Survey requirements for river flood assessment and spatial planning: Experiences from river hydrographic measurements and LIDAR surveys in the Philippines

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Outline of this Presentation

- Introduction to Natural Hazards in the Philippines
- The DREAM Program
- Requirements for River Surveys and Integration
- Some Examples and Applications
- Conclusions

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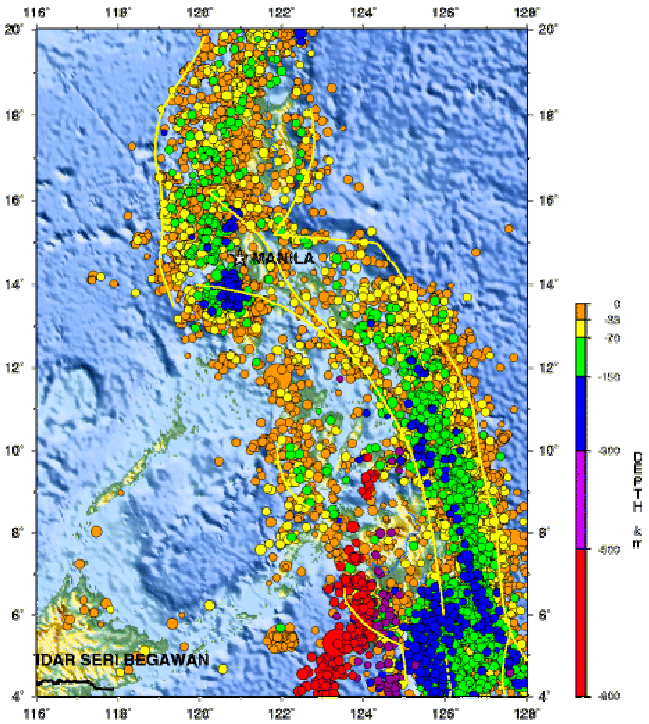
The Hazardscape of Philippines



- The geographic and geologic setting of the Philippines (part of Pacific Ring of Fire and Earthquake Belt) make it prone to various hazards, including:
  - weather and climate-related
  - volcano-related
  - earthquake-related (tsunami)
- Three of deadliest typhoons occured the past three years:
  - Dec 2011 – TS Washi – 1,268
  - Dec 2012 – TY Bopha – 1,901
  - Nov 2013 – TY Haiyan – **6,300**

The Hazardscape of Philippines

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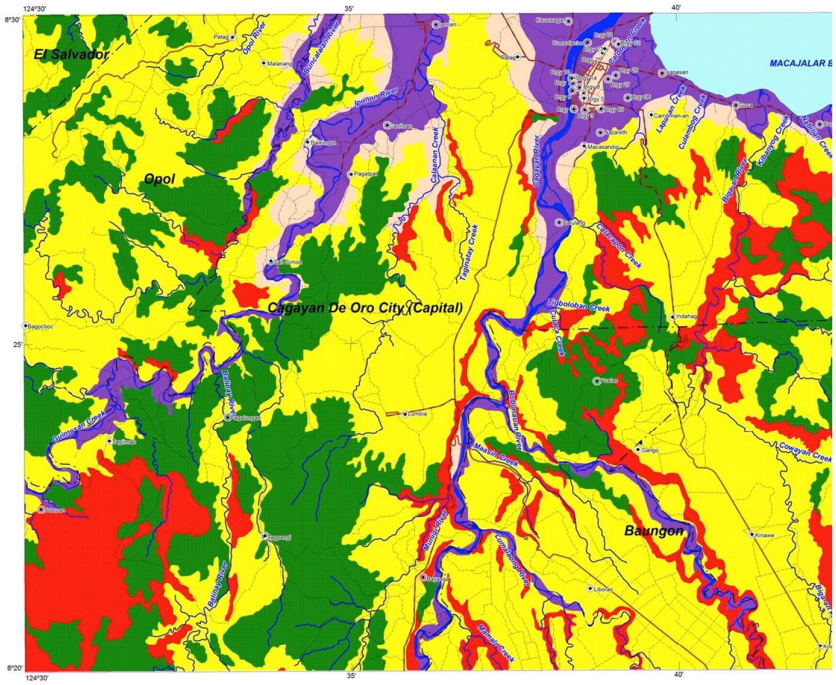
Source "http://en.wikipedia.org/wiki/Wikipedia:WikiProject_Tropical_cyclones/Tracks

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"

INDEX MAP

LANDSLIDE AND FLOOD SUSCEPTIBILITY MAP OF CAGAYAN DE ORO QUADRANGLE MISAMIS ORIENTAL AND BUKIDNON PROVINCES, PHILIPPINES



High susceptibility to landslide

Areas with high landslide susceptibility rating have active/recent landslides and tension cracks that would directly affect the community. Those with steep slopes and drainages that are prone to landslide damming are also highly susceptible to landslides.

Moderate susceptibility to landslide

Areas with moderate landslide susceptibility rating have inactive/old landslides and tension cracks which are located away from the community. These areas usually have moderate slopes.

Low susceptibility to landslide

Areas with low to gentle slopes and lacking tension cracks have low landslide susceptibility rating.

High susceptibility to flooding

Areas with greater than 1 meter flood height. These areas are usually flooded for several hours during heavy rains; include landforms of topographic lows such as active river channels, abandoned river channels and areas along river banks; also prone to flashfloods.

Low to moderate susceptibility to flooding

Areas with less than 1.0 meter flood height. These are usually inundated during prolonged and extensive heavy rainfall or extreme weather condition

Sheet No. 3945 III "Cagayan De Oro Quadrangle"

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
MINES AND GEOSCIENCES BUREAU
LANDS GEOLOGICAL SURVEY DIVISION

http://gdis.denr.gov.ph/mgbviewer/

Accessed: 18 September 2013

DOST PROJECTS UNDER THE NOAH

In response to President Aquino's instructions to put in place a responsive program for flood early warning mitigation, the DOST has undertaken among others a comprehensive flood hazard assessment of 18 major river systems in the country.

DEPARTMENT OF SCIENCE AND TECHNOLOGY

The Nationwide Disaster Risk and Exposure Assessment for Mitigation (DREAM) LIDAR Program

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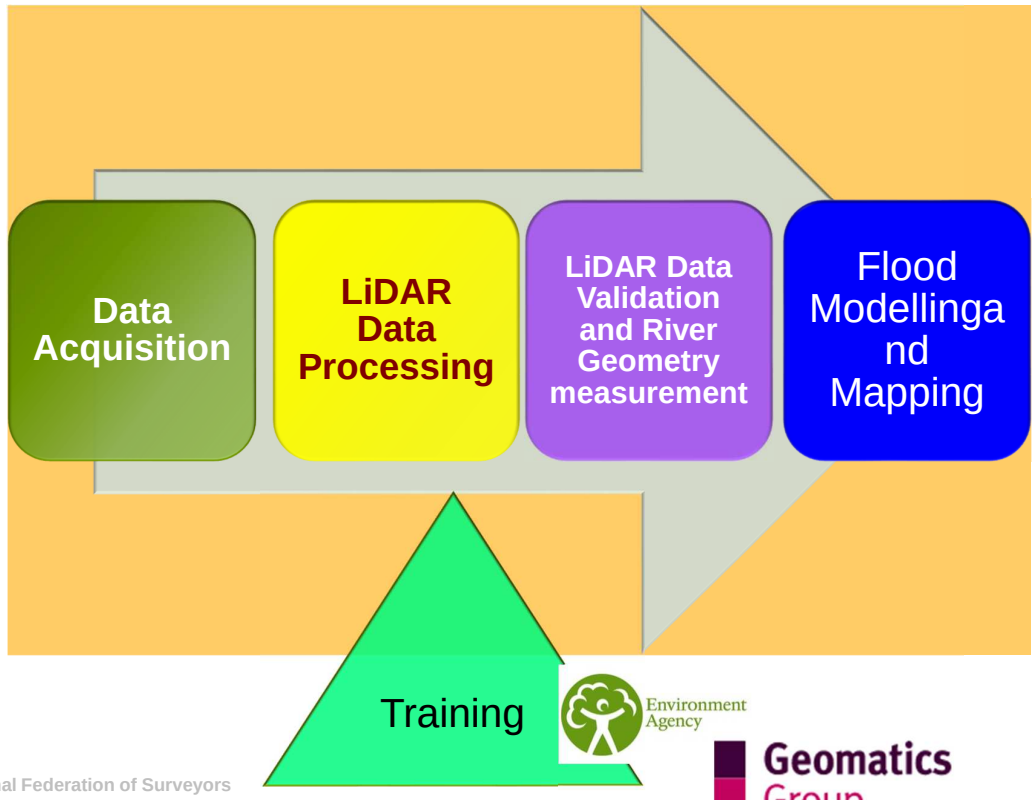
DREAM Program: Basic Information

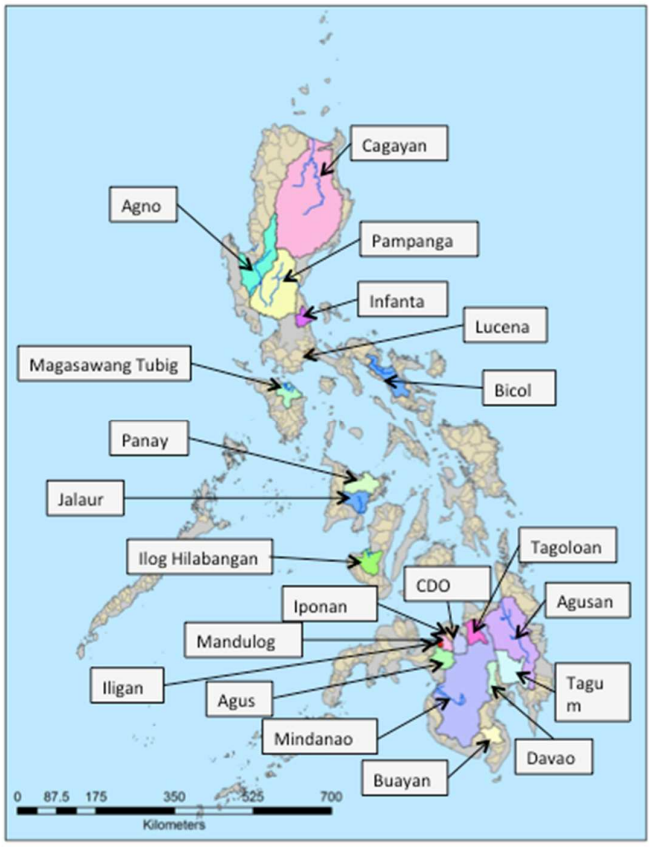
- **Program Duration:** Two (2) years from 2012 extended to Dec 2014
- **Funding source:** Department of Science and Technology (DOST) thru Grants-in-Aid Program
- Total Program personnel: 90 persons in peak period
- **Program Implementors:**
  - University of the Philippines
    - TCAGP: LiDAR Acquisition, Validation and Processing
    - Established a Program Office at the UP National Engineering Center
    - National Institute of Geological Sciences (NIGS) VTEC Lab: Flood Modeling and Simulation

DREAM Program: Component Projects – Capacities built



The DREAM LIDAR Program

- OBJECTIVE: to generate finer-scale flood hazard maps and inundation models to be used for 6-hr early warning
- Surveyed the 18 major river basins (RBs) prone to flooding through airborne LIDAR (3D mapping)
- 3D maps were used for flood simulation for different rainfall events



