Map

Villa Pag-Asa

Sumagui

Built-up areas  
(Residential/Institutions/Facilities)



### Legend

-  Buildings
- 25-Year Flood Depth**
-  0.00 - 1.10
-  1.10 - 1.81
-  1.81 - 2.50
-  2.50 - 3.41
-  3.4 - 6.05



121°28'0"E

121°28'30"E

121°29'0"E

121°29'30"E

12°48'0"N

12°48'0"N

12°47'30"N

12°47'30"N



121°28'0"E 121°28'30"E 121°29'0"E 121°29'30"E

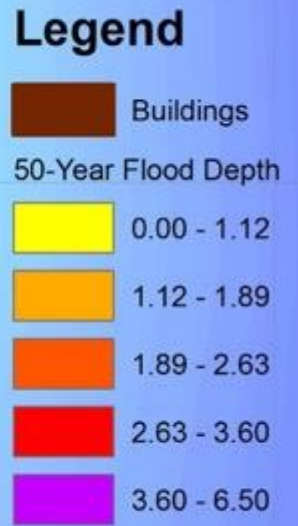
# SUMAGUI

## 50-Year Rain Return Period Flood Depth Map

Villa Pag-Asa

Sumagui

Built-up areas  
(Residential/Institutions/Facilities)



121°28'0"E 121°28'30"E 121°29'0"E 121°29'30"E

12°48'0"N  
12°47'30"N

12°48'0"N  
12°47'30"N

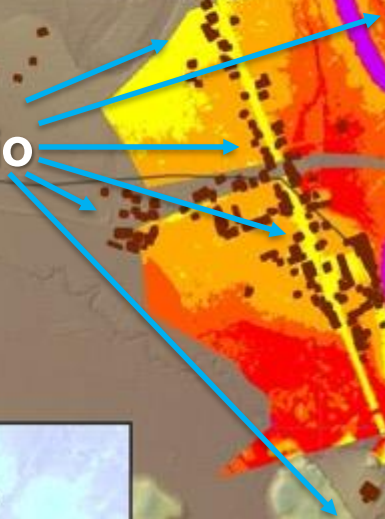



121°28'0"E 121°28'30"E 121°29'0"E 121°29'30"E

# SUMAGUI

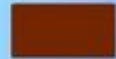





## 100-Year Rain Return Period Flood Depth Map

Built-up areas  
(Residential/Institutions/Facilities)

0 0.25 0.5  
Kilometers

### Legend

-  Buildings
- 100-yr Flood Depth**
-  0.00 - 1.14
-  1.14 - 1.96
-  1.96 - 2.74
-  2.76 - 3.75
-  3.75 - 6.92



