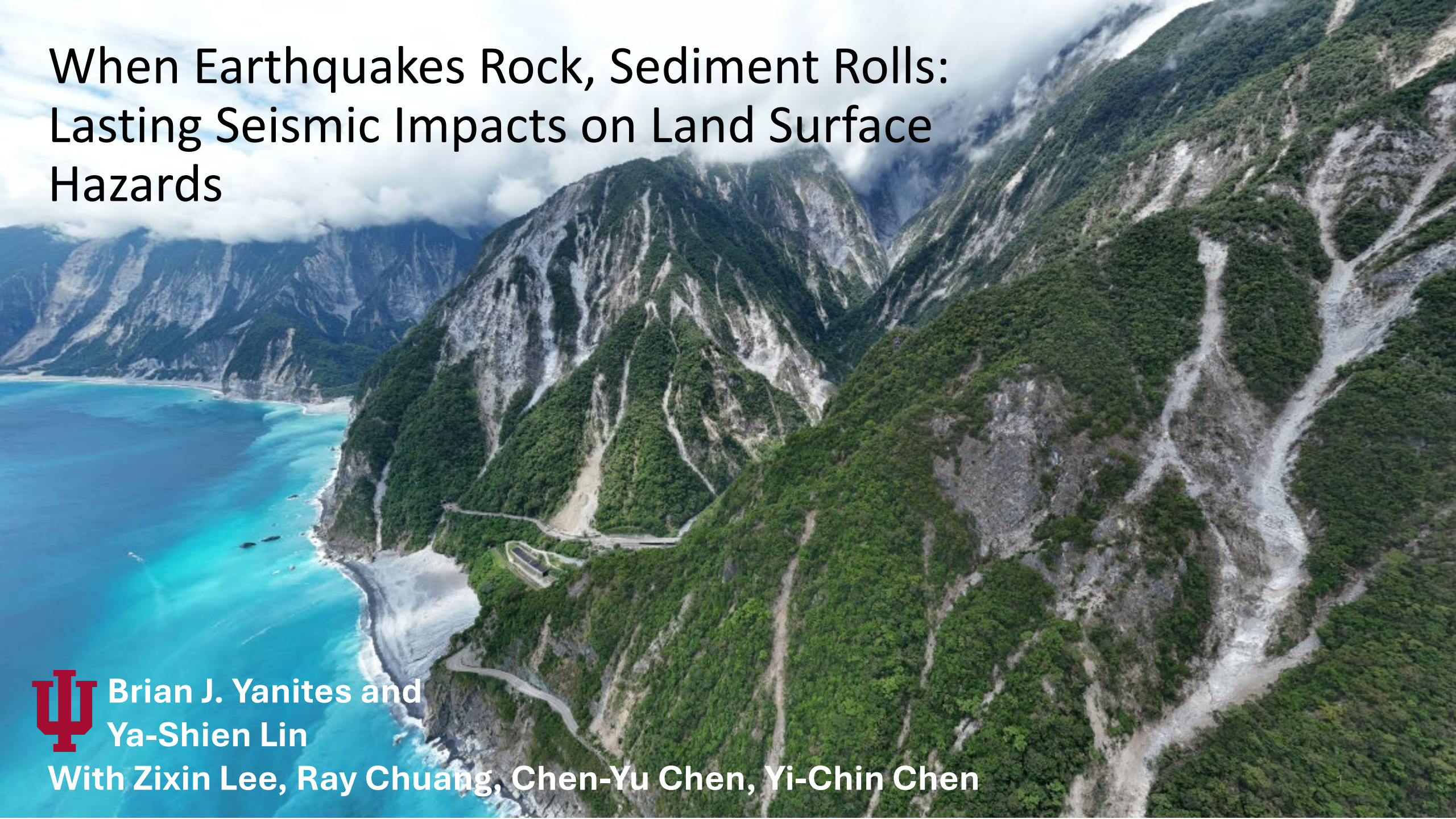
When Earthquakes Rock, Sediment Rolls: Lasting Seismic Impacts on Land Surface Hazards



Brian J. Yanites and
Ya-Shien Lin
With Zixin Lee, Ray Chuang, Chen-Yu Chen, Yi-Chin Chen

Landscapes are interconnected

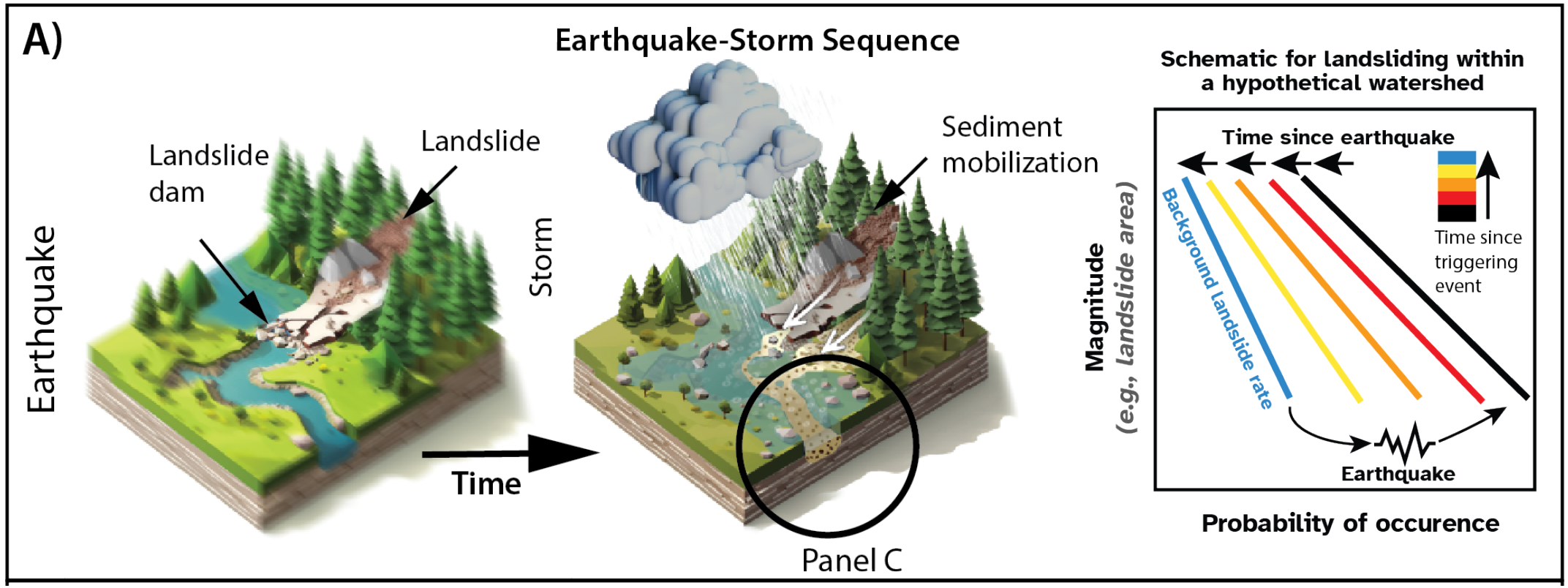
Google Earth, 3D perspective from Southern Taiwan

The interconnectedness of landscapes lead to cascading hazards

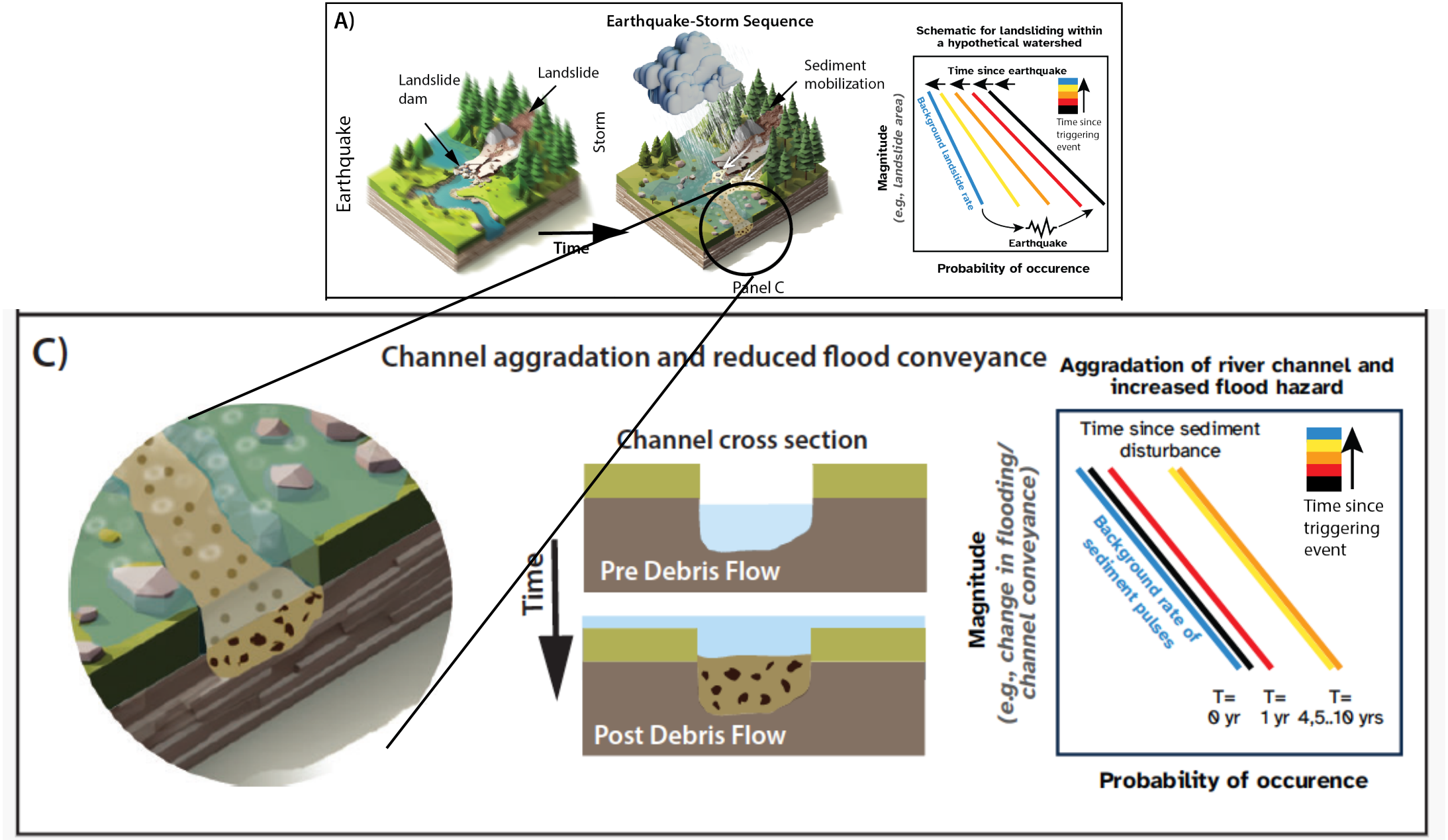
Photo by Chi Po-lin and provided by the Chi Po-lin Foundation, copyright Above Taiwan Cinema

