



**15TH NATIONAL
CONVENTION
ON STATISTICS**

03-05 OCTOBER 2022



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Rapid Assessment of Impacts of floods due to extreme rainfall: The case of Typhoon Ulysses in the Cagayan River Basin

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Disaster Statistics
Crowne Plaza Galleria Manila
3:30-5:00, 3 October 2022



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The Problem

Damages

Series of typhoons and continuous rainfall in November 2020 ravaged several parts of Luzon and Cagayan Valley is one of the areas hit the most



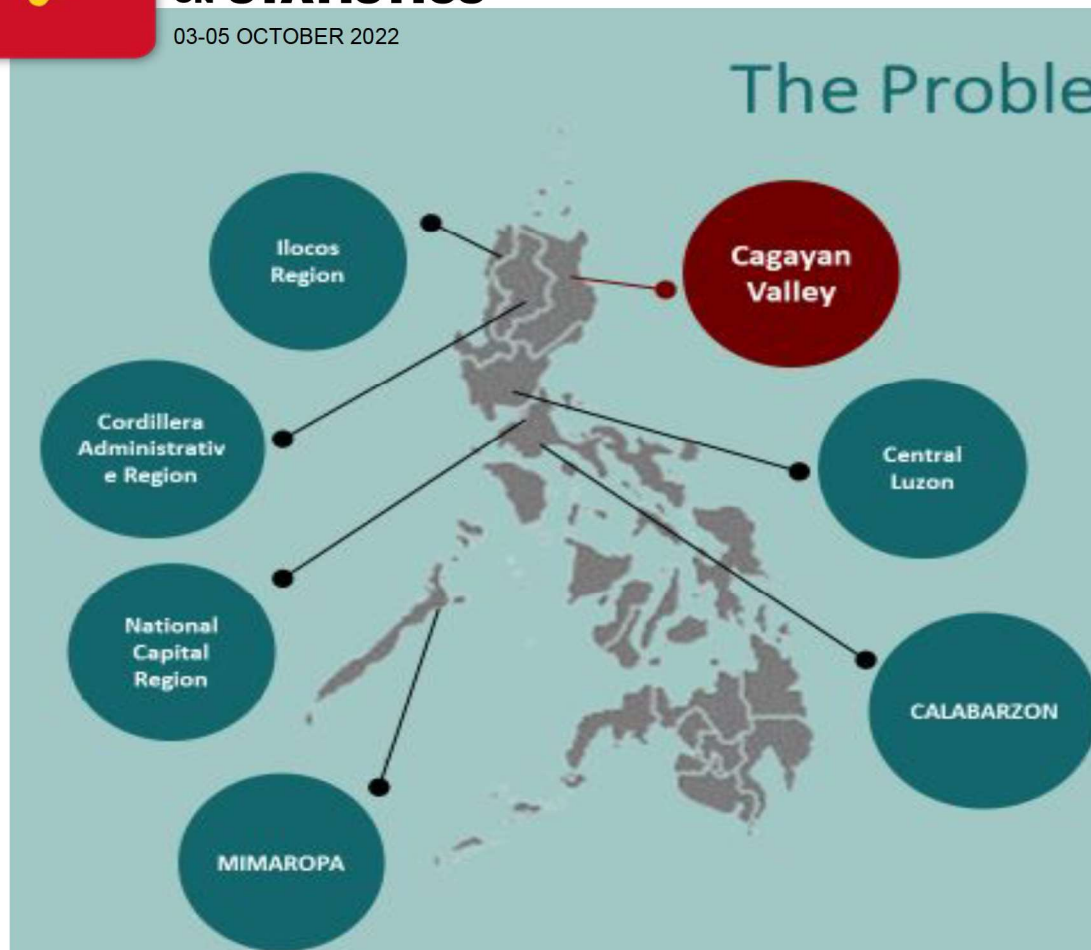
People



Homes

Problem

Most river basins lack baseline data and procedures for rapid flood risk assessment.



