The Global Tsunami Model (GTM) network

S. Lorito (INGV)

Finn Løvholt (NGI), J. Behrens (UHAM), A. Babeyko (GFZ), and the GTM community

GEM CONFERENCE – Are we making a difference?

13th - 14th June 2023

Centro Congressi Bergamo

Bergamo, Italy

INGV terremoti vulcani ambiente

ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

NGI

GFZ Helmholtz-Zentrum Potsdam

GTM global tsunami model

EPOS EUROPEAN PLATE OBSERVING SYSTEM

Universität Hamburg DER FORSCHUNG | DER LEHRE | DER BILDUNG

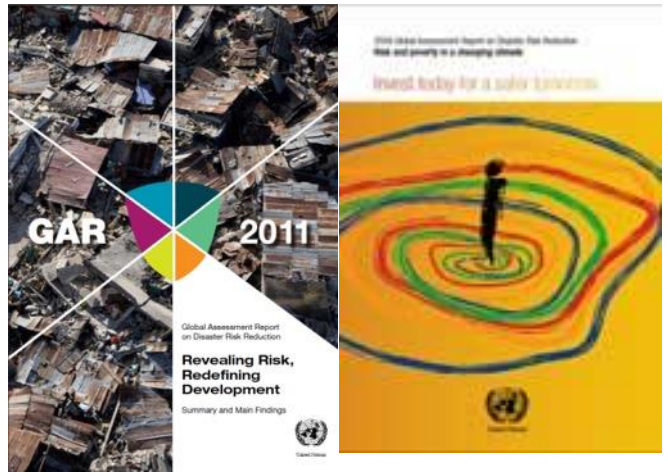
Why GTM – background for the initiative:

- ✓Multi-institutional work on hazard and risk for the UN-ISDR (Global Assessment Report, GAR)
- ✓**Idea:** Need to gather scientific community for
  - *Collective effort for improved understanding of global tsunami hazard and risk*
  - Provide reference maps
  - Improve methods, develop guidelines and standards
- ✓*Initiative from the tsunami community itself*
- ✓Ensure relevance towards stakeholders

GAR

Global Assessment Report on Disaster Risk Reduction

2015



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GTM's added values and vision

The GTM overall vision and goals are to collaboratively achieve a thorough understanding of tsunami hazard and risk, together with the processes that drive them.

- ✓ ***Improve and Develop probabilistic tsunami hazard and risk analysis methods, tools and good practices***
- ✓ ***Develop regional and global reference probabilistic tsunami hazard and risk models/maps***
- ✓ ***Establish reference pools of experts***
- ✓ ***Provide input and contribution to multi-hazard risk assessment through high-level harmonization with organizations covering other natural hazards***
- ✓ ***Interact with stakeholders to ensure relevance and proper dissemination of results and***
- ✓ ***Deal with uncertainty communication to non-scientists to contribute to risk management/reduction, inline with the SDFRR***

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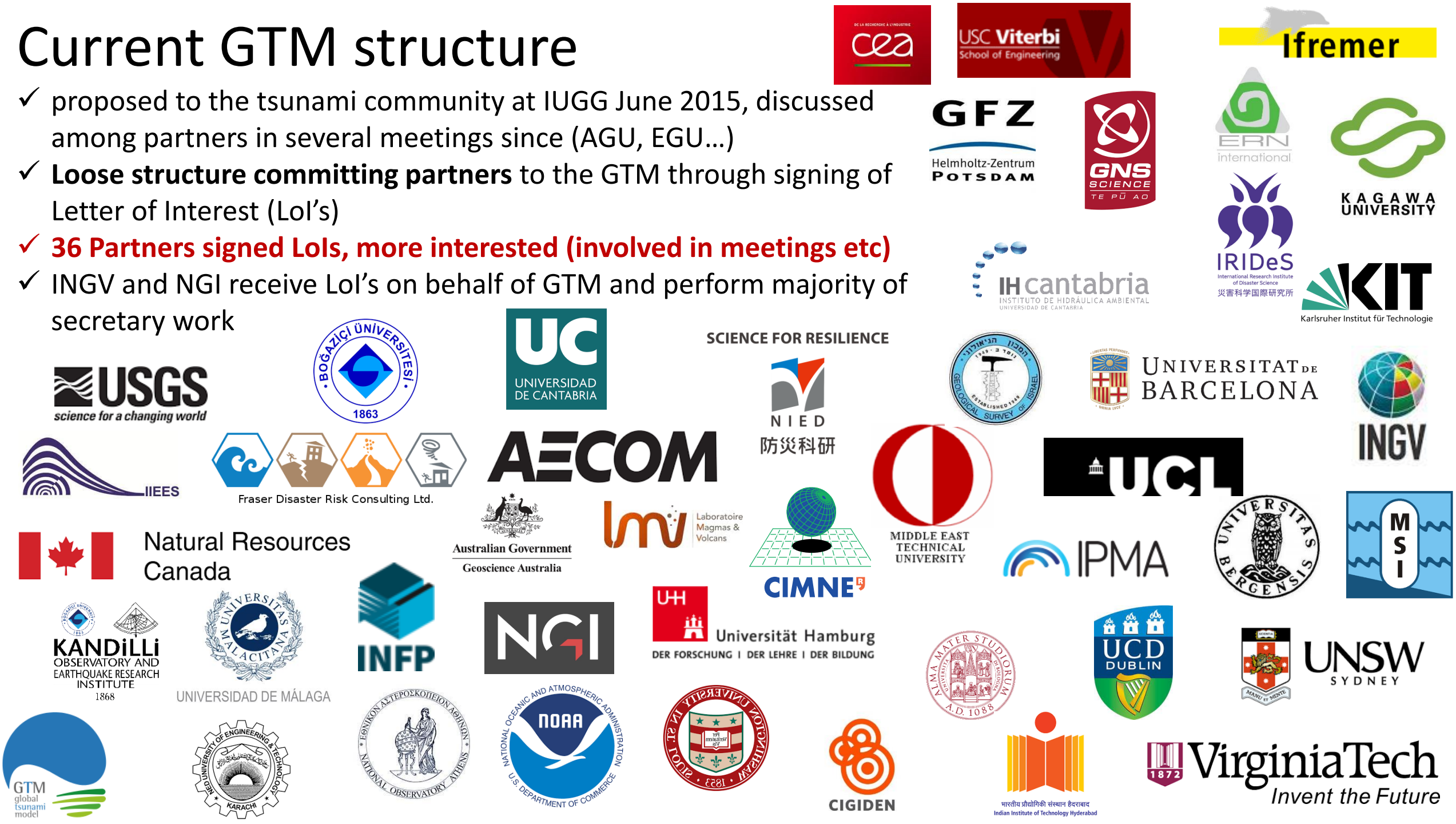
Current GTM structure

