

Community Engagement for Planning Resilience Multi-scenario Hazards Workshops

Dan Abramson, Associate Professor, UDP abramson@uw.edu
Lan Nguyen, PhD advisee, UDP lan8@uw.edu
Ann Bostrom, Professor, Public Policy & Governance, Co-Advisor

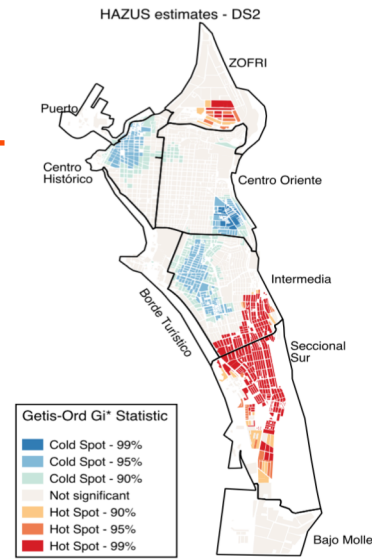
- Use long-term historical information and multiple scenarios to plan with uncertain information about the future – including cumulative/frequent hazards like sea level rise and storm flooding as well as catastrophic and rare hazards like earthquakes and tsunamis
- Leverage social networks to enable adaptive responses to hazards, given unique characteristics of place, and the possibility of increased isolation in a regional emergency
- Focus first on community values and assets, before discussing vulnerabilities, to identify co-benefits of mitigation, and elicit creative and robust ideas from workshop participants



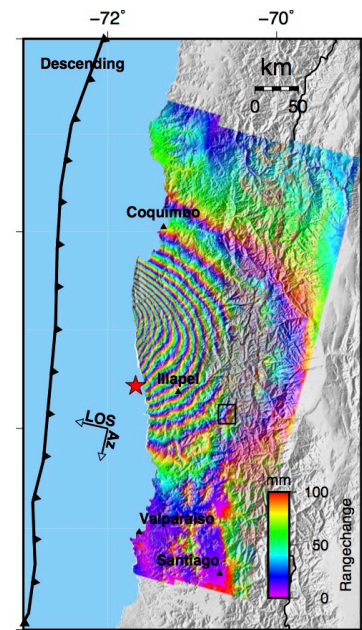


Paula Aguirre - CIGIDEN

- Contact info:
 - CIGIDEN @ School of Engineering, PUC
 - Mail: paula.aguirre@cigiden.cl
- Research projects:
 - Damage and risk assessment for extreme event scenarios
 - Integration of in-situ and remote sensing data for multi-hazard exposure modelling
 - Application of satellite remote sensing (multispectral imagery, radar, InSAR) for hazard & exposure modelling, and damage assessment.
 - Generation of synthetic ground motions.
 - Risk and resilience of distributed networks (e.g. emergency healthcare network).

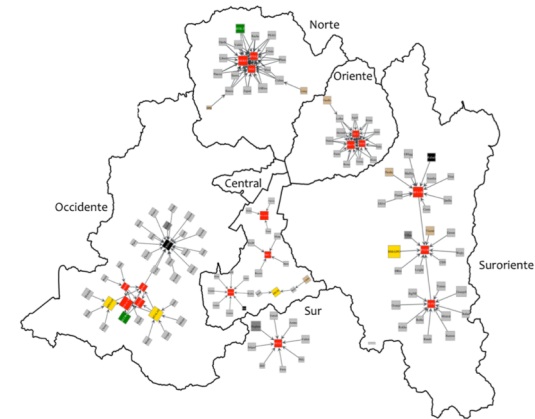


Iquique, Chile



2015 Illapel earthquake

Metropolitan Region - patient derivation map



Emergency healthcare network

- High complexity
- Medium complexity
- Low complexity
- SAPU/SAR





Diego Arcas

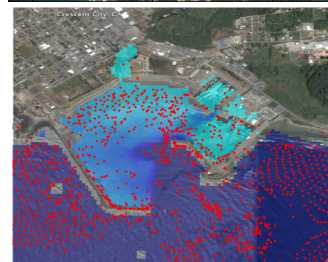
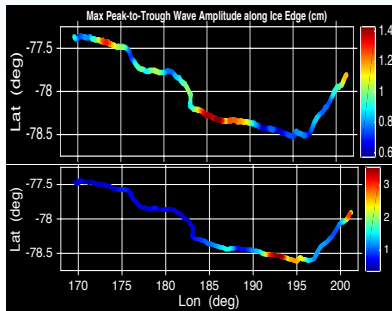
PMEL/NOAA Center for Tsunami Research

<https://www.pmel.noaa.gov/scientist/dr-diego-arcas>
diego.arcas@noaa.gov

Hazard Assessment & Research

Ross Sea Tsunami Hazard Assessment

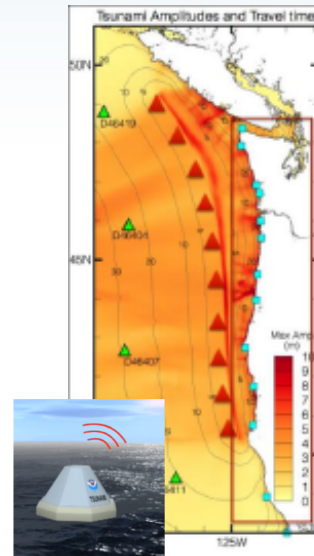
Computation of Debris Trajectories



Forecast Applications & Research

DART Tsunami Detection

Short-term Inundation Forecast of Tsunami: SIFT



Pedro Arduino

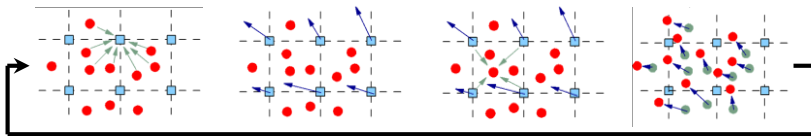
University of Washington, Professor

Email: parduino@uw.edu

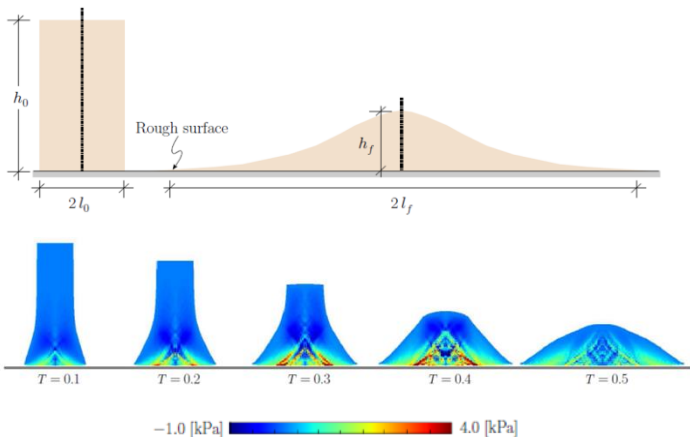
Web: <https://www.ce.washington.edu>



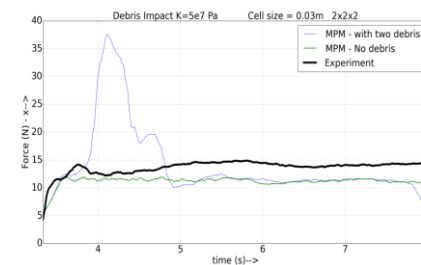
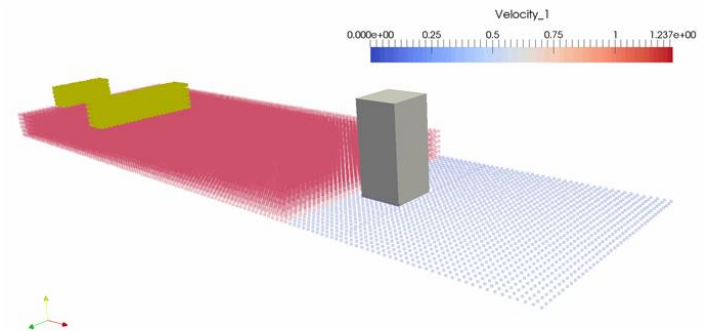
Applications of MPM to large deformation problems



Modeling granular flows & landslides

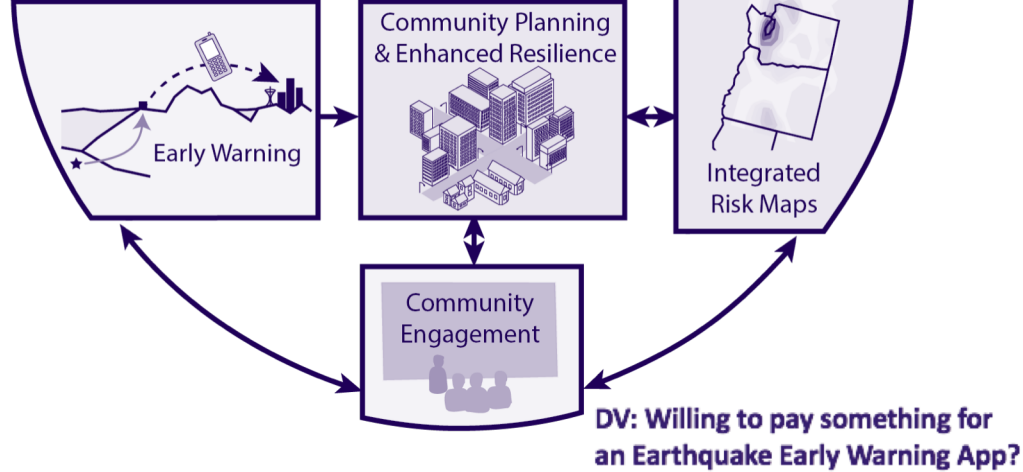


Modeling tsunami debris driven effects on structures



Ann Bostrom

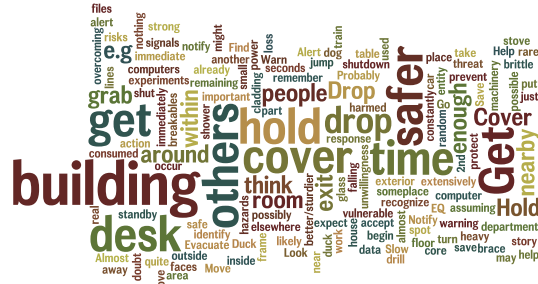
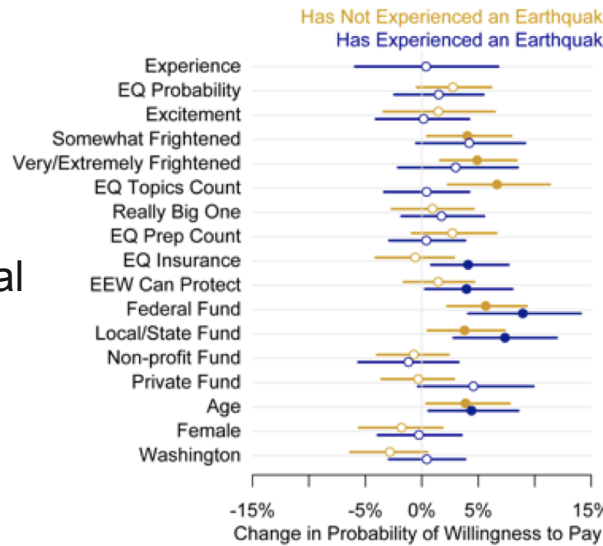
Weyerhaeuser endowed Professor of Environmental Policy, abostrom@uw.edu



DV: Willing to pay something for an Earthquake Early Warning App?

Disaster Science Research interests

- Hazard and risk perception—especially mental models and subjective risk assessments.
- Risk communication and decision making under uncertainty, including with maps, and focusing on extreme events (megaquakes, tsunamis, extreme weather events).
- Earthquake early warning, and forecast and warning systems for hazards.
- Citizen disaster science

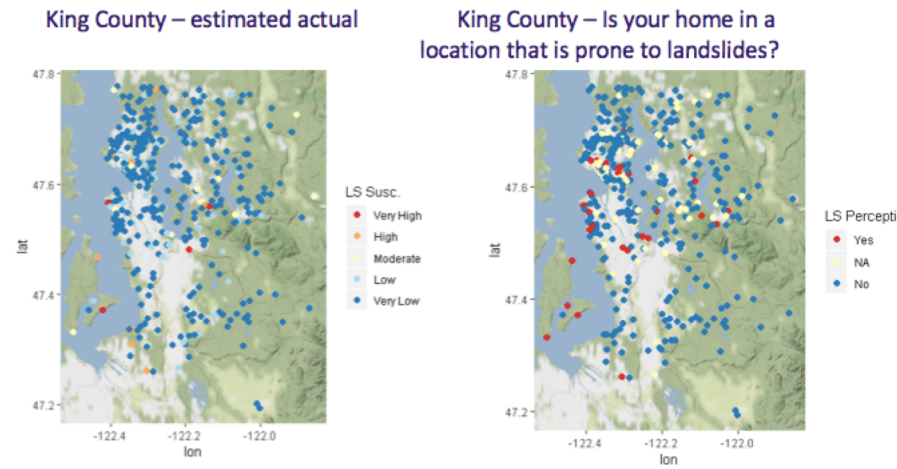


What could you do with 10 seconds of earthquake early warning?