Yanites et al., 2025

Cascading hazards, defined



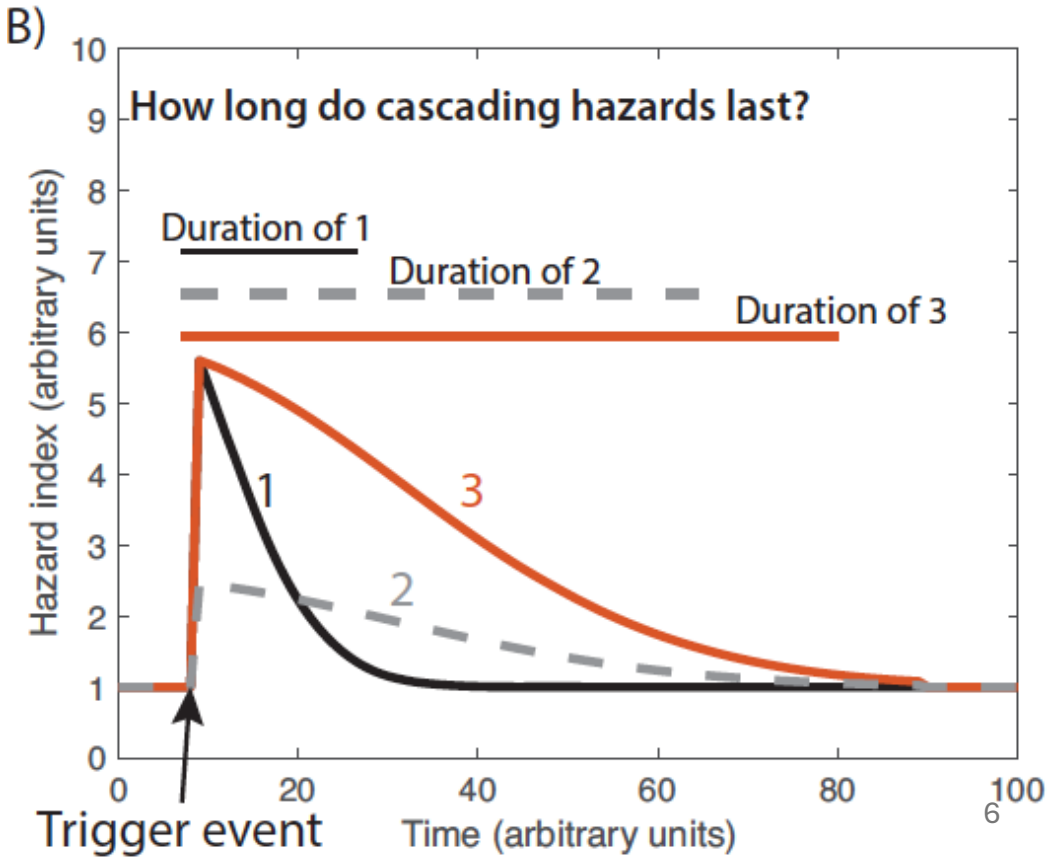
Yanites et al., 2025

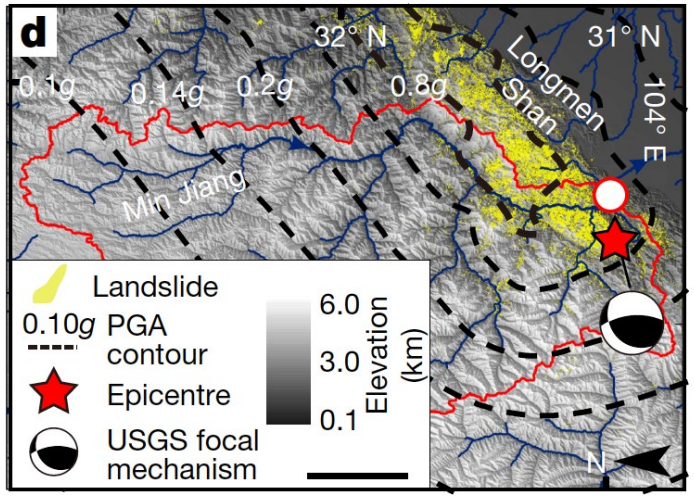


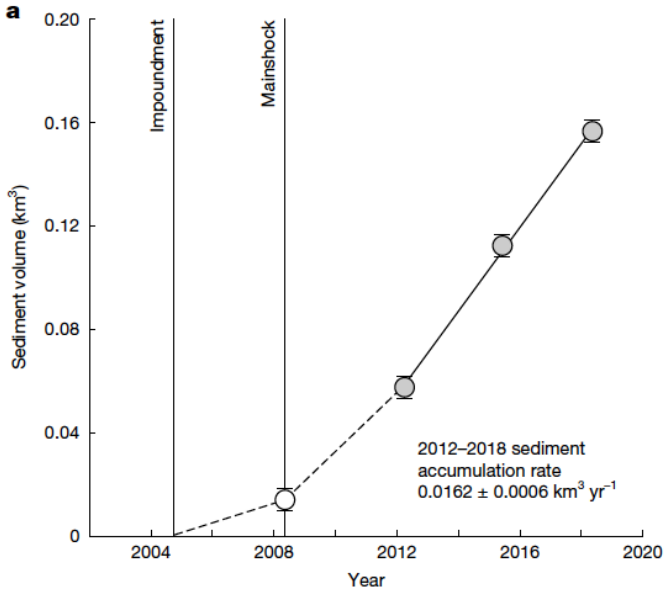
Yanites et al., 2025

Key research questions

- How does the ‘hazard signal’ propagate/emerge across the landscape?
  - What are the physical processes and thresholds that dictate the emergence of these cascades?
- What is the duration of the **‘tail’ of the hazard cascade**?







Article

Large riverbed sediment flux sustained for a decade after an earthquake

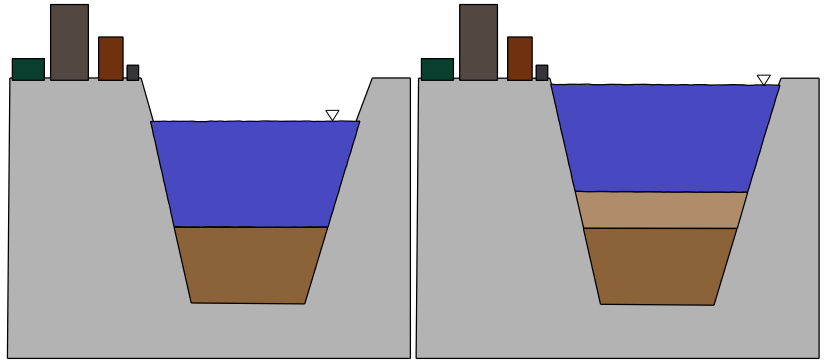
https://doi.org/10.1038/s41586-025-09354-8
Received: 7 December 2024
Accepted: 2 July 2025

Gen K. Li[1,2,3]✉, A. Joshua West[2], Zhangdong Jin[4,5,6], Hongrui Qiu[7], Fei Zhang[4,8], Jin Wang[4,6], Douglas E. Hammond[2], Alexander L. Densmore[9], Robert G. Hilton[10], Sijia Dong[2,3,11], Abra Atwood[2,12], Woodward W. Fischer[3] & Michael P. Lamb[3]

Wenchuan

Earthquake= Long-term disruption to landscape processes that impact hazards

Fluvial system and associated hazards are the longest part of this 'tail'



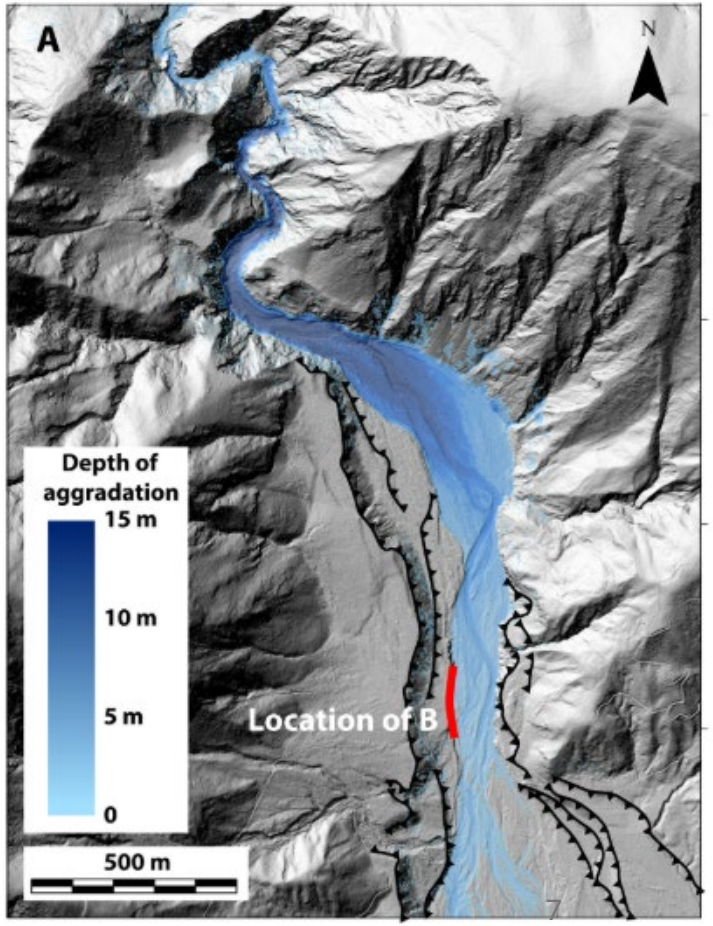
Kaikoura

SCIENCE ADVANCES | RESEARCH ARTICLE

GEOLOGY

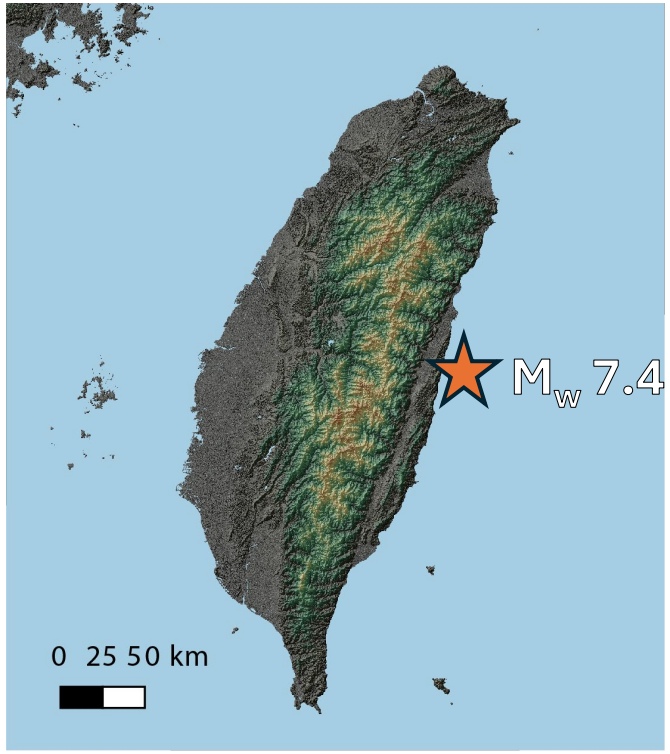
Controls on fluvial sediment evacuation following an earthquake-triggered landslide: Observations from LiDAR time series

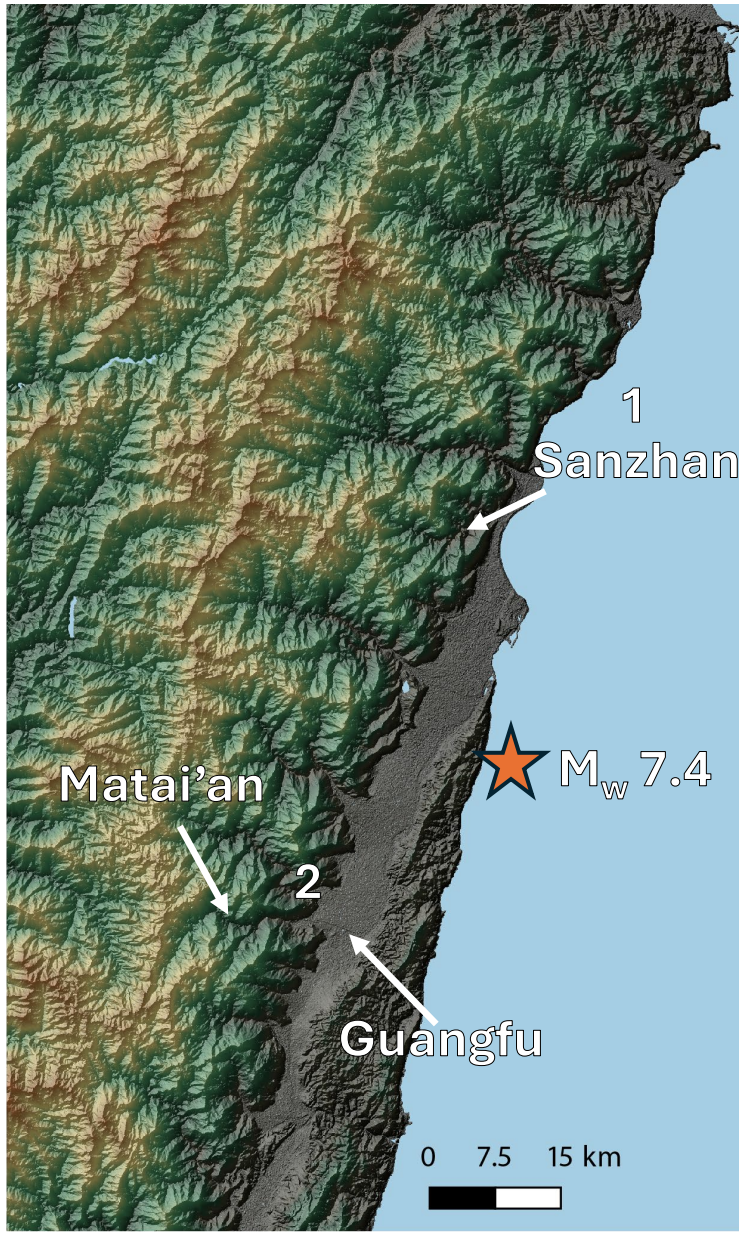
Jon Tunnicliffe[1]*, Jamie Howarth[2], Chris Massey[3]



The Tale of Two Tails

April 2024 Hualien Earthquake, eastern Taiwan





What is the magnitude and timescale of fluvial impacts following an earthquake?

