FITTER project: innovations and impact

Future Indonesian Tsunamis:
Towards End-to-End Quantification of Risk
(FITTER) Workshop

Serge Guillas (UCL, PI), Dimitra Salmanidou (UCL, co-I), Rozana Himaz (UCL, co-I), Mohammad Heidarzadeh (Bath, co-I)
and the Insurance Development Forum (IDF)

Funding: Lloyd's Tercentenary Research Foundation, Lighthill Risk Network, Lloyd's Register Foundation

1 March 2023

Together:

- **instruments created**
- **capacity and knowledge**

Indonesia increased capacity and resilience.

Key stakeholders:

UNDP, Oasis, BRIN

World Tsunami Awareness Day:

Innovative Financing for Tsunami Resilience

Friday, 12 November 2021 | 03:00 - 05:00 PM Jakarta Time | 09:00 - 11:00 AM CET

Opening Remarks

Sophie Kemkhadze
Deputy Resident Representative
UNDP Indonesia

Usui Masato
Minister, Economic Division
Embassy of Japan

Kristiyanto
Senior Policy Analyst,
Fiscal Policy Agency
Ministry of Finance, Republic of Indonesia

Raditya Jati
Deputy for Disaster System and Strategy,
National Disaster Management Authority
(BNPB)

Panel Session

Disaster Risks, Data, and Information
Udrekh
National Disaster Management Authority
(BNPB)

Strengthening Indonesia's Fiscal Resilience to Natural Disasters
Kristiyanto
Ministry of Finance, Republic of Indonesia

Advancing Disaster Resilience Planning through Catastrophe-Loss Modelling
Rozana Himaz
University College London

Innovative Financing Solutions
Muhammad Didi Hardiana
UNDP Indonesia

Join via:

Moderated by:

Understanding tsunami hazard and risk and reaching out to communities:
Study cases from Indonesia

Join our working group meeting on risk communication & dissemination
with Dr. Nuraini Rahma Hanifa
Research Center of Geotechnology,
Research Organization of Earth Sciences
BRIN - Indonesian National Agency for Research and Innovation

DEC 08 • 9:00 AM GMT

REGISTER HERE

WORLD TSUNAMI AWARENESS DAY

INTERNATIONAL WEBINAR SERIES : CHAPTER 3
BUILDING THE COASTAL REGIONAL AND COMMUNITY RESILIENCE IN TIMES OF TURBULENCE:
RECALIBRATING OUR DEVELOPMENT - RESILIENCE RELATION

FREE E-CERTIFICATE

CRITICAL AND TURBULENT EARTH:
LINKING THE FRONTIERS AND HUMAN SURVIVAL

KEYNOTES SPEAKERS

Dr. Edi Prio Pambudi, S.E., MA.
Staf Ahli Bid. Konektivitas, Pengembangan dan SDA
Kementerian Koordinator Perekonomian

Dr. Eng. Hamzah Latief, M.Si.
Kelompok Keilmuan Oseonografi, Fakultas Ilmu dan Teknologi Kebumian, ITB

SPEAKERS

Rick Bailey
IOC-UNESCO/Secr. IOTWMS

Prof. Fumihiko Imamura
Tohoku University

Dr. Abdul Muhari S.Si, M.T.
Kepala Pusat Data Informasi dan Komunikasi Kebencanaan
BNPB

SPEAKERS

Prof. Dr. Jakob Rhyner
Universität Bonn, Germany

Dr. Dimitra Salmanidou
University College London

Ir. Dwi Larso M.SIE, Ph.D
LPDP
Indonesian Education Scholarship

DAAD
Deutscher Akademischer Austauschdienst

MODERATOR

Dr. Ir. Udrekh S.E., M.Sc
Irina Rafliana, M.Si
Dr. Rahma Hanifa Assoc.Prof. Ir. Harkunti P R, Ph. D

Dr. Simon Plank
German Aerospace Center

Thursday, Dec 16, 2021
9 AM (GMT +7)

Registration :
http://bit.ly/indonesiaresilience3
More information :
http://linktr.ee/DirektoratPERB

Live Streaming via Youtube
https://bit.ly/WTADSession3

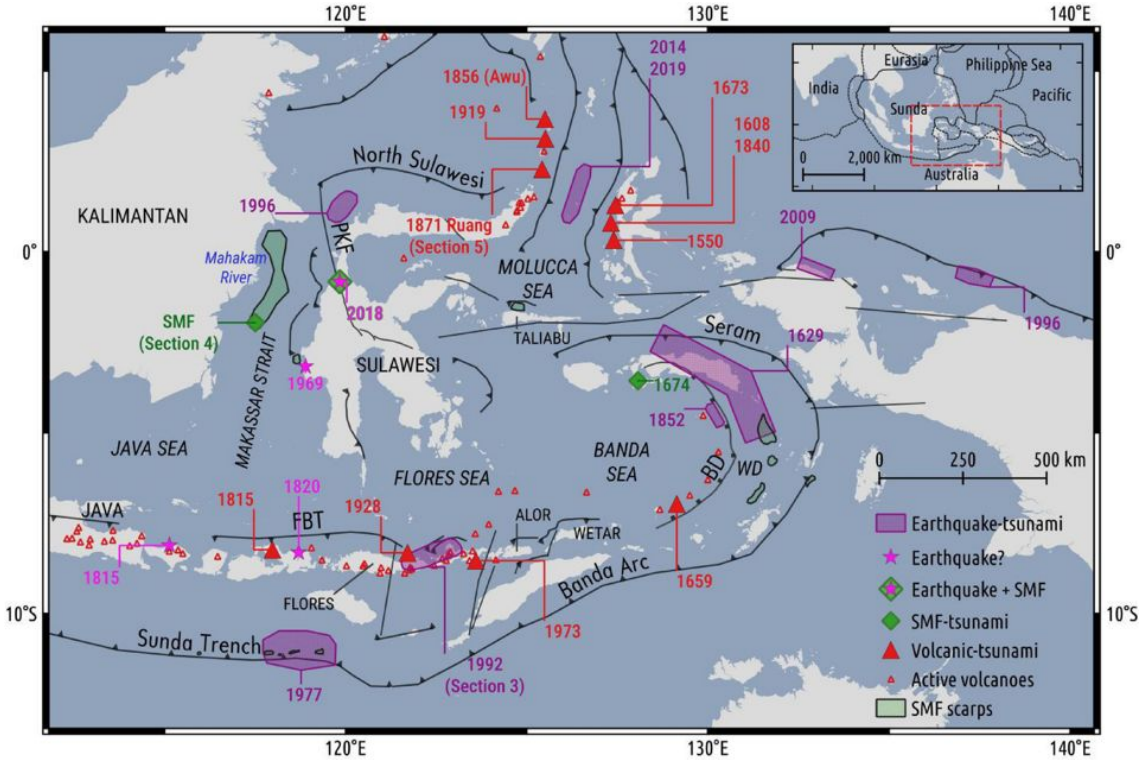
Inspire Indonesia

Illustration of holistic risk modelling

- **First proof-of-concept** for Cilacap using the Oasis loss modelling framework.