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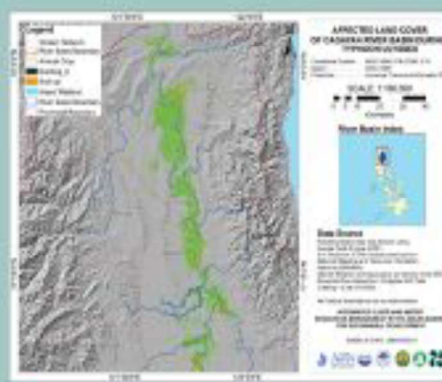
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Status of the Study in the Philippines



Complementary Monitoring

The limitations of the hydrological model-based method are addressed by satellite-based flood extent monitoring (Rahman & Di, 2017)

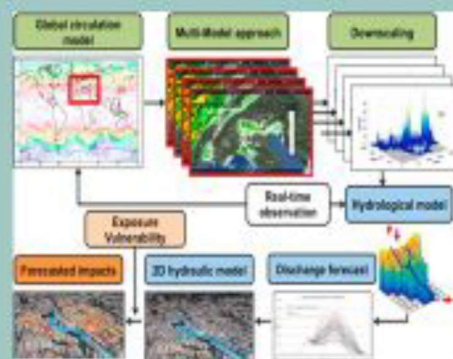


First in the country

foremost in the country and the region. GEE can offer an estimation of flood damages but in very low-resolution datasets (MODIS land cover 500m, JRC Population 250m) thereby affecting the accuracy of reports.

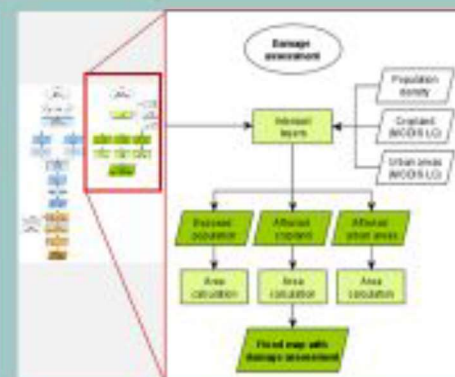
LiDAR extent is incomplete

Attempts to map flood vulnerability using hydrological model-based in the Philippines using LiDAR, but the coverage for sufficiently high accurate DEM is not complete especially in the river basin context.



Attempt to use different dataset

No studies have yet been conducted to evaluate and map the actual flooding of the entire Cagayan River Basin using different datasets in GEE.



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Objectives

The objective of this study is to assess the impacts of floods in Cagayan River Basin due to typhoon Ulysses. Specifically it aims to:

- a. map flood extent; and
- b. estimate the damages brought by the flood of typhoon Ulysses