Probabilistic Mapping and Communication in Hazard Planning and Mitigation (with Dan Abramson, Randy Leveque, Frank Gonzalez, Loyce Adams, Lan Nguyen and other M9 researchers)

Landslide susceptibility maps



Hydrodynamics:

Source characterization

Tsunami Modeling

Coastal interaction:

Edge Waves

Resonance

Context and Impact

Historical records, surveys

Recurrence

Deterministic and probabilistic hazard assessments

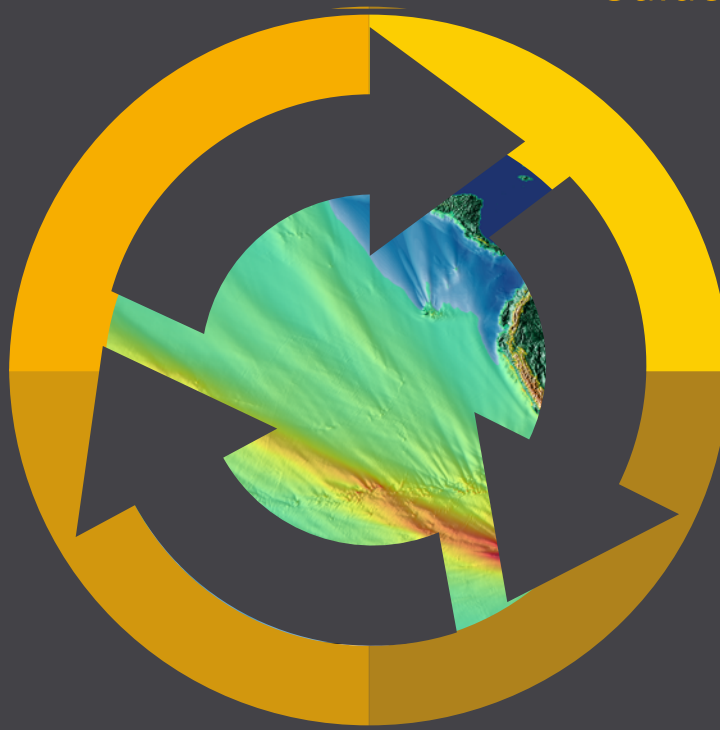
Mitigation and preparedness

Guidelines for hazard estimation, evacuation routes,

Emergency:

Early Warning Systems

NRT



CIGIDEN

Centro de Investigación
para la Gestión Integrada
de Riesgos de Desastres





Youngjun Choe

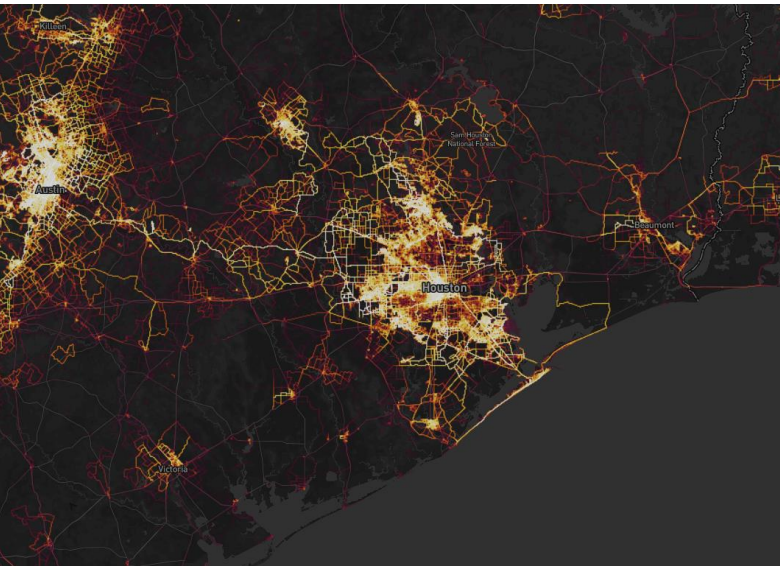
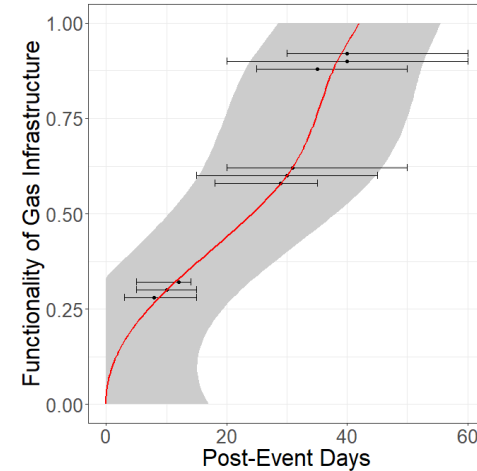
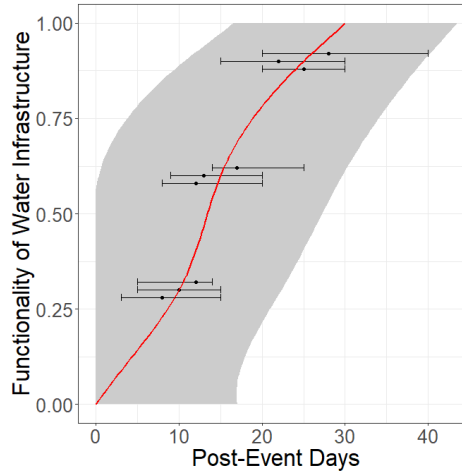
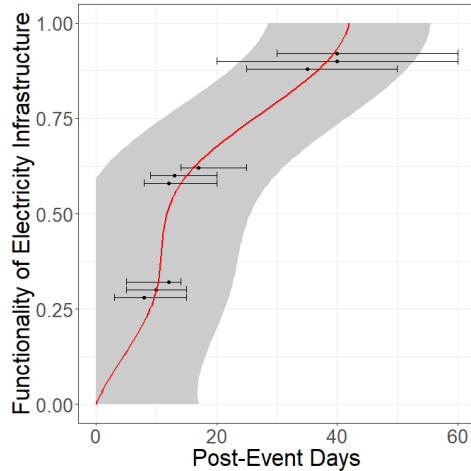
Assistant Professor

Industrial & Systems Engineering, UW

<https://faculty.washington.edu/ychoe/>

<https://www.DDSLab.info>

- Measurement/prediction of post-disaster recovery
- Damage assessment using remote sensing





Jorge Crempien

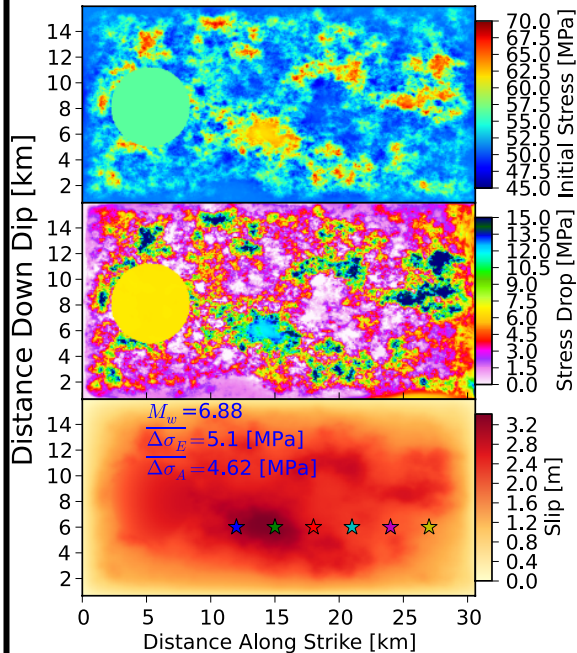
Assistant Professor at PUC + CIGIDEN

jocrempie@ing.puc.cl

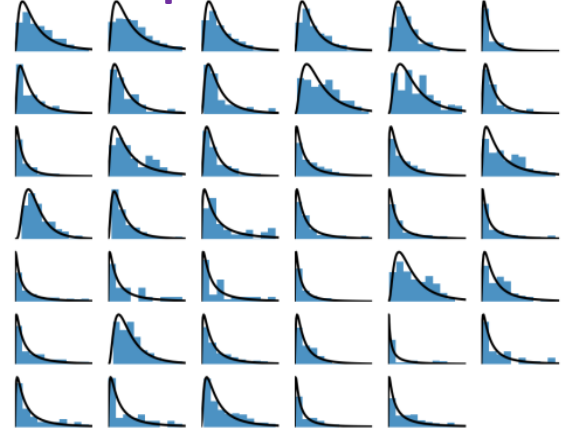
Research Interests

- Physics-based simulation of earthquake source processes with **kinematic** and **dynamic rupture** methods.
- Simulation of near field **strong motion** for engineering purposes.
- Simulation of **tsunami processes** with physics-based methods.
- Inversion of multiple data (strong motion, tsunami, GPS) to find kinematic earthquake rupture.
- constraining physical processes such as **probability distributions** and **spatial correlations** of kinematic rupture parameters .