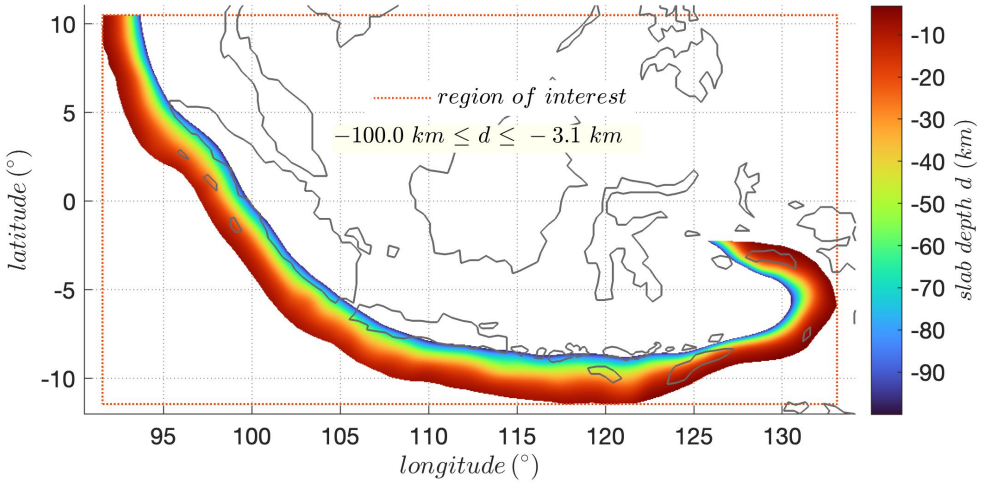
  Salmanidou et al. 2021. 'Impact of future tsunamis from the Java trench on household welfare: Merging geophysics and economics through catastrophe modelling'. *International Journal of Disaster Risk Reduction*. Open access paper available here: https://doi.org/10.1016/j.ijdrr.2021.102291

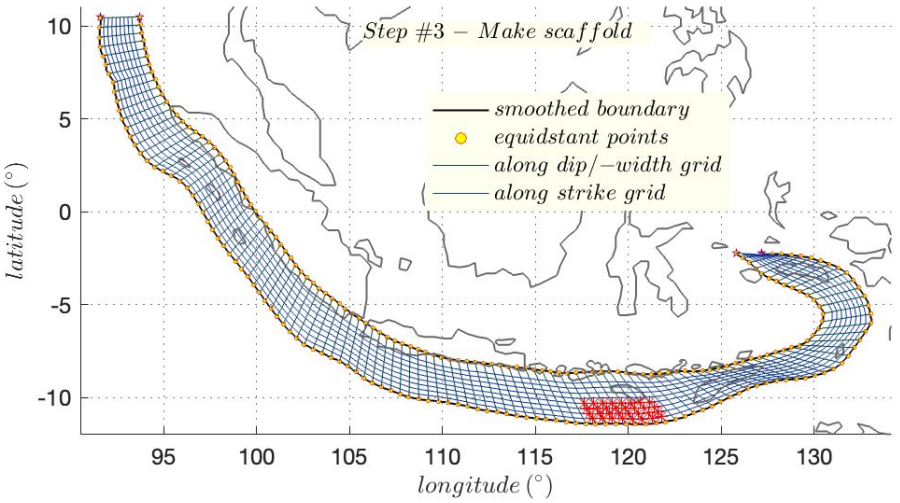
- **South Java**: full probabilistic, regional tsunami risk for livelihoods + policy relevance of integrating microeconomic data to catastrophe modelling
- **Sumatra**: full probabilistic, regional tsunami risk for livelihoods and health expenditures
- **East Kalimantan**: full probabilistic, regional tsunami hazard for planning (e.g. new capital region).



Hazard : Earthquake tsunamis in the national scale

- Tsunami hazard in Java and Sumatra trench
- Slab2
  - database of subduction zone geometries
  - Depth, strike, dip, thickness
- Okada fault displacement



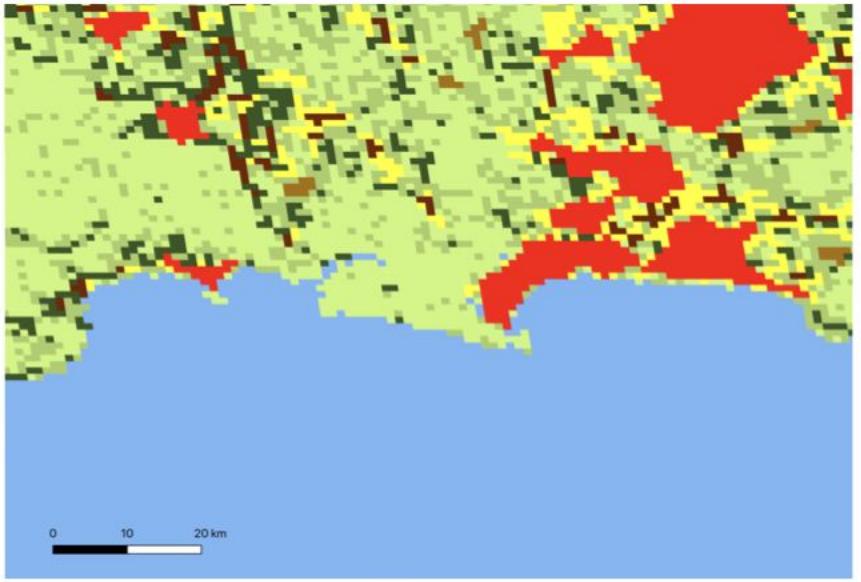


Hazard: Exposure driven assessment

- Eight regions

Table 1 Logic of the GHSL SMOD second hierarchical level

Population density of cells, inhabitants per km²	Minimum population size of the cluster of cells (settlement size) ≥50,000	50,000 - 5,000	5,000 - 500	No minimum population size criterion (not an entity)
≥1500	Urban Centre	Dense Urban Cluster	Rural Cluster	
300 - 1500		Semi-Dense Urban Cluster		Suburban or peri urban grid cells
300 - 50				Low Density Rural grid cells
<50				Very Low Density Rural grid cells