- ✓ proposed to the tsunami community at IUGG June 2015, discussed among partners in several meetings since (AGU, EGU…)
- ✓ **Loose structure committing partners** to the GTM through signing of Letter of Interest (LoI's)
- ✓ **36 Partners signed LoIs, more interested (involved in meetings etc)**
- ✓ INGV and NGI receive LoI's on behalf of GTM and perform majority of secretary work



Global and European networking initiatives – chronology and interlinkage

- ✓Global tsunami hazard and risk analysis for the UNDRR Global Assessment Reports (GAR). First probabilistic global risk analysis for **GAR15**.
- ✓As a consequence the **Global Tsunami Model (GTM)** was formed as a networking initiative in 2015
- ✓In 2016-2018: First European community based tsunami hazard map for Europe developed through the **TSUMAPS-NEAM** project
- ✓In 2019 – the **AGITHAR** COST Action was funded for European partners, as an initiative to increase efforts to consolidate GTM
- ✓The European tsunami community is a candidate Thematic Core Service (TCS) of the EC infrastructure **EPOS-ERIC**.
- ✓A series of European projects aiming at providing community models contribute indirectly (**ChEESE1&2, eFlows4HPC, DT-GEO, Geo-INQUIRE**)

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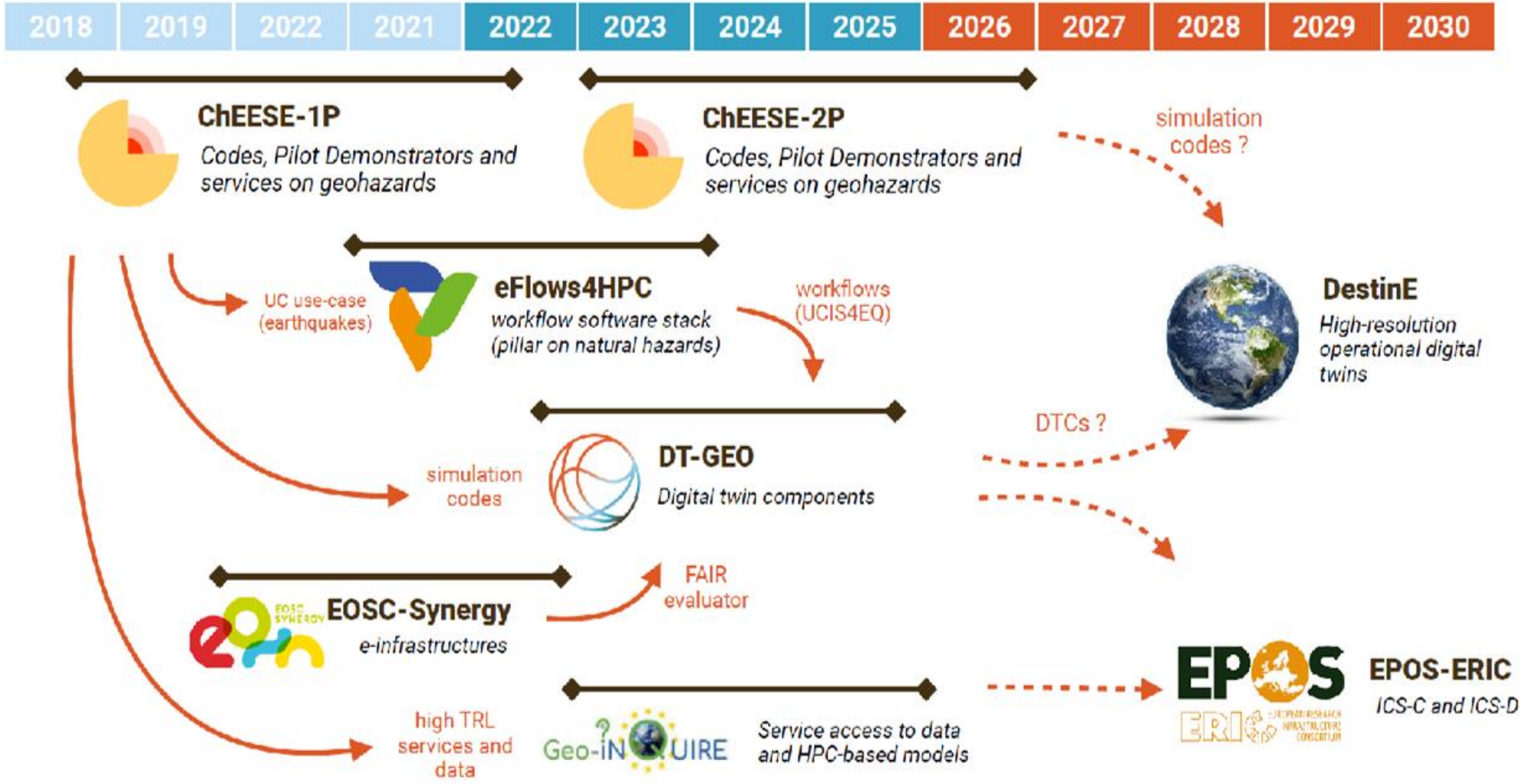
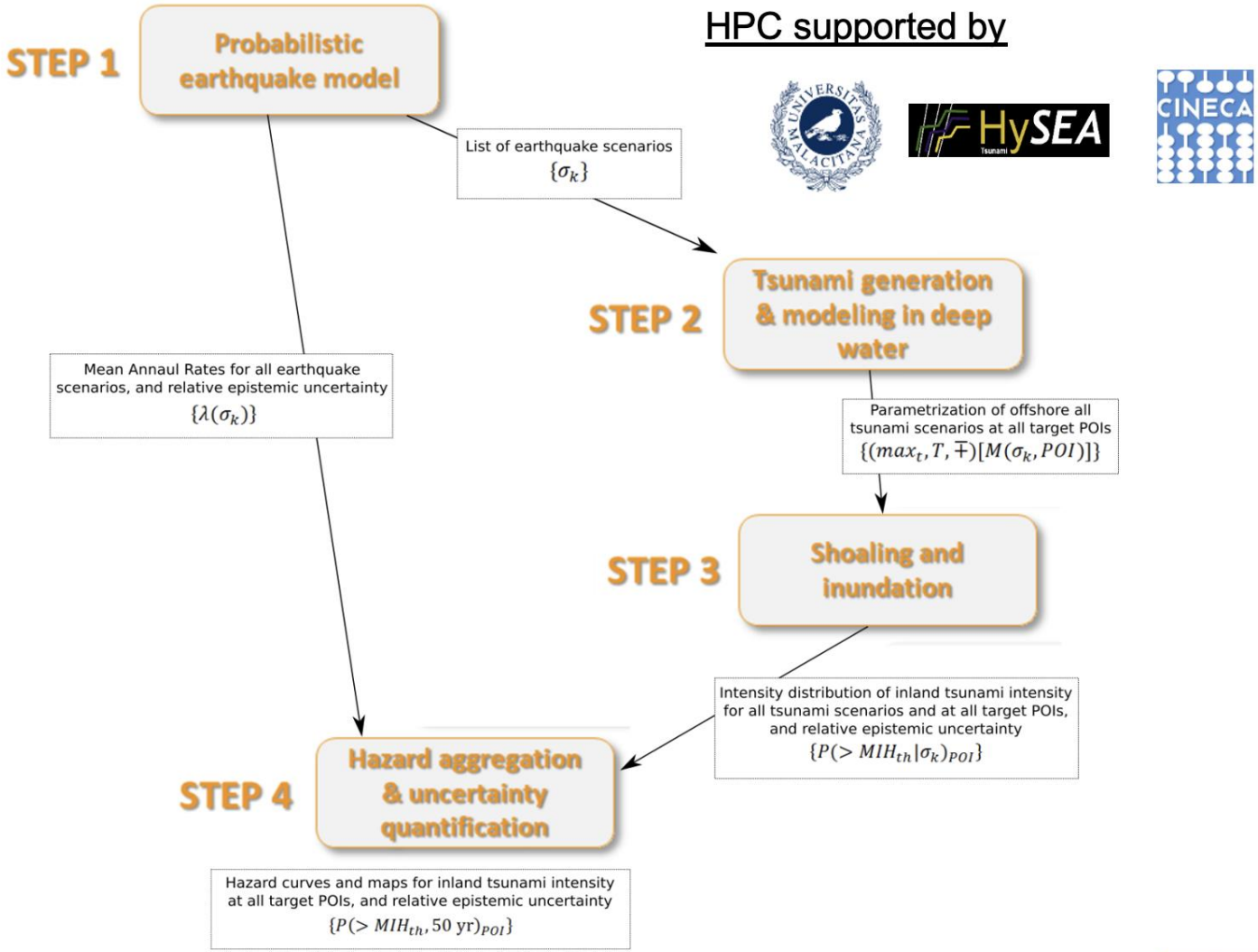
The project's ecosystem