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03-05 OCTOBER 2022



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Materials and Methods

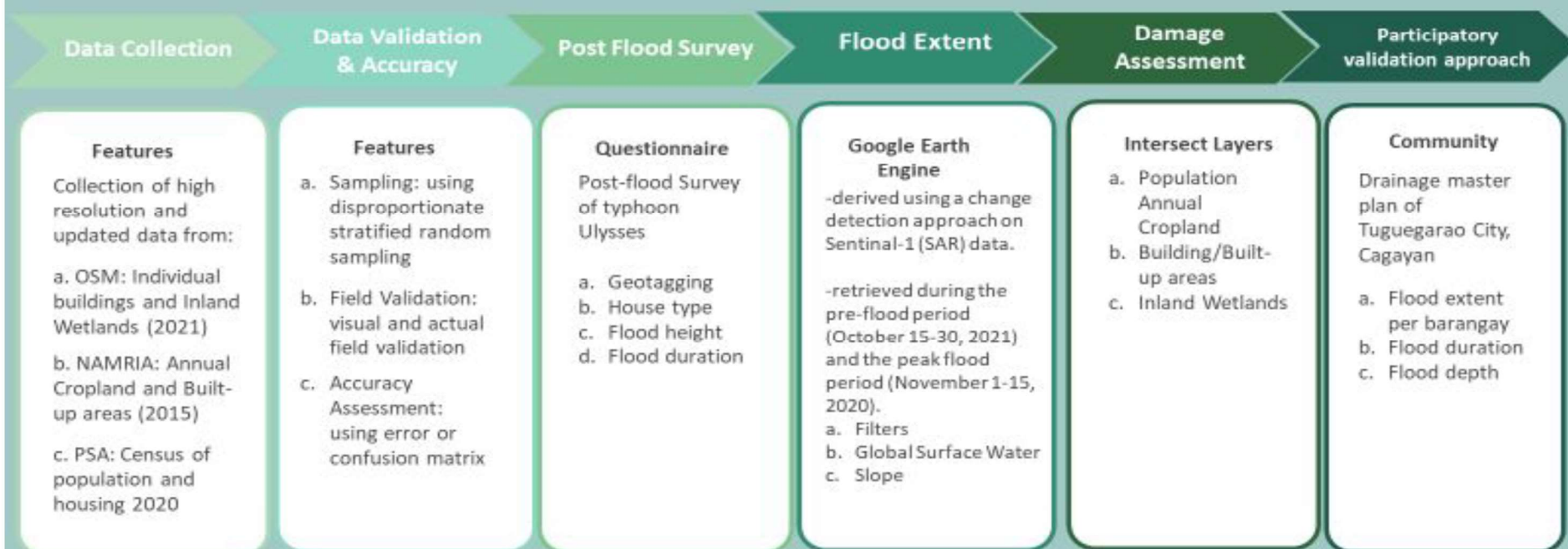


Figure 1. Overall general framework for the integrated flood risk management action

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Methods and Results

Data Collection

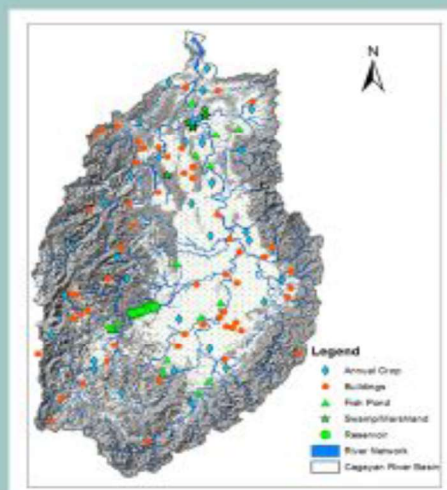
Data Validation
& Accuracy

Post Flood Survey

Flood Extent

Damage
Assessment

Participatory
validation approach



Sampling

Quality control and ground validation of datasets were implemented. Disproportionate stratified random sampling was used as a sampling method



Validation

Ground validation was done in 7 days from May 4-8, 2021 and May 11-12, 2021. GPS, fields sheets, camera were prepared

Table 3.1. Error matrix for the feature classes

Preliminary Classification	Validated			User Accuracy
	Annual Crop	Built-up	Inland Wetland	
Annual Crop	58	1	1	96.67%
Buildings		60		100.00%
Inland Wetland	2		58	96.67%
No. of Validation Points	60	61	59	100.00%
Producer Accuracy	96.67%	98.36%	98.31%	97.78%

Table 3.2. Error Matrix for sub-classification of Inland Wetlands

Preliminary Classification	Validated			User Accuracy
	Fish Pond	Swamps/Marshland	Reservoir	
Fish Pond	20			100.00%
Swamps/marshland		18		90.00%
Reservoir			20	100.00%
No. of Validation Points	20	18	20	100.00%
Producer Accuracy	100.00%	100.00%	100.00%	96.67%

Accuracy of datasets

The accuracy of the map was computed through the confusion matrix also known as error matrix. These are highly acceptable and indicate that the data can be utilized to estimate flood damage.

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03-05 OCTOBER 2022



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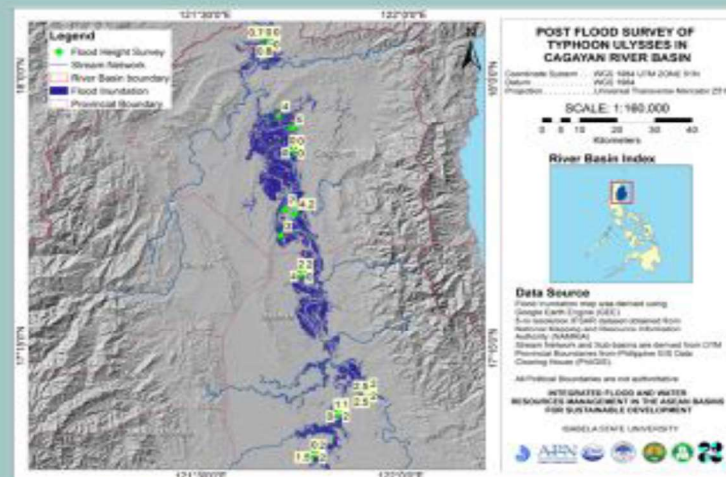
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Post Flood Survey

Field surveys thru questionnaires and field investigations were conducted at different barangays in the Cagayan river basin randomly.