Hualien earthquake

April 4, 2024

Typical convective storm

June 29, 2024

Typhoon Gaemi

July 25th, 2024

Typhoon Krathon

October 3rd, 2024

Typhoon Kong-rey

October 31st, 2024

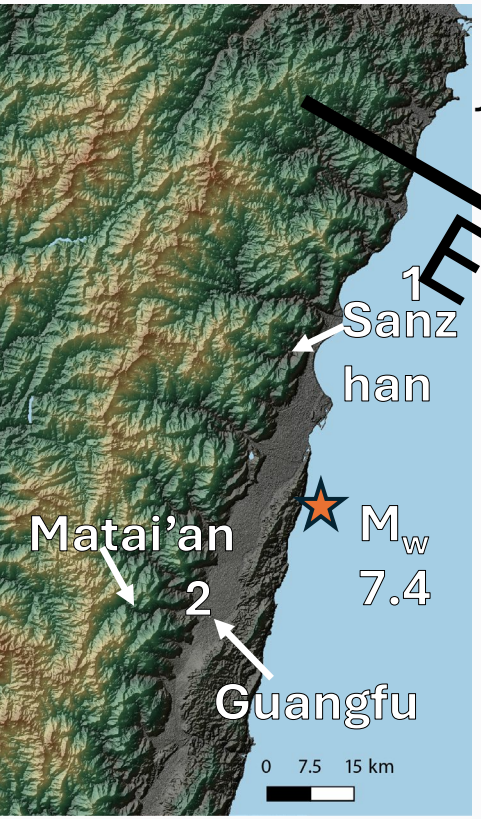
Tropical Storm Wipha

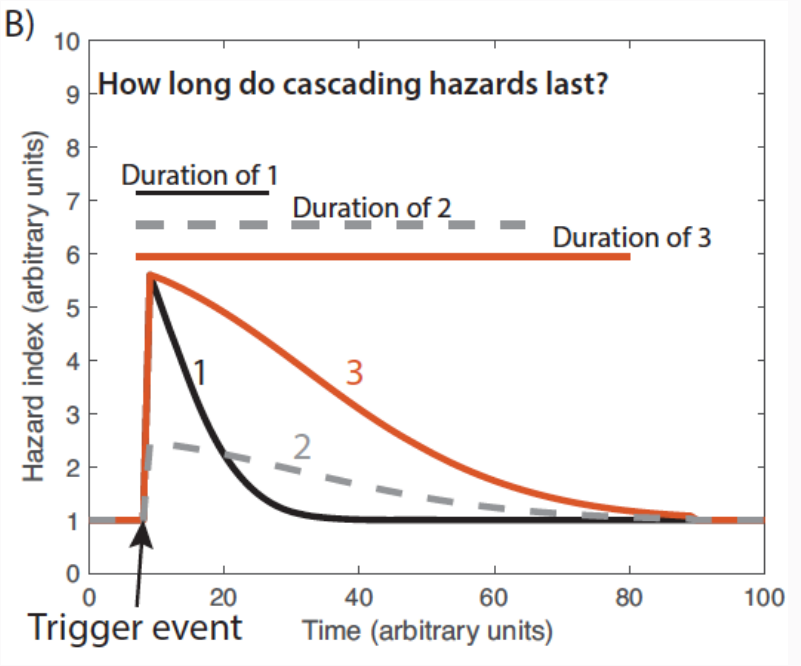
July 19th, 2025

Typhoon Ragasa

September 24th, 2025

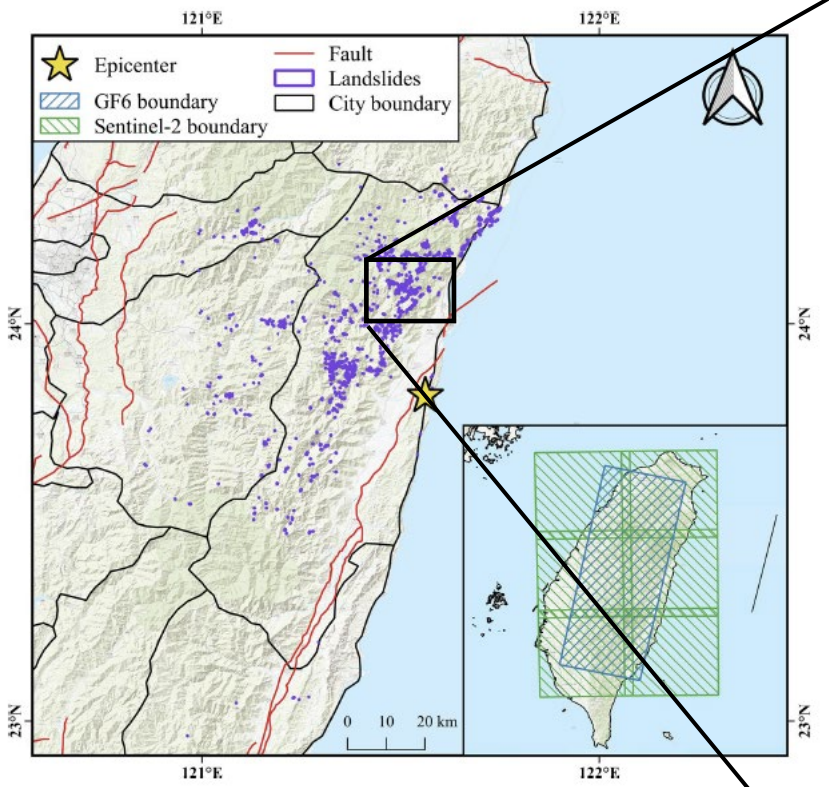
Event sequence



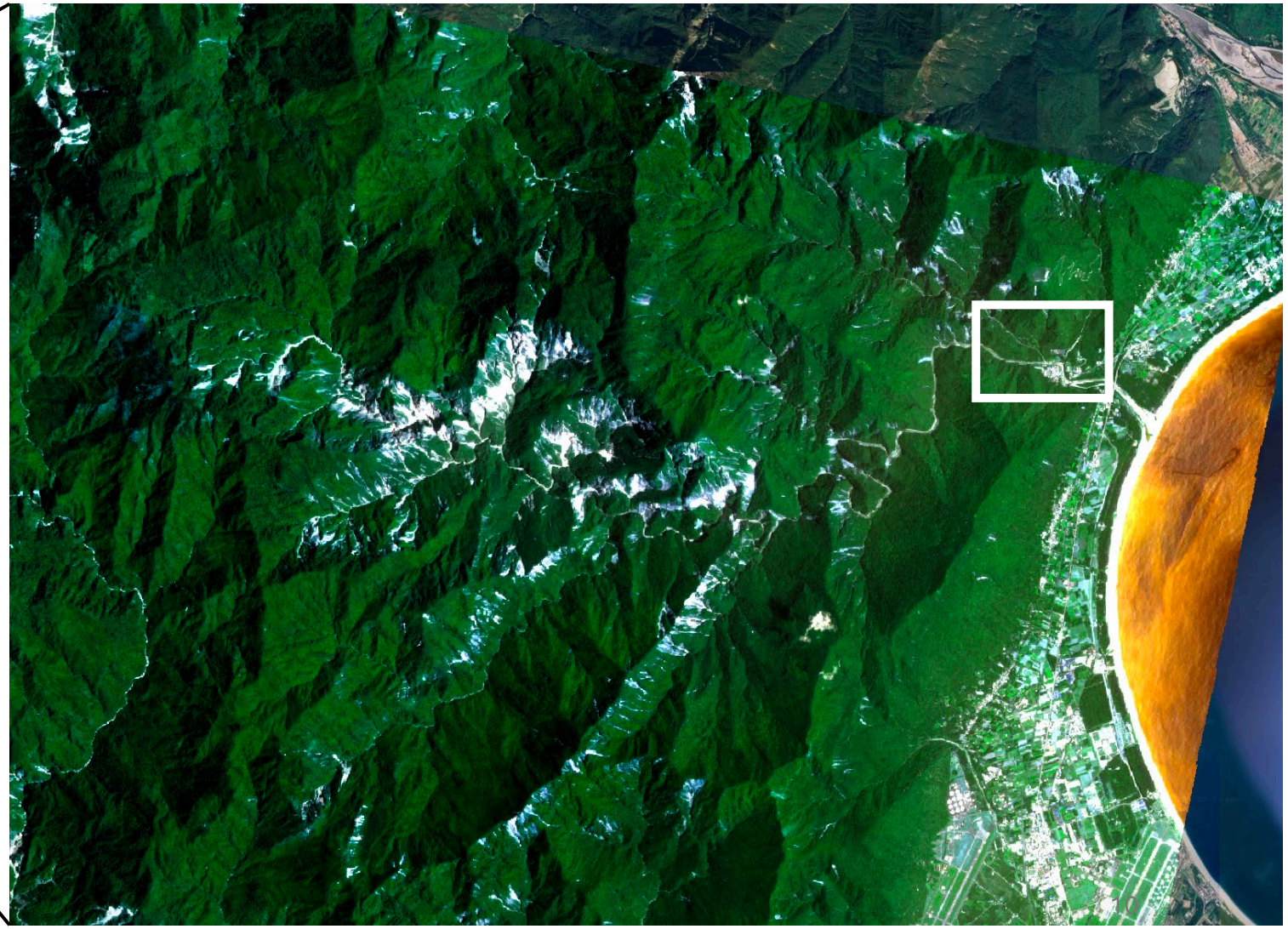


What is the magnitude and timescale of fluvial impacts following an earthquake?