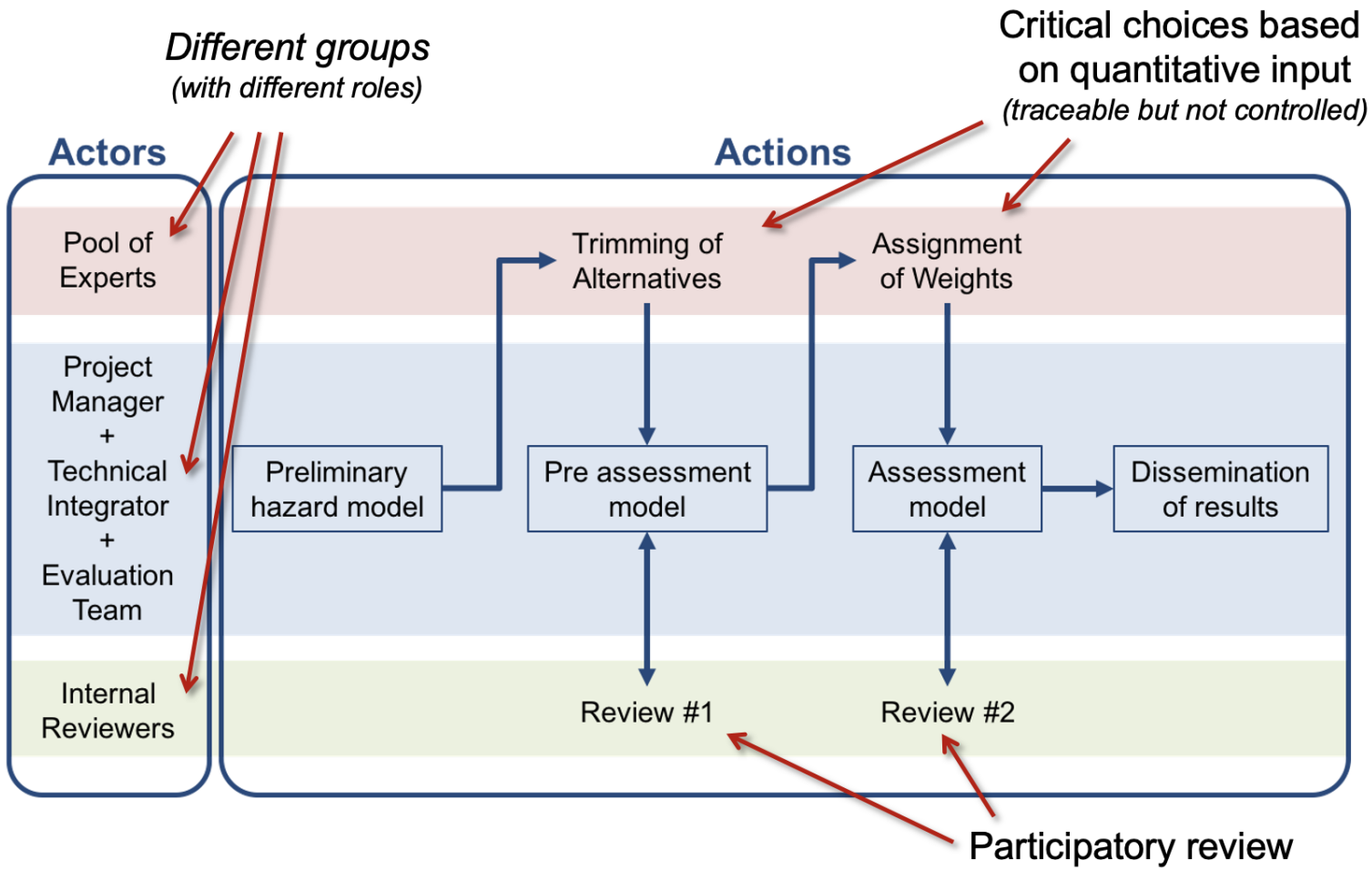


Hazard assessment workflow



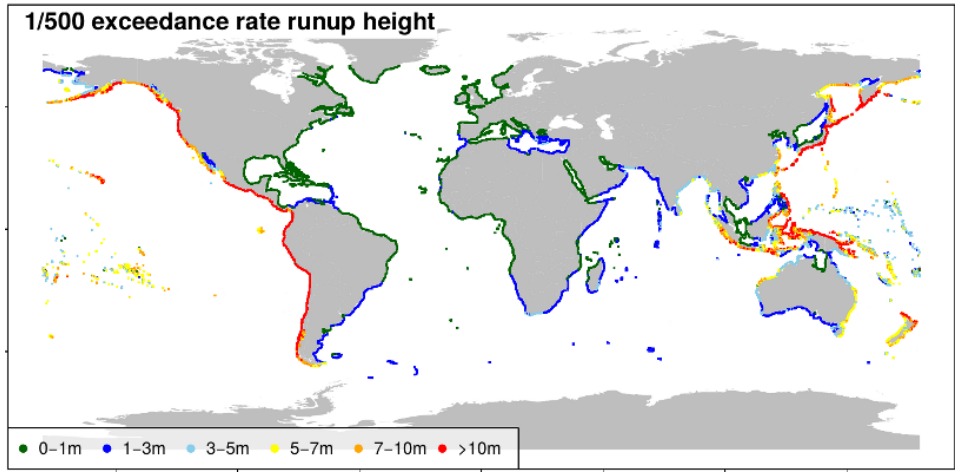
HPC supported by

Multiple-Expert Management Protocol

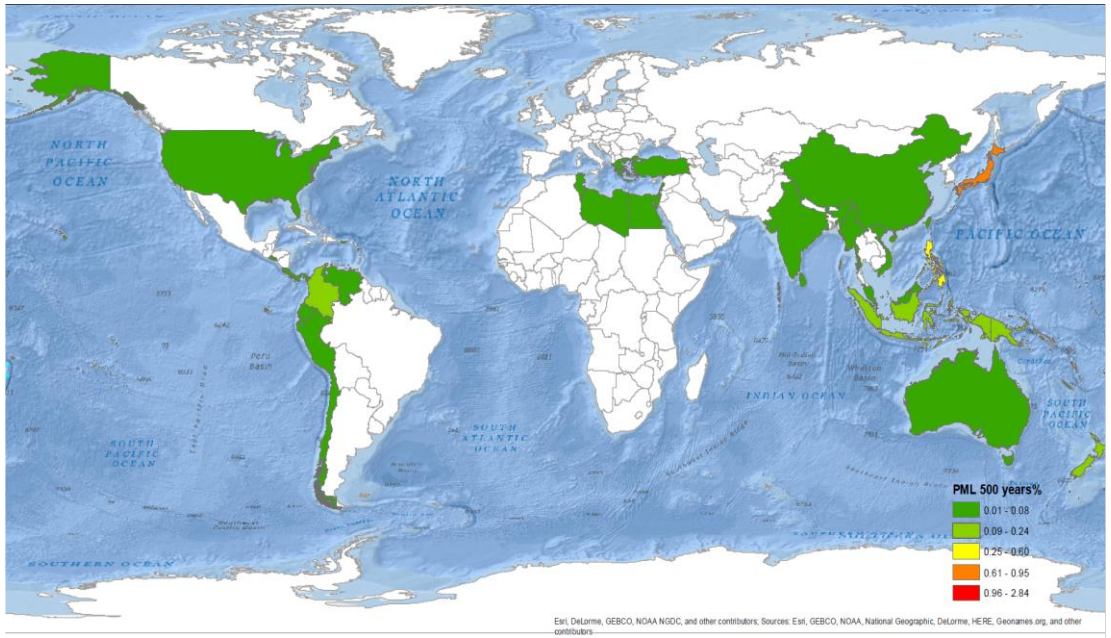


GTM GLOBAL products

- ✓GAR15 global tsunami risk maps
- ✓Global tsunami hazard maps



Davies et al., GSL Special Publ. 2018