Aircrafts used for LIDAR operation

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

LiDAR Mapping Systems for DREAM

LIDAR Sensor (full-wave) 1 + RGB Camera

Topographic

LIDAR sensor 2 + RGB
++ Full wave form

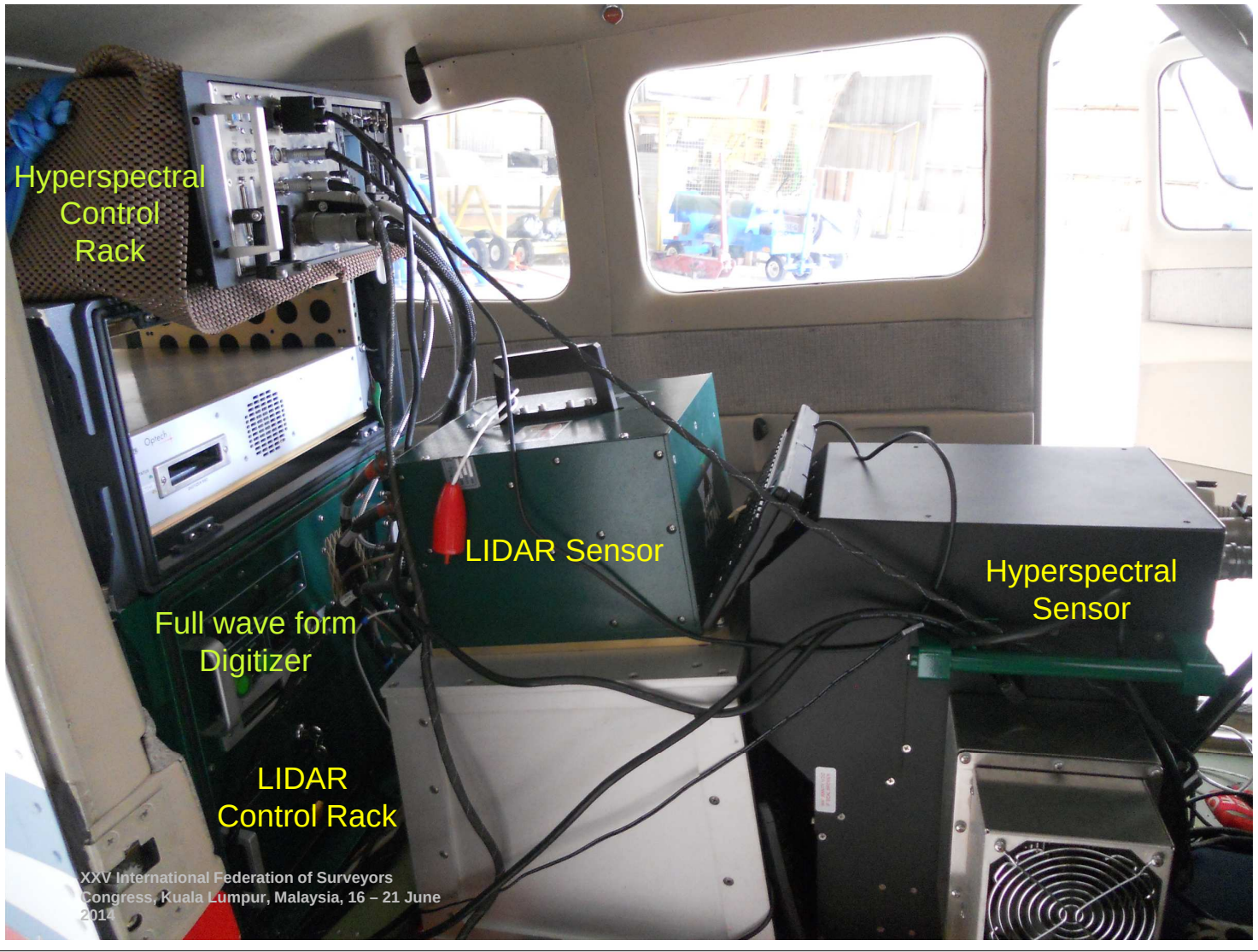
Topographic (for land) LIDAR

LIDAR Sensor 3 + CASI

Bathymetric (Water) LIDAR

LIDAR Sensor (full-wave) 1 + RGB Camera

Topographic



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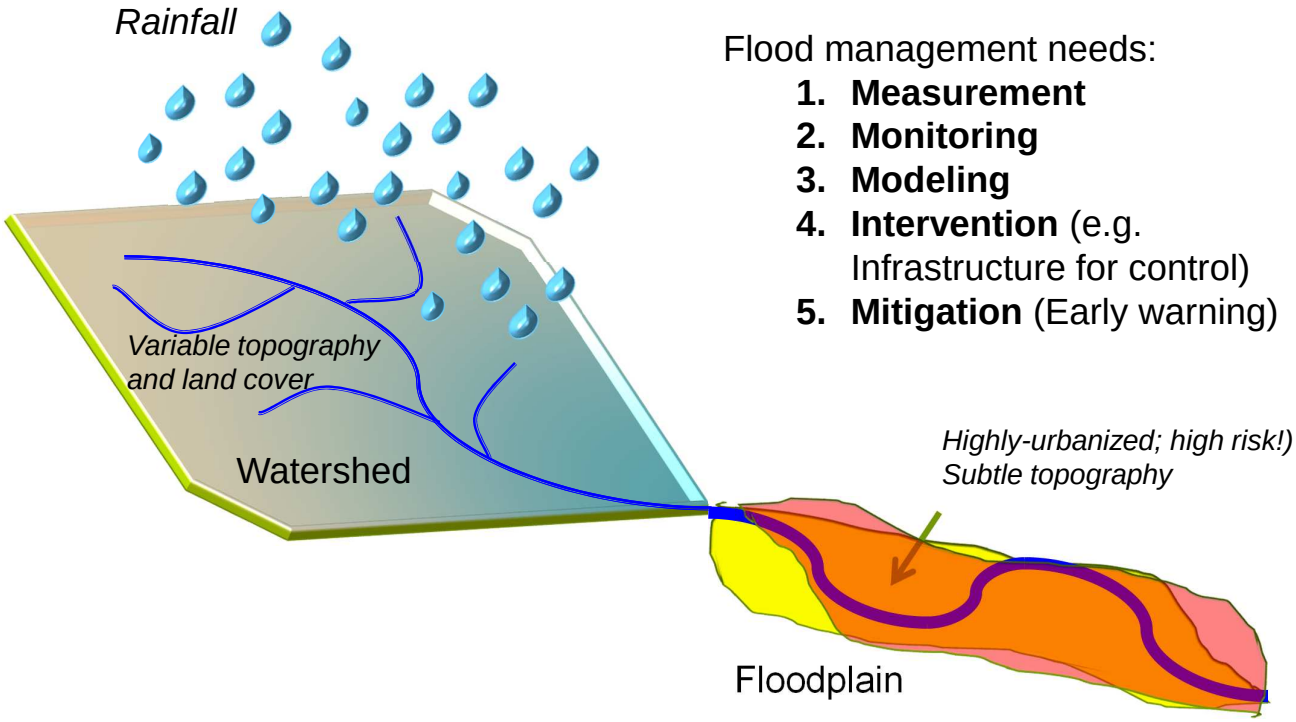
Spatial Framework for Flood Analysis



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

Survey Requirements for River Flood Assessment

Survey activity	Method
River cross section	GNSS PPK
River profile	GNSS PPK and/or Mobile Mapping System
River bathymetry	Echosounder+DGPS
Flood plain topography	LIDAR Survey
River hydrometry (velocity, flow)	Acoustic doppler current profiler (ADCP), velocity meter (propeller type)

Data Validation and Bathymetry Surveys

(a) Bathymetry survey

(a) River cross section survey

Riverbank Survey using a Mobile Mapping System

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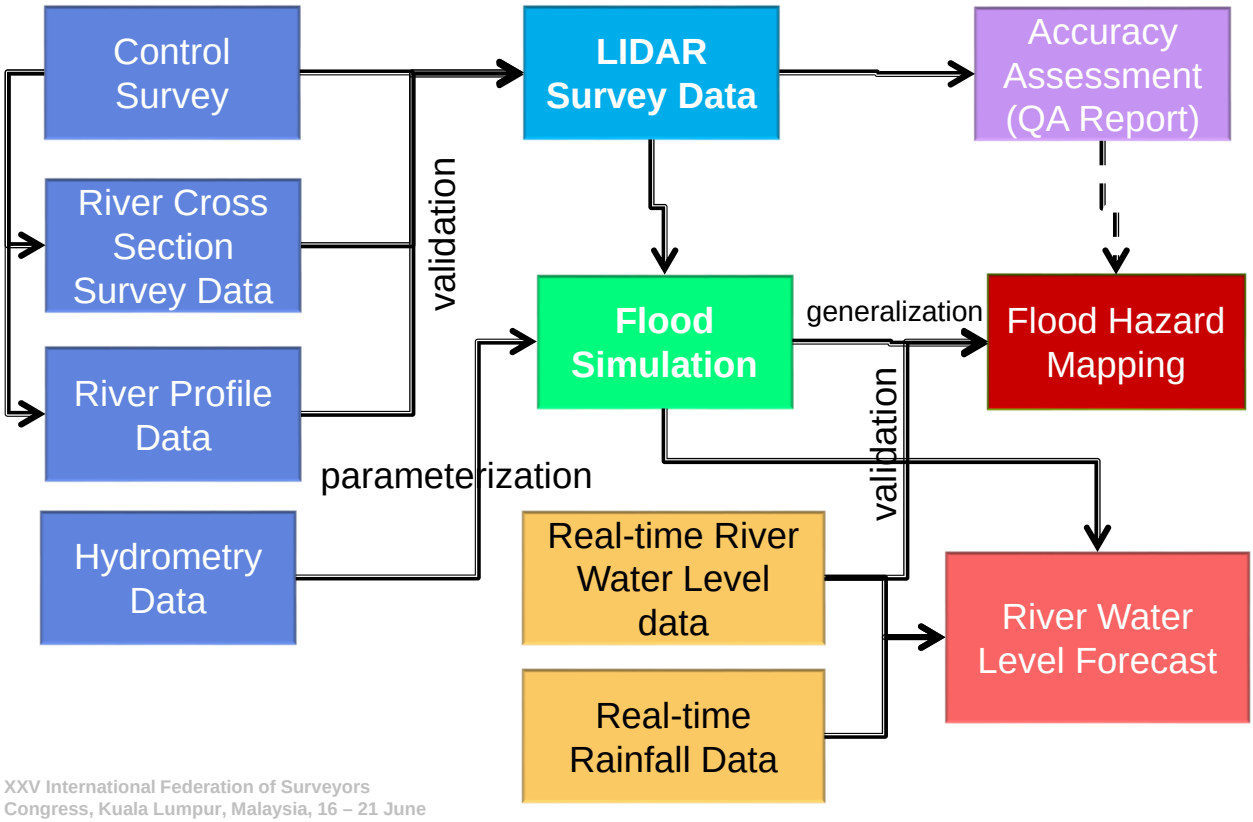
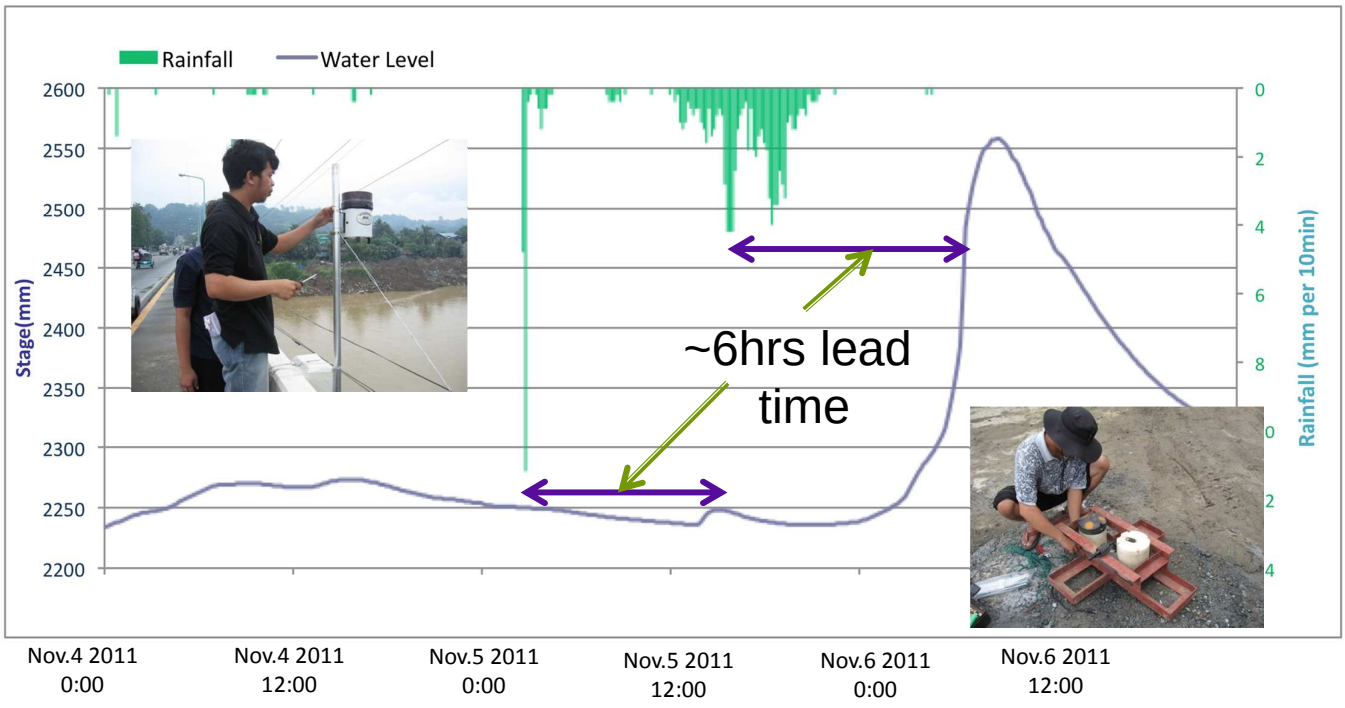
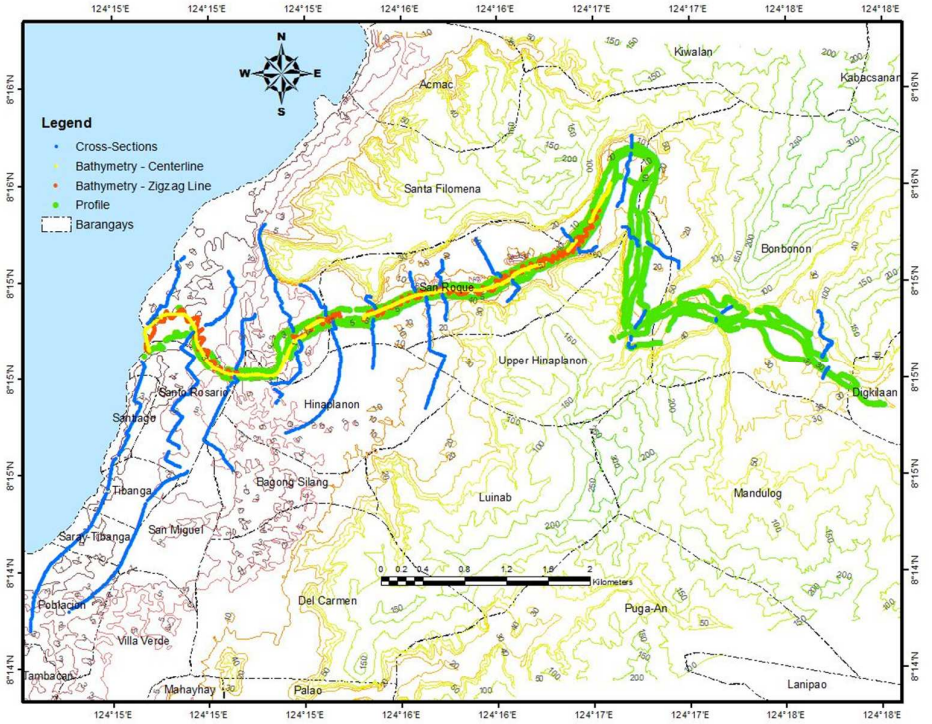
Integration River Survey Data