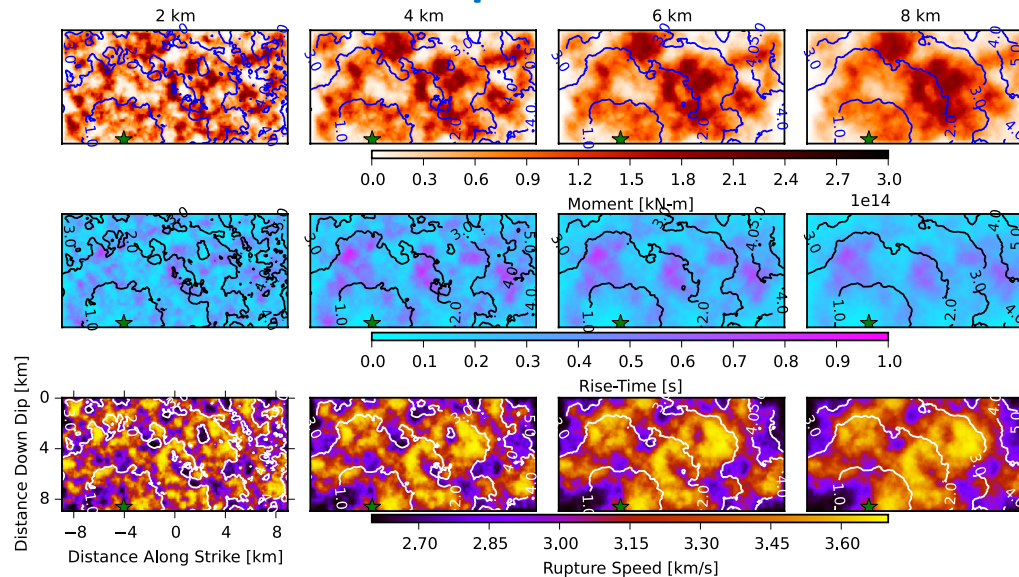
Dynamic rupture simulations



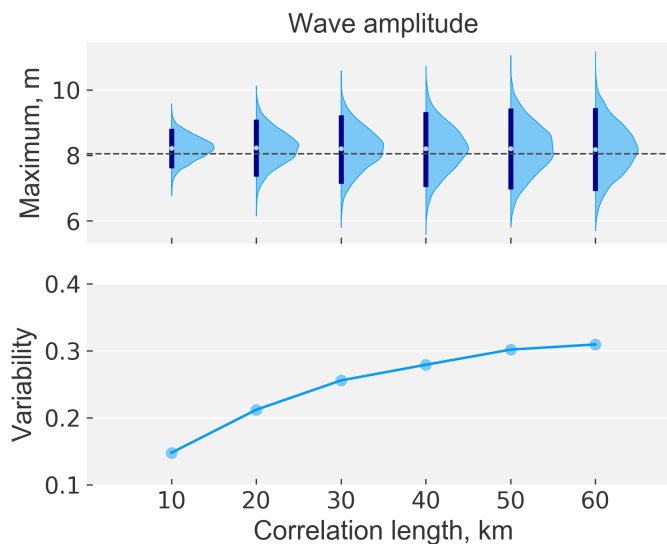
Slip distributions



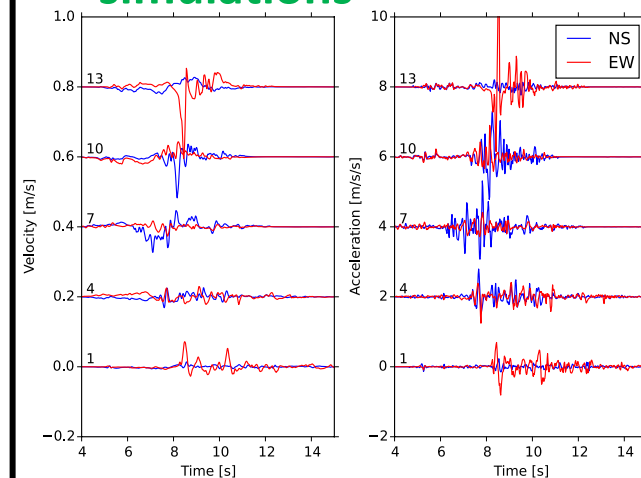
Kinematic rupture simulations



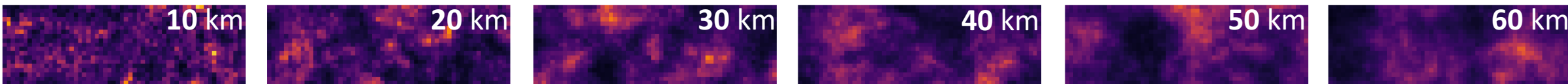
Tsunami simulations



Synthetic strong motion simulations



Spatial correlations



G-FAST GNSS-Based Early Warning Module

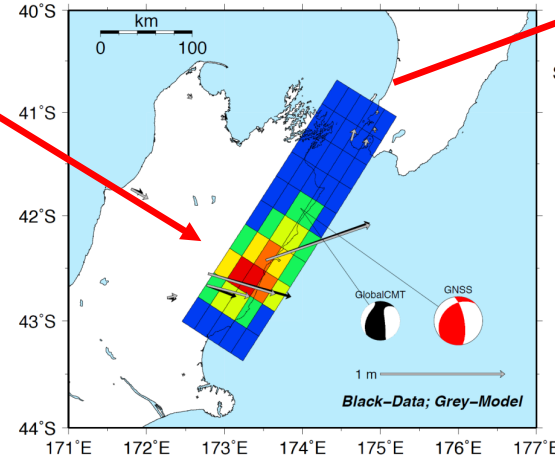
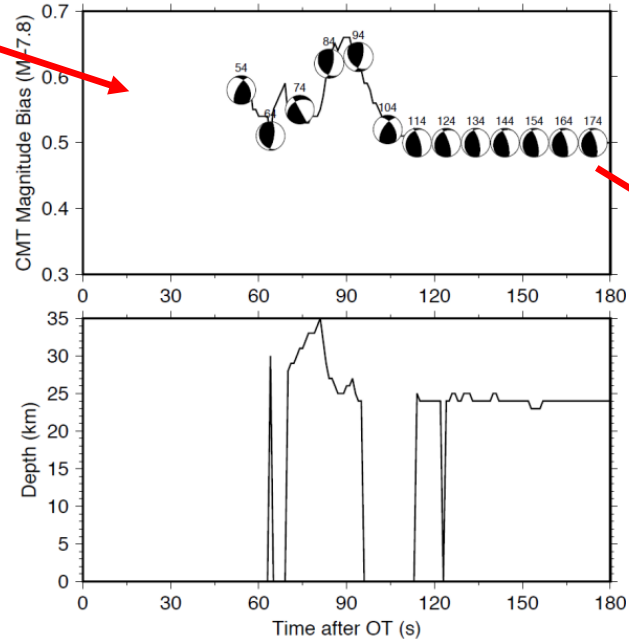
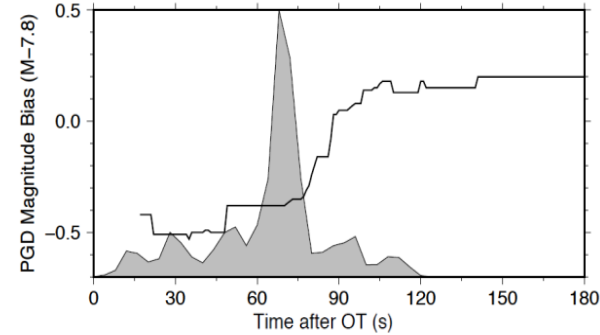
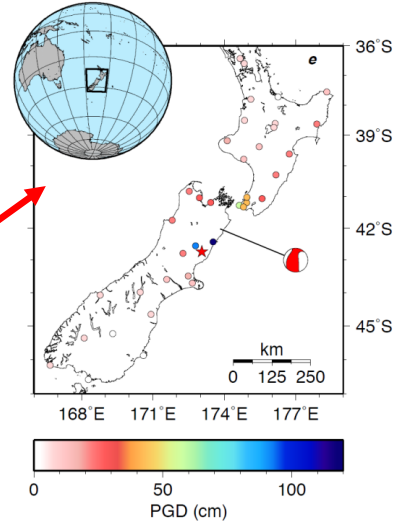
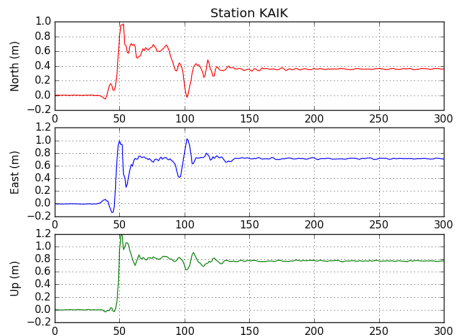
ShakeAlert trigger

Geodetic modeling modules

PGD scaling

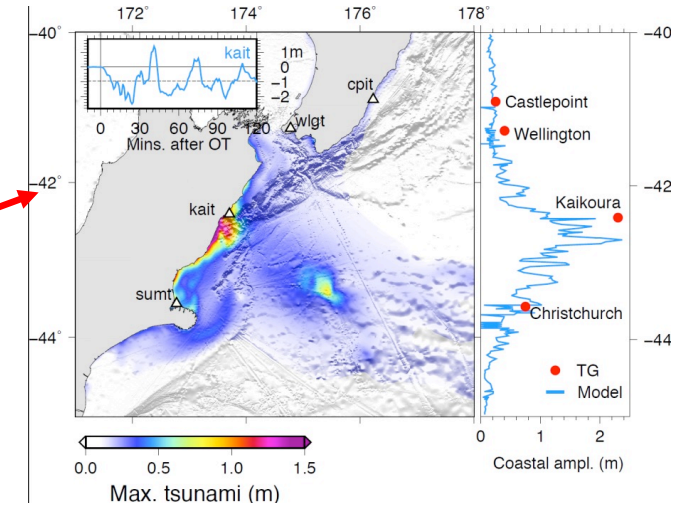
CMT-driven Finite Fault (FF) inversion

GNSS Waveforms



Bulletin of the Seismological Society of America, Vol. 108, No. 3B, pp. 1736-1745, July 2018, doi: 10.1785/0120170247

Hypothetical Real-Time GNSS Modeling of the 2016 M_w 7.8
 Kaikōura Earthquake: Perspectives from Ground
 Motion and Tsunami Inundation Prediction
 by Brendan W. Crowell, Diego Melgar, and Jianguhui Geng



Taking output of G-FAST's FF inversion will help aid in near-field tsunami forecasts

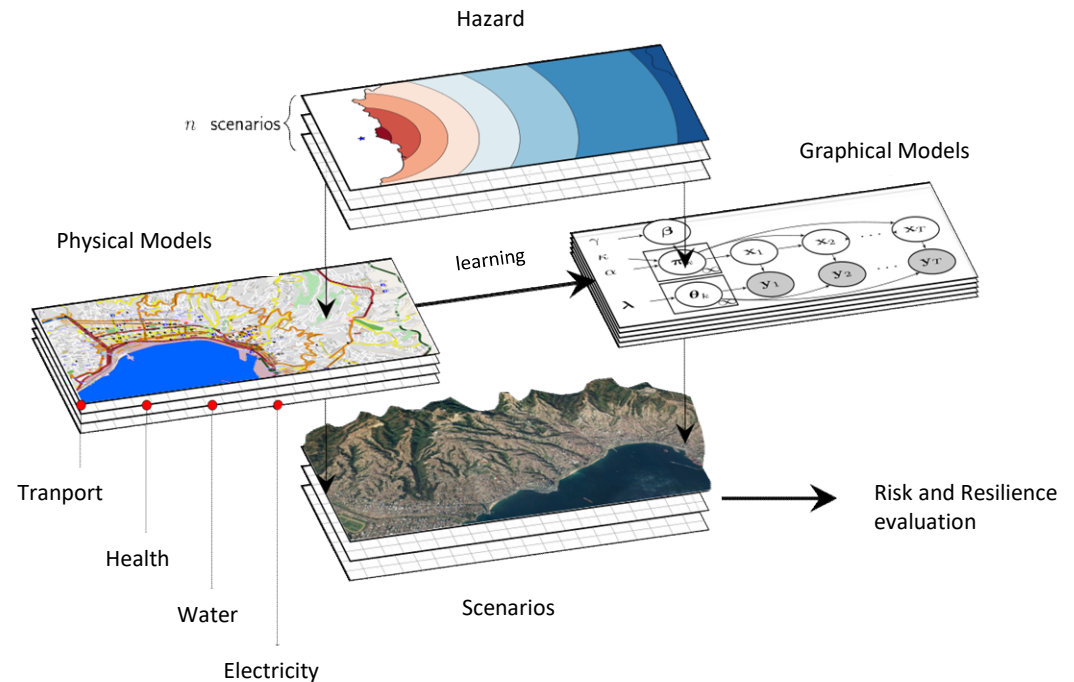


Research Interests

- Synthetic ground motion generation
- Seismic risk of complex systems and networks
- Inelastic response and fragility of RC buildings
- Seismic protection of structures



- Dean of the School of Engineering, PUC (2010 -)
- Professor, Structural and Geotechnical Engineering, PUC (1986 -)
- PI of the Research Center for Integrated Management of Natural Disasters, CIGIDEN (2013 -)
- Director of the National Natural Disaster Resilience Institute (ITReND) (2019 -)
- PI of Project SIBER-RISK, Fondecyt (2017-2020)





Alison Duvall

Assistant Professor
Dept. of Earth and Space Sciences
University of Washington



Research Expertise:

- tectonically driven landscape evolution
- tectonic geomorphology
- surface processes (fluvial and hillslope) & erosion
- faulting and mountain building processes (over thousands and millions of years timescales)

Methodology/tools:

- geochronology
- low-temperature thermochronology

Current Projects:



- M9 Cascadia & Seattle Fault landslides
- Subduction initiation, Haida Gwaii
- Evolution of the Marlborough Fault System, New Zealand
- Mantle and surface interactions, Idaho

- geomorphic/geologic mapping
- numerical modeling of landscapes

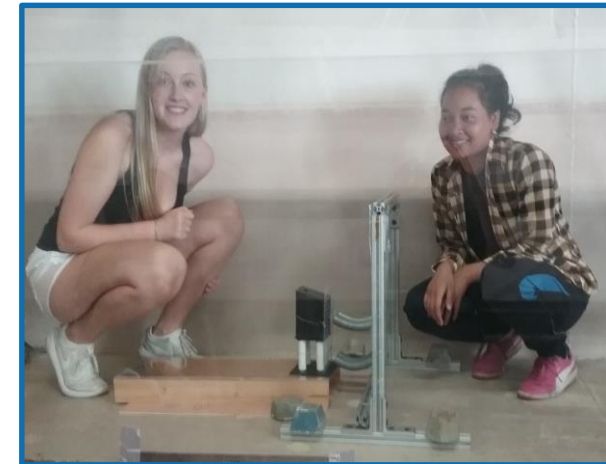
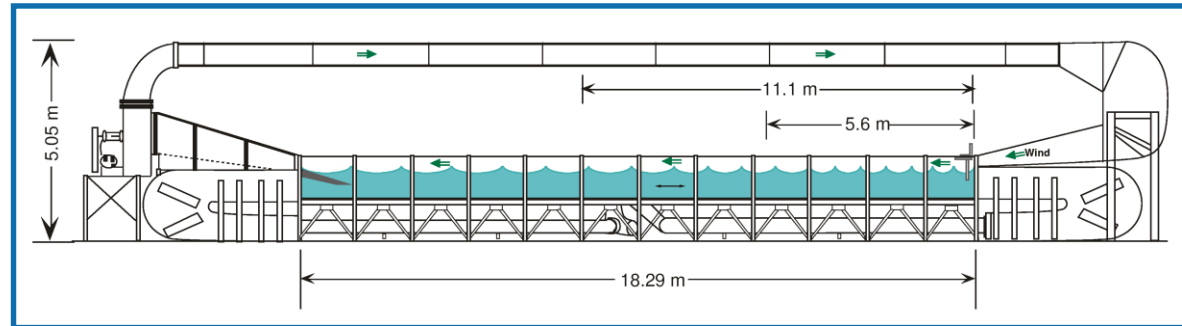
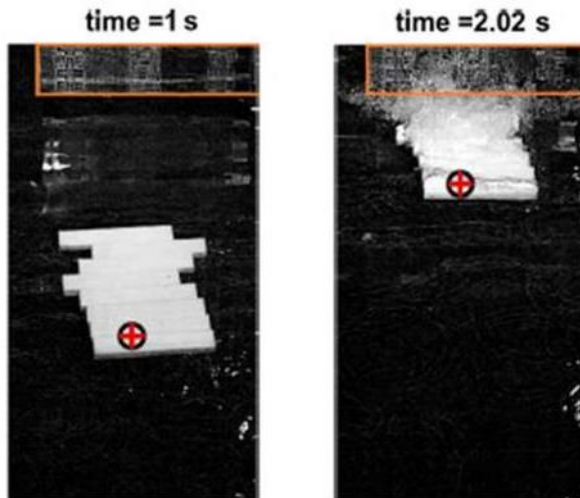
Marc Eberhard



University of Washington
Email: eberhard@uw.edu
Web: <https://www.ce.washington.edu>

Planned Debris Tests at UW (2019) (Constant Flow)

Debris Tests at OSU (2017) (Single Wave)