121°28'0"E 121°28'30"E 121°29'0"E 121°29'30"E

12°48'0"N  
12°47'30"N

12°48'0"N  
12°47'30"N

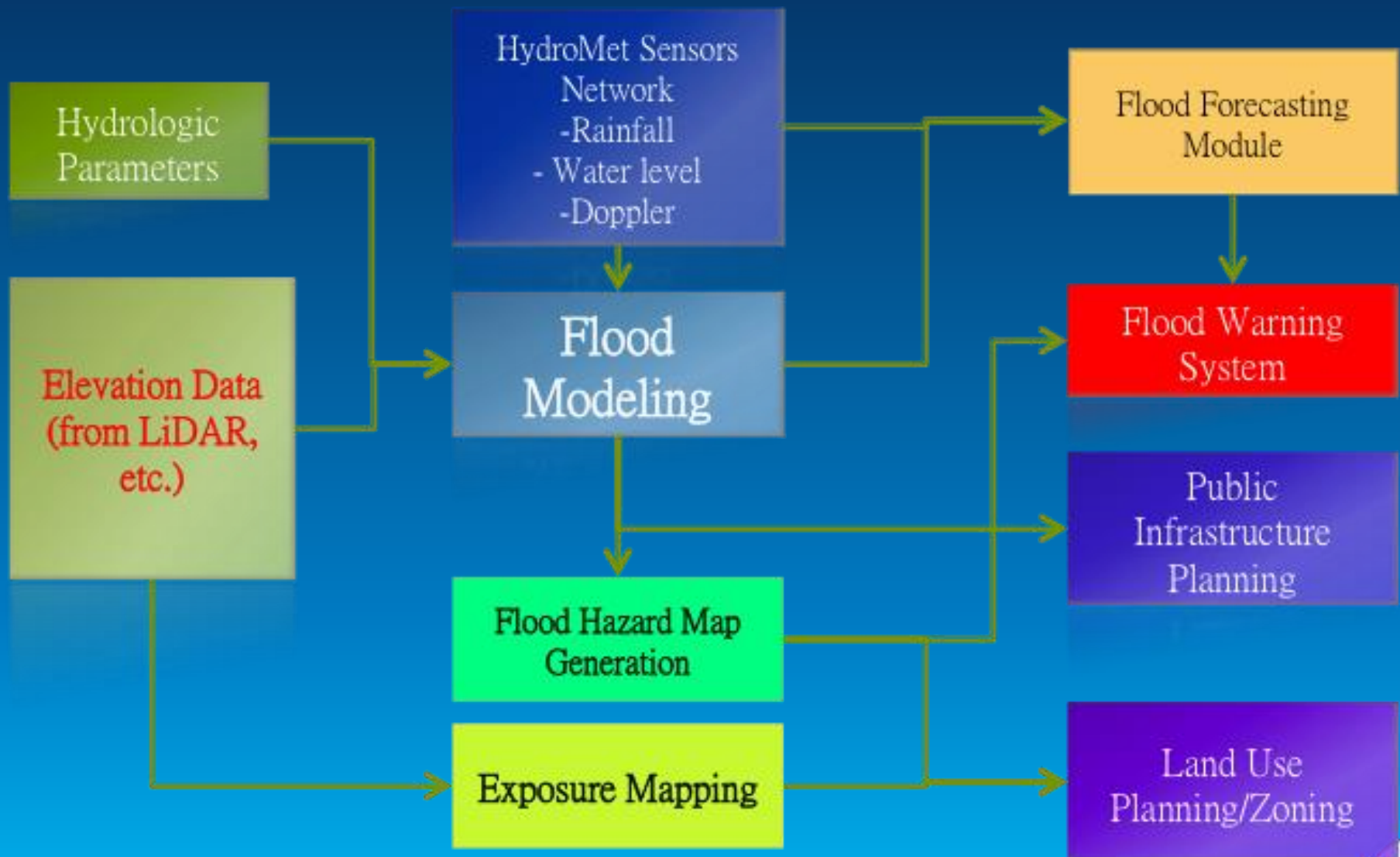
# CONCLUDING REMARKS

- **Gathered LiDAR data can serve a vital input in various applications that would benefit stakeholders and agencies in the Philippines in addressing natural hazards and disasters**
- **High resolution and updated flood hazard maps can provide more detailed information for appropriate mitigation and action to reduce the effect of climate related disaster events**





# Integrated Flood Information System



# Online platform for flood monitoring & forecasting

Phil-LIDAR Basins » UP DREAM Program

Talomo		Agsalin					
Region XII		Water Level Sensors (WLS)	Rain Gauges	Spilling Level	Current Level	Last Updated	Links
		Balete Bridge, Gloria, Oriental Mindoro	Manguyang Elem. School, Gloria, Oriental Mindoro	L: 10.05 m R: 8.82 m	0.00 m		<a href="#">Forecast</a>
Region XIII		Amnay					
Cabadbaran		Water Level Sensors (WLS)	Rain Gauges	Spilling Level	Current Level	Last Updated	Links
Kalinawan		Amnay Bridge, Sablayan, Occ. Mindoro		L: 40.42 m R: 39.31 m	0.00 m		
Tago		Anahawin					
Region XVIII		Water Level Sensors (WLS)	Rain Gauges	Spilling Level	Current Level	Last Updated	Links
Danao		Anahawin Bridge (Down Stream), Occidental Mindoro		L: 4.81 m R: 4.51 m	0.00 m		
Himogaan River		Anahawin Bridge (Up Stream), Occidental Mindoro		L: 4.88 m R: 2.83 m	0.00 m		
Imbang		Babuyan					
Malugo		Water Level Sensors (WLS)	Rain Gauges	Spilling Level	Current Level	Last Updated	Links
Talabaan		Babuyan Bridge, Puerto Princesa City		L: 6.59 m R: 5.72 m	0.00 m		
		Baroc					
		Water Level Sensors (WLS)	Rain Gauges	Spilling Level	Current Level	Last Updated	Links
		Baroc Bridge, San Jose, Occidental Mindoro		L: 4.28 m R: 4.03 m	0.00 m		
		Bongabong					
		Water Level Sensors (WLS)	Rain Gauges	Spilling Level	Current Level	Last Updated	Links

