

Geo-INQUIRE installation: BingClaw - Model for simulating dynamics of cohesive Landslides - Norwegian Geotechnical Institute (NGI), Norway.

Project title: Rainfall-Induced Landslide-Tsunami Modelling for Coastal Barangays of Southeastern Leyte Island, Philippines

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Project Report:

On April 12, 2022, while the Province of Leyte in the Philippines was responding from multiple deadly landslides caused by Tropical Storm Megi (local name, Agaton), videos of another landslide, this time, generating a tsunami in Pilar, Abuyog spread in social media. Recognizing that this might be the first ever video-recorded rainfall-induced landslide-tsunami in the country, the University of the Philippines Resilience Institute along with then fellows from the UPVTC Regional Environmental Information System, Central Visayan Institute Foundation, National Institute of Geological Sciences and UPD CS Science and Society Program [sent a team to investigate the landslide and tsunami impact](#). It was revealed from the interviews of survivors, review of video documentation and field investigation that at least two distinct major debris flow events buried Pilar, reached the shore and each generated tsunamis. All interviews and field data confirmed that the first of the two landslide-tsunamis was larger and produced the wave that obliterated the structures along the shores of Pilar. Although only video-recorded when its far field waves reached another village, field evidence indicated that the first landslide-tsunami event run up to 11.5m asl in Pilar (Minimo et al., 2023).

Field investigation indicated that the landslide source is composed of old volcanoclastic deposits that also underlie the southeastern mountains of Abuyog and parts of Southern Leyte. Multiple areas in this old volcanic terrain also had slope failures following the intense rainfall in April

2022, some of these also reached the shore. This called for [building the capacity of the Philippines for modelling landslide-induced tsunamis](#) for hazard mapping and coastal development planning.

Expanding from the initial modelling of the Gallego (2024) which also used Bingclaw and Geoclaw, Project RILTiMe (Rainfall-Induced Landslide-Tsunami Modelling for Coastal Barangays of Southeastern Leyte Island, Philippines) focused first [cascading the training to the UP NOAH Hazards Assessment Team](#) and then on the sensitivity and parametric tests for the debris flow and tsunami modelling of the Pilar event.

The following parameters were varied:

Parameter	Values					
Density (kg/m ³)	2000			1784 (measured sample density)		
Initial Yield Strength (kPa)	60	65	70	80	90	100
Residual Yield Strength (kPa)	1		2		3	
Friction Drag	0.01			0.001		
Pressure Drag	1.0			0.01		
Source area	Without entrainment			With entrainment		
Depth of slip area	Based on post landslide topography			-3m from post-landslide topography in the slip area		
Scale factor (for tsunami modelling)	1		2		3	
Volume (m ³)	~310k			~710k		