Sanzhan: Coseismic landslides and fluvial export

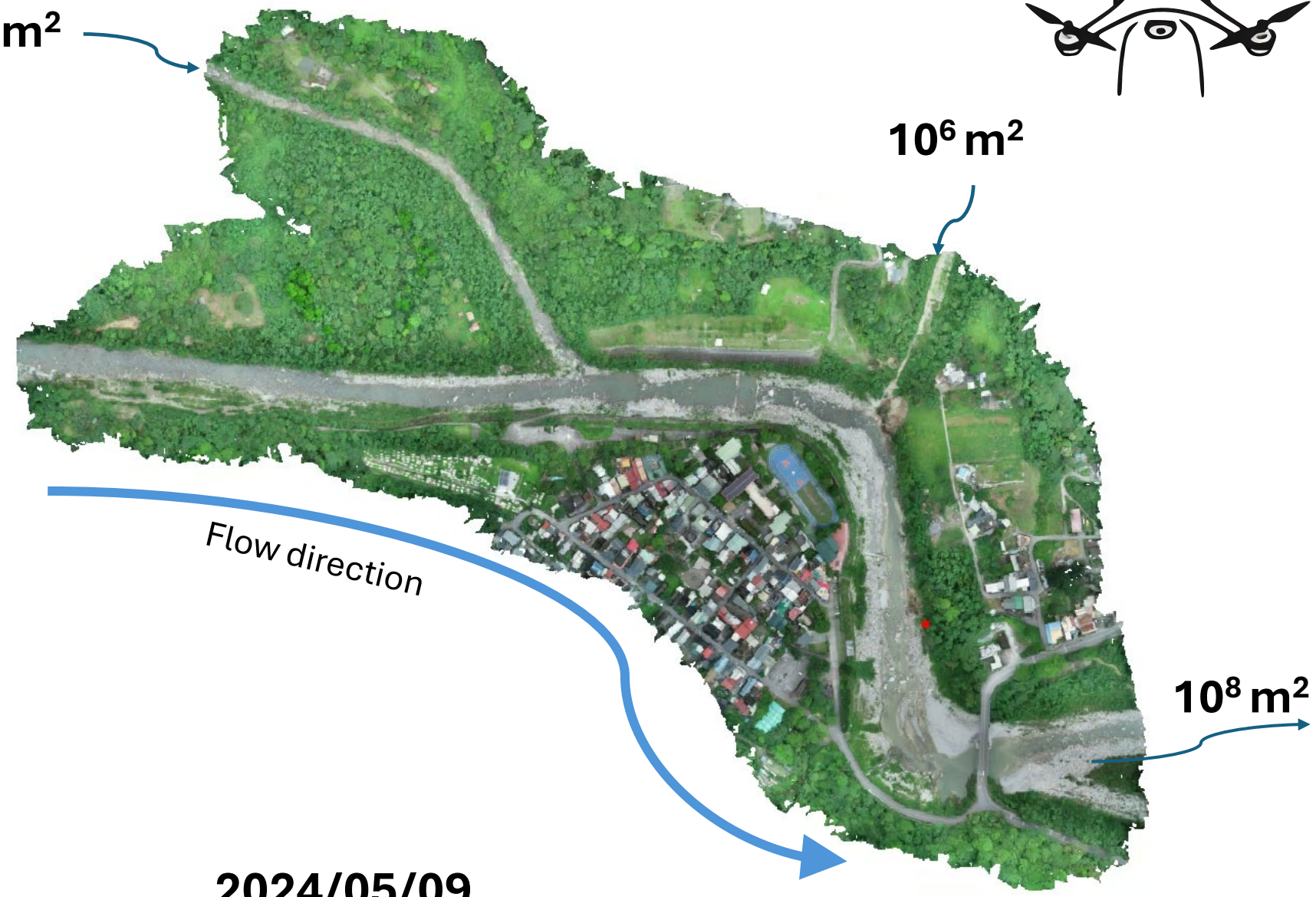


Chen et al., 2025 Landslides



Sanzhan

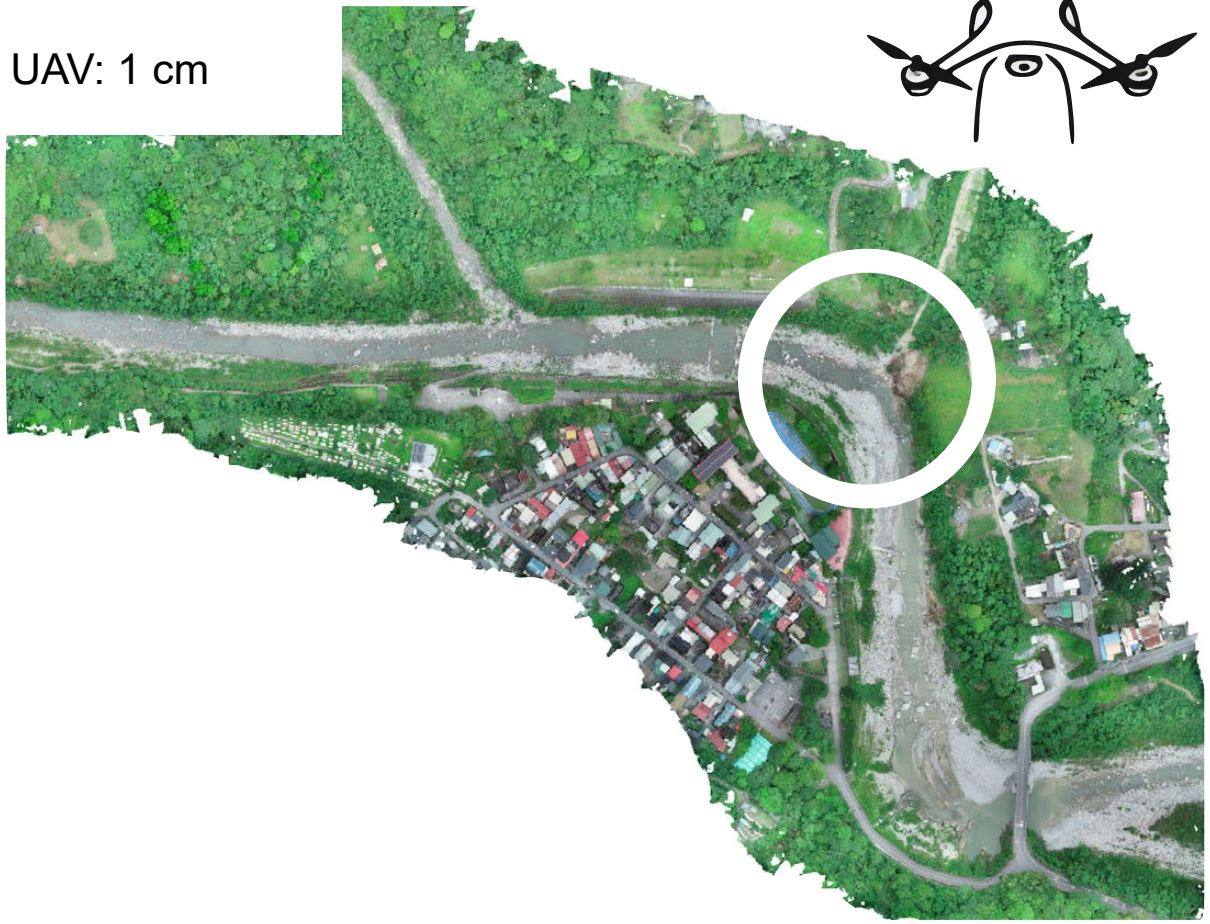
- Small basin
- Variable tributary size.
- Accessible

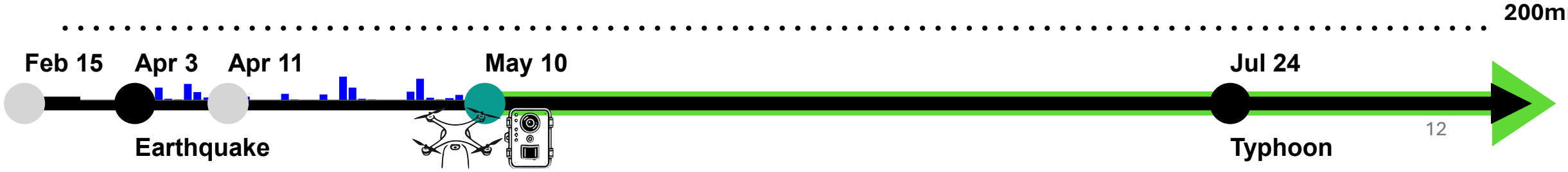


2024/05/09

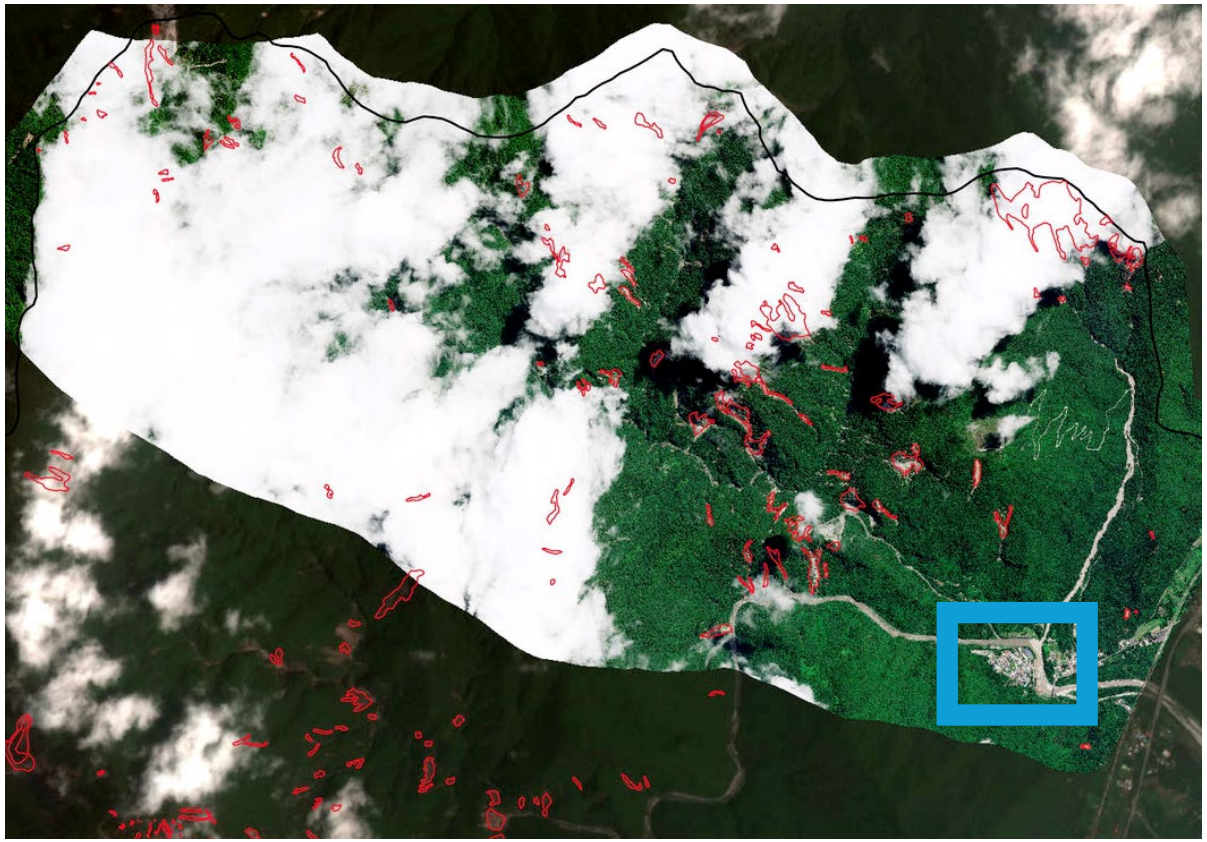
Monitor fluvial response after each typhoon

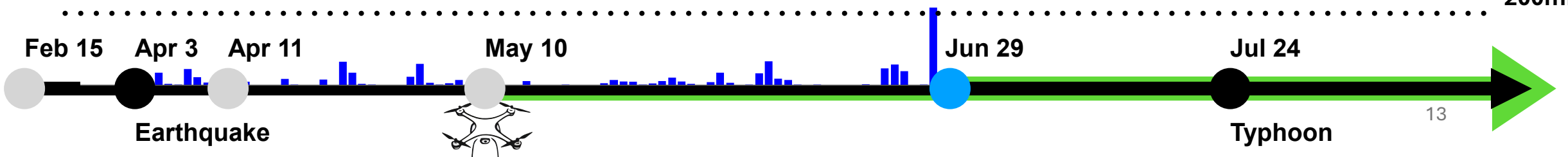
UAV: 1 cm





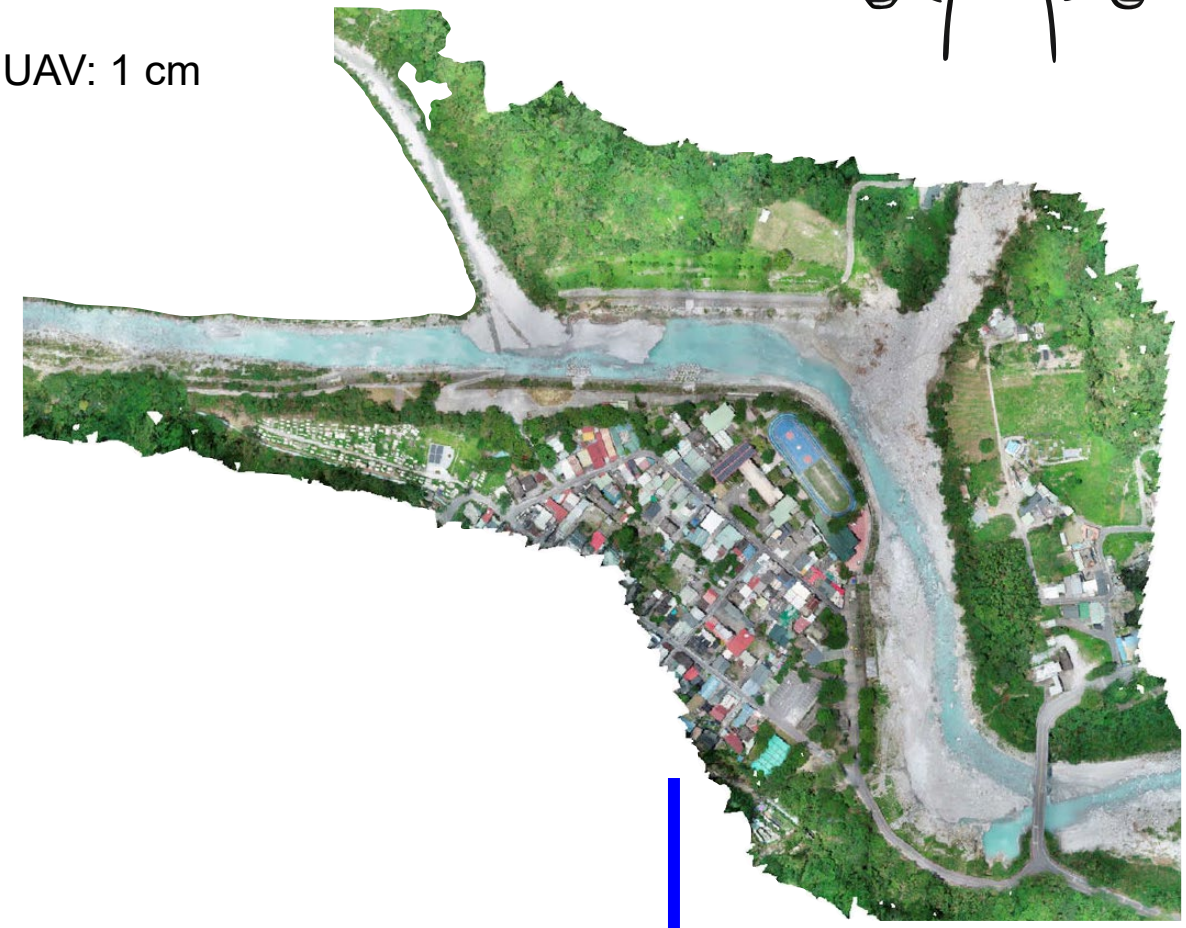
Shift in rainfall threshold for small basins