Exposure

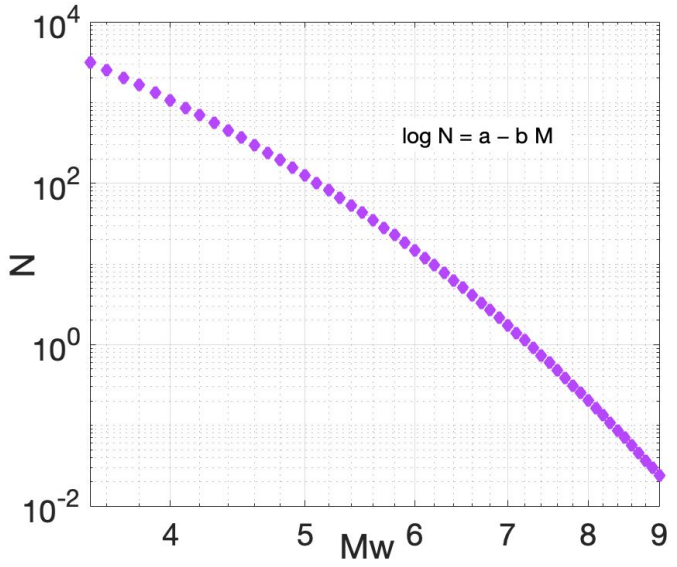
- Each sub-district has a different asset value
- Total Insured Value (TIV):
  average asset value – % insured assets
- A total of 620 subdistricts were evaluated

Hazard: Occurrences

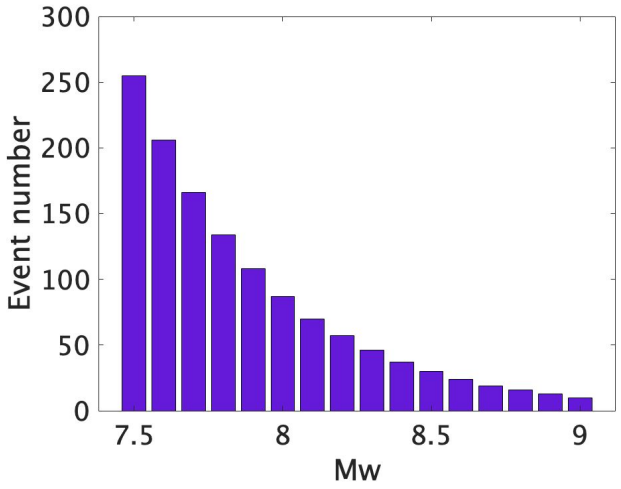
Gutenberg-Richter law:

$$\log_{10} N = 16.7 - 0.62 \log_{10} M_0$$

- extrapolation to larger events
- interevent times follow an exponential distribution
- 1,278 events Mw>=7.5 & <=9 in 15,000 years
- Selected randomly from the set of 3,000 emulators
- Poisson distribution to distribute the events over time