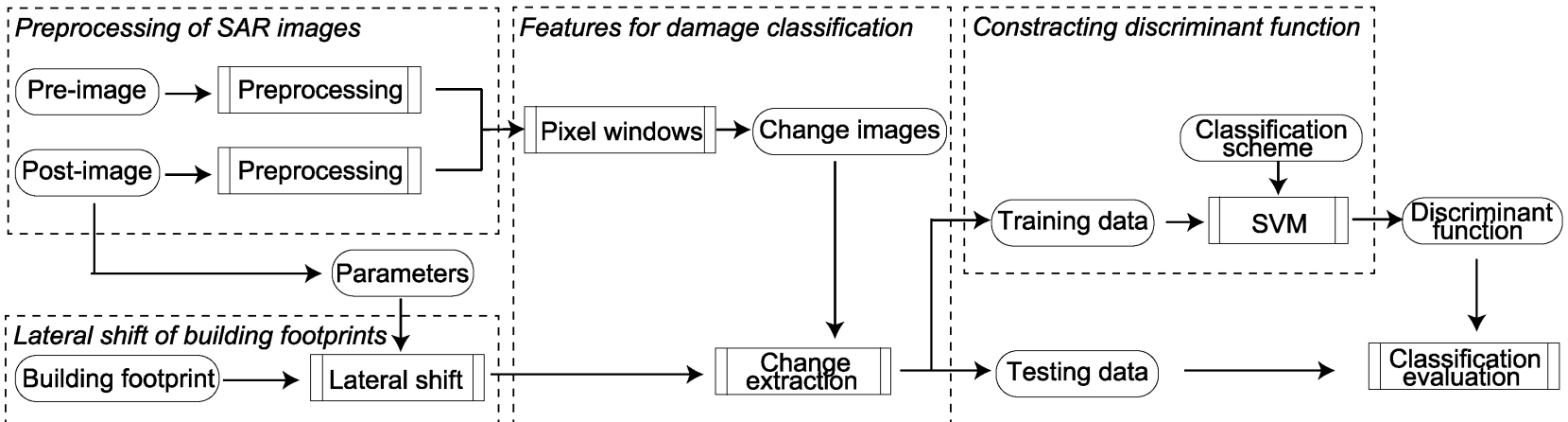
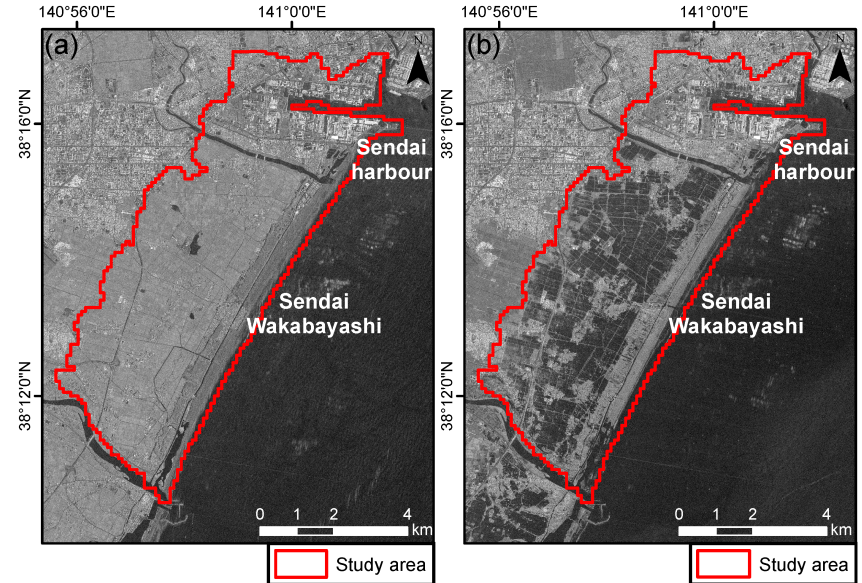


Yukio Endo

Master's student, Tohoku University

Research interests

- Synthetic aperture radar
- Disaster damage assessment
- Image processing
- Machine learning



Endo, Y., et al. "New Insights into Multiclass Damage Classification of Tsunami-Induced Building Damage from SAR Images." *Remote Sensing* 10.12 (2018): 2059.

Bob Freitag, UW Research Faculty coming from FEMA

Instructor for Courses in: Community Resilience, Floodplain Management, Hazards Mitigation, Water

Director of the Institute of Hazards Mitigation Planning and Research (IHMP) - We are a design community committed to exploiting benefits while reducing risks to a tolerable level that arise from our changing world .

Recent IHMP Research: ([Addressing Change](#))

- Tsunami Construction Manual – WEMD
- Scenario-based Flood Risk Mapping – DHS
- Tsunami SafeHaven Planning -- NERP
- Whatcom County – Resilience Scenarios – FEMA
- Hazards Mitigation plan for the City of Everett – Everett
- Floods Risks following Wildland Fires: A Case Study: Plain, Washington –FEMA
- Policy Dialogue during the Response-Recovery Transition Phase and Implication for Long-term Recovery: Case Study, Katmandu (Nepal) – NSF
- Hazard Mitigation Practices by Jurisdictions along Gulf and Atlantic Coasts – NSF



Yo Fukushima

IRIDeS, Tohoku Univ.

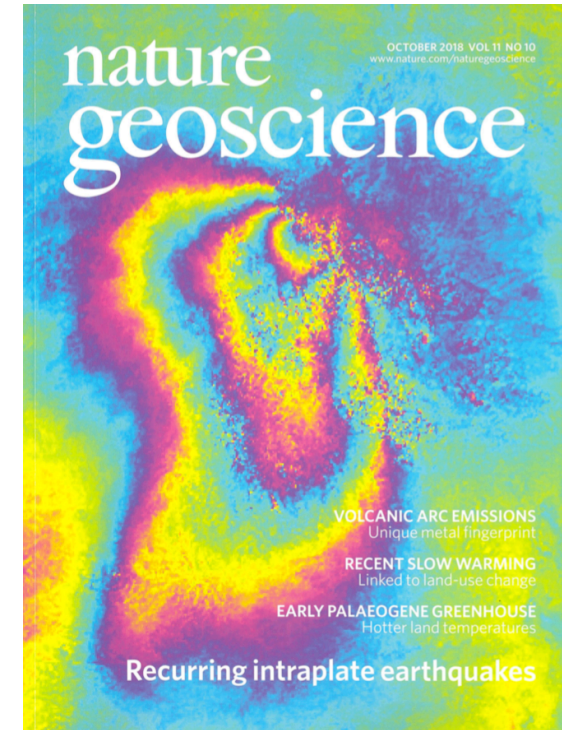
<https://yofuku.github.io>



(Real) Speciality: earthquake (and volcano) physics through crustal deformation data especially space geodesy

Other keywords: Synthetic Aperture Radar (SAR) interferometry (InSAR), Modeling, Inverse methods

(I have access to practically unlimited amount of ALOS-2 SAR data)



(Fukushima et al., 2018)
doi: 10.1038/s41561-018-0201-x

Secondary interests: earthquake forecasts, using long-term forecast information for disaster risk reduction, using short-term forecast information for evacuation and disaster mitigation

- What kind of “anomalous” signals could we observe before megaquakes?
- What could happen after observing anomalous signals?
- How can we visualize what could happen after observing anomalous signals?



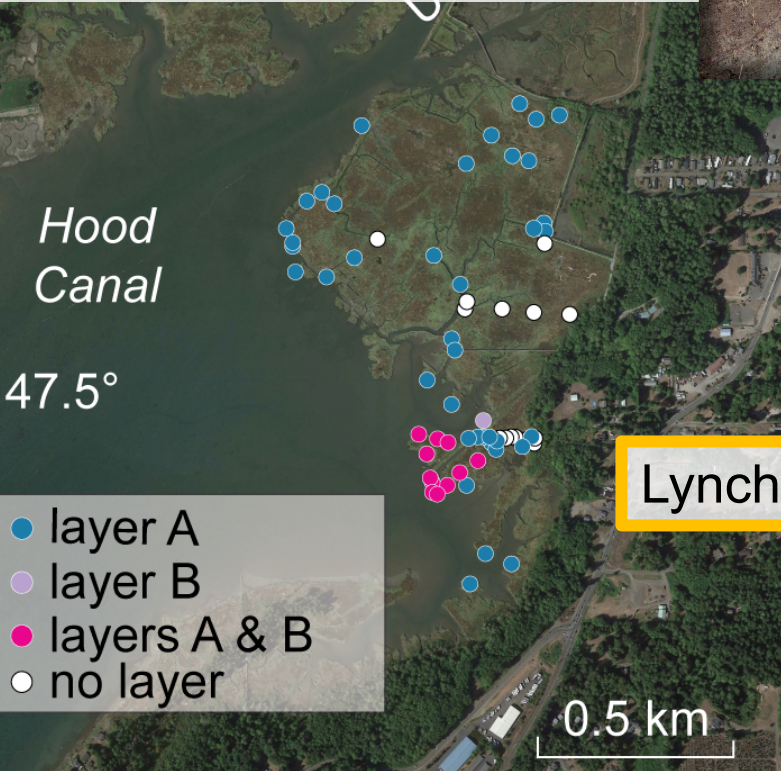
Carrie Garrison-Laney, cegl@uw.edu

Washington Sea Grant | University of Washington | PMEL Liaison



Puget Sound tsunami geology:

- Sediment properties
- Radiocarbon ages
- Diatom (microfossil) paleoecology

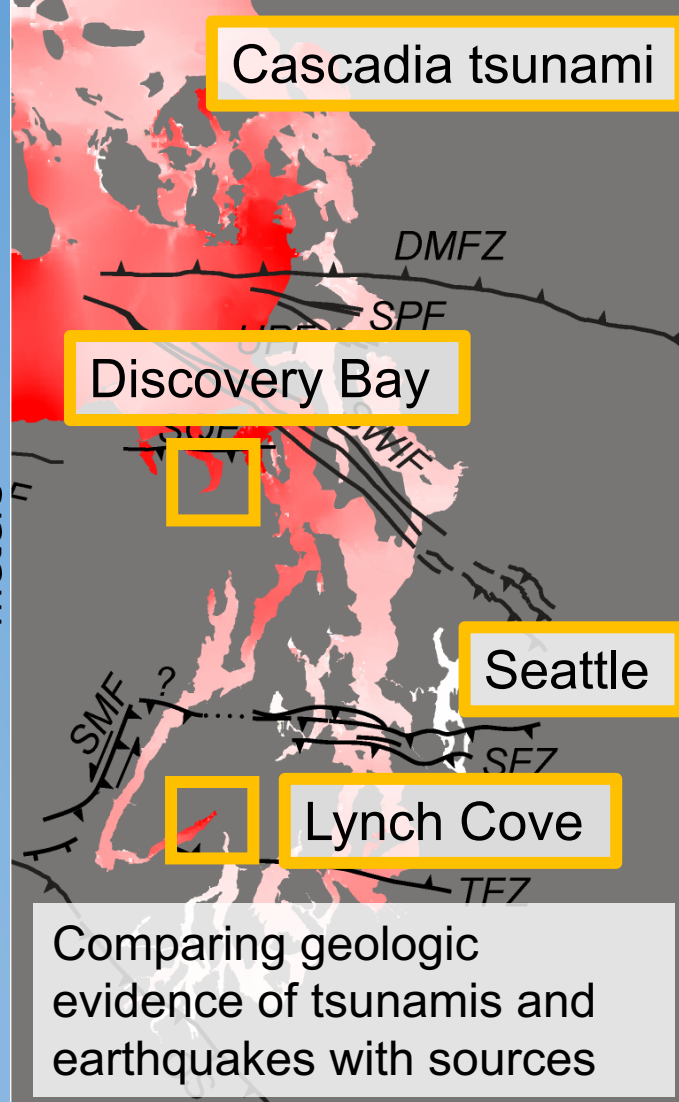
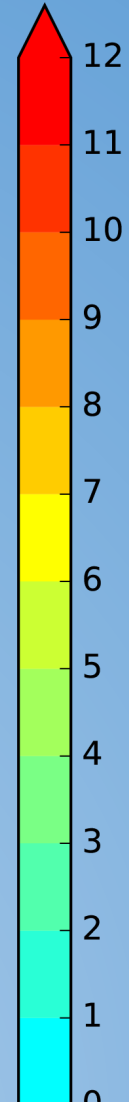
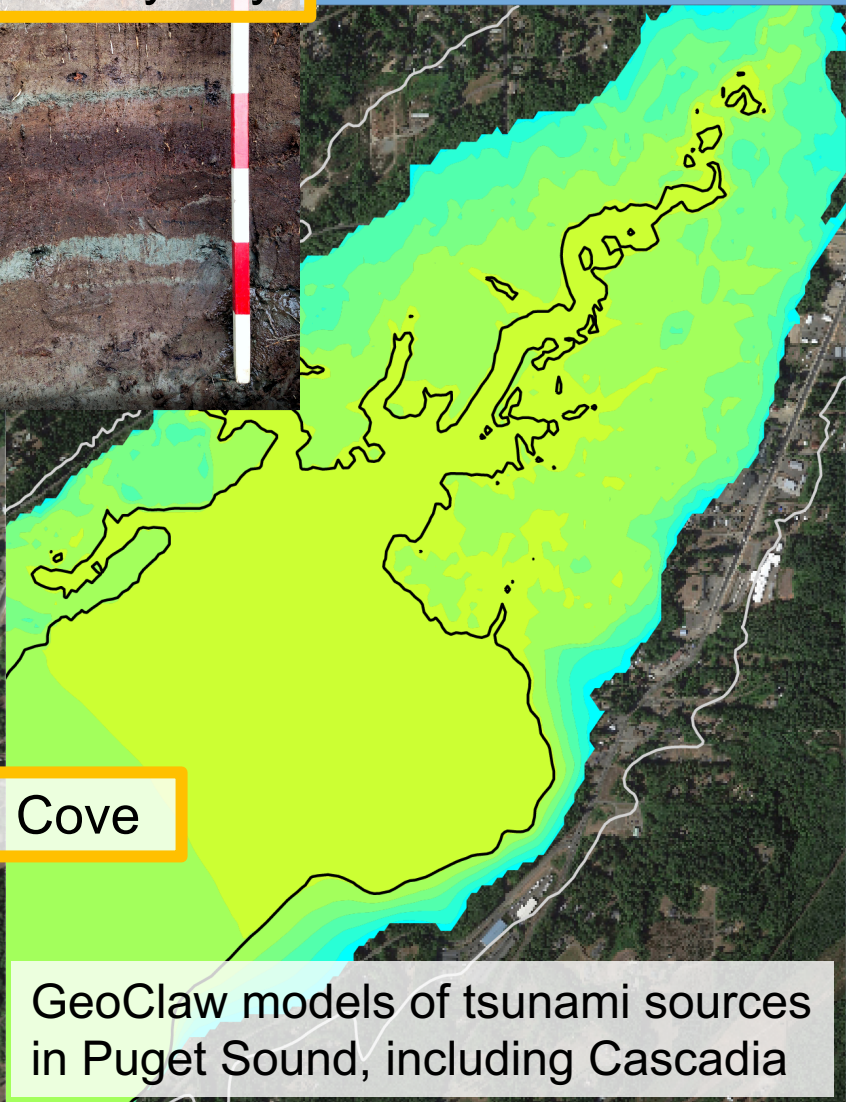