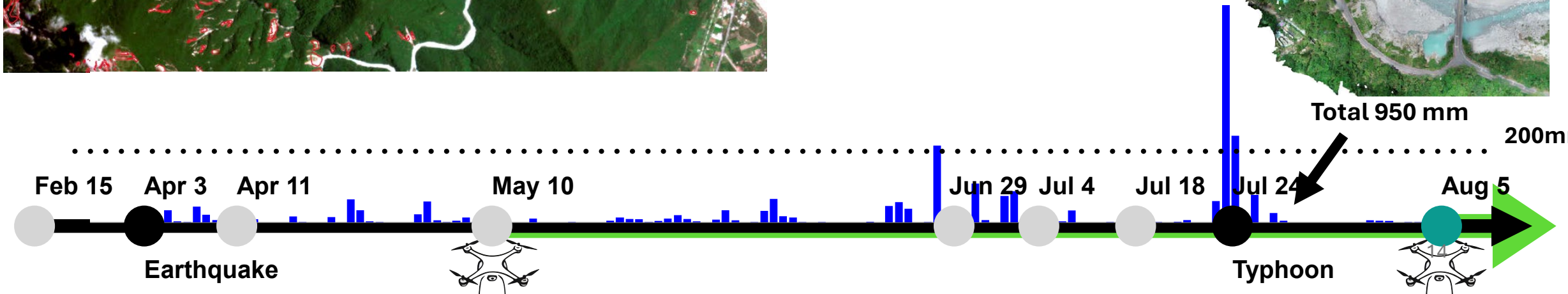




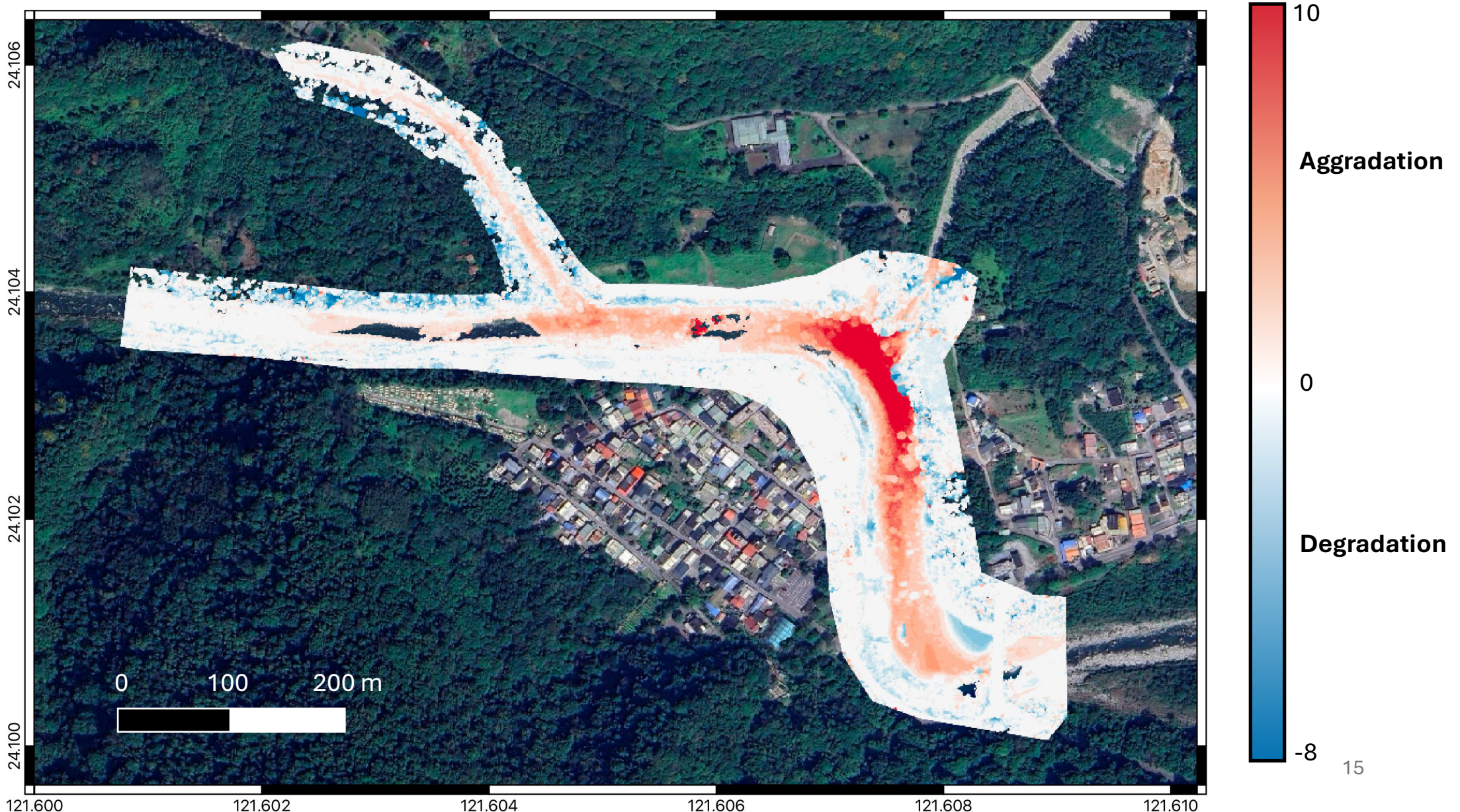
Basin spanning storms

UAV: 1 cm





High spatial and temporal resolution elevation change



2024/05/09

2024/08/06

Typhoon Gaemi

July 25th, 2024

2024/10/19

Typhoon Krathon

October 3rd, 2024

2024/12/24

Typhoon Kong-rey

October 31st, 2024

2025/03/12

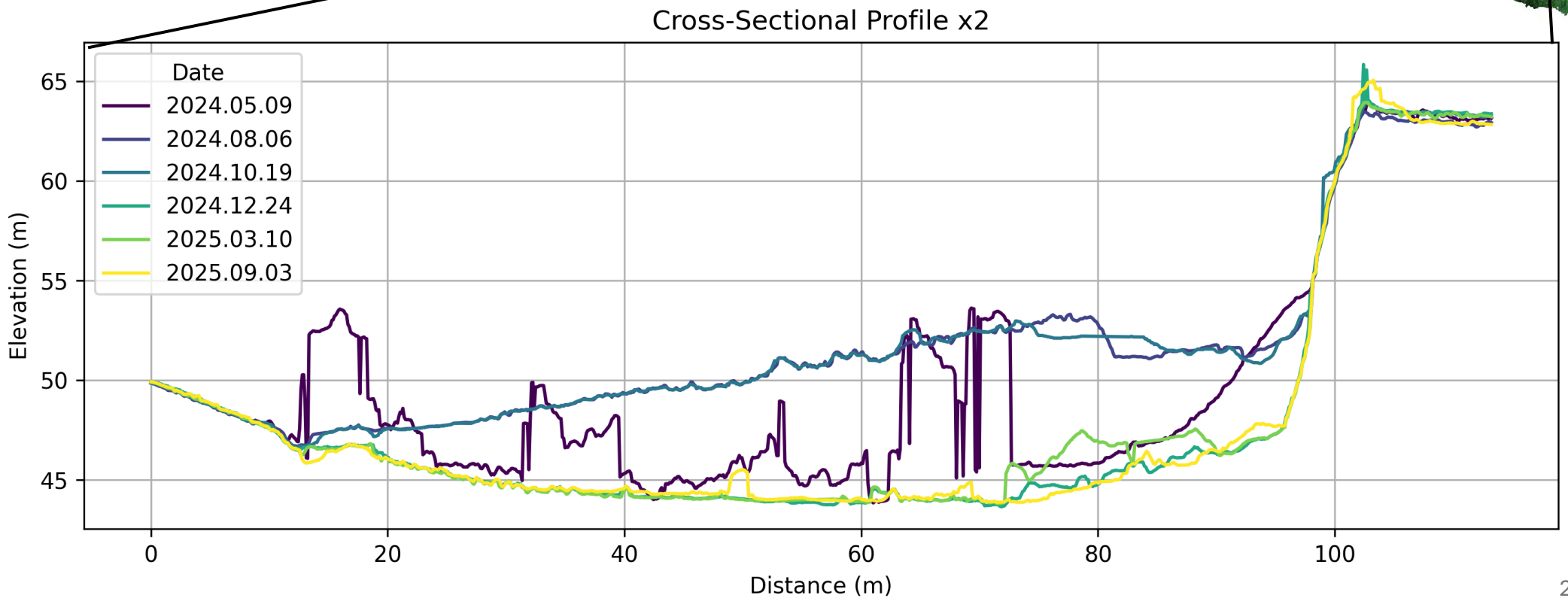
2025/09/03

Tropical Storm Wipha

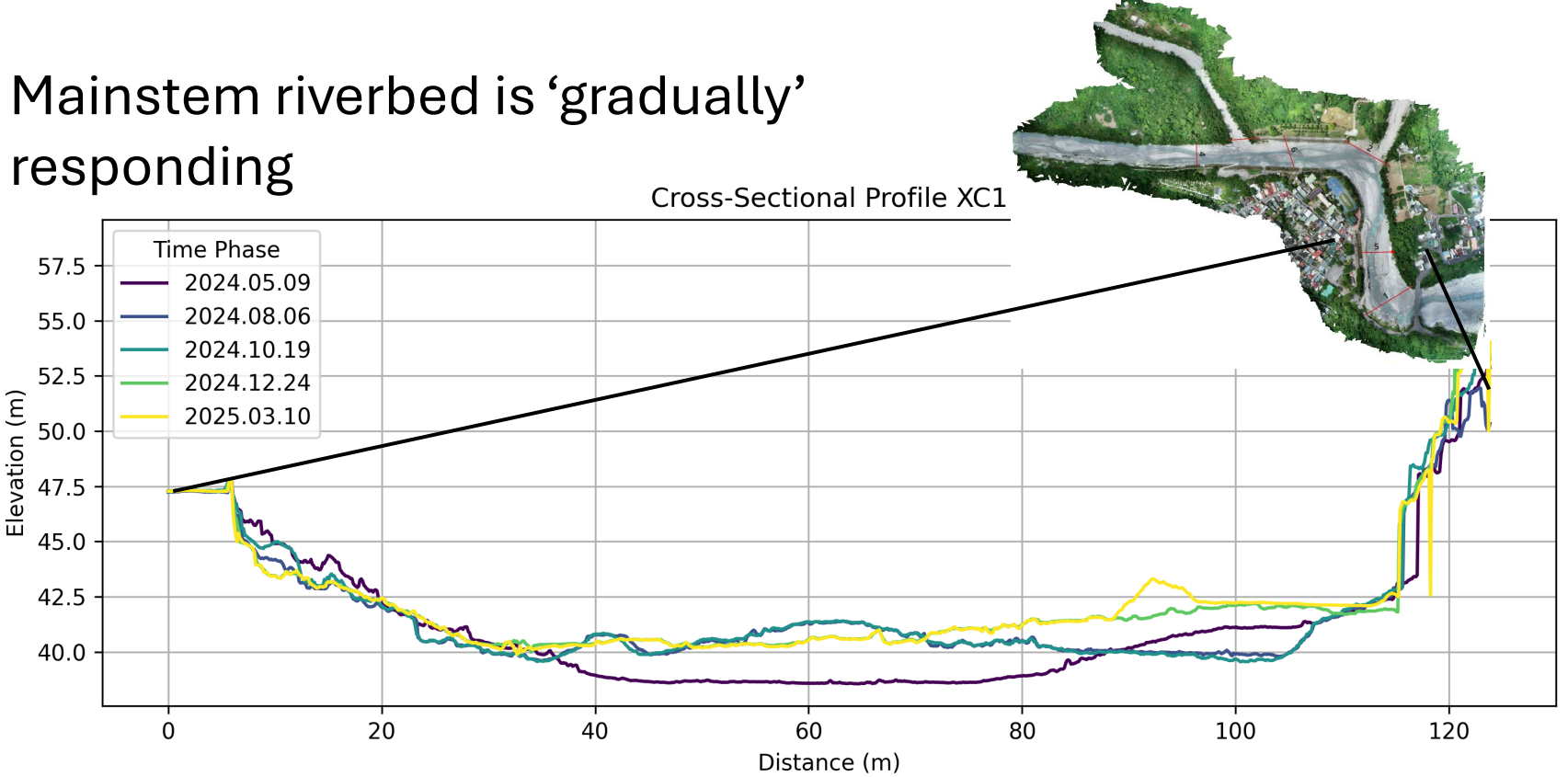
July 19th, 2025


4