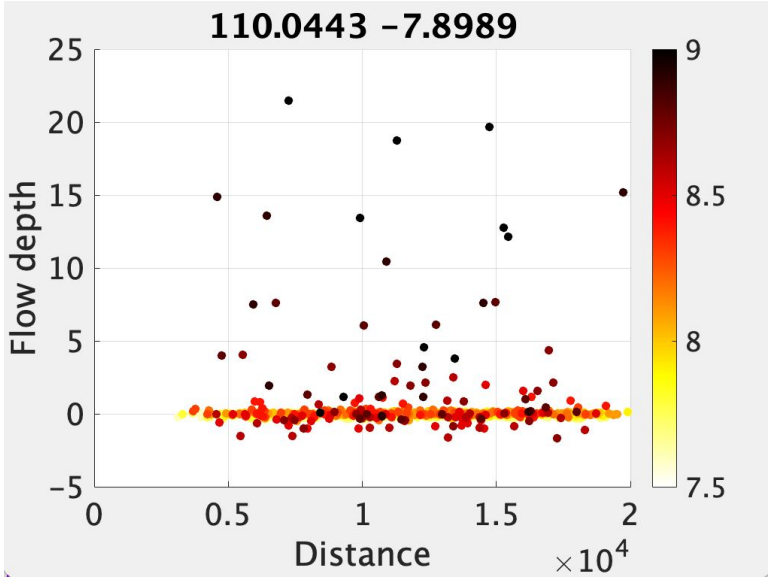


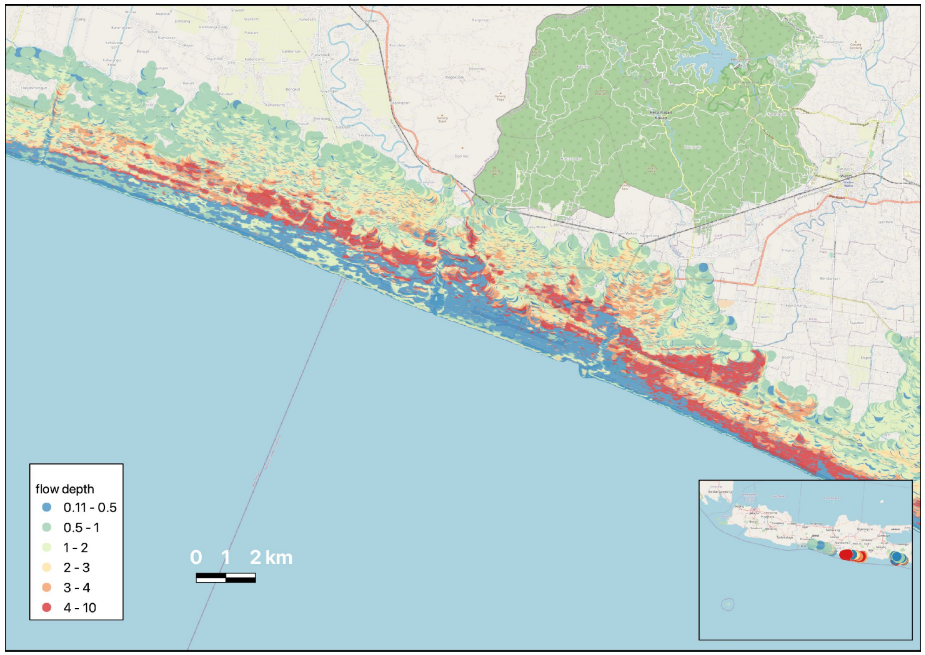
Based on Okal, 2012



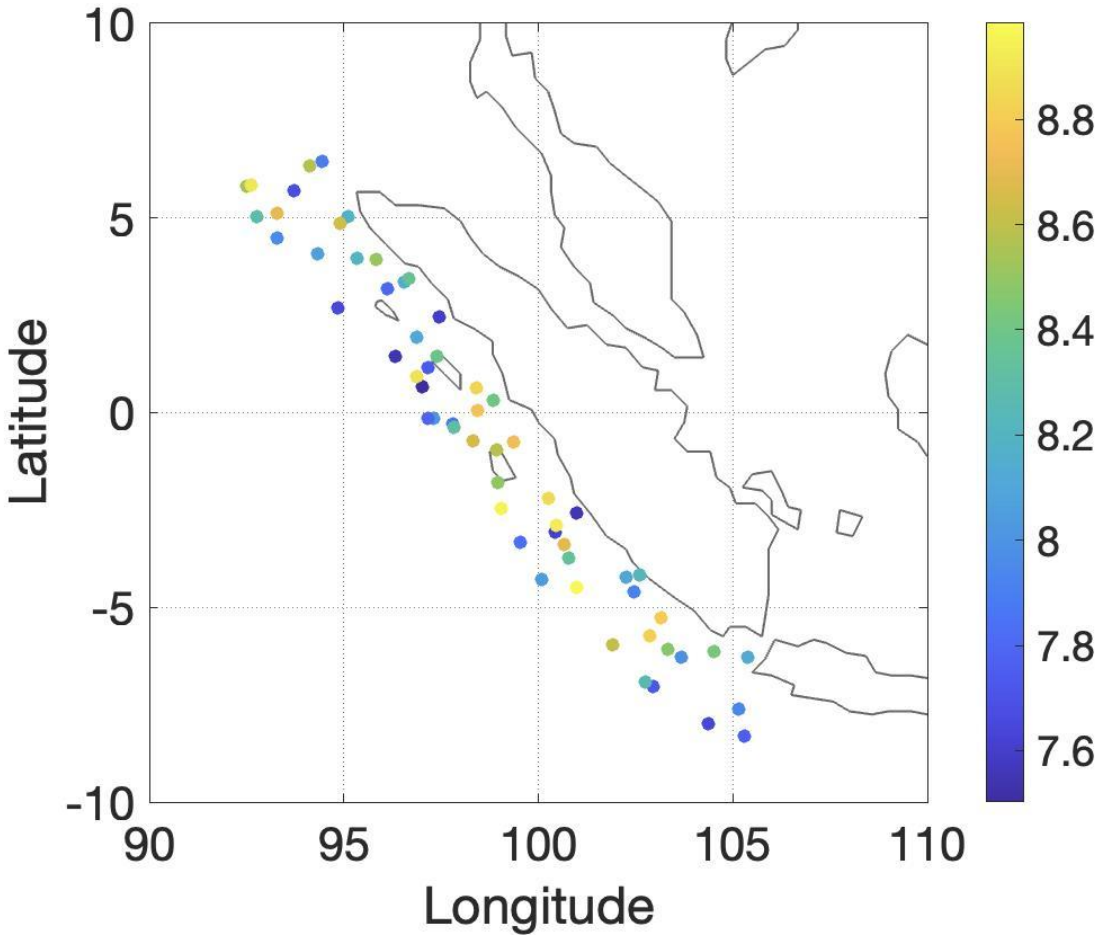
Probabilistic tsunami hazard in South Java

- 1,278 scenarios
- 130,414 emulators - locations at risk
- Mw determining factor
- Directionality effect





Sumatra

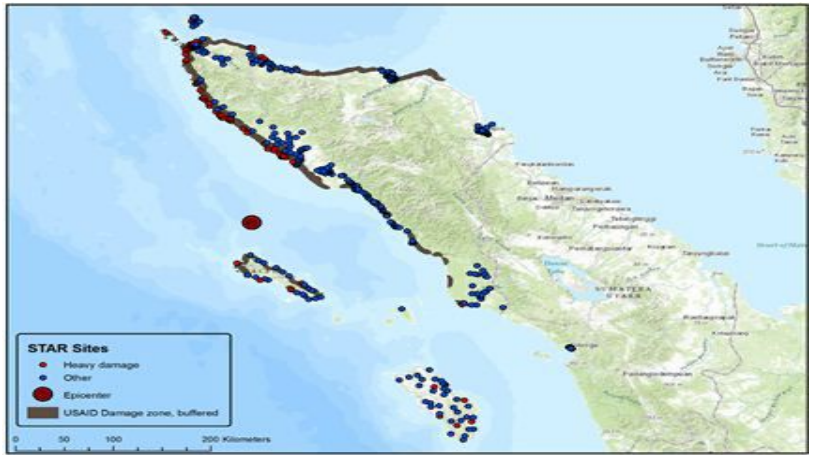


Sumatra: 60 runs, to train an emulator and create 1200 tsunami events

Innovative vulnerability model using microeconomic surveys

(1) loss to household-level business and non-business assets
(2) Cost to out-of-pocket health spending

- Based on 2004 Boxing day tsunami experience captured by data collected 5-14 months after the event from around 6000 households in Aceh and North Sumatra (STAR1 data: http://stardata.org/): tsunami specific and denser than IFLS.



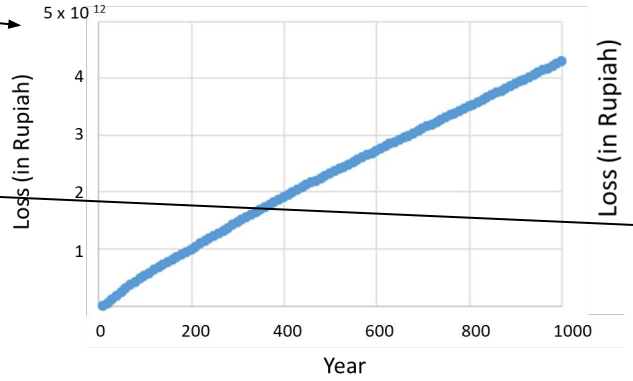
Source:https://blogs.worldbank.org/impactevaluations/resilience-and-recovery-ten-years-after-2004-indian-ocean-tsunami-summary-results-star-project