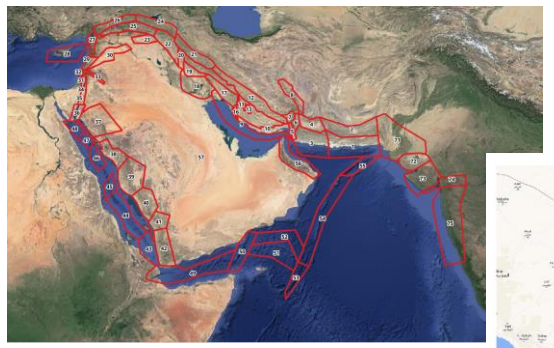
GAR
Global Assessment Report on Disaster Risk Reduction
2015

GTM global tsunami model

GTM regional products

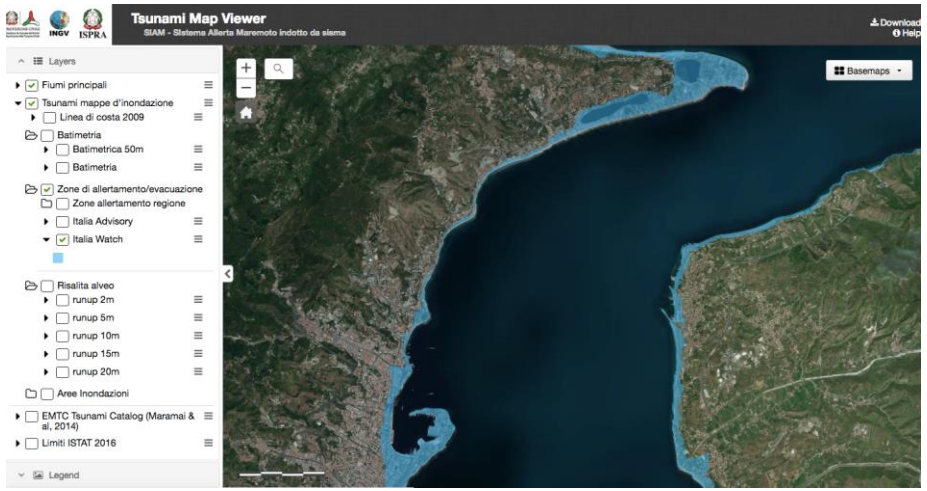
- ✓TSUMAPS-NEAM community hazard maps for Europe –Italy NEAMTWS
- ✓Makran trench hazard analysis and community engagement