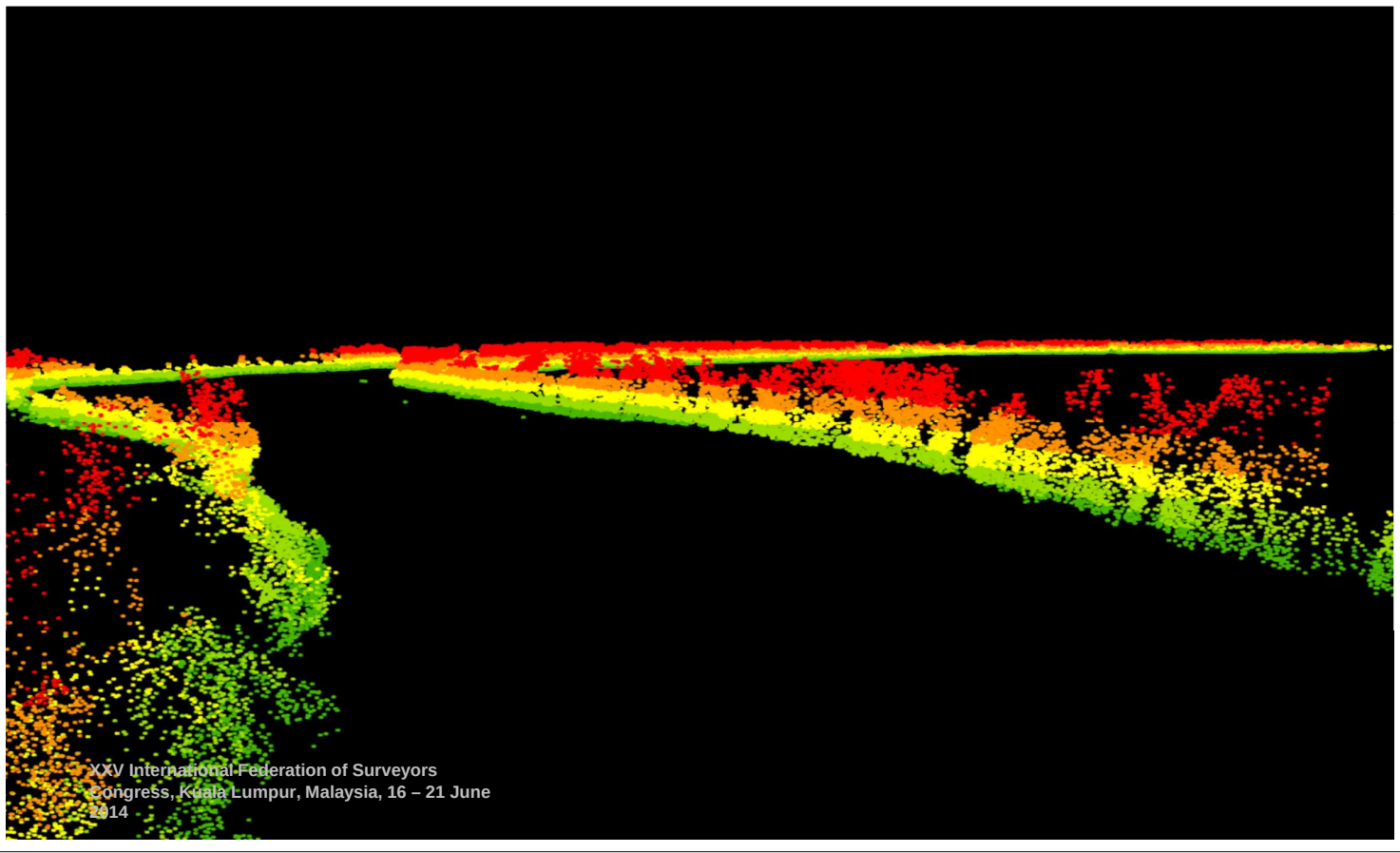
Hydrometry Sensor Deployment



River profile, cross section and bathymetry points

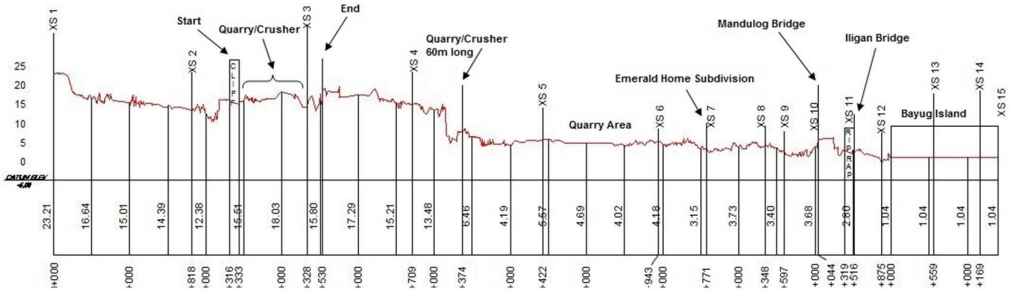


Processed Mobile Lidar Data

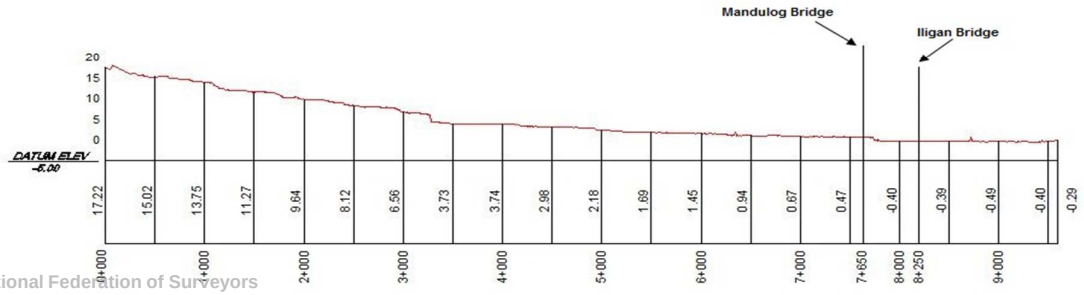


River Cross Section

UPPER RIGHT BANK PROFILE OF MANDULOG RIVER

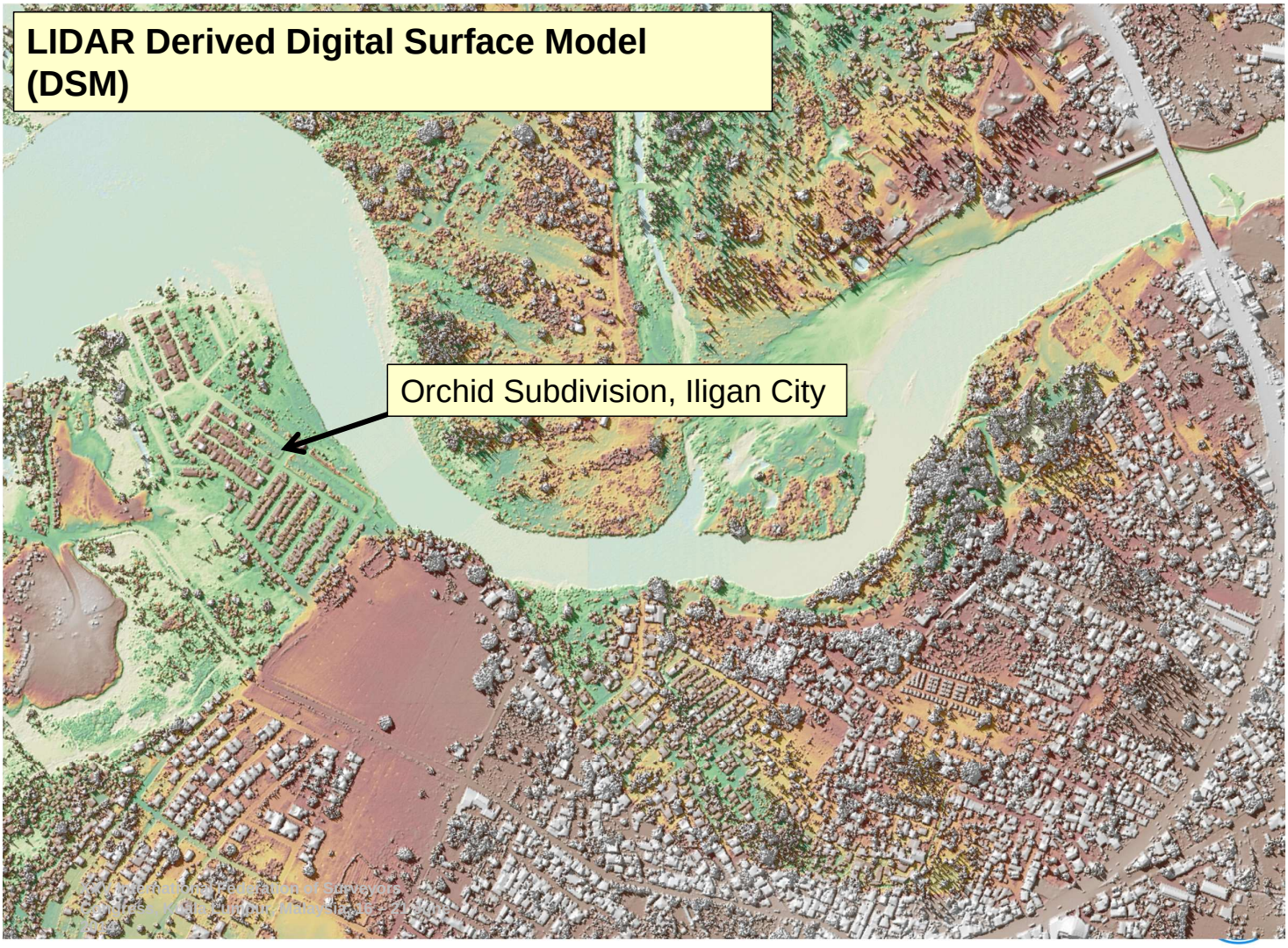


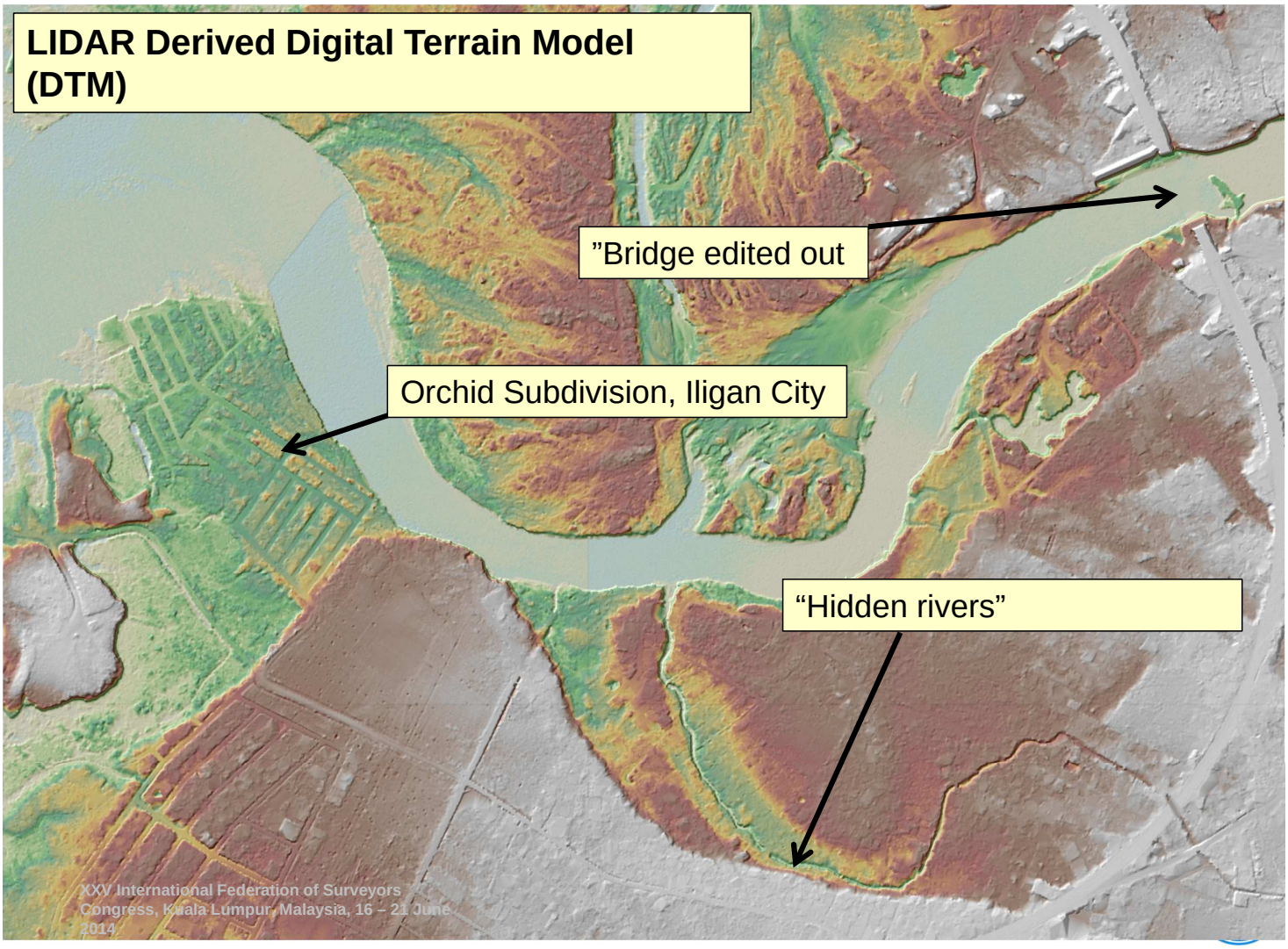
LOWER RIGHT BANK PROFILE OF MANDULOG RIVER



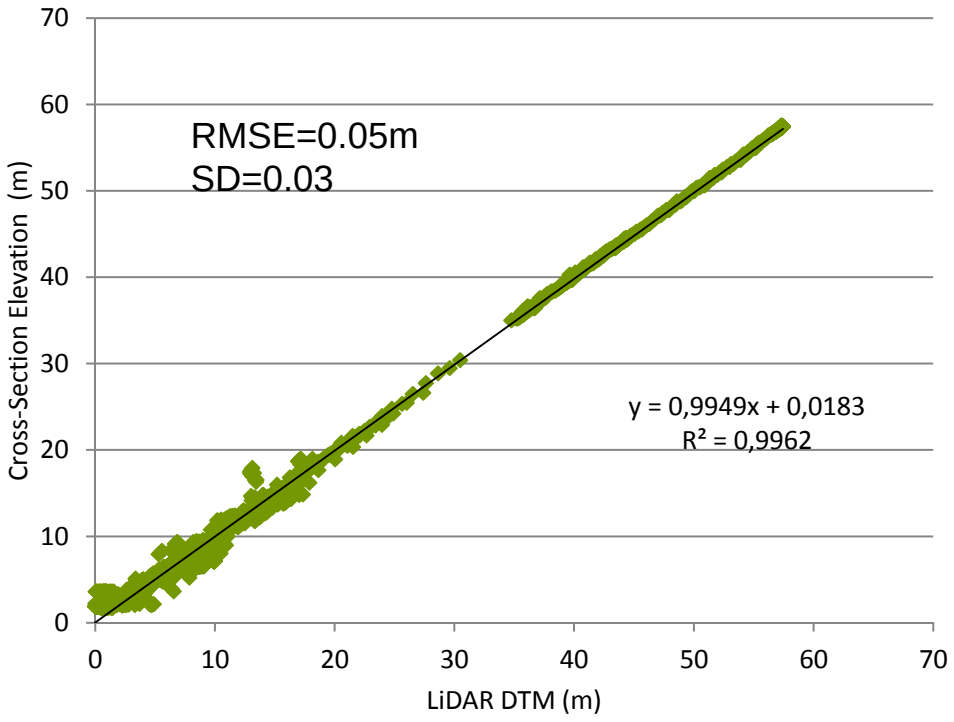
Vertical exaggeration
H = 1:10000

LIDAR Derived Digital Surface Model (DSM)