- layer A
- layer B
- layers A & B
- no layer

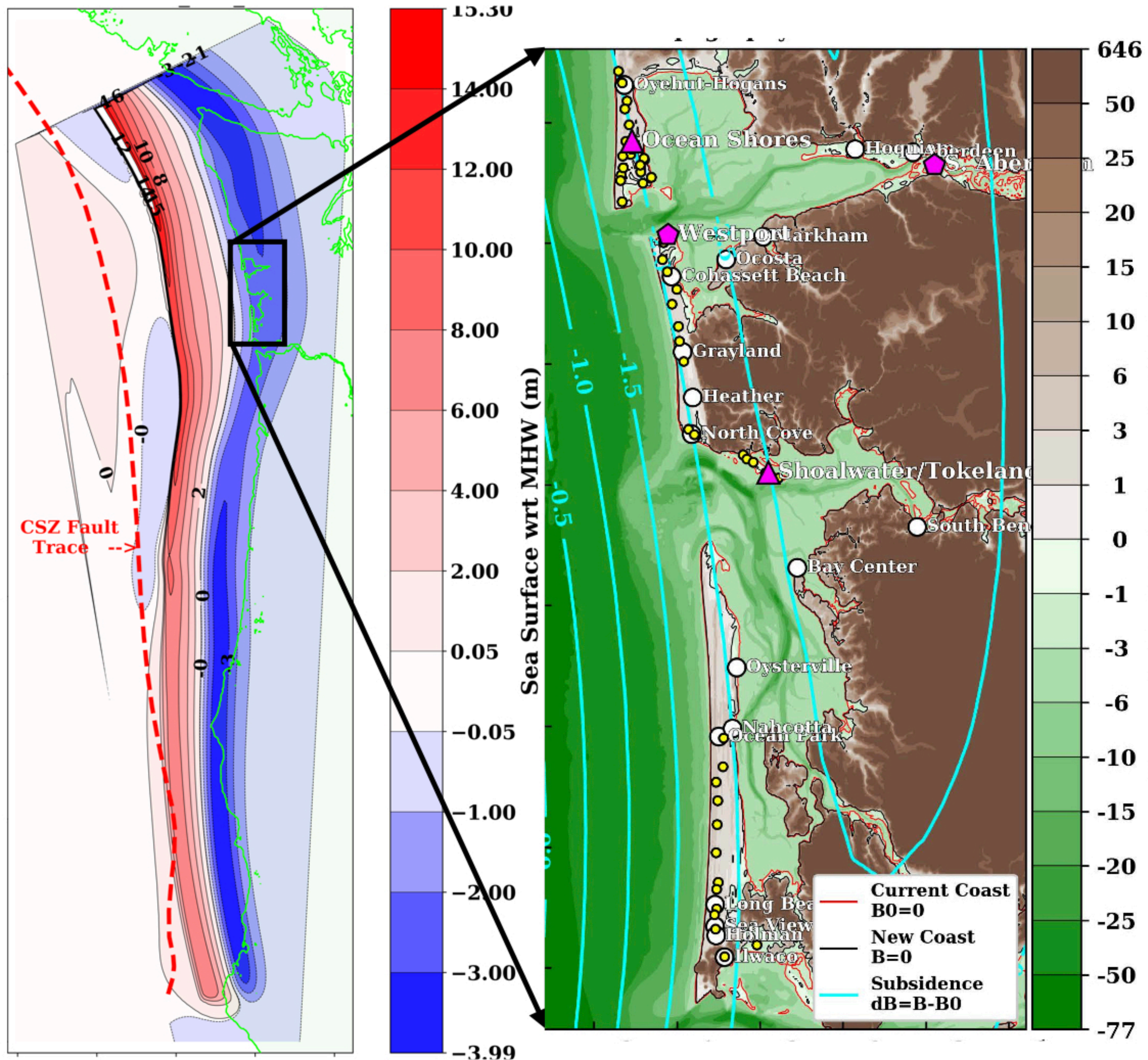
Discovery Bay



Lynch Cove



Comparing geologic evidence of tsunamis and earthquakes with sources



Frank González
 UW Earth & Space Sciences
 figonzal@uw.edu

Interests

- Probabilistic & Deterministic Tsunami Hazard Assessment
- Forecast and Warning
- Effective and ***Constructive*** Science Communication with Officials, Residents

Vertical Evacuation Structures

Grays Harbor County & Pacific County

- > 40 K residents in Tsunami Hazard Zones
- ~ 50 VES sites studied by Safe Haven Project
- 20-30 minutes evacuation time

Community Questions

How confident are you about ***Probability, Subsidence, Wave Height, ... ?***

Dr. Gabriel Gonzalez

Professor

Geological Sciences Department

Universidad Católica del Norte

Deputy Director CIGIDEN

Chile

www.cigiden.cl

ggonzale@ucn.cl



Research fields

- Neotectonics
- Active tectonics
- Earthquake geology
- Paleoseismology
- Seismology
- Tsunami
- Natural hazards

My research is published in:

Geology

Tectonics

Tectonophysics

Geophysical Research Letter

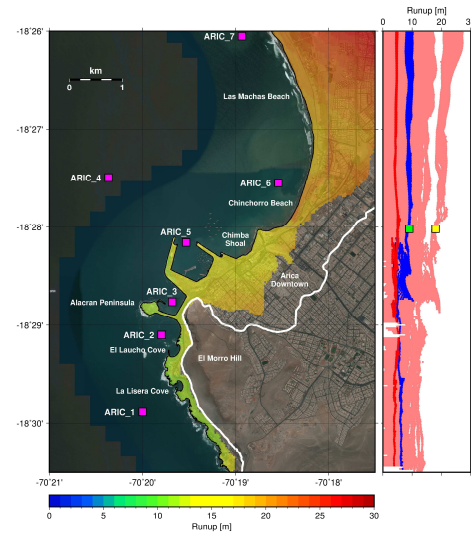
Pure and Applied Geophysics





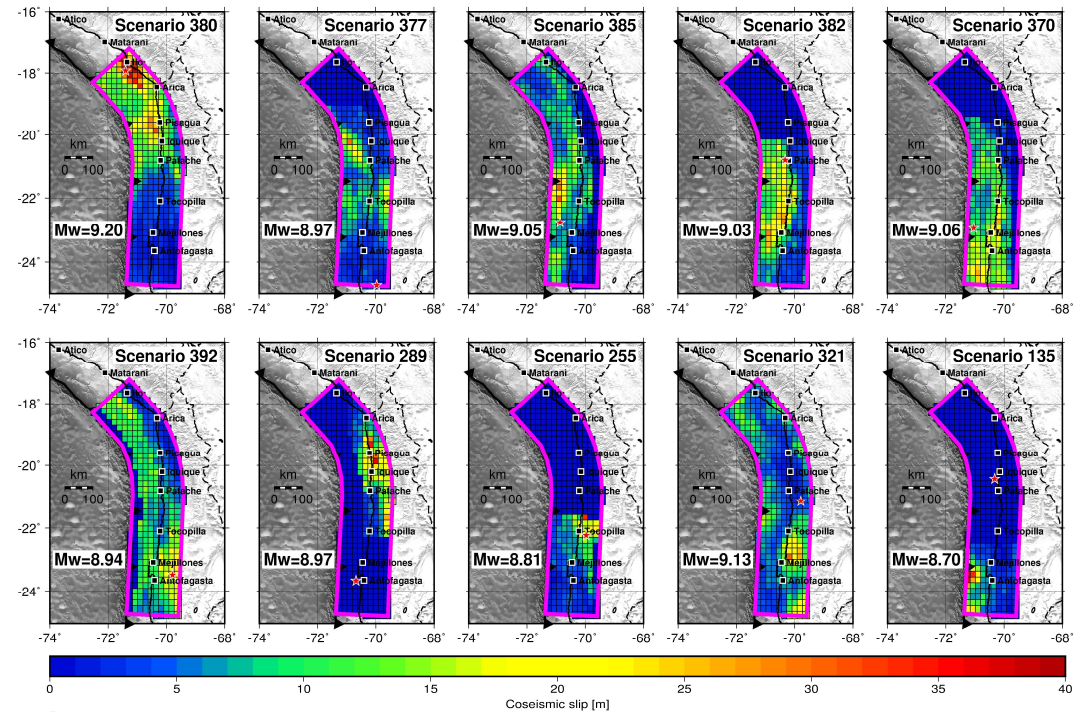
Juan González

Oceanographer/Graduate student
 Department of Geological Sciences
 Universidad Católica del Norte
 Antofagasta, Chile
 Email: juan.gonzalez@cigiden.cl



Research interests

- Tsunami numerical modeling.
- Earthquake scenarios for active seismic gaps.
- Probabilistic and stochastic tsunami hazard analysis.
- Uncertainty analysis.
- Multihazard links of megathrust scenarios (active normal faults, volcano and mass wasting).
- Tsunami Early Warning Systems.



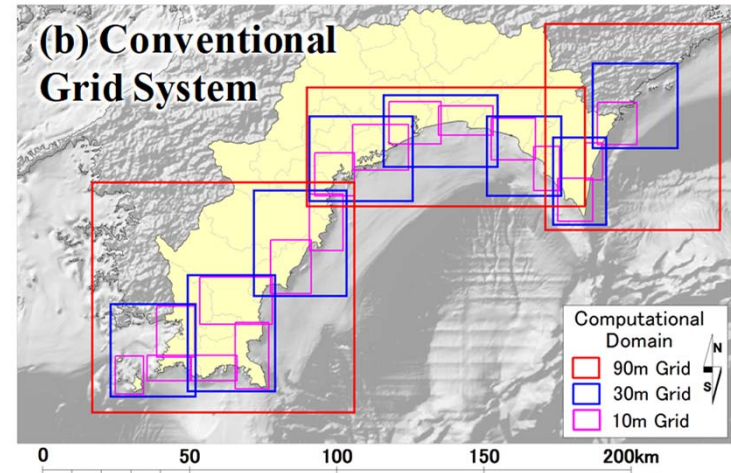
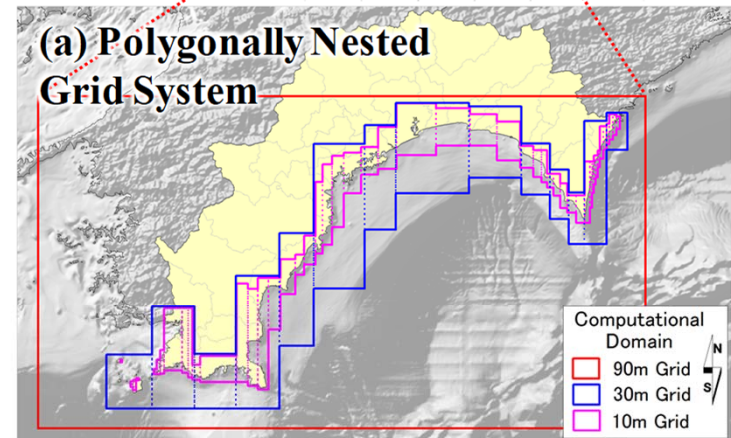
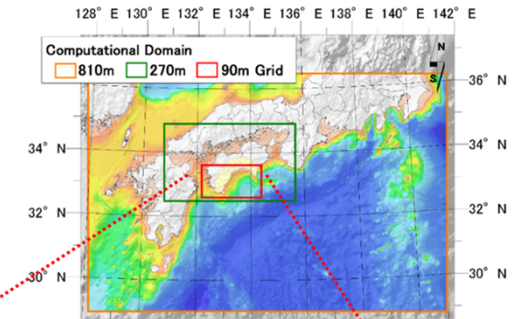
Takuya Inoue

Graduate Student, Tohoku University
 Kokusai Kogyo CO., LTD.
 (takuya_inoue <at> kk-grp.jp)



Working on
 “**realtime tsunami inundation forecast**”
 on a regional scale (e.g., entire Japan/U.S.)

Efficient Numerical Model



Study Areas and Results

Calculation Regions: 810m (shown left), 270m, 90m, 30m, 10m
 Platform: SX-ACE Cores Used: 256 Calc. Time: 6 hours

7 Minutes Fault Estimation

10 Minutes Tsunami Simulation

Visualization/Dissemination of Information

20 Minutes After Event

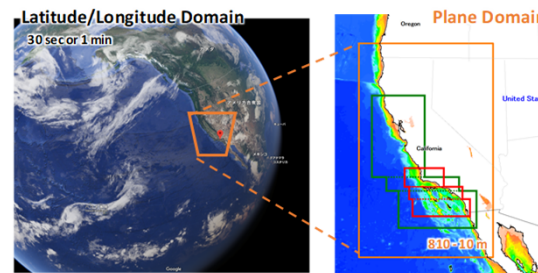
Study Area	Kochi	Shizuoka	Miyagi*
No. of Grids	16.5 million	8.0 million	15.7 million
Time Step (sec)	0.10	0.05	0.10
Exec. Time (min)	6.7	7.3	6.5

*Ishinomaki and Higashimatsushima cities

Flowchart of forecast

Current Research:

- Integrated computation of far-/near-field tsunami
- Utilization of Artificial Intelligence (AI)





Real-time Tsunami Inundation and Damage Forecast w/ HPCI

Shunichi Koshimura (Tohoku Univ.) koshimura@irides.tohoku.ac.jp
Yusaku Ohta (Tohoku Univ.)