UNESCAP



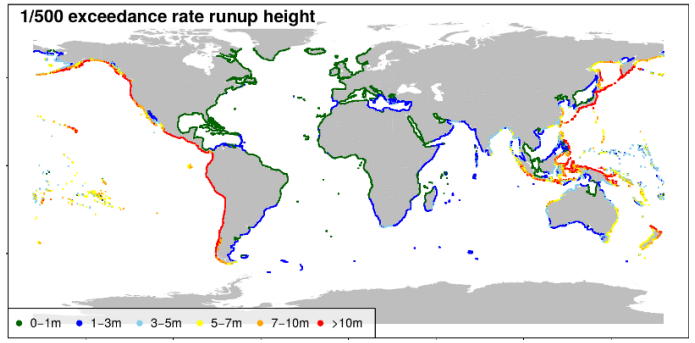
Example alternative #1

Example alternative #2

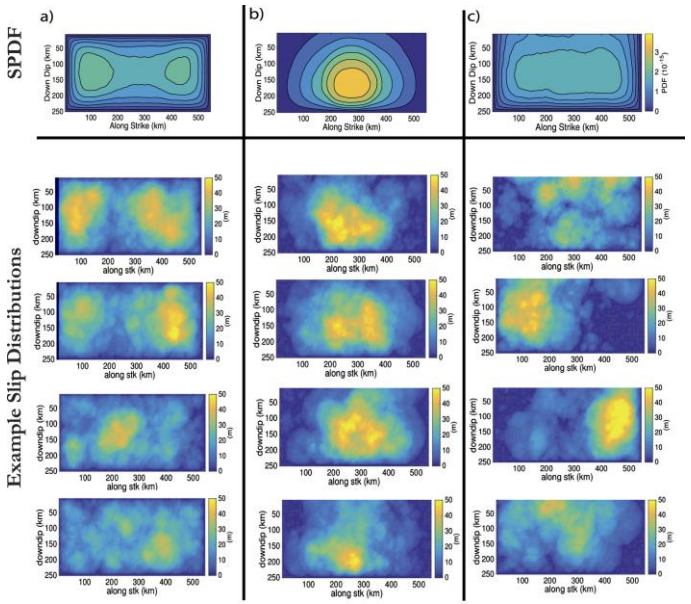


CHEESE 2 GTM PTHA MODEL

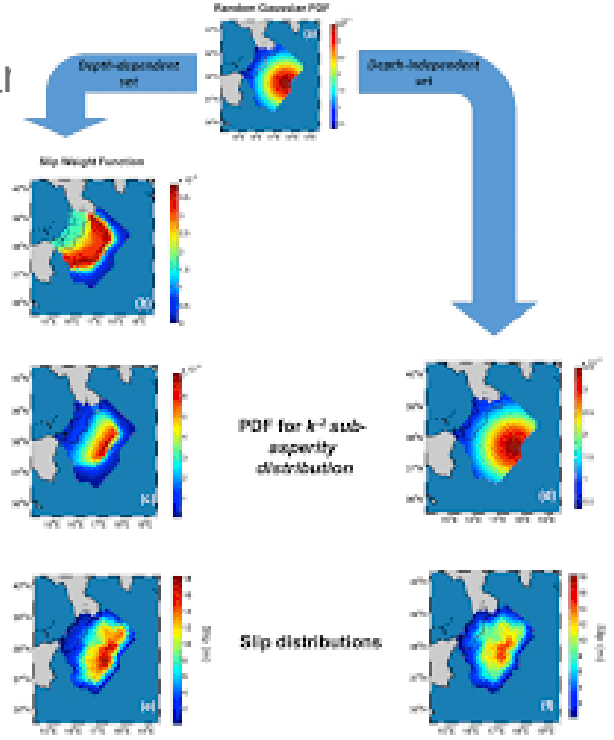
ChEESE is the **Centre of Excellence (CoE) for Exascale in Solid Earth** and aims to become a hub for HPC software within the solid ear community.



Davies et al., GSL Special Publ. 2018



Murphy et al., 2016



Scala et al., 2016

OPENQUAKE
calculate share explore

COMPUTATIONAL CHALLENGES

To prepare 11 community flagship codes to address 12 domain-specific exascale Computational Challenges.

PILOT DEMONSTRATORS

To develop a new generation of 9 Pilot Demonstrators for scientific problems requiring exascale computing.

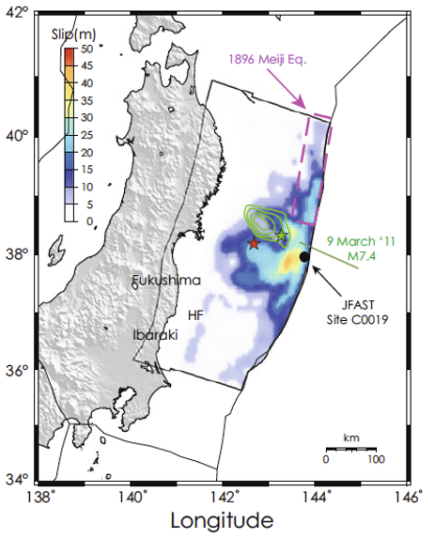
SIMULATION CASES

To use these Pilot Demonstrators in 15 Simulation Cases of particular relevance in terms of science, social relevance, or urgency.