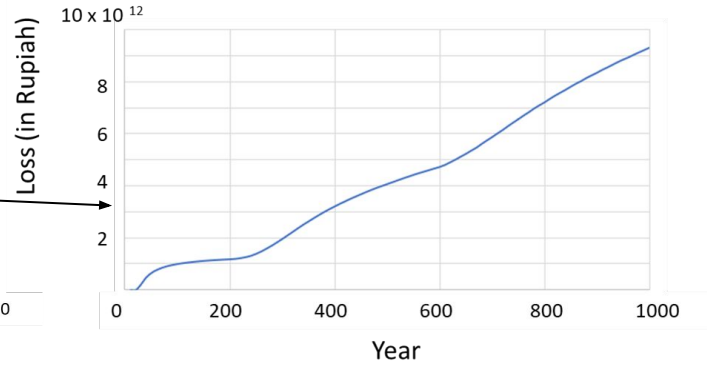
- Considers internal and external validity (main uncertainties captured)
- Multinomial logit regression model to fit into Oasis bins

Loss exceedance curves (**assets**) in South Java
Loss exceedance curves (**assets/health**) in Sumatra

Asset Losses South Java:
200 years: 0,98 trillion ($ 64.5 million)
600 years: 2,71 trillion ($ 178 million)
1000 years: 4,28 trillion ($ 281 million)

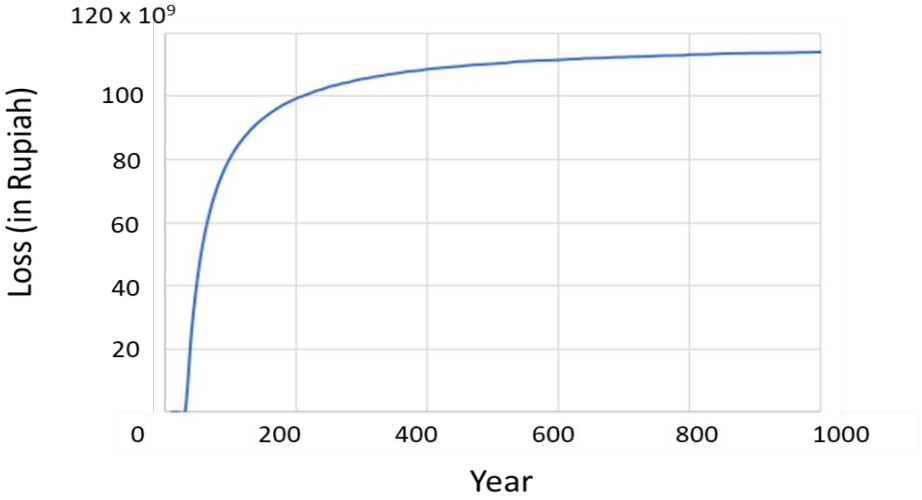
Asset Losses Sumatra
200 years: 1.18 trillion ($ 77 million)
600 years: 4.74 trillion ($ 312 million)
1000 years: 9.32 trillion ($ 613 million)





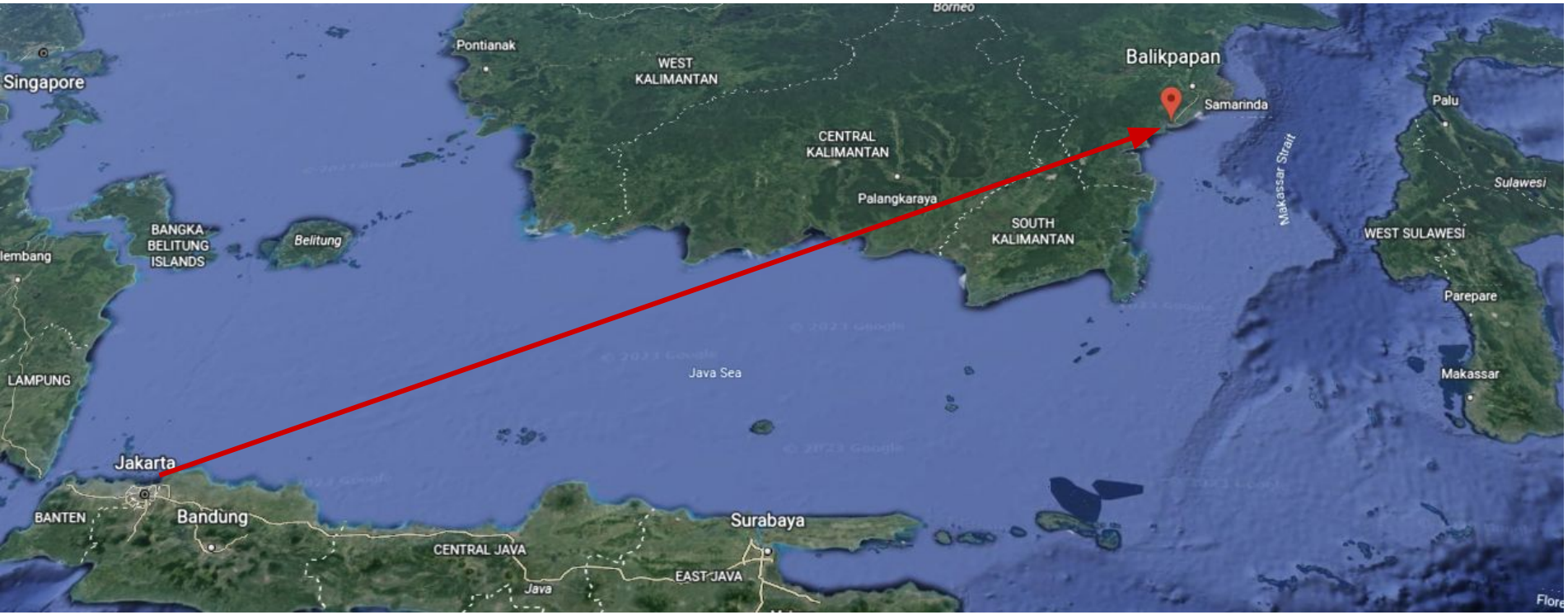
(Indonesian fund: $500 m)

Health (Sumatra)
200 years: 100 million ($ 6.5 million)
600 years: 111 million ($ 7.3 million)
1000 years: 114 million ($ 7.5 million)