IMPACT

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HAZARD

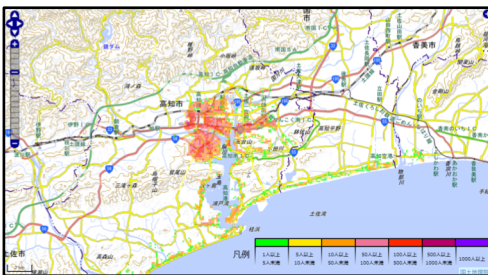
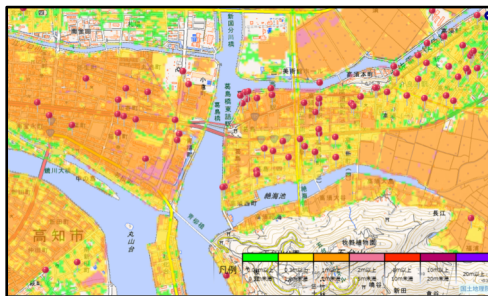
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EXPOSURE

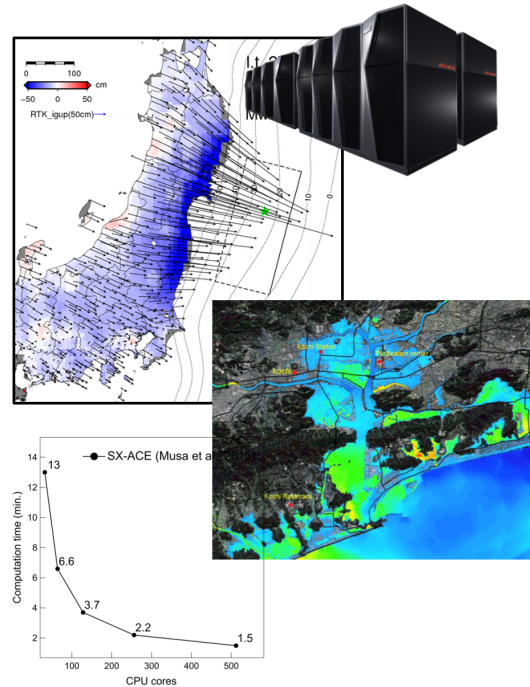
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VULNERABILITY

Mapping Product



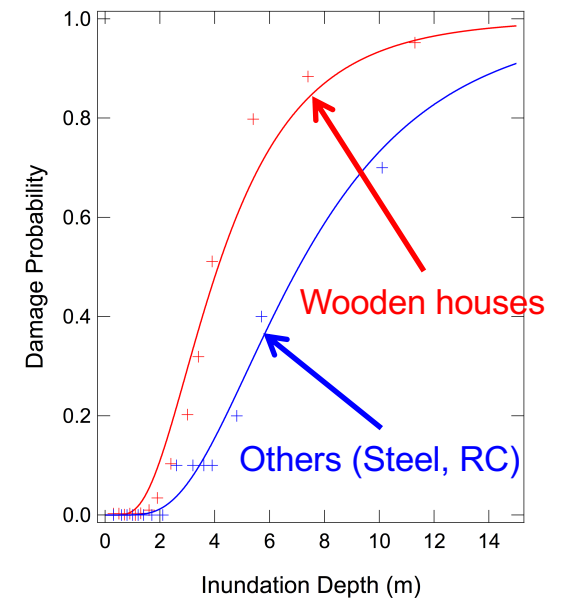
Observation
Real-time Simulation



Building data
Population data
Land use data



Fragility curves



Naoko Kuriyama,

Associate Professor, Dr. of Engineering,
kuri@kobe-u.ac.jp, tel/fax, +81-78-803-6432
 Dept. of Architecture, Graduate School of Engineering,
 Kobe University, JAPAN



Research Theme: Characteristics of the Disaster Prevention Group Relocation Promotion Project in the Great East Japan Earthquake and Evaluation on Residential Environments after Relocation.

Keywords: Great East Japan Earthquake, Disaster Prevention Group Relocation Promotion Project, Disaster Public Housing, Plug-in type relocation, Residential Environments



Fig.2.女川町塚浜地区 Onagawa Town, Tsukahana District, Miyagi Prefecture. (Source 2)

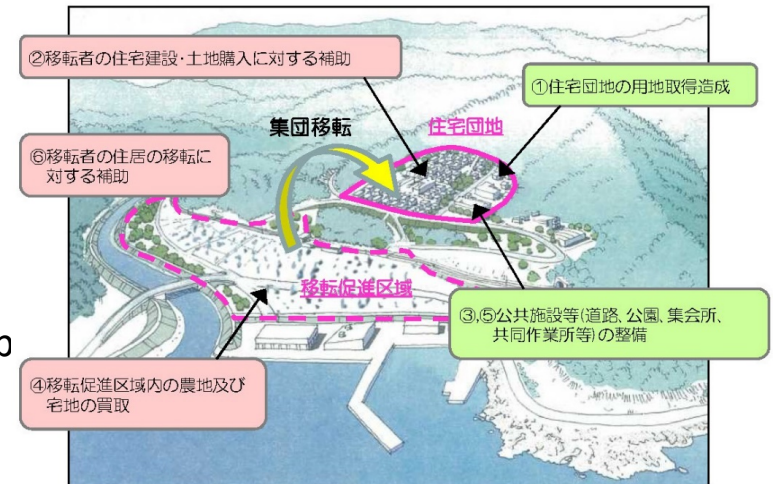


Fig.1. Image of Disaster Prevention Group Relocation Promotion Project.(Source 1)

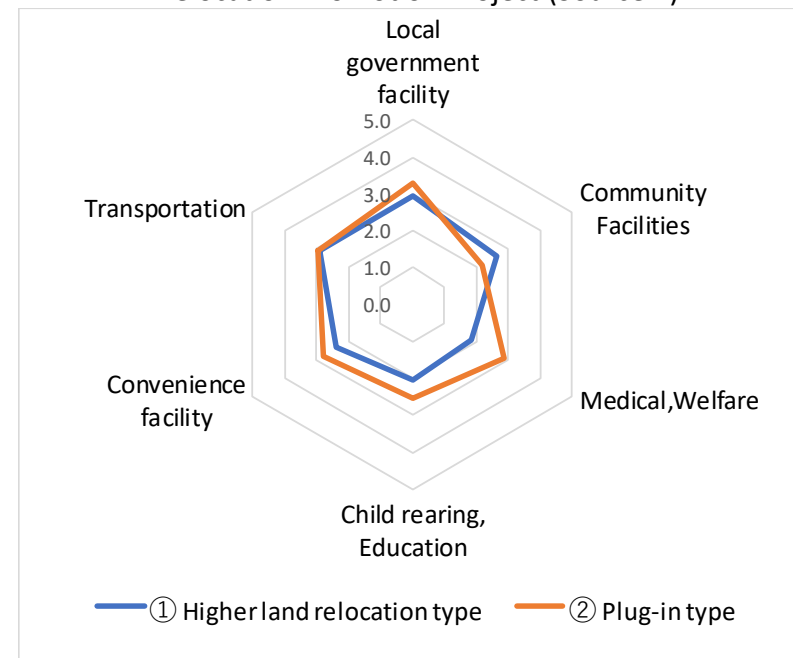


Fig.3. Residential Environments after relocation depending on the relocation type. (Source 3)

1) Ministry of Land, Infrastructure, Transport and Tourism http://www.mlit.go.jp/toshi/toshi_tobou_tk_000009.html

2) Disaster Prevention Group Relocation Promotion Projects in Miyagi Prefecture <https://www.pref.miyagi.jp/soshiki/kentaku/bousyuujouhou.html>

3) Master Thesis of Kojima Naohisa (Feb.2019, Graduate School of Engineering, Kobe University)

Dawn Lehman

CEE
Professor
&
Director of
Structural-
Research
Laboratory



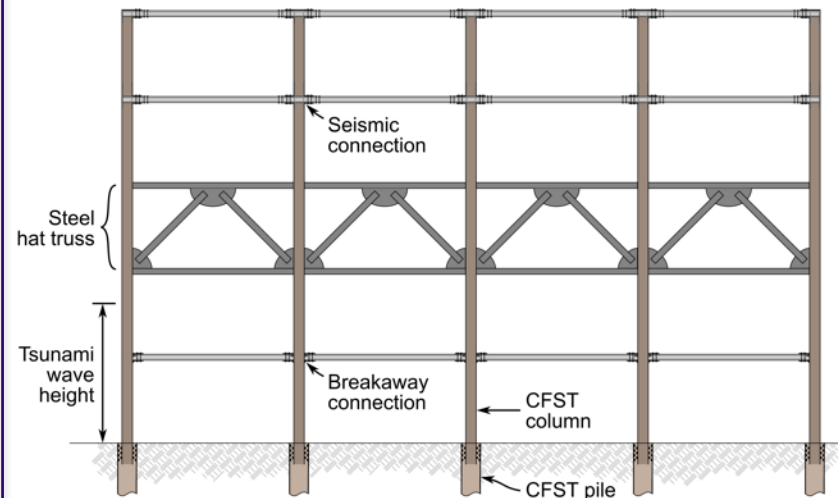
Research Interests

- > Large-scale structural testing
- > Numerical simulation of structural systems to extreme loading
- > Development of structural systems for buildings and bridge in earthquake & tsunami prone regions
- > Retrofit of older structural systems for natural hazards

New NSF Project on VES

Title: Vertical Evacuation Structures Subjected to Sequential Earthquake and Tsunami Loadings.

Research Objectives & Research Approach: Develop new system for earthquake and tsunami resistant structures. Testing of new slab-CFT column systems in UW structures lab. Testing of wall and new CFT systems in OSU wave flume. Simulation including structure-fluid interaction using OpenSees & OpenFoam



Jorge León

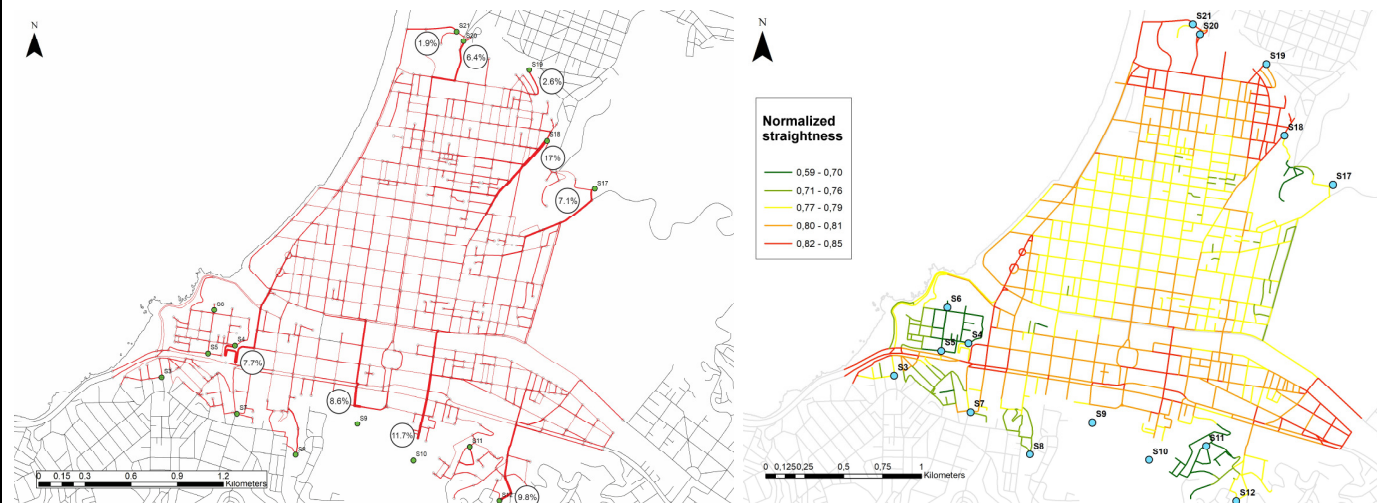


- **Doctor of Philosophy (PhD) in Architecture and Planning, Melbourne School of Design, University of Melbourne, Australia.**
- **Bachelor of Architecture, Department of Architecture, Federico Santa María Technical University, Valparaíso, Chile.**
- **Research interest:** The role of urban forms (at a range of scales of analysis) in supporting populations' responses during rapid onset emergencies such as earthquakes, tsunamis and wildfires.