Sampling

84 locations and households were surveyed for highest actual flood depth and flood duration. The data was used to determine threshold value of flood extent using GEE. Those with a zero value indicate that no flooding happened in that specific location.

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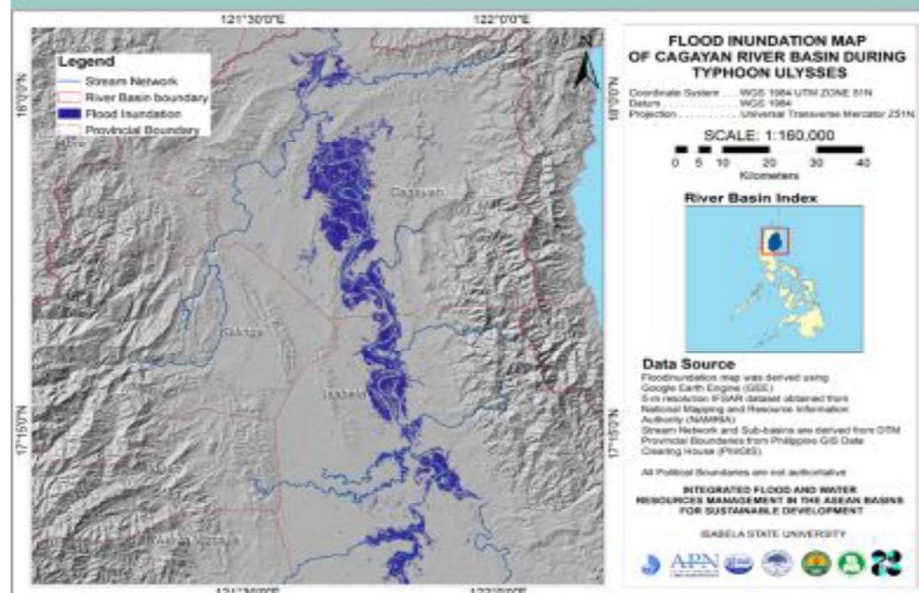


Figure 3. Final flood inundation map of Typhoon Ulysses in November 2020

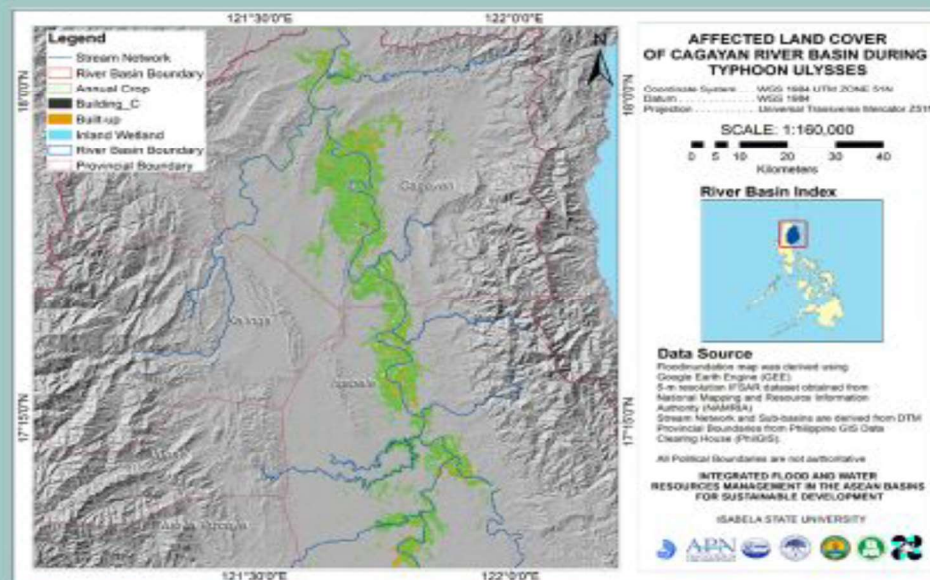


Figure 4. Affected land cover in Cagayan River basin during the flood due to Typhoon Ulysses