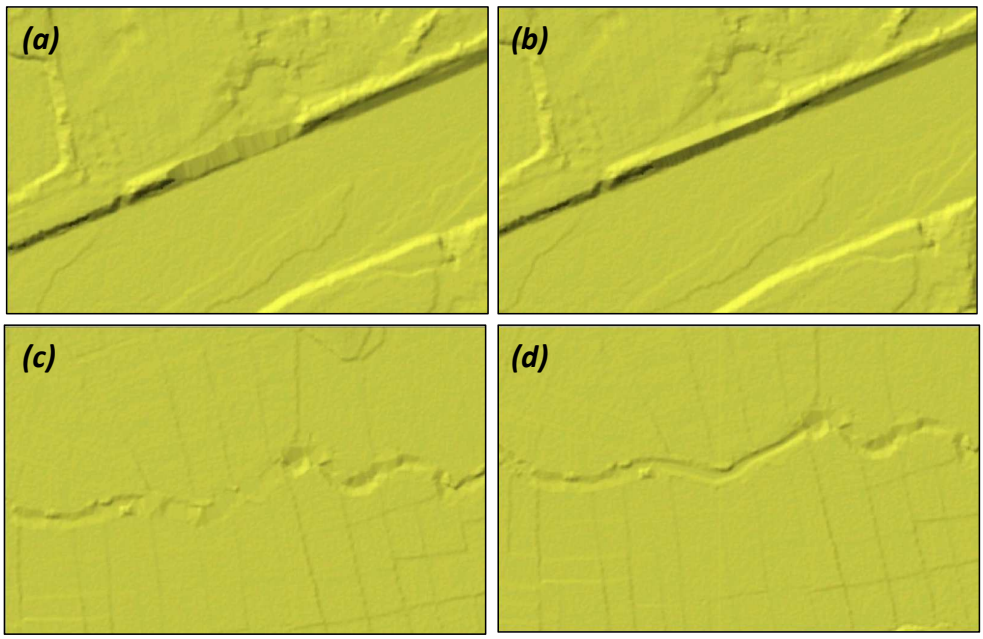


Cagayan de Oro: LIDAR vs Validation Points



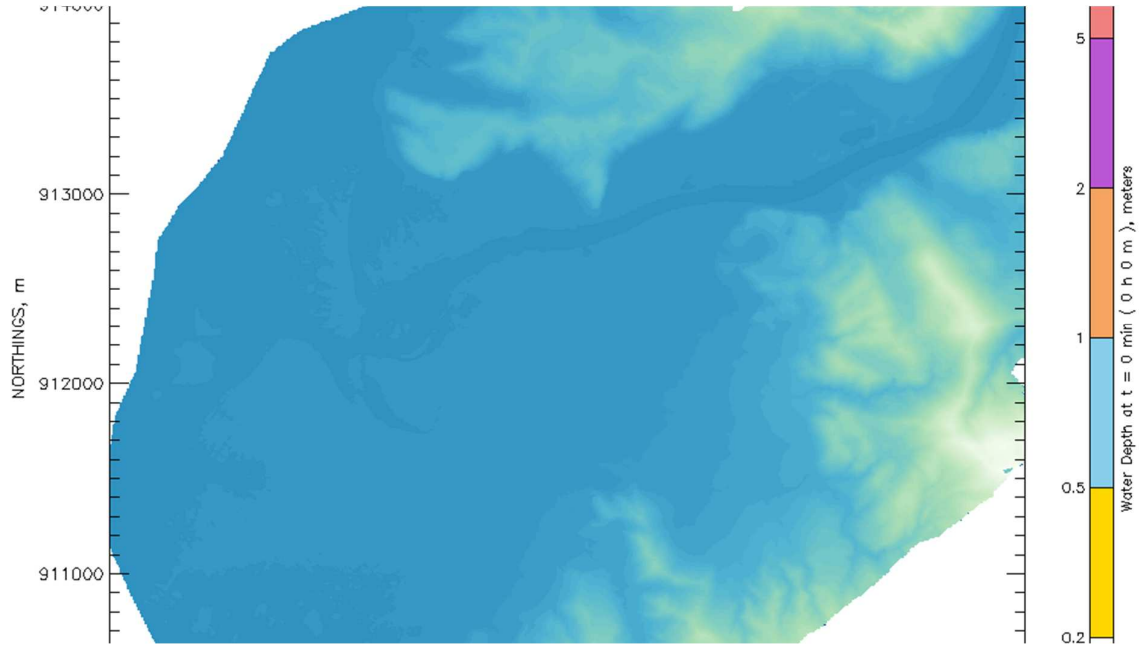
4905 points from cross-section survey data were used to validate the LIDAR datase

Manual Editing of DTM

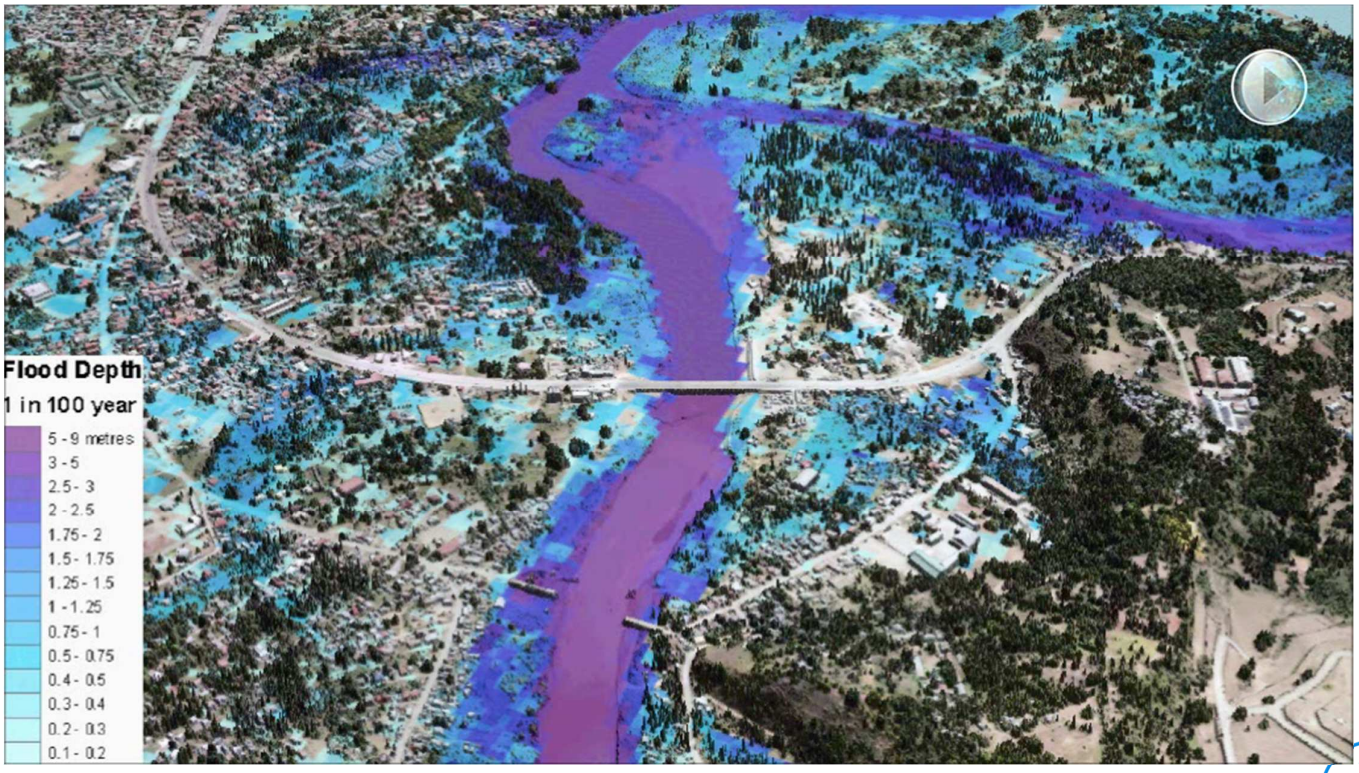


Images of DTMs before and after manual editing. Image (a) shows an embankment that might have been cut by the classification routine while image (b) shows the changes in the same area after manual editing. Image (c) and (d) show an example of a stream before and after it has been edited, respectively.