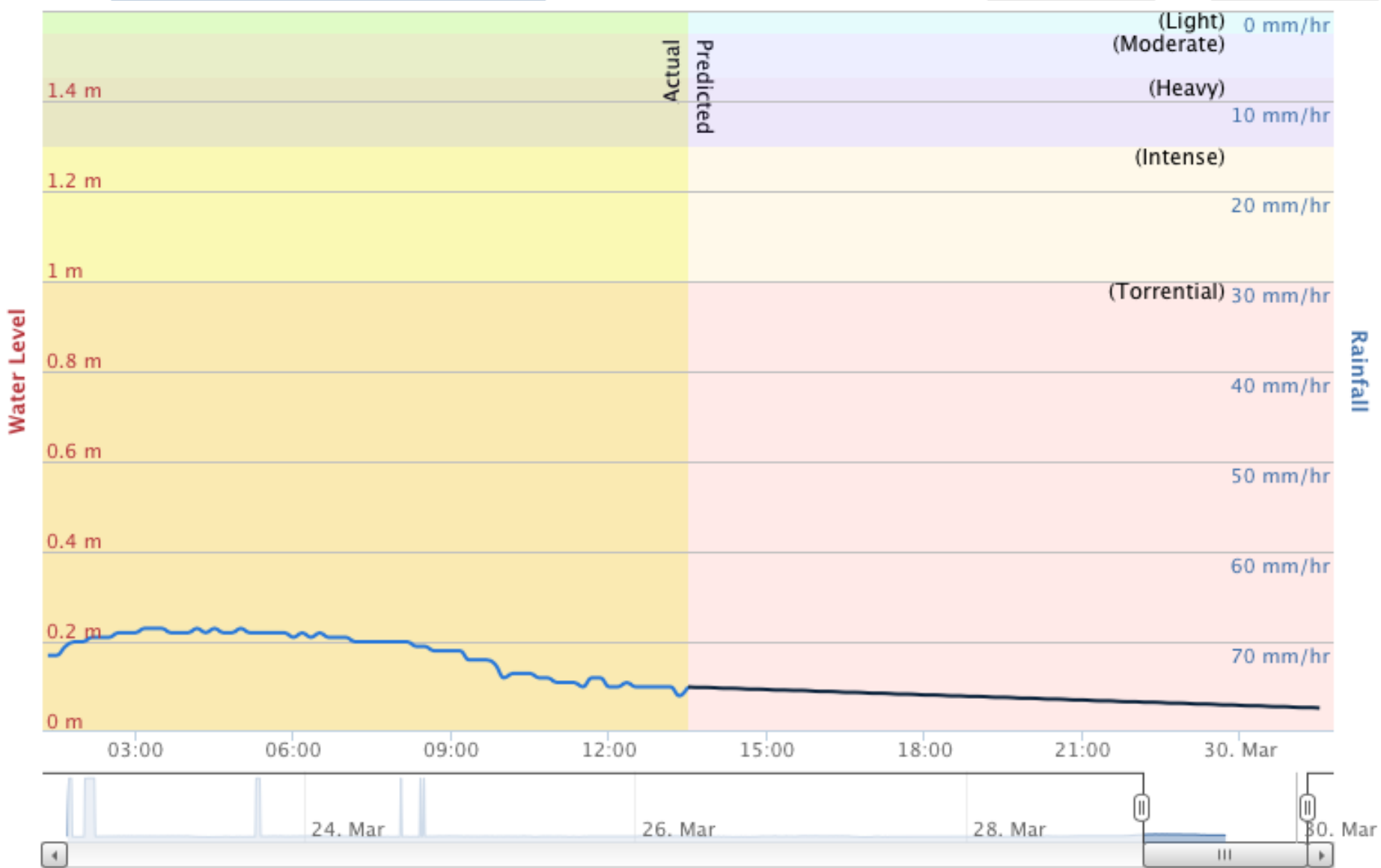


# BALITE BRIDGE @2016-03-29 13:30:00



Zoom 1h 3h 6h 12h 1d 3d 6d 12d

From Mar 29, 2016 To Mar 30, 2016



— Actual — Predicted ■ MANGUYANG ELEMENTARY SCHOOL



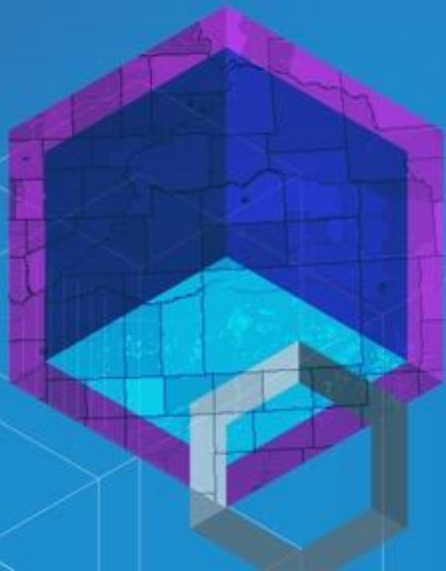
# **Phi-LiDAR 1**

**University of the Philippines Los Baños**



# Thank You!

## Questions?



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