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Methods and Results



Table 1. Summary of flooded area and damages per province

Province	Area (km ²)	Flooded Area (km ²)	% Area	% Area of inundation	Annual Crop (km ²)	Built up Count	Area (km ²)	Inland Wetland (km ²)	Population	% Affected Population	Total (km ²)
Cagayan	2,897.67	271.35	9.3645%	53.9621%	344.36	4355	2.19	0.55	111,959	50.36%	347.128
Isabela	8,813.95	230.98	2.6206%	45.9335%	269.10	2981	4.03	0.03	113,633	49.62%	273.162
Kalinga	10,276.73	0.50	0.0048%	0.0986%	0.55	36			37	0.02%	0.545
Ifugao	2,503.45	0.02	0.0009%	0.0045%	0.04	4			3	0.00%	0.043
Apayao	3,913.88	0.01	0.0002%	0.0013%	0.00	2			1	0.00%	0.000
TOTAL	28,405.68	502.86	1.7703%	100.0000%	614.05	7378	6.22	0.58	225,634	100.00%	620.879

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Fig. 2.3.9. Representatives from barangays identifies the extent and duration time in their area during Typhoon Ulysses

Flood extents were mapped by residents and instructed to assign appropriate colors to each section of their barangay

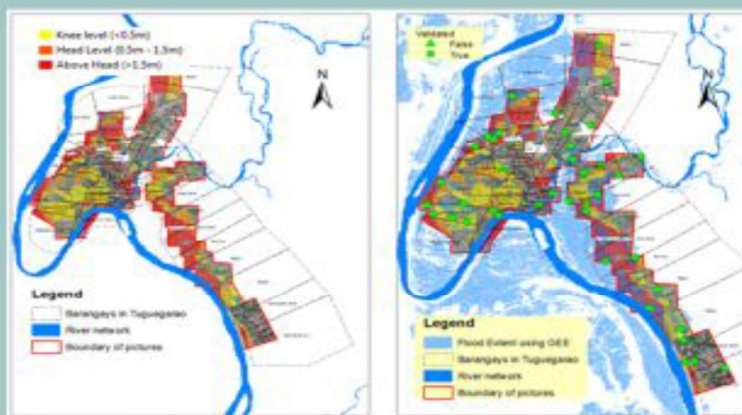


Fig. 2.3.10. Georeferenced data of flood maps from Hydronet (left) and sampling points for validation of flood extent using GEE (right)

The consulting agency carefully digitized the output maps in Google Earth producing laid out maps in JPEG format, which were then georeferenced by our group for flood extent validation using GEE.

Validation of flood extent using participatory approach reveals 95% accuracy.



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Conclusion and Recommendation

01 Readily available datasets

The main datasets used by the method are readily available in the Philippines and may be utilized by flood mappers without difficulty. The high-resolution datasets were used to evaluate damages instead of the default materials used by GEE.

03 Accuracy of flood map

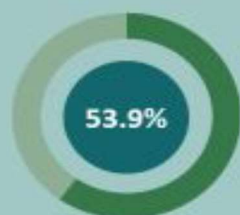
The accuracy of flood extent was highly reasonable to map the flood during Ulysses. In this case, a more detailed validation data on site is recommended not only focusing in Tuguegarao.

02 GEE as a viable rapid assessment tool for flood mapping and assessment

This scientific study found out that evaluating damages using GEE is a suitable tool to complement to existing flood risk assessment of DRRM. As a result, the framework can be useful in assessing the vulnerability of assets to flood events

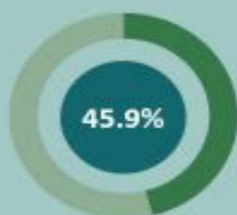
04 Implementation

The concurrent flood study imposes adopting an integrated, multi-hazard, multi-stakeholder approach with an emphasis on disaster risk mitigation, preparedness, streamlining of the relief distribution system, with emphasis of self-reliance on LGUs and NGOs for sustenance with local resources and practices.



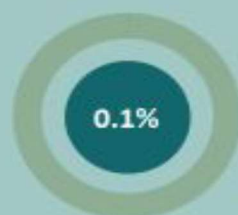
Cagayan

271.35 km²



Isabela

230.98 km²



Kalinga

0.5 km²



Ifugao

0.02 km²



Apayao

0.01 km²

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Thank you!



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