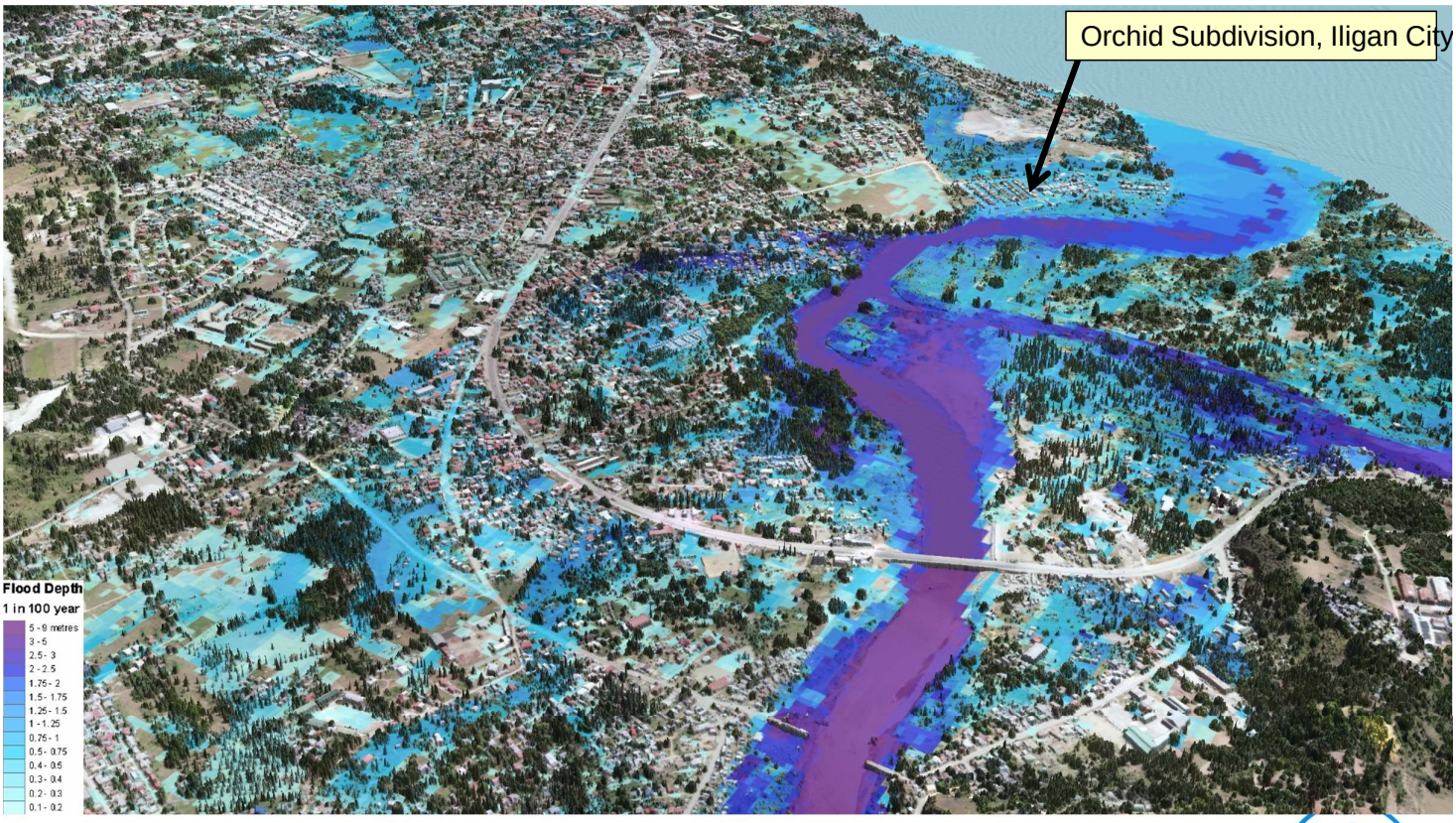
Flood inundation and velocity mapping using a high-performance computing facility



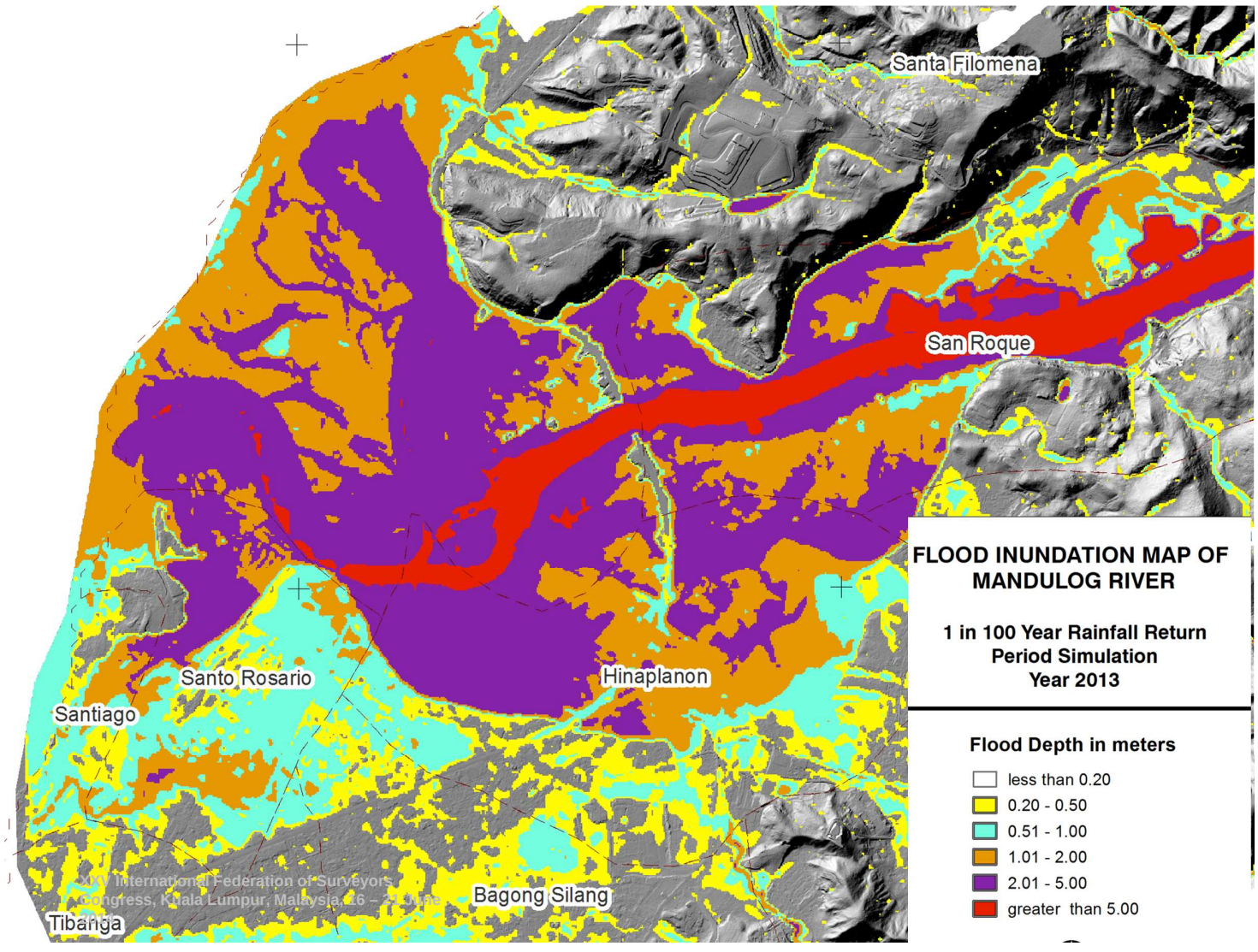
Visualizing flood hazard map in 3D: Ex. Iligan

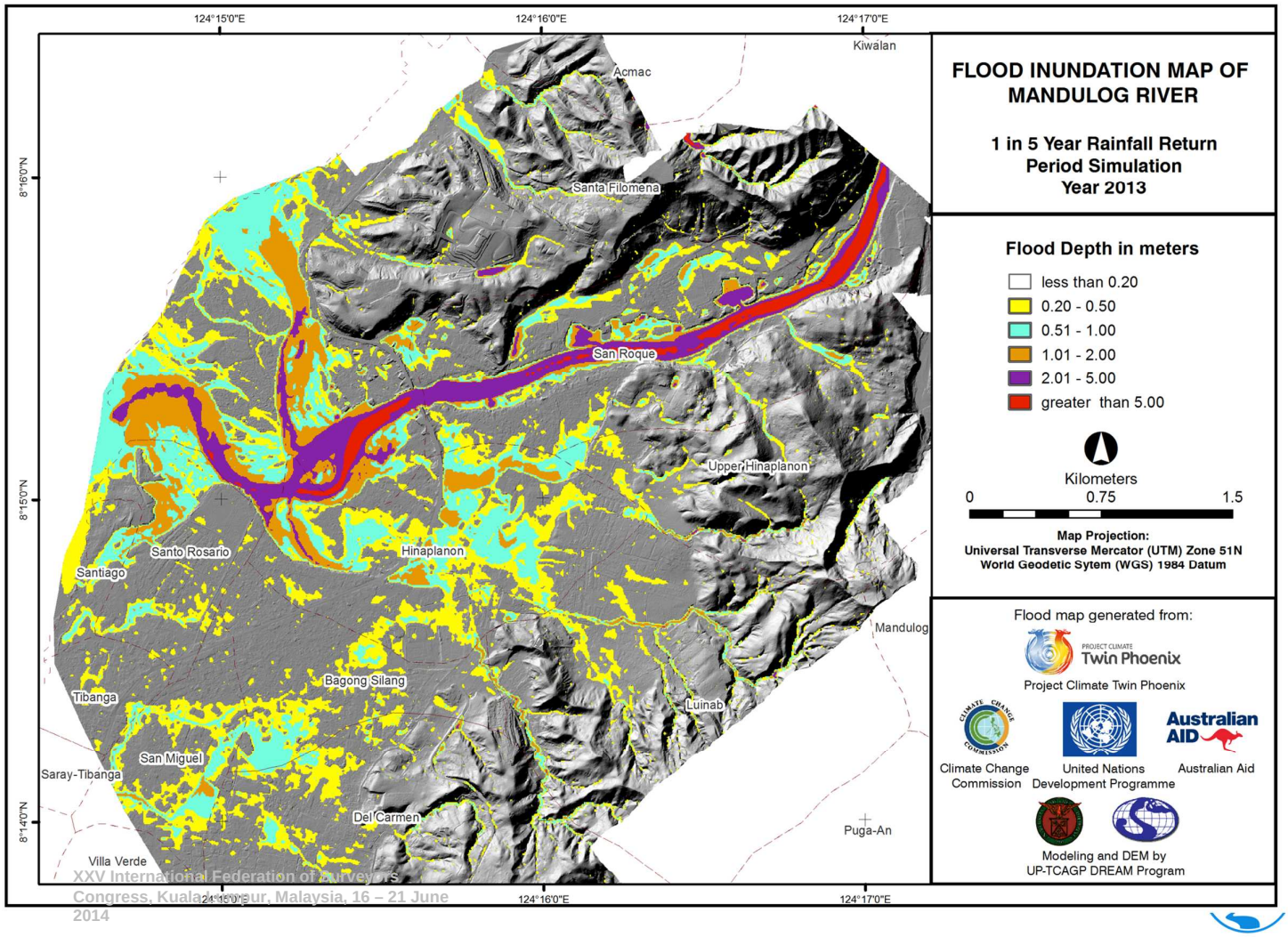


3D Visualisation of the Flood Model derived using LIDAR data for the Mandulog River, Iligan City. 1 in 100 year event modelled, flood depth shown.



© Image from 1 in 100 year flood model produced by the DREAM-LIDAR component of Project NOAH. Modelled flood depth is shown overlain on the surveyed aerial photo and LIDAR Digital Surface Model.