6
2
5
1

Tributaries respond rapidly

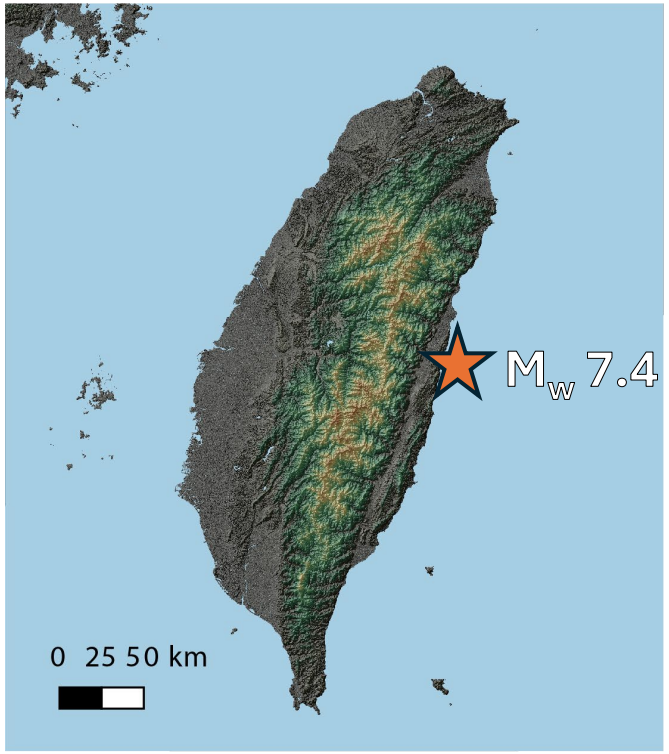


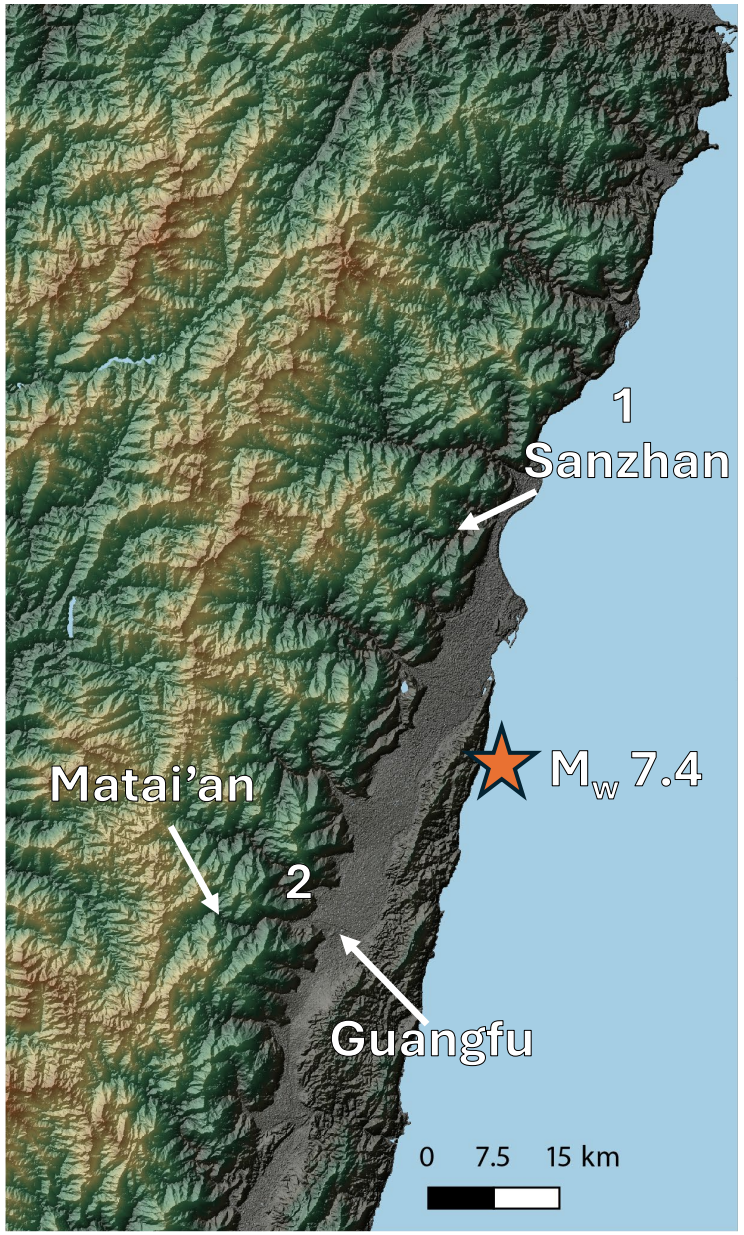
Mainstem riverbed is ‘gradually’ responding



The Tale of Two Tails

The tragedy of Guangfu



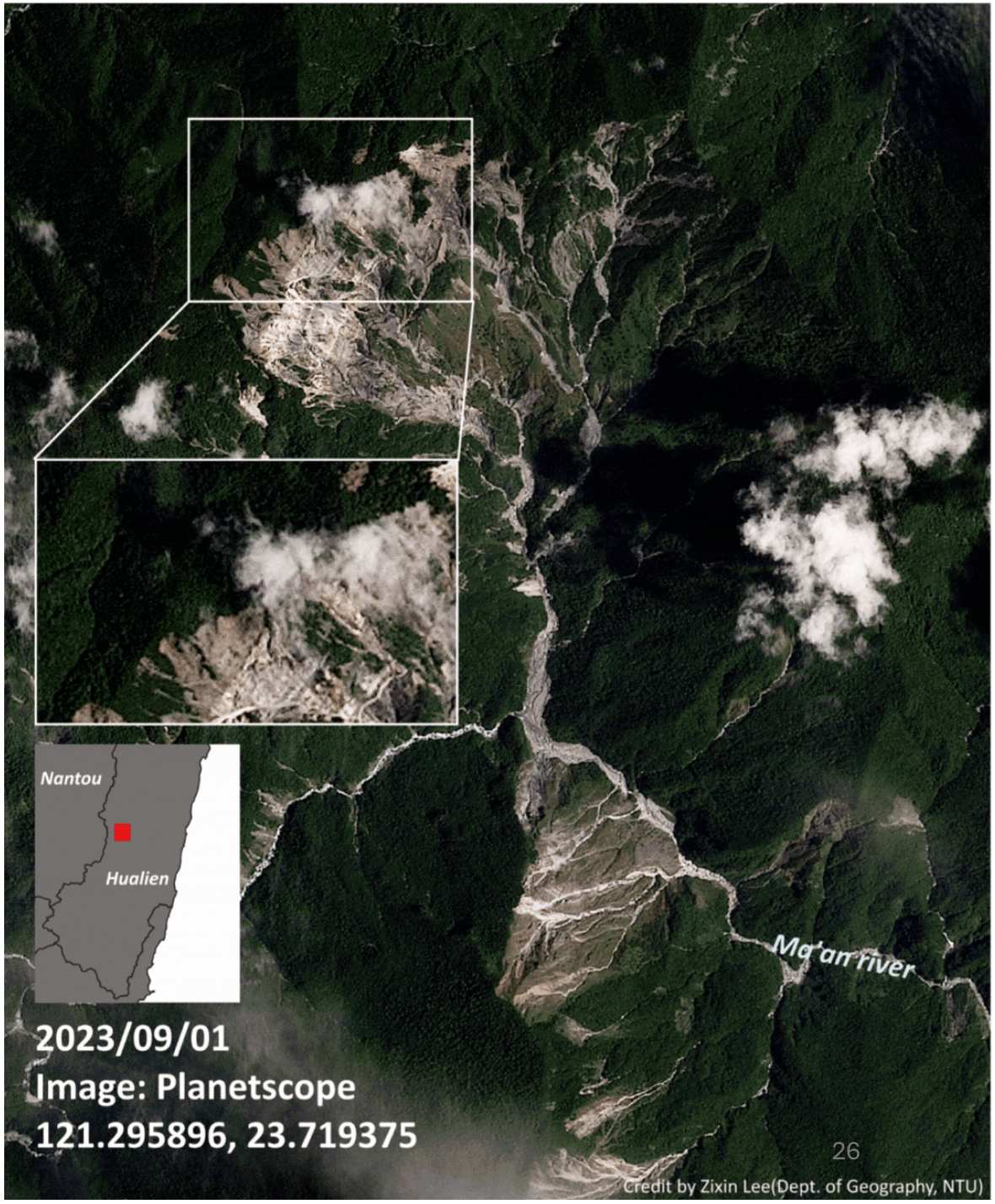


The Matai'an Landslide July 21st, 2025

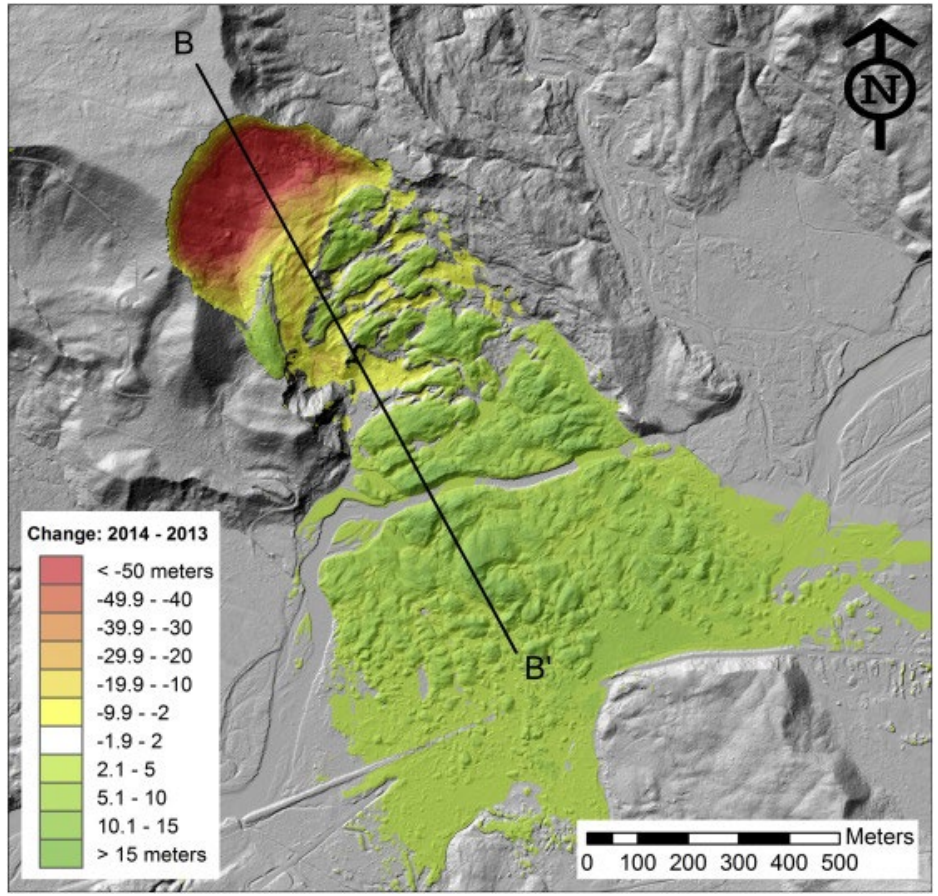
- Area has been a region of 'unrest' for some time
- Largest seismically detected landslide since USGS started documenting
- Over a mile wide