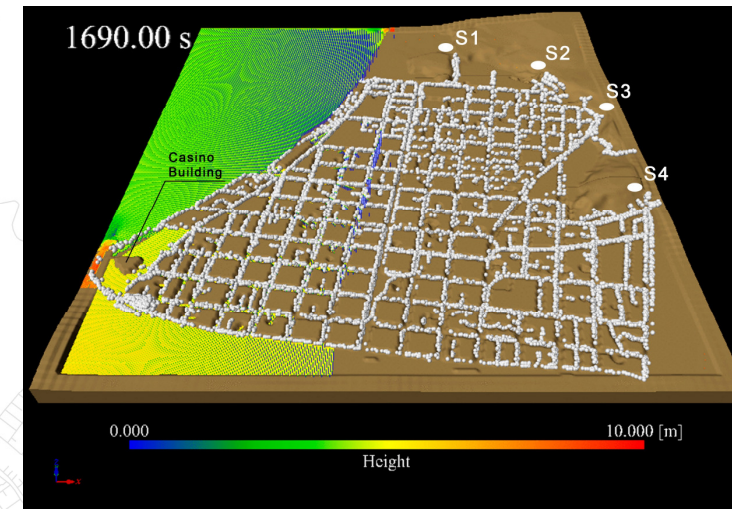


UNIVERSIDAD TECNICA
FEDERICO SANTA MARIA

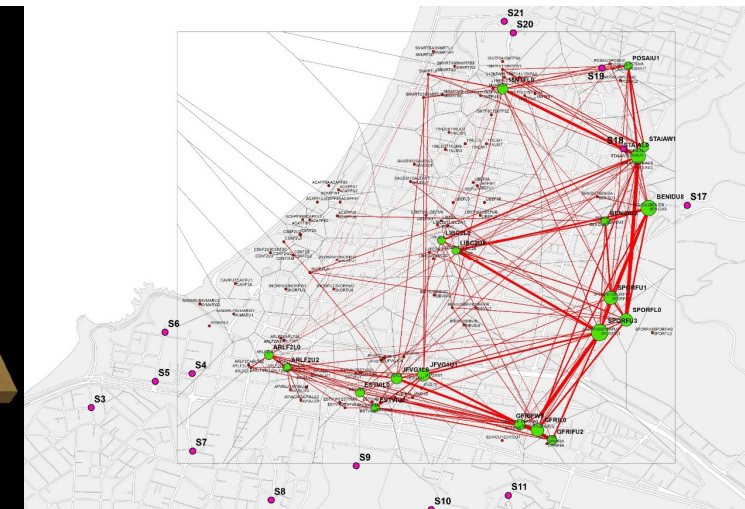
Urban configuration model: system of linked spatial elements (streets, squares, parks, etc.) through which people move



Agent-based + tsunami flood model

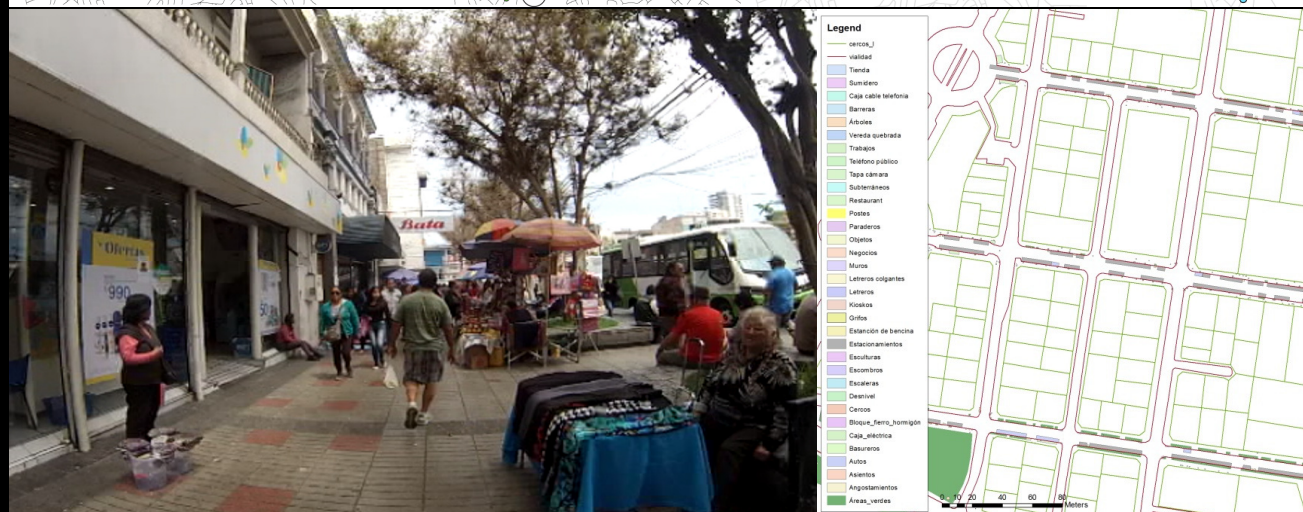


Real evacuation behavior analysis through call detail records (CDR)



Macro-scale of analysis

Micro-scale of analysis



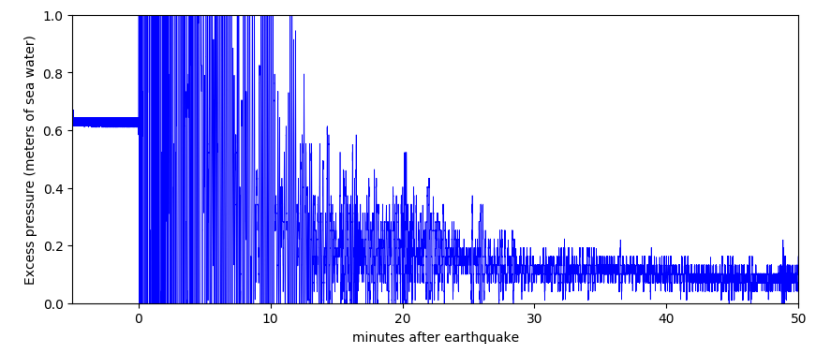
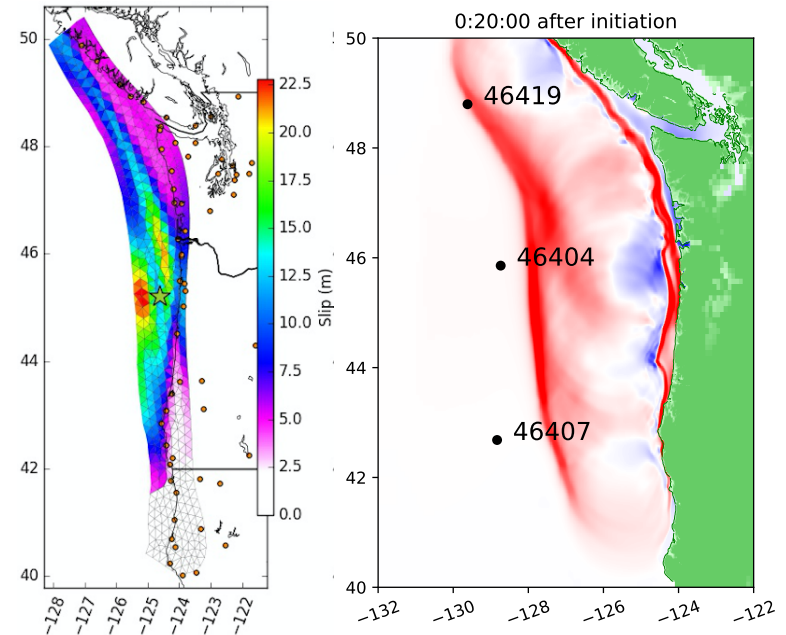
Evacuees' spatial experience along escape routes / classification of routes according to their suitability for evacuation

Community-based knowledge

Randy LeVeque, rjl@uw.edu
<http://staff.washington.edu/rjl/>



- Core developer of **GeoClaw** software for modeling tsunamis, storm surge, etc. [recent projects]
- Approaches to generating random earthquakes for PTHA and/or testing early warning systems. [paper1, paper2]
- Efficient sampling and filtering of sources for PTHA [FEMA project]
- Coupled seismic-hydroacoustic-tsunami modeling for better understanding of sea floor pressure measurements in the source region. [paper]



Bre MacInnes
Central Washington University

Tsunami modeling
Tsunami field observations

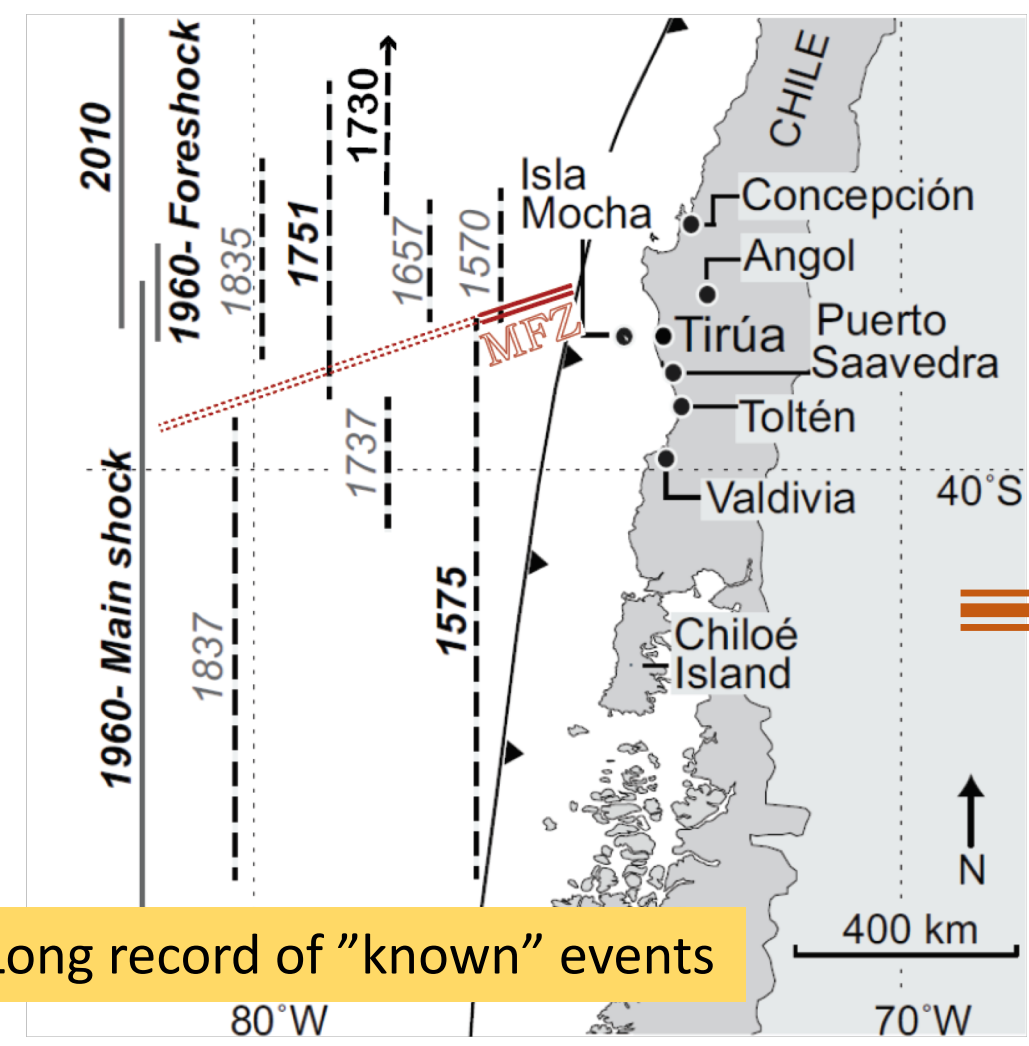
... and linking these two topics to learn about:

- past earthquake rupture parameters
- subduction-zone dynamics
- tsunami behavior

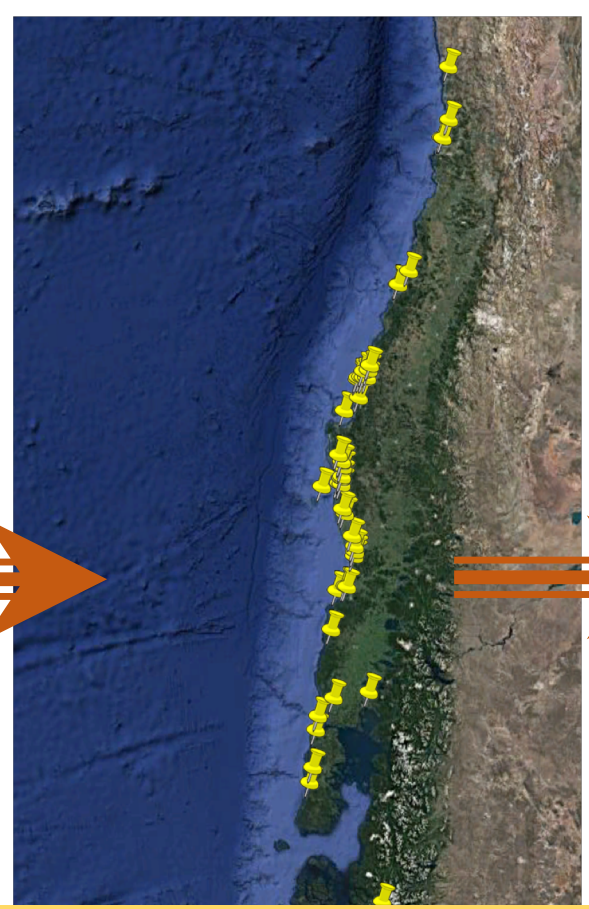
Currently doing work in:
Chile
Puget Sound