GTM global tsunami model

CHEESE 2 GTM PTHA MODEL

Importance of slip heterogeneity



Romano et al., SREP, 2014

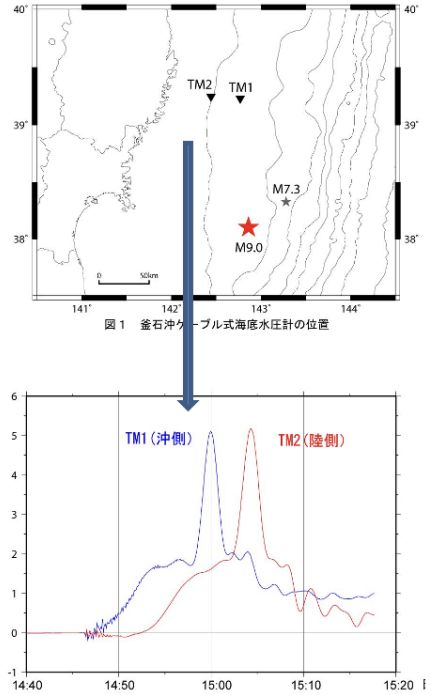
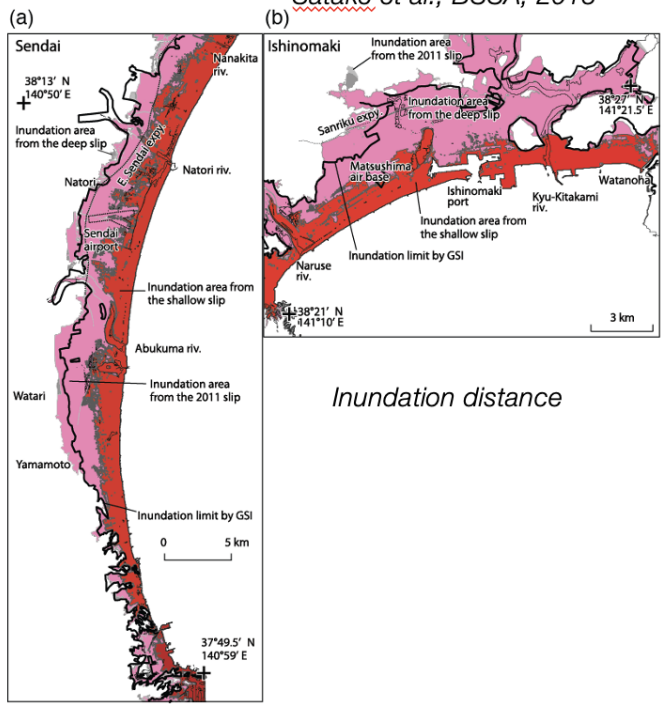


図１　釜石沖ケーブル式海底水圧計の位置

Romano et al., SREP, 2014

Satake et al., BSSA, 2013

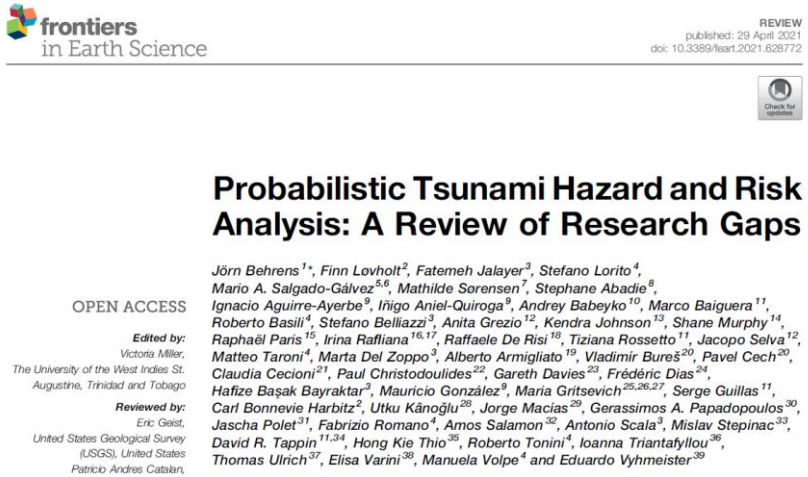


Inundation distance

Shallow slip → Short wavelength → Small inundation distance

Deep slip → Long wavelength → Large inundation distance

Community papers – dissemination - technological advances preparing for next steps – GTM - AGITHAR



frontiers in Earth Science

REVIEW
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Probabilistic Tsunami Hazard and Risk Analysis: A Review of Research Gaps

OPEN ACCESS

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frontiers in Earth Science

ORIGINAL RESEARCH
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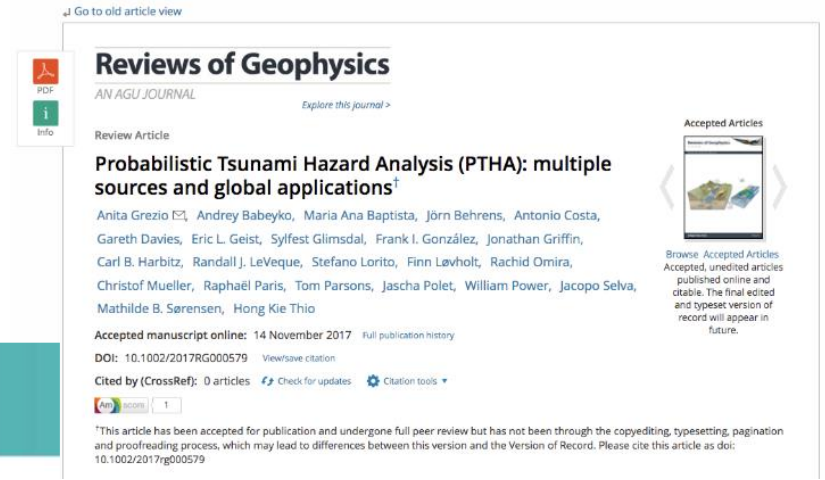
Probabilistic Tsunami Hazard Analysis: High Performance Computing for Massive Scale Inundation Simulations