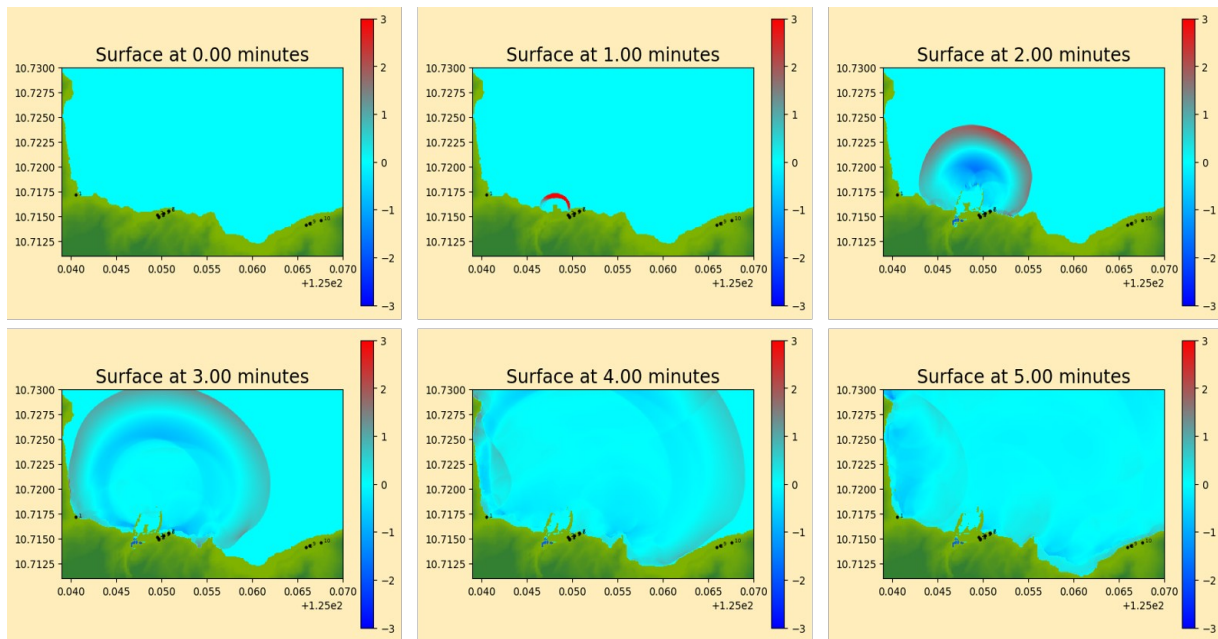
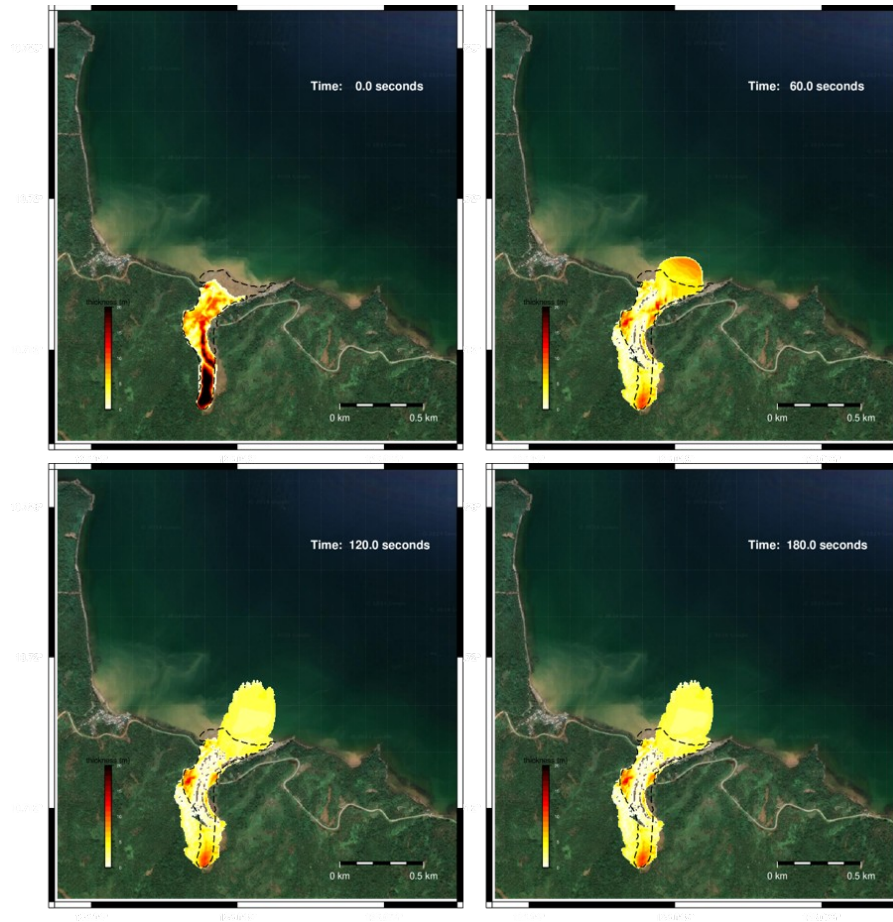


Figure 1. Sample model for Pilar Debris Flow and its corresponding tsunami model.

Figure 1 shows a sample of the model for Pilar Debris Flow and its corresponding tsunami. This model assumed a density of 2000 kg/m^3 , initial yield strength of 70 kPa , residual yield strength of 3 kPa , friction drag of 0.001 , pressure drag of 0.01 and a scale factor of 2 to account for the entrainment. Like most of the models, this simulated the general debris flow direction as seen in the video recording of the second debris flow event. It also generated a maximum of 6 m tsunami wave height. Only one model using the shallow wave equation has produced wave heights comparable to those documented for the first debris flow. That required a deeper slip area, a larger volume, and inclusion of scale factor to account for entrainment. However, the landslide model for that significantly deviated from the recorded and mapped flow direction. The resulting landslide extent of all models expanded beyond the area of the deposits, especially at the initiation phase, indicating that model refinements are still necessary before we test the more computationally heavy Boussinesq model and for other sites.

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