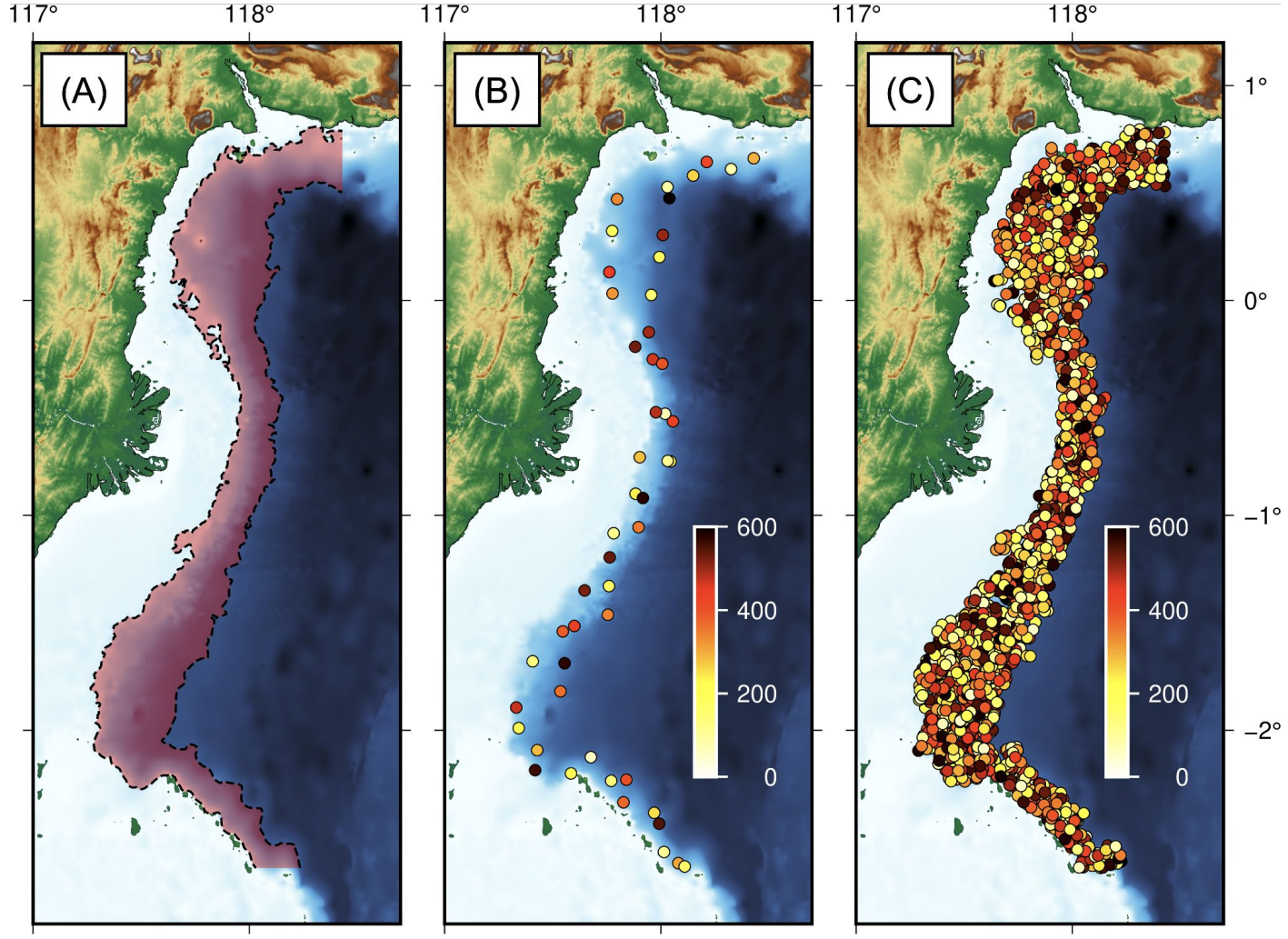


Financial instruments, filling knowledge gap in Indonesia

- **Effective** spending
- **Optimising policy** of handouts, building design etc
- Free accessible data (hazard, vulnerability, exposure) in **Oasis Hub**
- **Resilience/stability** (new capital city in Kalimantan)