Tropical Storm Wipha

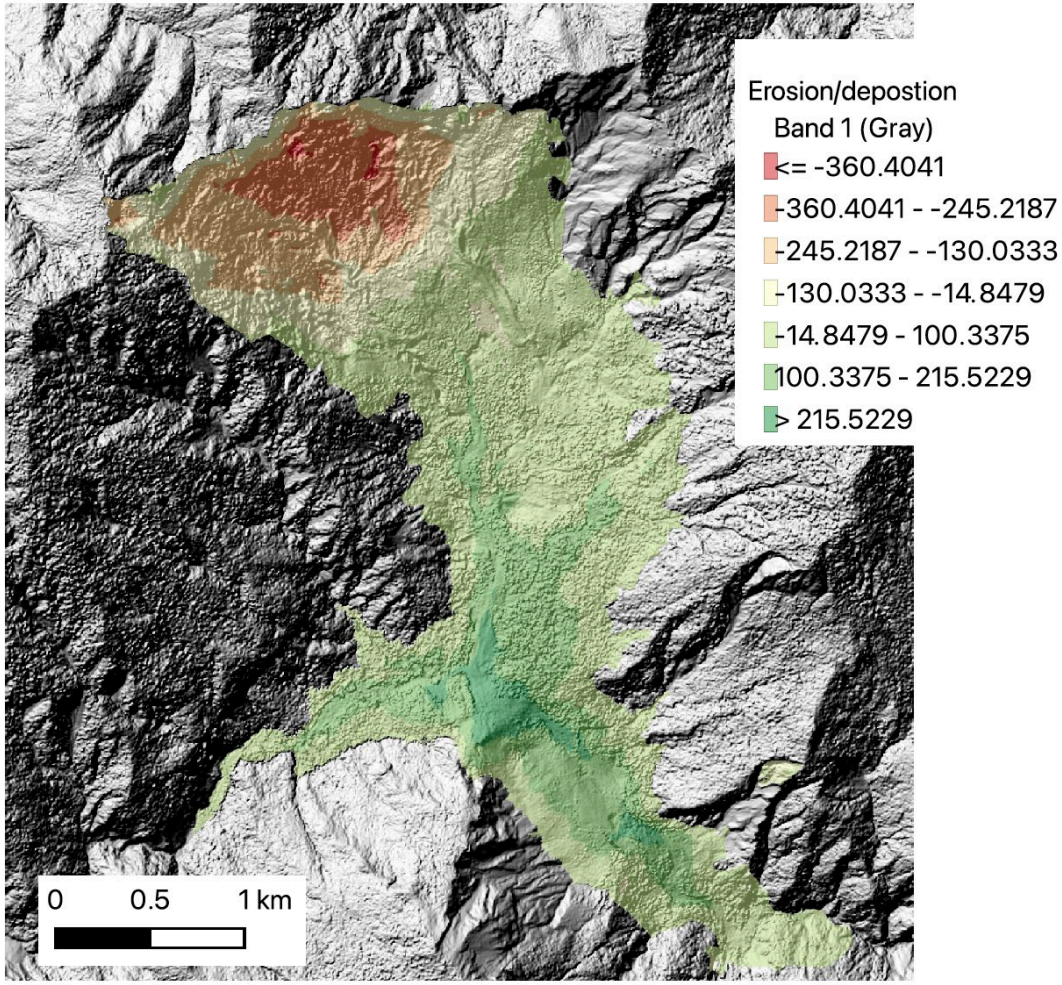
July 19th, 2025



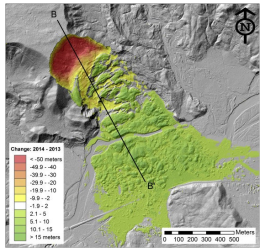
Oso comparison

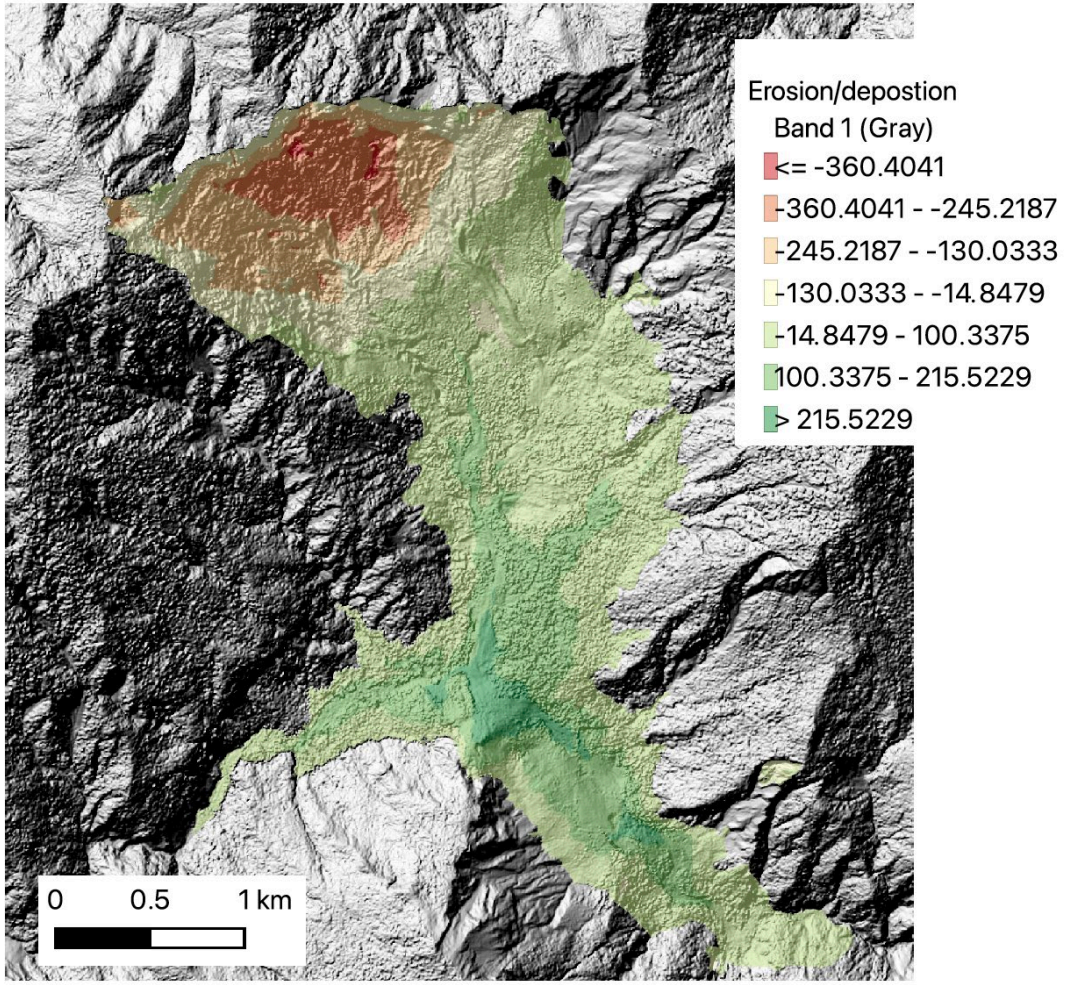


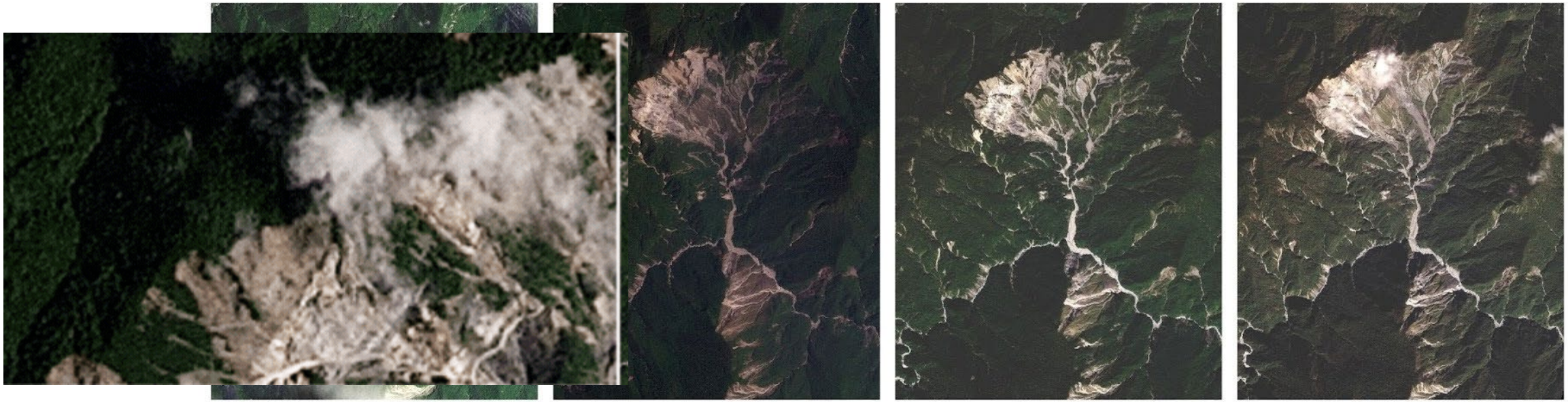
Wartman et al., 2016



Oso comparison



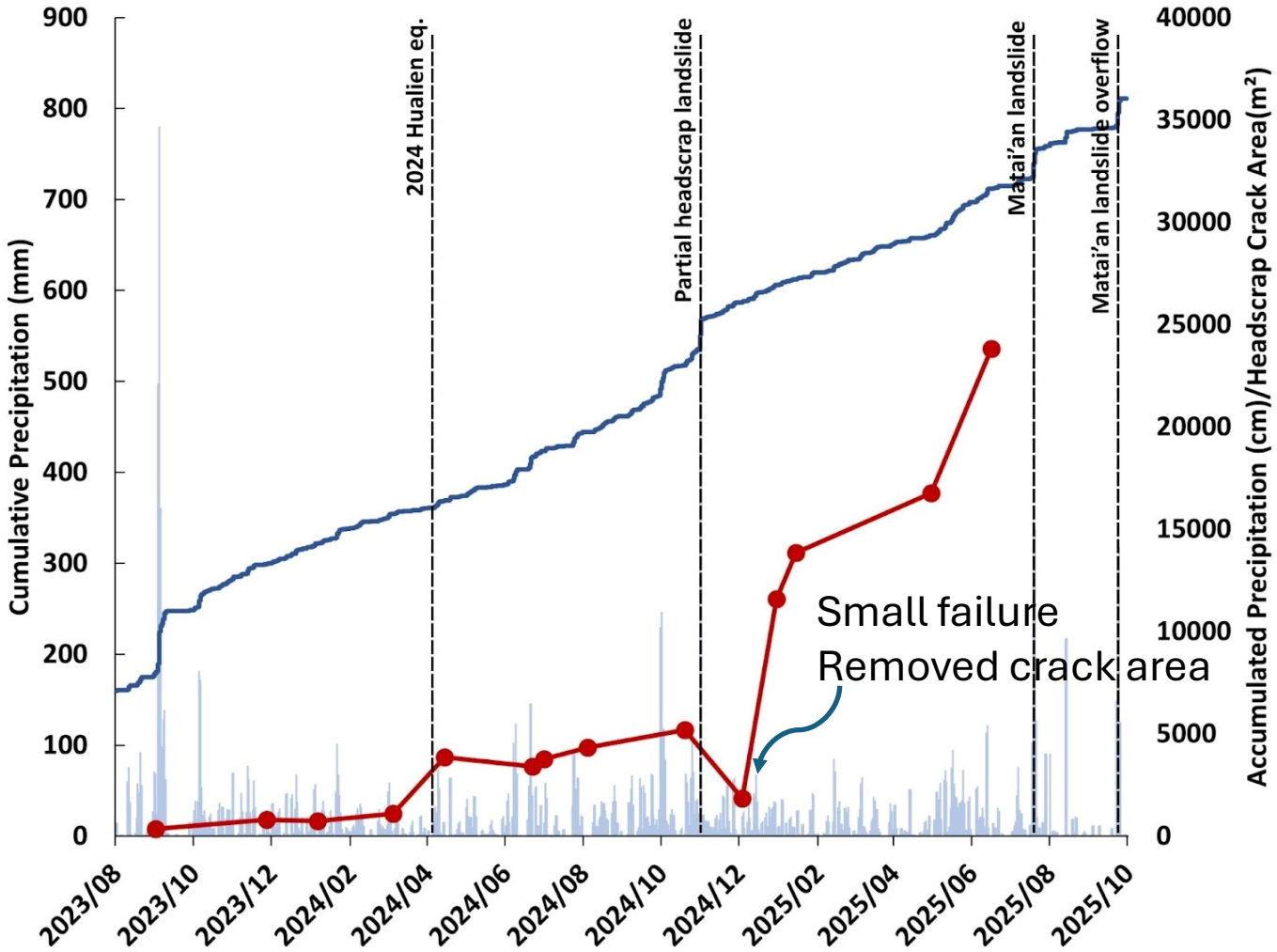




2023/09/01 2024/03/05 2024/04/14 2024/12/30

2025/06/16 2025/07/25 2025/08/23 2025/09/27

Seismically accelerated failure



Impoundment filled for two months

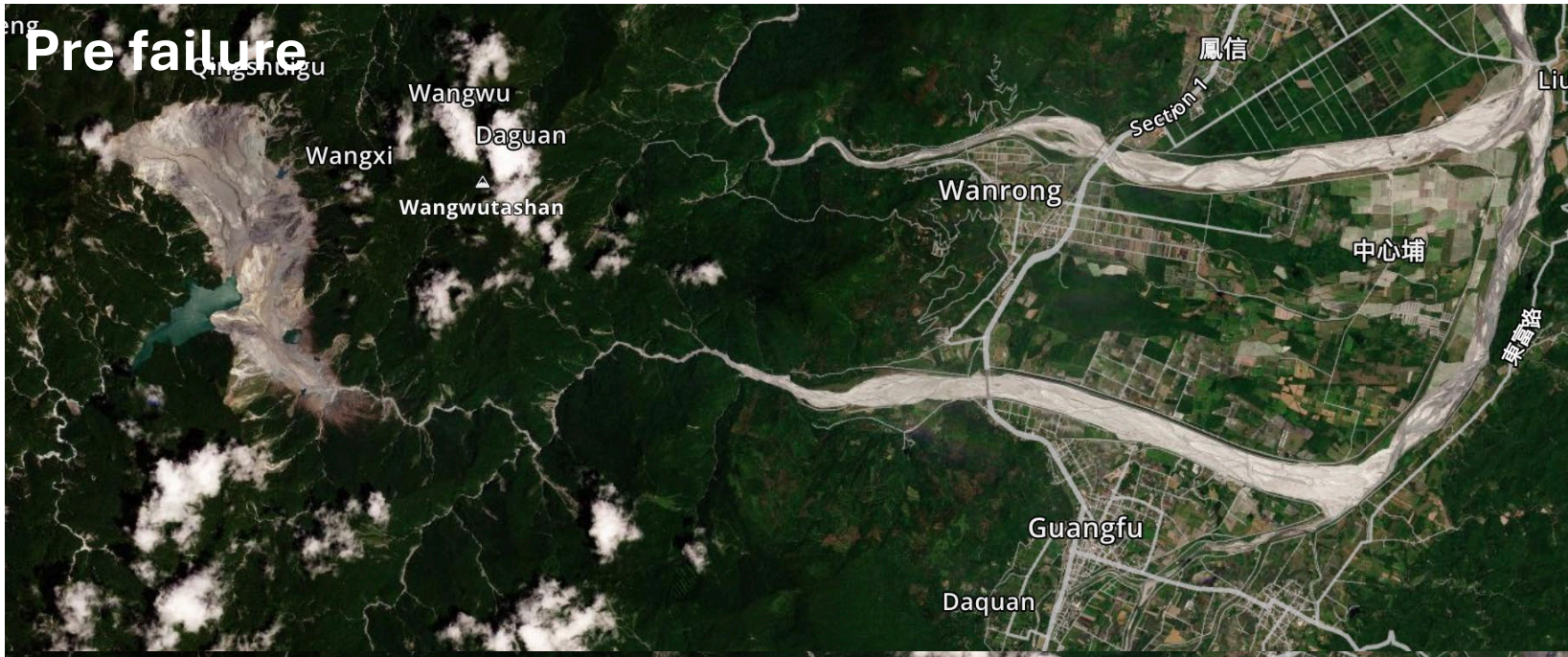
Aug. 15, 2025

https://hualien.forest.gov.tw/

Dam failure, September 24th, 2025

Typhoon Ragasa

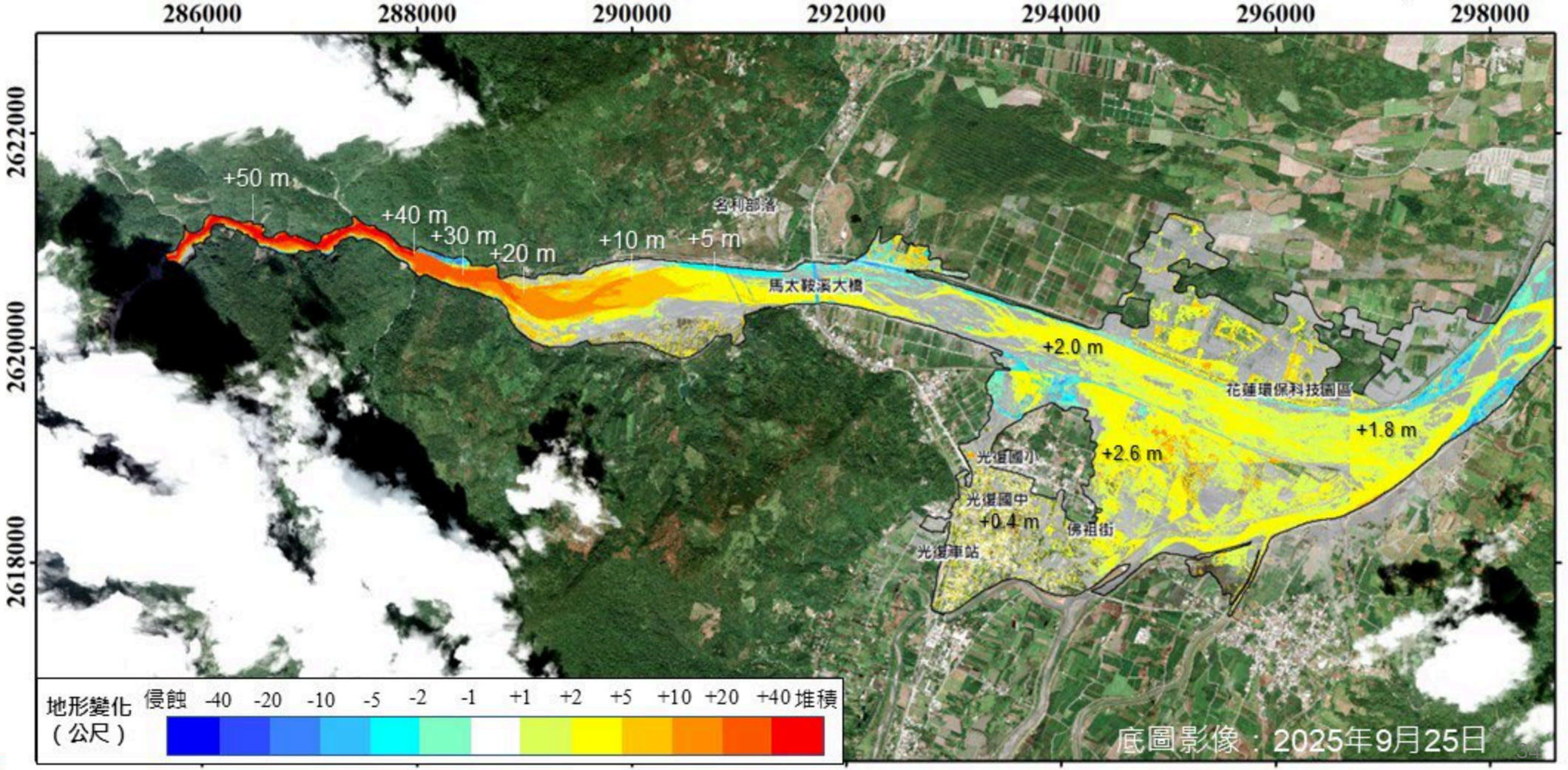
September 24th, 2025



https://www.taipeitimes.com/News/taiwan/archives/2025/09/30/2003844664

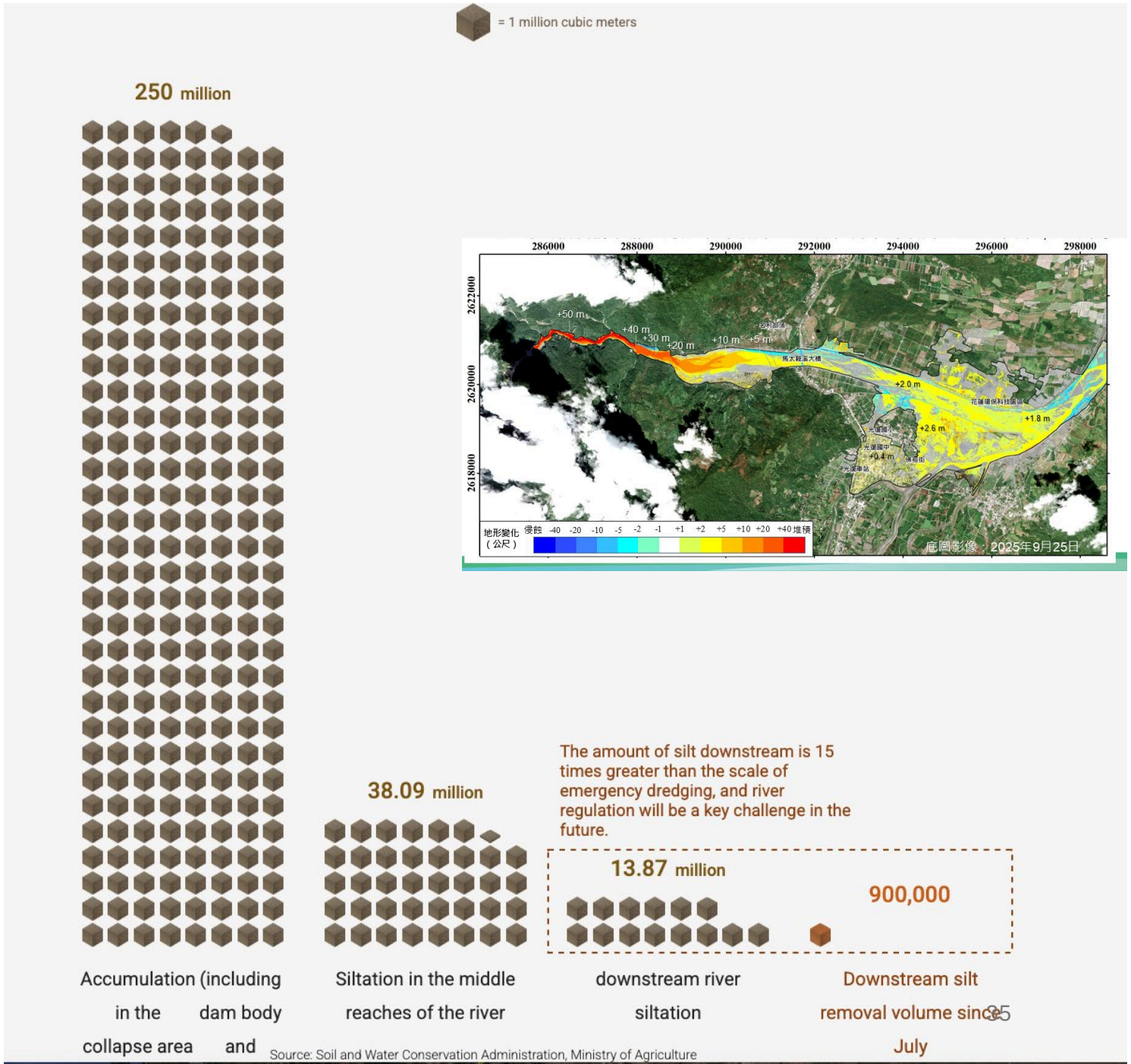
馬太鞍溪下游地形變化

- **總淤積量：3,170萬方 (以2025/9/25災後數值地形與2022年數值地形計算所得)**
  - ✓ **馬太鞍溪橋上游**：河道平均淤高13.3m，累計2,045萬方
  - ✓ **馬太鞍溪橋下游**：河道平均淤高2m，佛祖街平均淤高2.6m，累計1,125萬方



<1/3 of sediment mobilized

https://www.cw.com.tw/graphics/hualien-mataian-barrier-lake-2025/index.html



https://www.ksnews.com.tw/e/39878

Summary and key takeaways

- Seismic events act as catalysts for widespread landscape disturbance.
- Shifting thresholds: The initial disruption triggers a sequence of interconnected surface processes that evolve over diverse spatial and temporal scales.
- These cascading processes can sustain or amplify hazard potential well beyond the timeframe of the original earthquake.
- Finally, the tale of the tails in Eastern Taiwan is not over. Both Sanzhan and Matai'an Rivers will continue to see aggradation and fluvial hazard amplification for years to come.

Questions?

Views from the Matai’an and Sanzhan riverbeds 1 year ago


CAUTION CAUTION
#遇震勿驚慌
#避難小心防
花蓮觀光糖廠防震宣導
Hualien Tourism Sugar Factory
The Propaganda of Earthquake Prevention
保命三步驟
1 DROP
趴下
2 COVER
掩護
3 HOLD ON
穩住
台糖公司花東區處
關心您