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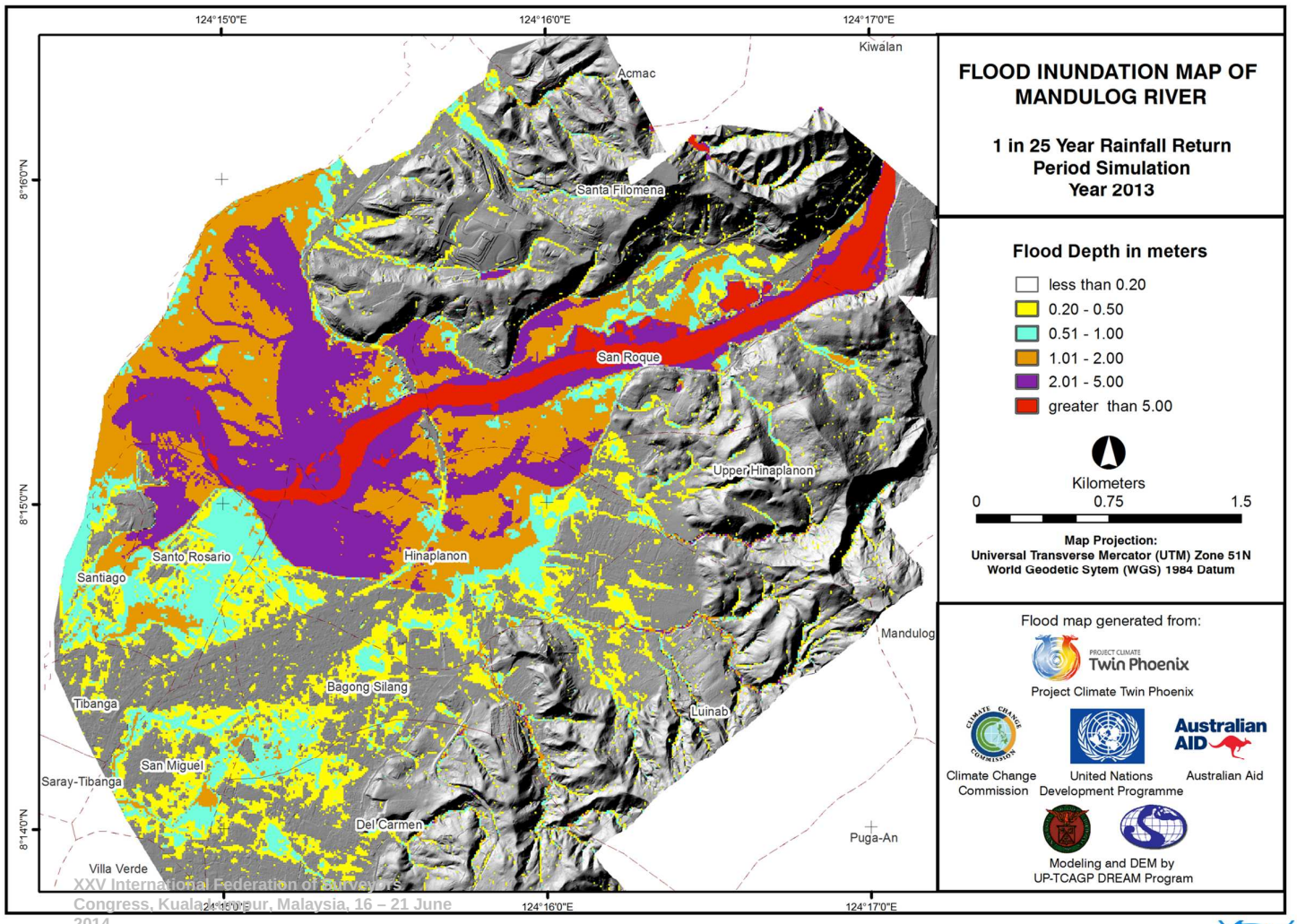

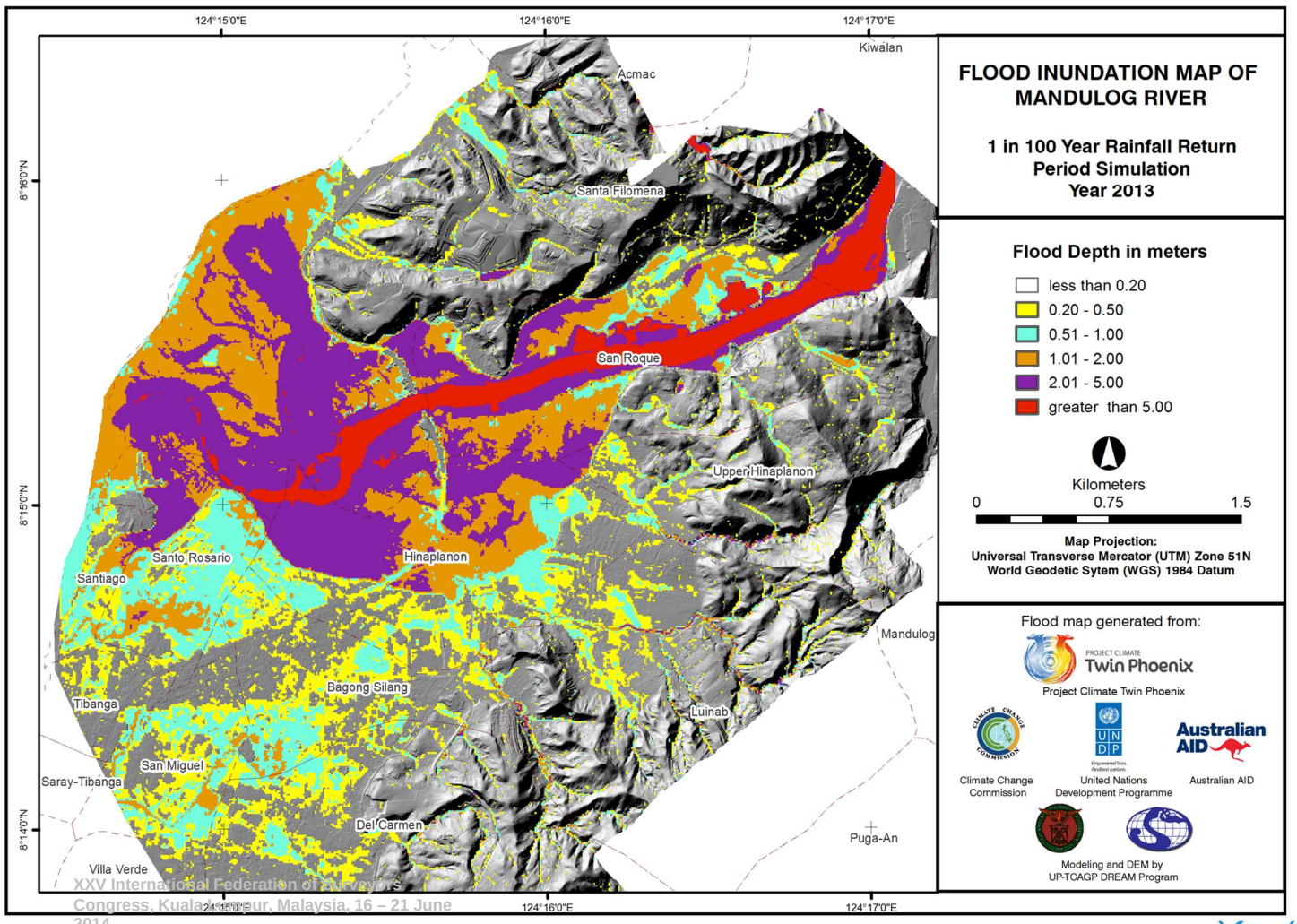

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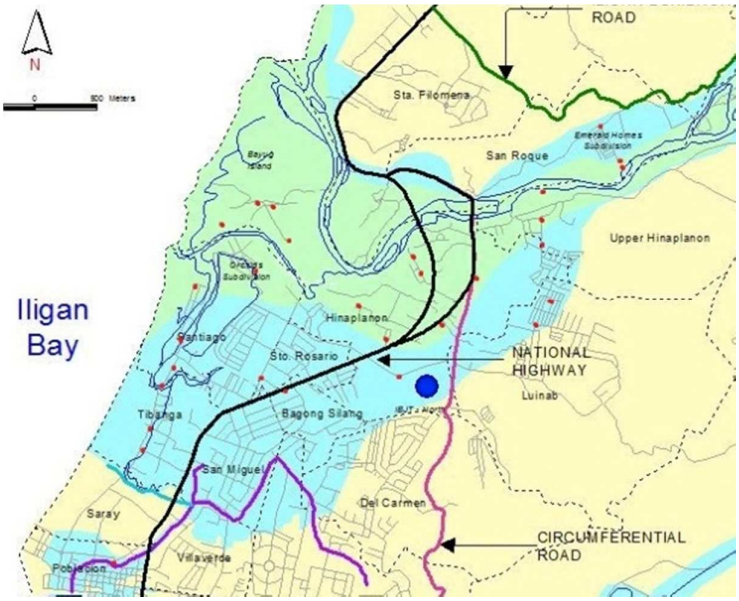
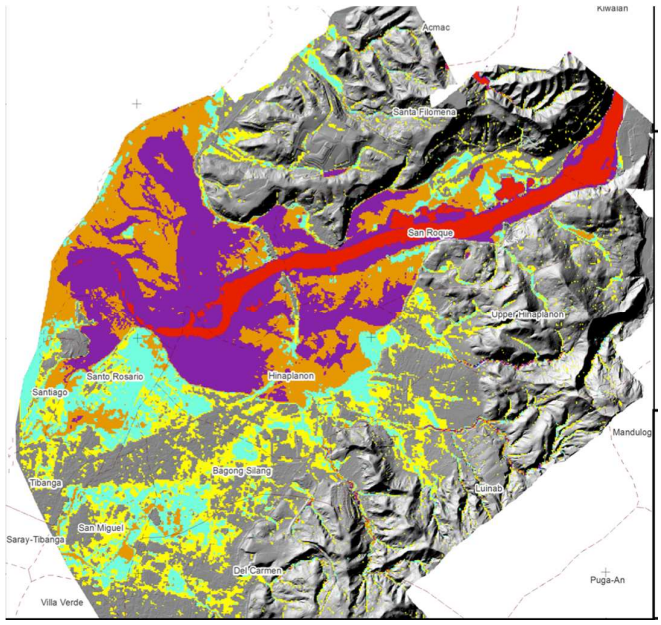
Comparison of Flood Maps



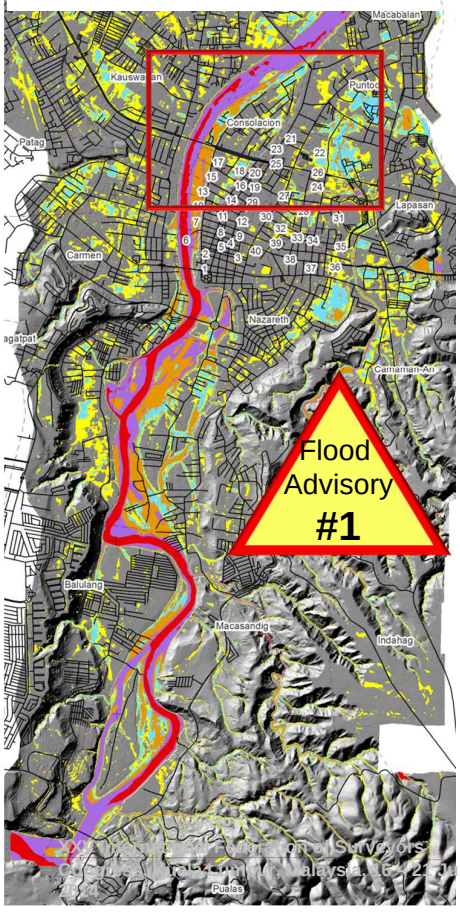
Typhoon Sendong (2011) Flood Map
Source: Iligan CPDO



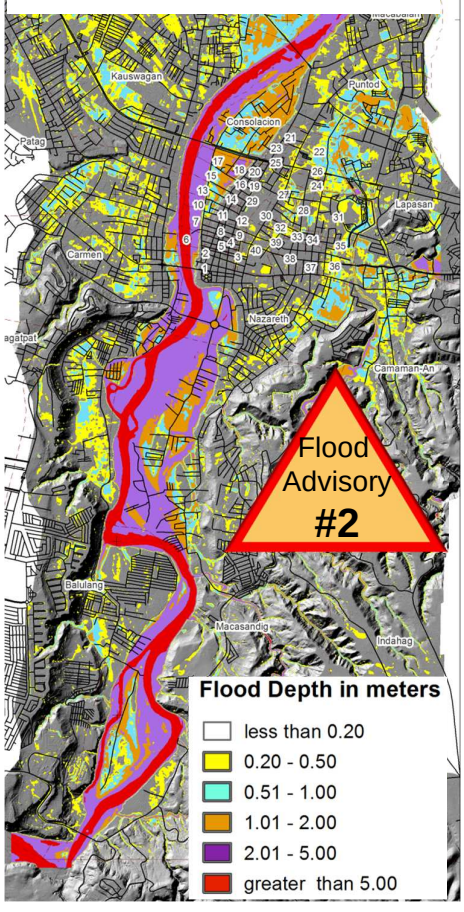
100-year Flood Map
Source: Project Climate Twin Phoenix