Landslides in the Makassar strait: design

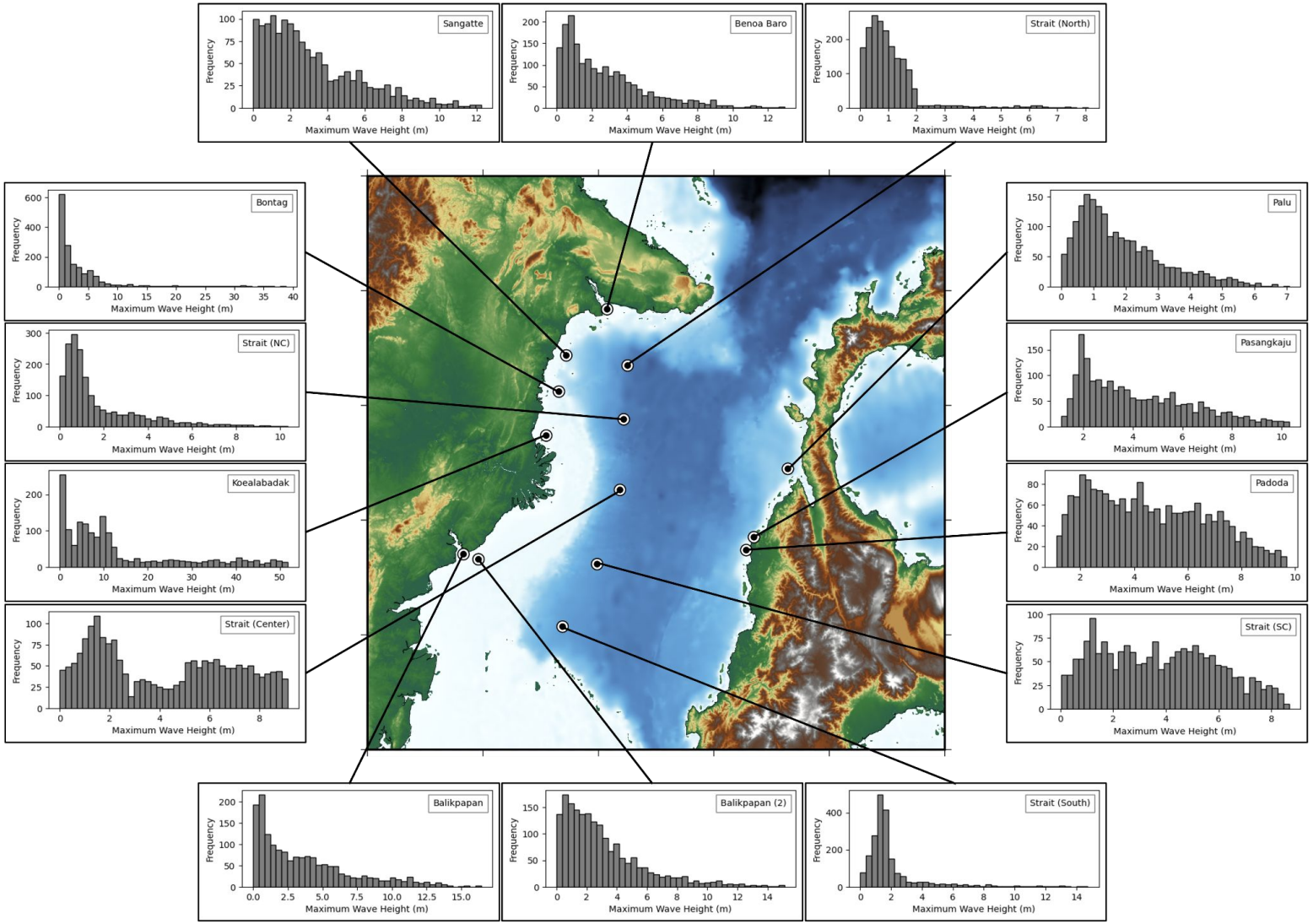


Sampling of training and emulator input landslide locations.
(A) Extent of location sampling space (shaded red) defined by 113 m and 1657 m depth contours (dashed black lines).
(B) Locations of 50 training submarine landslides, coloured by volume.
(C) Locations of 2,000 emulator input landslide locations, coloured by volume

Landslides in the Makassar strait: simulation

Landslides in the Makassar strait: hazard

Emulated results of landslide tsunamis making use of 50 initial runs. Histograms of wave heights from these 2000 tsunamis at 8 locations



Capacity building

Policy and change maker	Additional funding, Support early warning systems, moving towards Indonesia (SDG)
Urban planning	Future collaborators and partners: Resilience Development Initiative (ITB), Plan Indonesia, PhD students

References

Ehara, A., & Guillas, S. (2021a). An adaptive strategy for sequential designs of multilevel computer experiments, accepted, *International Journal for Uncertainty Quantification.*

Ehara, A., Salmanidou, D.M., Heidarzadeh, M. and Guillas, S., (2023), Multi-level emulation of tsunami simulations over Cilacap, South Java, Indonesia, *Computational Geosciences* **27**, 127–142.
Open access: https://doi.org/10.1007/s10596-022-10183-1

Gopinathan, D., Venugopal, M., Roy, D., Rajendran, K., Guillas, S., & Dias, F. (2017). Uncertainties in the 2004 Sumatra–Andaman source through nonlinear stochastic inversion of tsunami waves. *Proc. Roy Soc. A 473*(2205), 20170353.

Himaz, R., (2022), 'Business Recovery in Aceh and North Sumatra following the Indian Ocean tsunami', *International Journal of Disaster Risk Reduction, 73, p 102868.* Open access: https://doi.org/10.1016/j.ijdrr.2022.102868

Himaz, R. and Syukriyah, D., Short and medium-run effects of the Indian Ocean tsunami on health costs in Indonesia, under review.

Li, K., Giles, D., Karvonen, T., Guillas, S., & Briol, F. X. (2022). Multilevel Bayesian Quadrature. *arXiv preprint arXiv:2210.08329*. To appear, AISTATS2023.

Pranantyo, I. R., Heidarzadeh, M., & Cummins, P. R. (2021). Complex tsunami hazards in eastern Indonesia from seismic and non-seismic sources: Deterministic modelling based on historical and modern data. *Geoscience Letters*, *8*(1), 1-16.

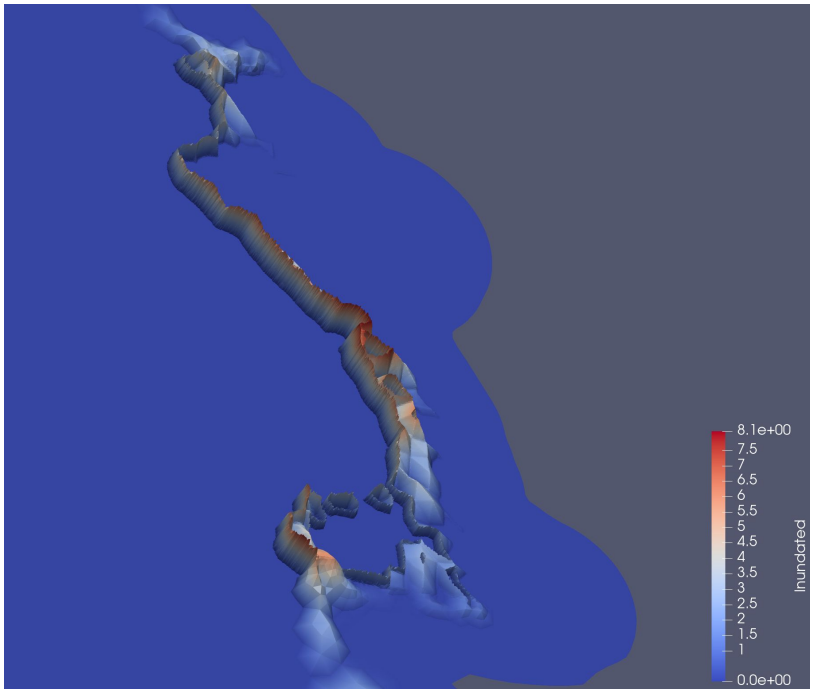
Salmanidou, D. M., Ehara, A., Himaz, R., Heidarzadeh, M., & Guillas, S. (2021). Impact of future tsunamis from the Java trench on household welfare: Merging geophysics and economics through catastrophe modelling. *International Journal of Disaster Risk Reduction*, *61*, 102291. Open access: https://doi.org/10.1016/j.ijdrr.2021.102291