Steven J. Gibbons[1]*, Stefano Lorito[2], Jorge Macías[3], Finn Løvholt[1], Jacopo Selva[4], Manuela Volpe[2], Carlos Sánchez-Linares[3], Andrey Babeyko[5], Beatriz Brizuela[2], Antonella Cirella[2], Manuel J. Castro[3], Marc de la Asunción[3], Piero Lanucara[6], Sylfest Glimsdal[1], Maria Concetta Lorenzino[2], Massimo Nazaria[2], Luca Pizzimenti[2], Fabrizio Romano[2], Antonio Scala[7], Roberto Tonini[2], José Manuel González Vida[3] and Malte Vöge[1]



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Review Article

Probabilistic Tsunami Hazard Analysis (PTHA): multiple sources and global applications†

Anita Grezio, Andrey Babeyko, Maria Ana Baptista, Jörn Behrens, Antonio Costa, Gareth Davies, Eric L. Geist, Sylfest Glimsdal, Frank I. González, Jonathan Griffin, Carl B. Harbitz, Randall J. LeVeque, Stefano Lorito, Finn Løvholt, Rachid Omira, Christof Mueller, Raphaël Paris, Tom Parsons, Jascha Polet, William Power, Jacopo Selva, Mathilde B. Sørensen, Hong Kie Thio

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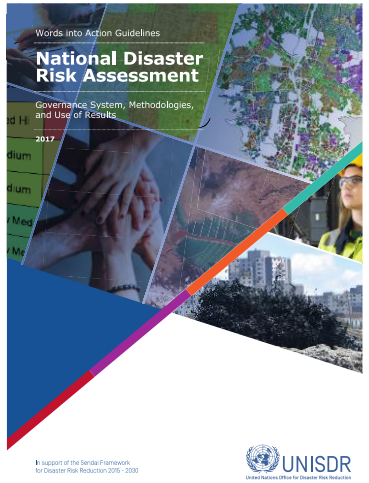
Tsunami risk communication and management: Contemporary gaps and challenges

Irina Rafliana[a,b,*], Fatemeh Jalayer[c], Andrea Cerase[d,e], Lorenzo Cugliari[e], Marco Baiguera[f], Dimitra Salmanidou[g], Öcal Necmioğlu[h,1], Ignacio Aguirre Ayerbe[i], Stefano Lorito[e], Stuart Fraser[j], Finn Løvholt[k], Andrey Babeyko[l], Mario A. Salgado-Gálvez[m,n], Jacopo Selva[o], Raffaele De Risi[p], Mathilde B. Sørensen[q], Jörn Behrens[r], Iñigo Aniel-Quiroga[i], Marta Del Zoppo[c], Stefano Belliazzi[c], Ignatius Ryan Pranantyo[s], Alessandro Amato[e], Ufuk Hancilar[h]



Present operational status

- ✓Presently GTM is a **research network** on hazard and risk modelling
- ✓Mainly European focus / activity at present through networking, software provision, and guidelines for hazard and risk analysis:
- ✓**AGITHAR** COST Action
- ✓**EPOS** (European Plate Observing System) Tsunami Thematic Core Service (TCS) – service provision of hazard and risk tools through tsunamidata.org
- ✓Significant technological progress of PTHA methods in European projects

Global Earthquake Model
Future Plans and Possible Collaborations

AGITHAR Stakeholders Workshop May 2023

Helen Crowley (Secretary General-elect)
Marco Pagani (Hazard Team Coordinator)
Vitor Silva (Risk Team Coordinator)

UCL, London, 17 May 2023

working together
to assess risk

GEM
GLOBAL EARTHQUAKE MODEL

OQ
OPENQUAKE

Ideas for GEM and GTM Collaboration

- Common modelling of global earthquake occurrence (defining and characterising seismic sources)
- Sharing global hazard products (e.g. stochastic event sets) as a common basis for global PSHA and PTHA
- Global exposure modelling
  - Increase spatial resolution of GEM's global exposure model around coastal areas
  - Input on GEM Building Taxonomy for tsunami-related attributes (e.g. hydrodynamic attributes at the ground floor)
- Include tsunami hazard footprints, damage and loss data in Earthquake Scenarios Database
- Explore the use of OpenQuake-engine for tsunami risk assessment
- Prepare a project proposal on integrated assessment of risk accounting for both ground shaking and tsunami hazards.

Ideas for GEM and GTM Collaboration

- **Common modelling of global earthquake occurrence (defining and characterising seismic sources)**
- **Sharing global hazard products (e.g. stochastic event sets) as a common basis for global PSHA and PTHA (ongoing collaboration: testing of EW PTF, AI surrogate models vs PTHA)**
- Global exposure modelling
  - Increase spatial resolution of GEM's global exposure model around coastal areas
  - Input on GEM Building Taxonomy for tsunami-related attributes (e.g. hydrodynamic attributes at the ground floor)
- Include tsunami hazard footprints, damage and loss data in Earthquake Scenarios Database
- **Explore the use of OpenQuake-engine for tsunami risk assessment**
- Prepare a project proposal on integrated assessment of risk accounting for both ground shaking and tsunami hazards.
- **Cascade effects: e.g. Tsunamigenic seismically-induced landslides?**

Thank you for your attention!

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www.globaltsunamimodel.org