Development of Flood Advisory System based on Maps and Rainfall Data

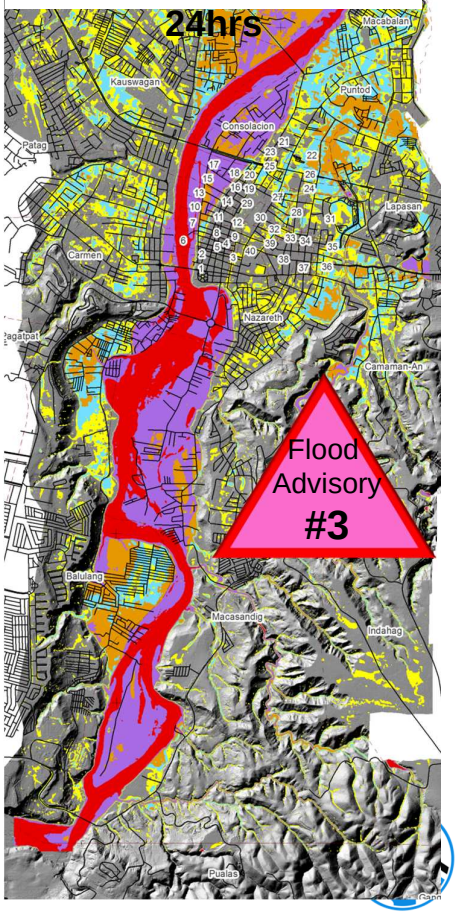
129mm rainfall in 24hrs



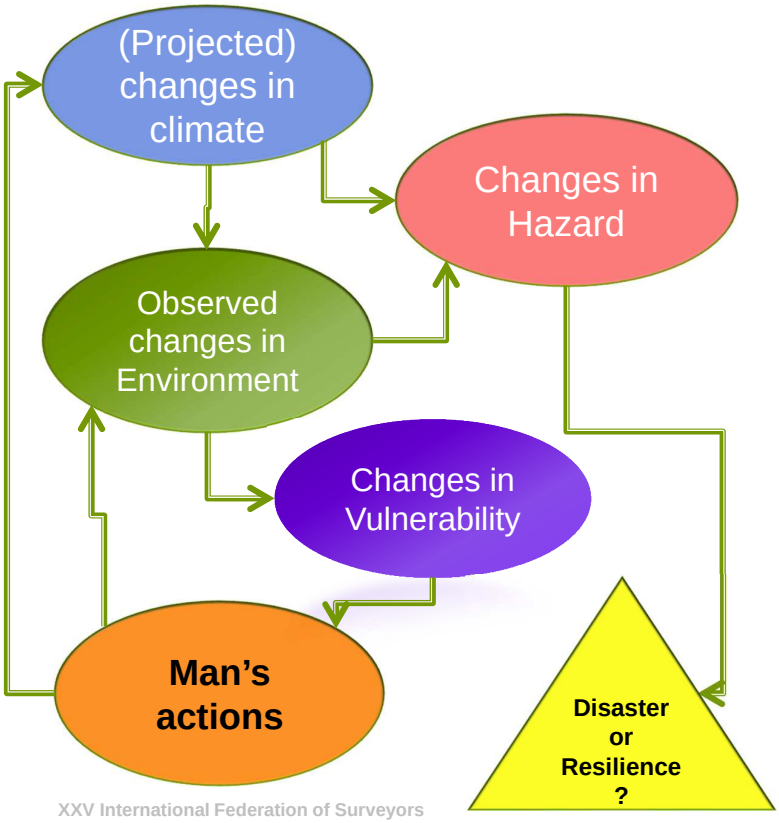
190mm rainfall in 24hrs

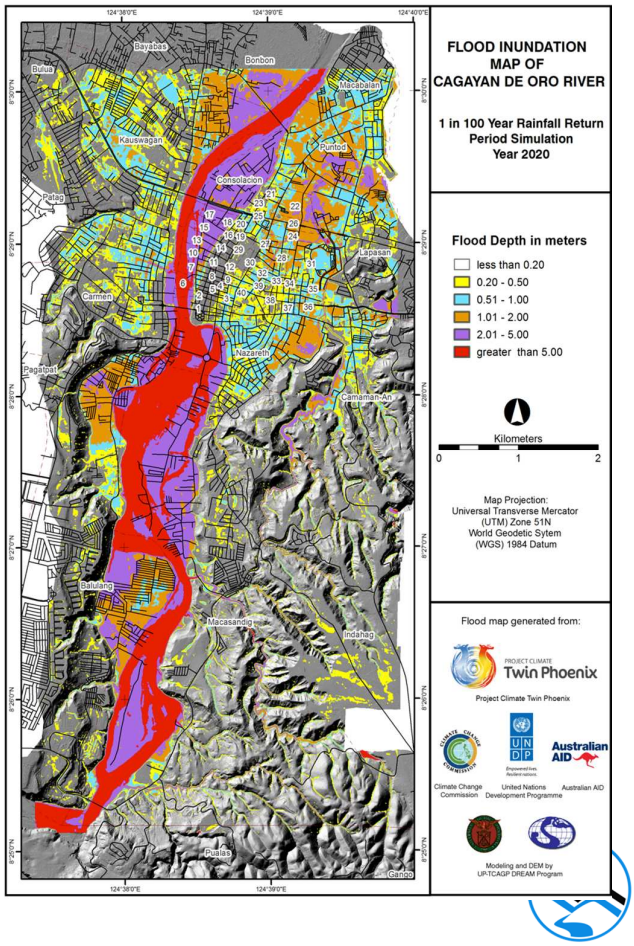


240mm rainfall in 24hrs



Projected Flood Extent (2020 climate scenario)





Deployment of online sensors

DOST-ASTI

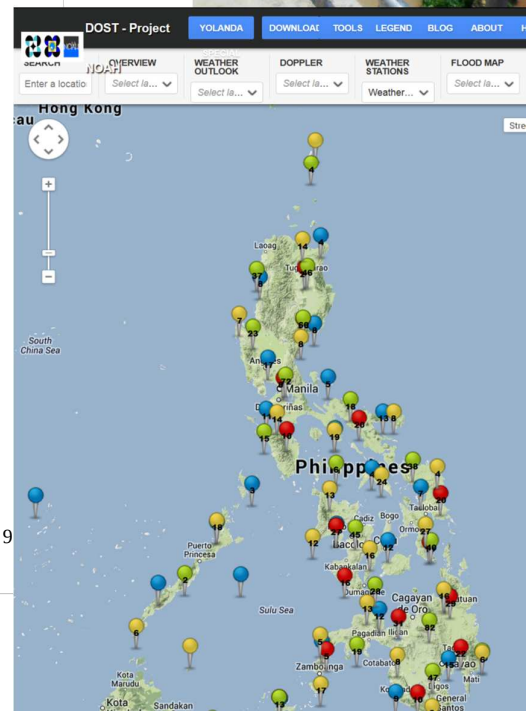
Devices designed and assembled by ASTI-DOST

Measures
- Wind Speed
- Wind direction
- Air Temperature
- Air humidity
- Air pressure
- Rain amount, duration & intensity

Automated Weather Station (AWS)

Automated Rain Gauge (ARG)

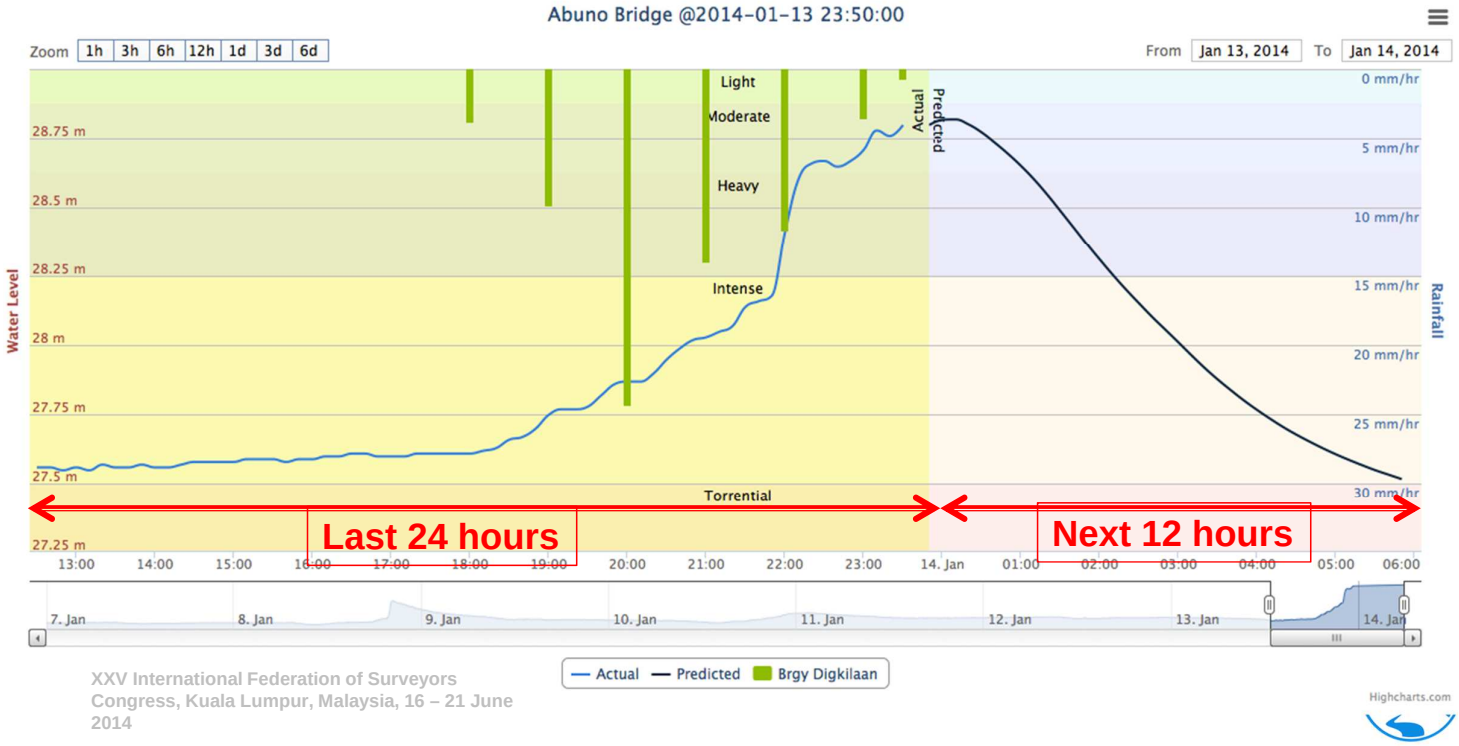
Measures amount of rainfall over a period of time