Additional slides for Sumatra

Sumatra

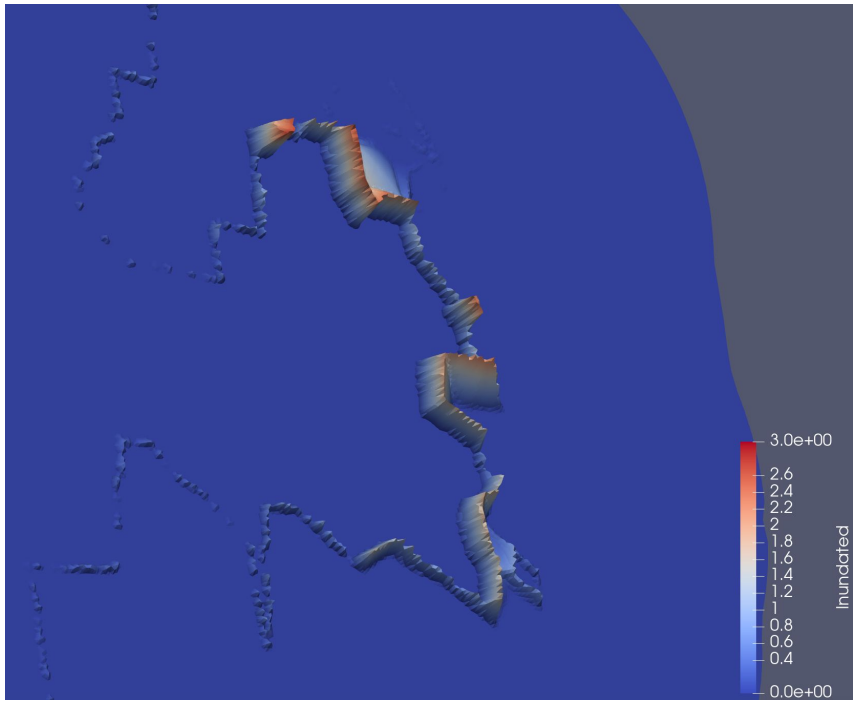
Inundation plot near Bengkulu

Earthquake at lon= 99.051385 lat=2.4707562
Mw=8.95800481

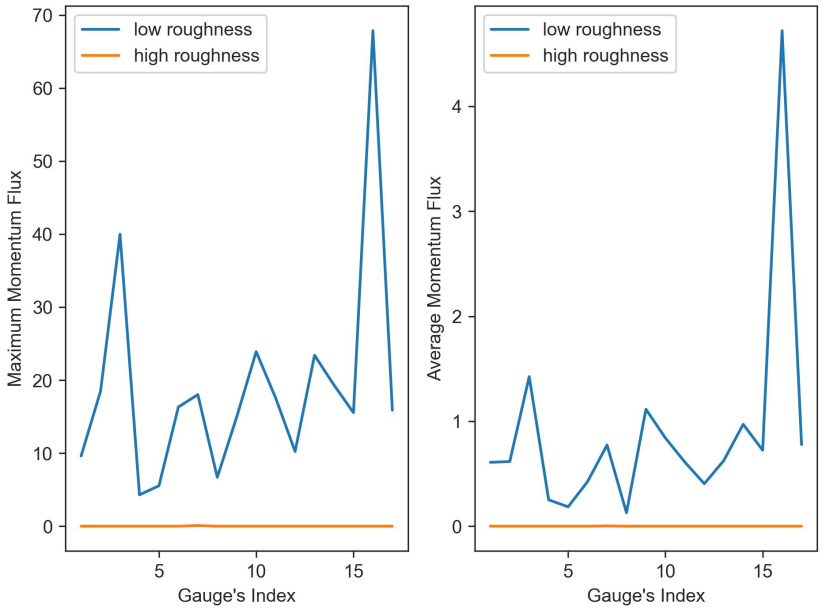


Inundation plot near Padang

Earthquake at lon= 96.8623223 lat=0.92884643
Mw=8.88674776



Sumatra: Momentum Flux

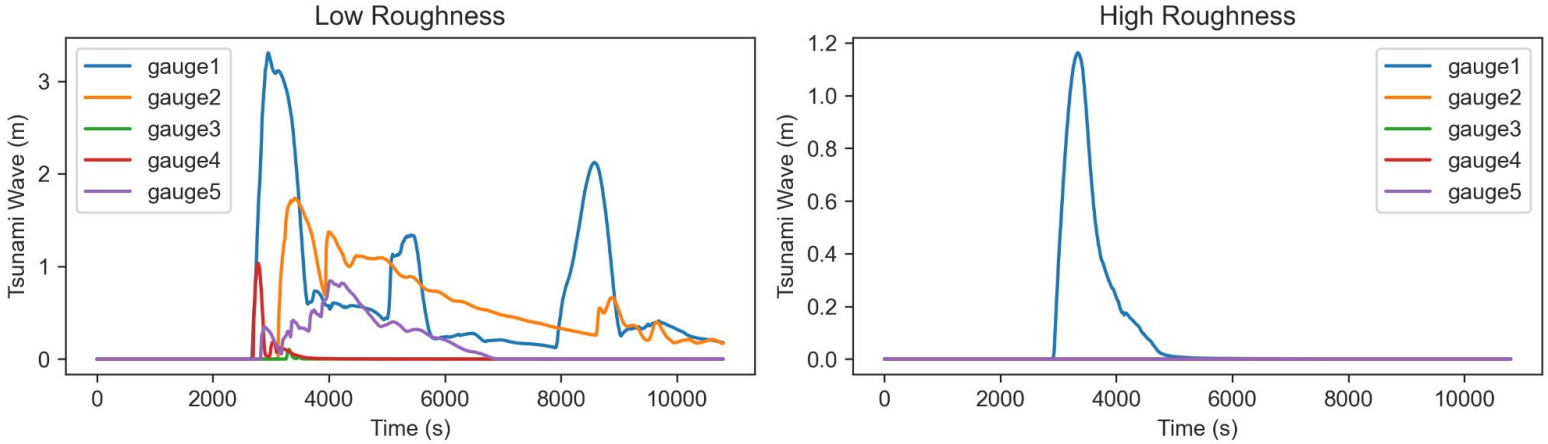


Momentum Flux M=hv^2

- Helpful for assessing tsunami force acting on important buildings
- Helpful for placing prevention structure in disaster risk management

Average of maximum momentum flux (MMF) and average momentum flux (AMF) for the roughness

- Roughness has a significant impact on tsunami force but is considered to be fixed in Volna-OP2, e.g. forests or mangroves on the coast will increase roughness and will reduce tsunami damage.



Sumatra: Momentum Flux

Multilevel Bayesian Quadrature (MLBQ)

- MLBQ is a Bayesian probabilistic numerical method for approximating integrals
- MLBQ makes use of multifidelity models and prior information about the integrand, which leads to faster convergence rates
- MLBQ provides probabilistic uncertainty quantification for the value of the integral given limited function evaluations