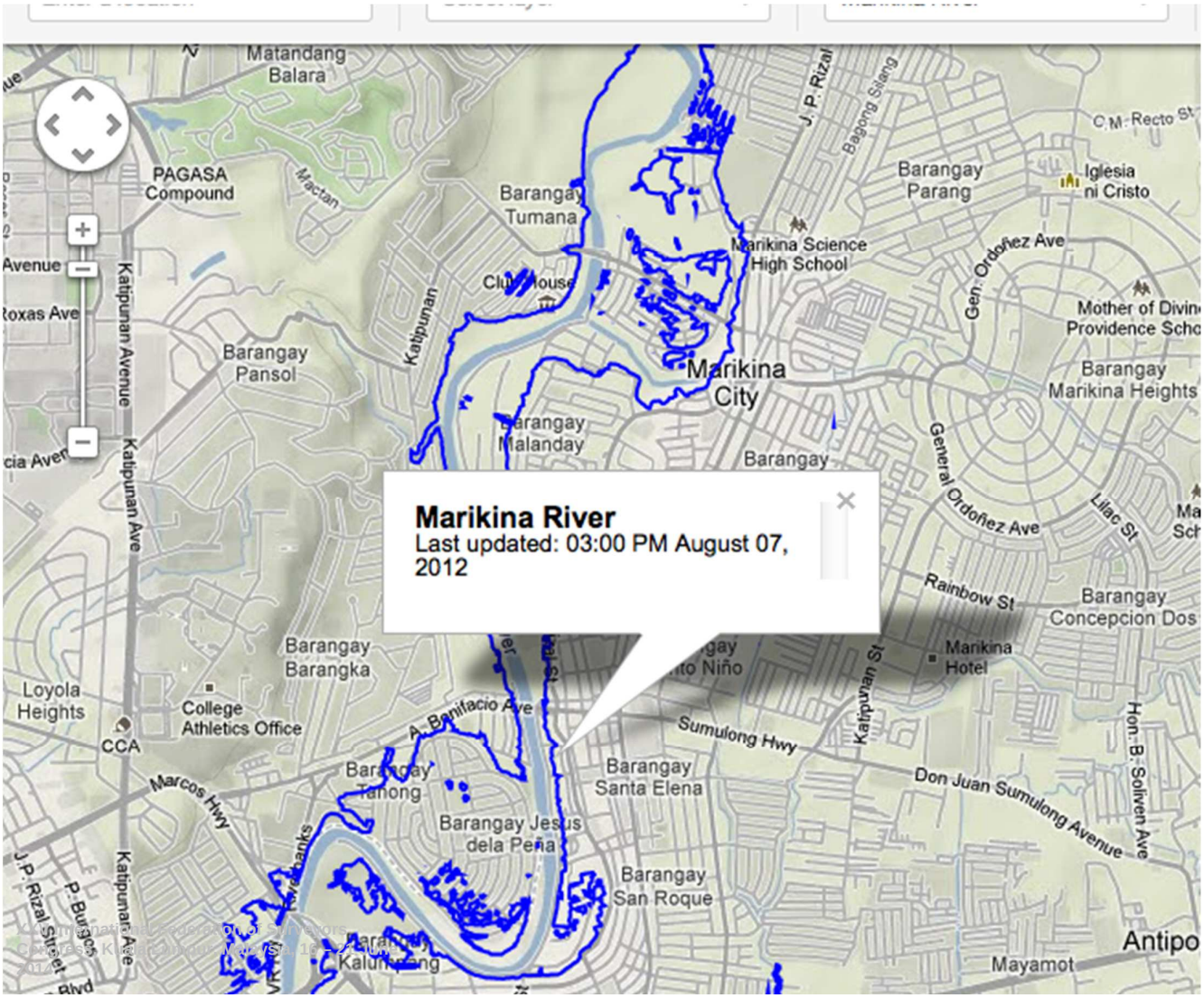


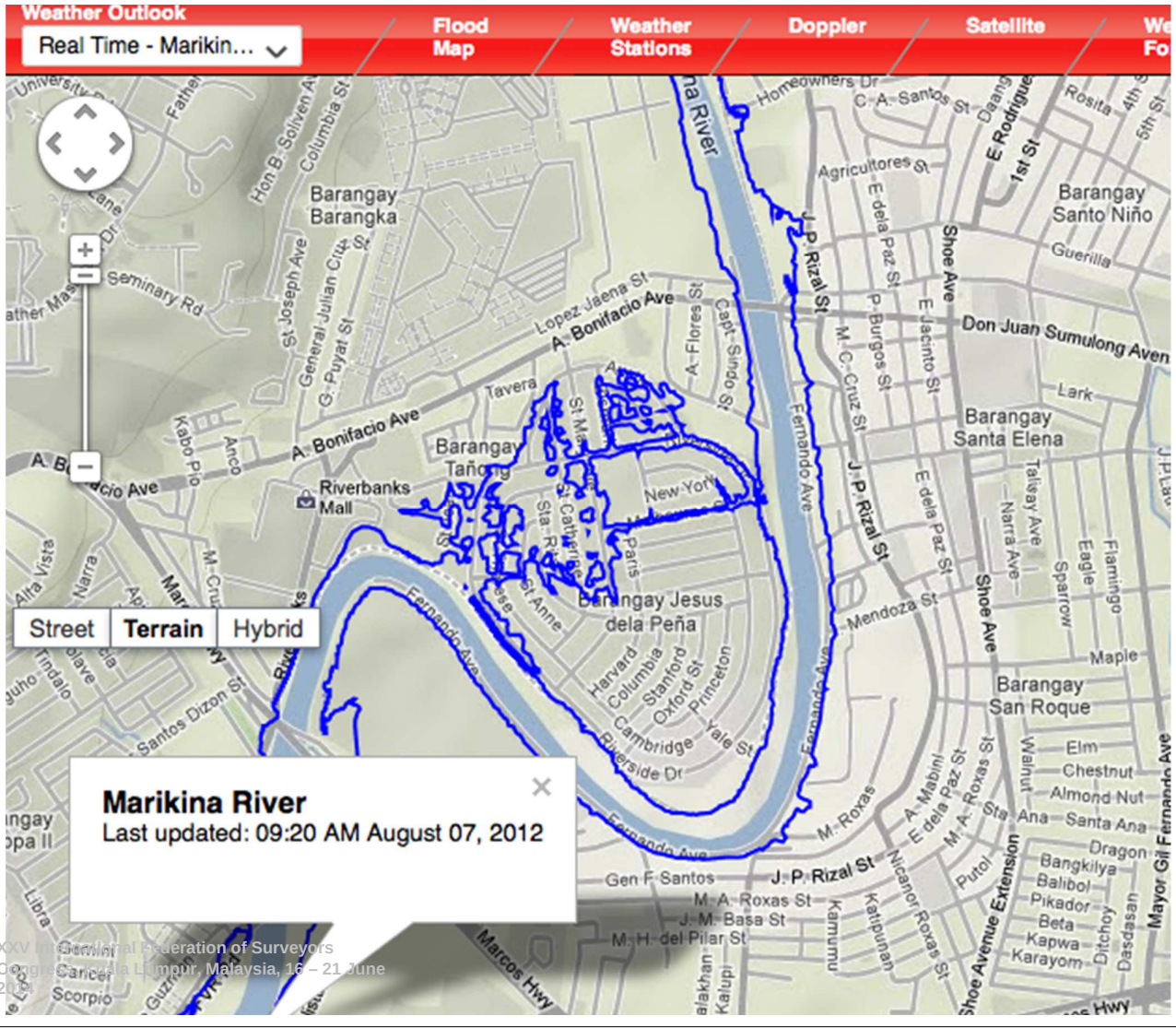
LIDAR-based Modeling for Early Warning

Automated Water Level Forecast

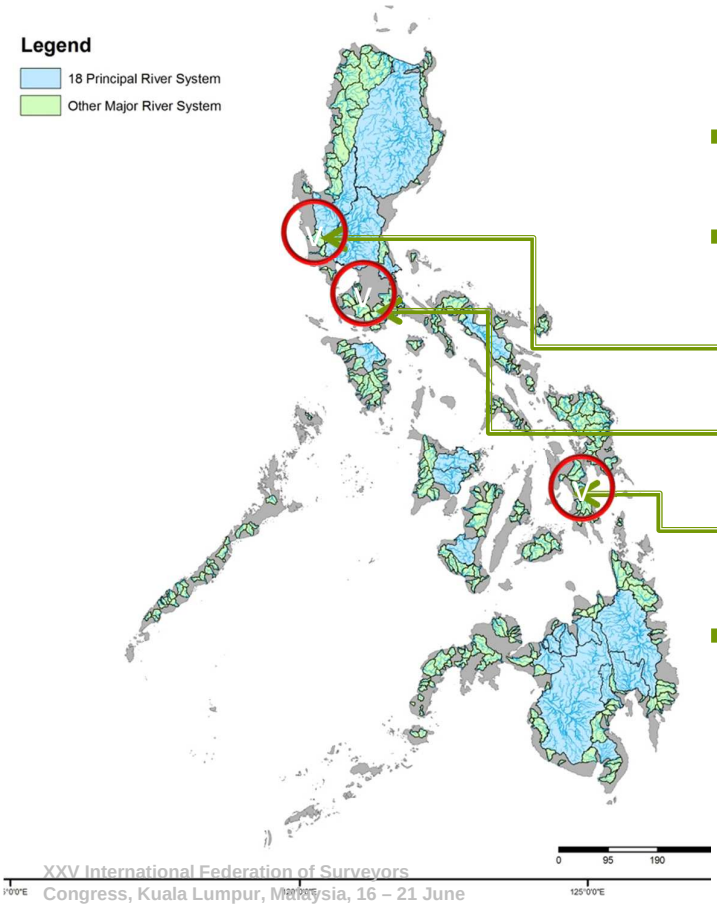
- Water level sensor data are tied to a single datum all throughout the River Profile




Matandang Balara
PAGASA Compound
Barangay Tumana
Barangay Parang
Iglesia ni Cristo
Marikina Science High School
Barangay Pansol
Marikina City
Barangay Malanday
Barangay Marikina Heights
Marikina River
Last updated: 03:00 PM August 07, 2012
Barangay Barangka
Loyola Heights
College Athletics Office
CCA
Marikina Hotel
Barangay Concepcion Dos
Barangay Tañong
Barangay Santa Elena
Barangay Jesus dela Peña
Barangay San Roque
Antipo
Mayamot

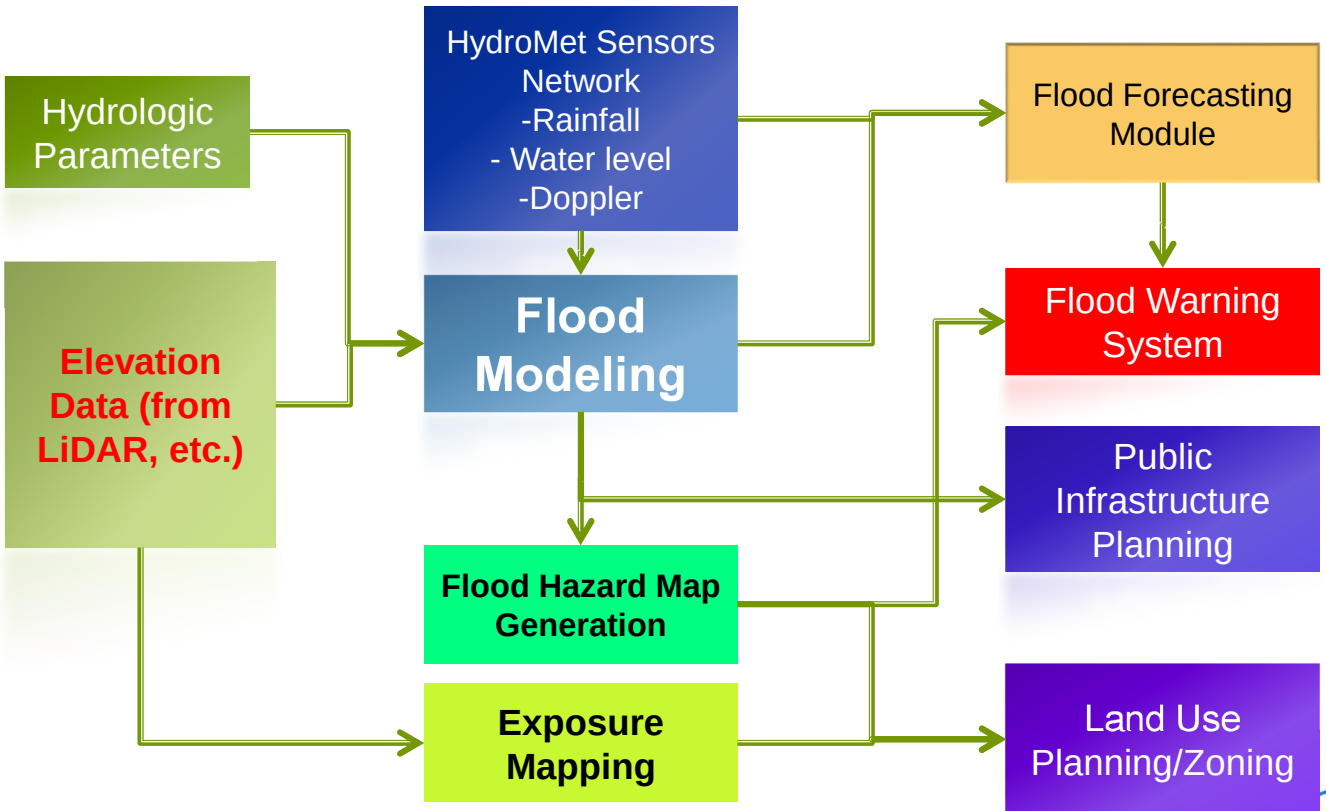

Weather Outlook
Real Time - Marikin...
Flood Map
Weather Stations
Doppler
Satellite
Street
Terrain
Hybrid
Marikina River
Last updated: 09:20 AM August 07, 2012
Barangay Barangka
Barangay Santo Niño
Barangay Tañong
Barangay Santa Elena
Barangay Jesus dela Peña
Barangay San Roque
Riverbanks Mall
A. Bonifacio Ave
J. P. Rizal St
Marcos Hwy

PHILIDAR1- DREAM Phase 2: Coverage



- Covers 300 other river systems in the Philippines
- Will prioritize flood plain areas then the upland areas
  - Zambales and Bataan already covered (flooded 2013)
  - Calabarzon area now being acquired (flooded 2013)
  - Tacloban – Leyte “Yolanda” area being covered
- Government agencies are asked to send priority sites for flight planning purposes

Integrated Flood Information System



Summary and Conclusions

- A major program to acquire elevation data using airborne LiDAR is ongoing to cover major river systems in the Philippines for purposes of flood hazard assessment and early warning is underway
- Various river survey techniques and technologies are used to provide a comprehensive, fit-for-purpose data resource for flood simulation and mapping
- Flood information products such as flood inundation, velocity and flood hazard maps are generated
- Real-time products such as Water level forecasts
- Various scenarios of rain return periods provide options for planning, development and mitigation.

Acknowledgements:
DOST for R&D Funding,
UP-ERDT Program for the Faculty Research Dissemination Grant,
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