Previously worked in:
Kamchatka
Kuril Islands
Aleutian Islands

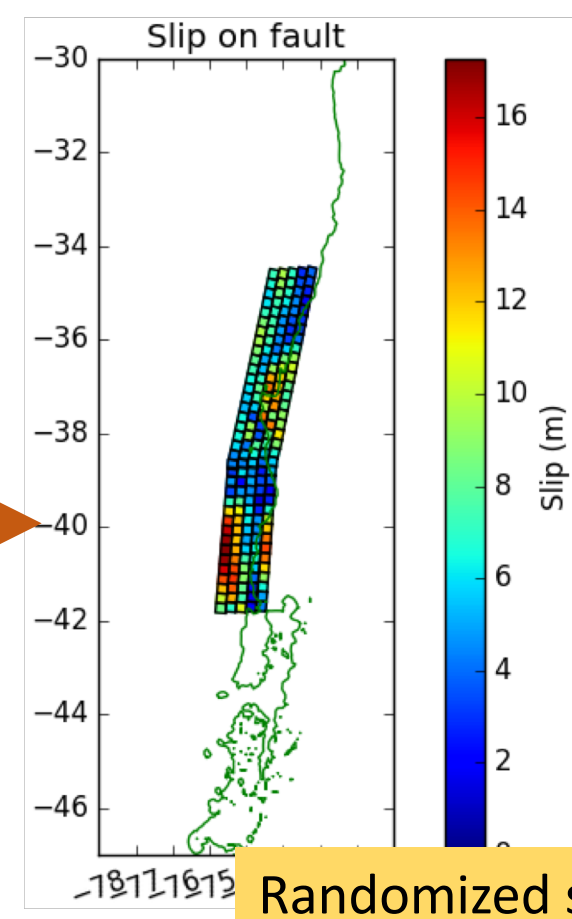
For example in Chile



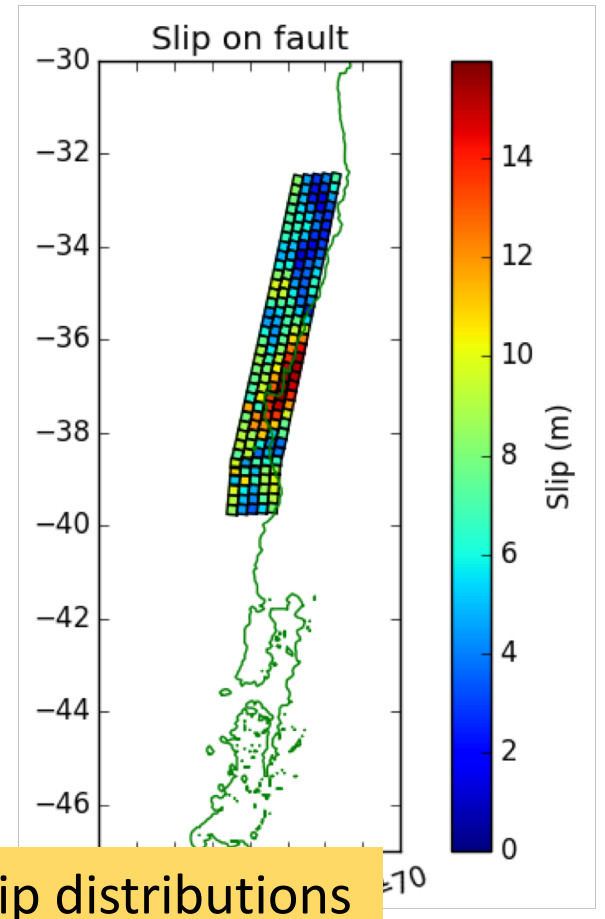
Long record of "known" events



Geologic and written records



Randomized slip distributions



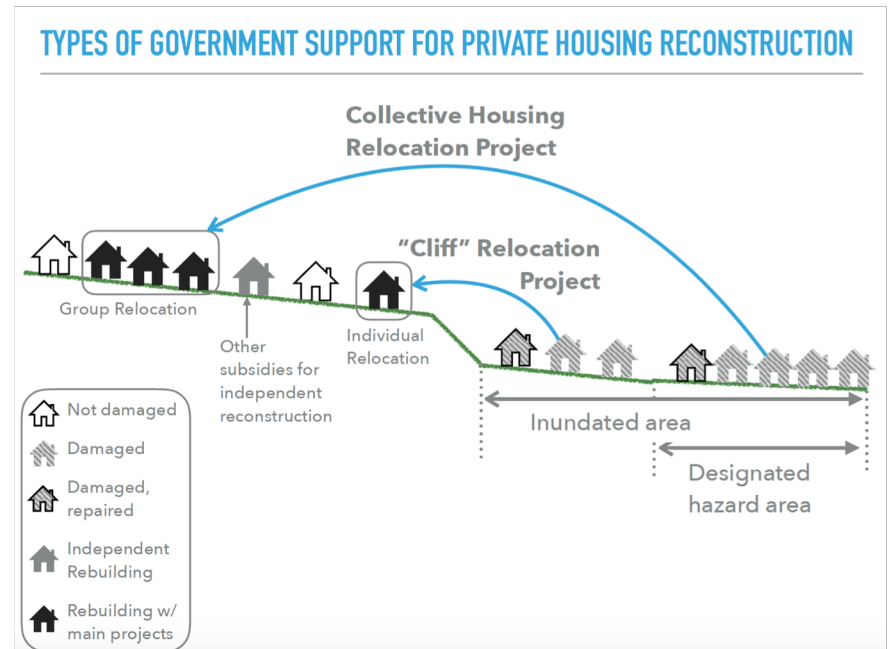
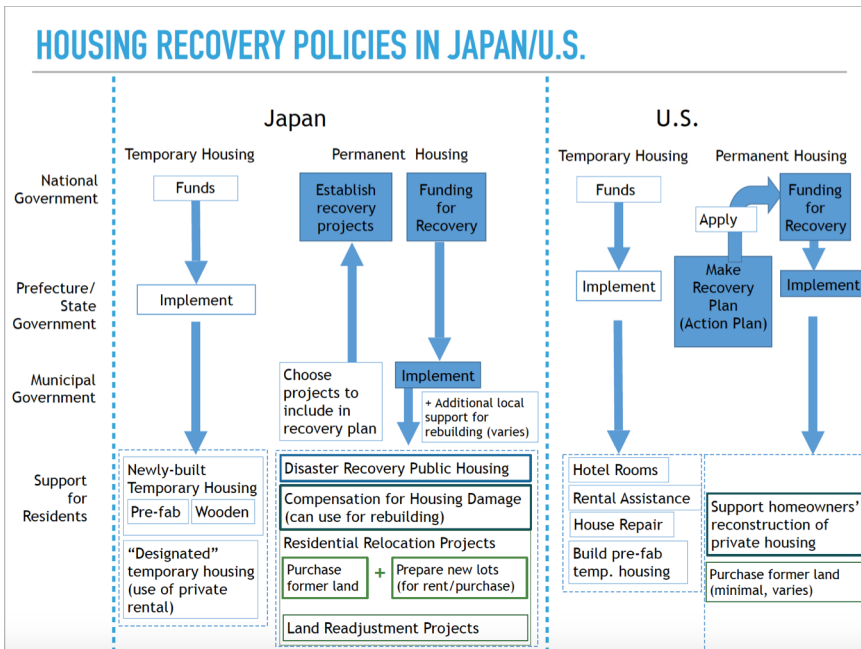


Liz Maly Associate Professor, IRIDeS, Tohoku U
 (International Research Institute of Disaster Science
 PhD Architecture, Kobe University
 M. Arch, UW-Seattle



Research interests and themes:

- “People-Centered Housing Recovery”
- post-disaster housing reconstruction
- community-based recovery planning
- risk-based land use planning/housing relocation
- impact of recovery projects residents’ housing/living environment





Assoc. Prof. Erick Mas
ReGiD-IRIDeS-Tohoku University

mas@irides.tohoku.ac.jp

About me

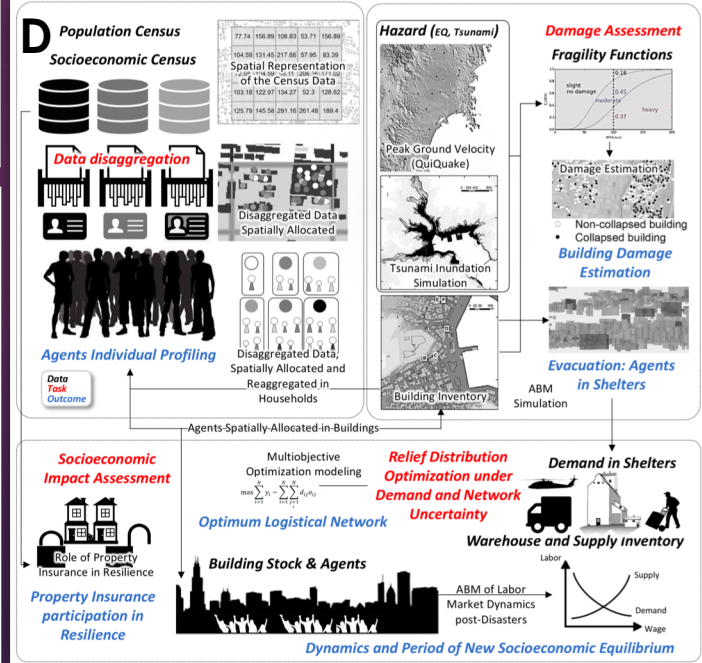
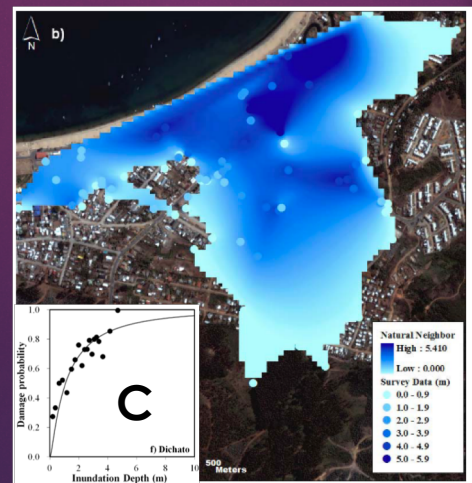
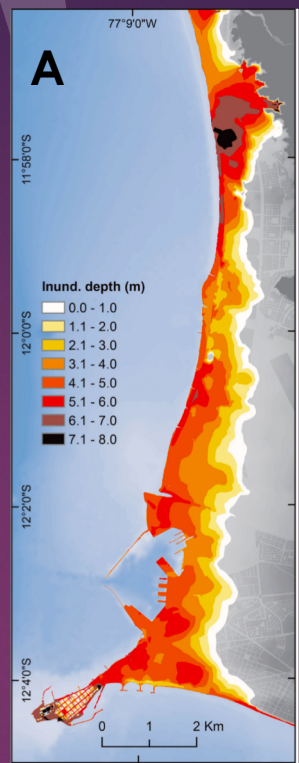
- Bach. Civil Engineering (UNI, Peru)
- MSc. Disaster Risk Management (UNI, Peru)
- PhD. Tsunami Engineering (Tohoku Univ.)
- 5 years Working experience in Disaster Management for Regional Government in Peru

Research Interests

- A. Tsunami modeling
- B. Tsunami evacuation simulation
- C. Damage assessment
- D. Disaster cycle simulation

Research Methods

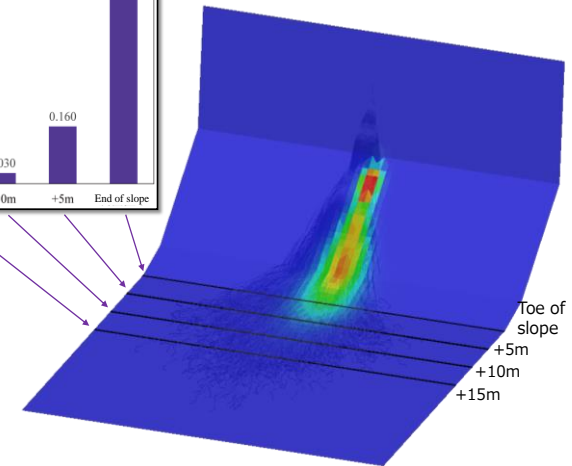
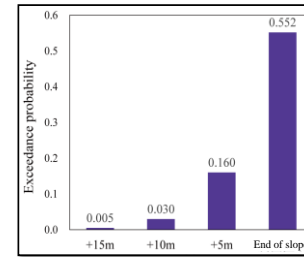
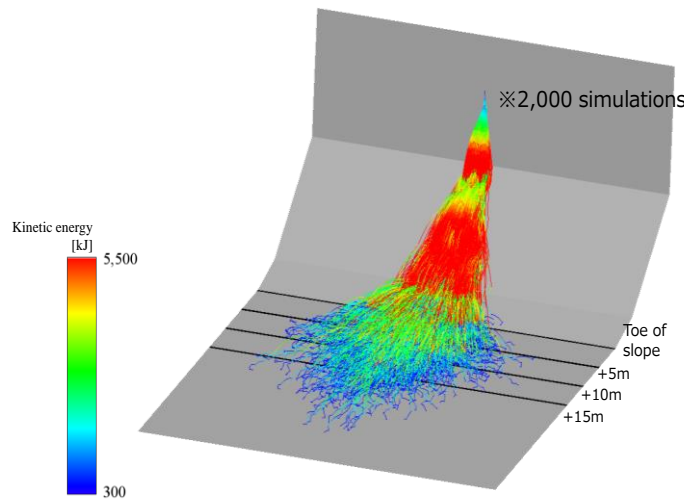
- Numerical Simulation
- Agent-based simulation
- GIS Analysis



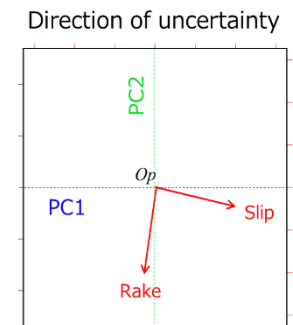
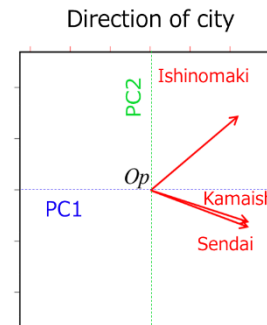
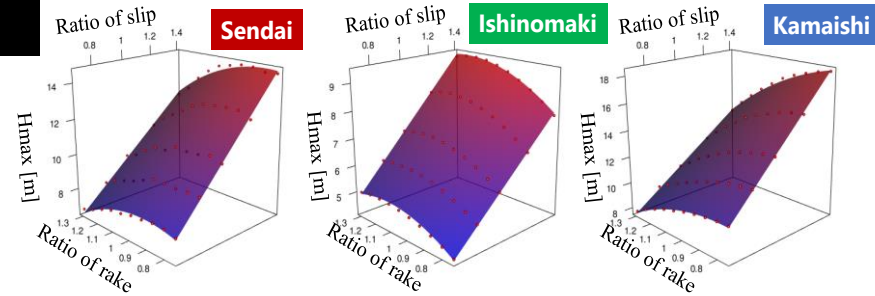
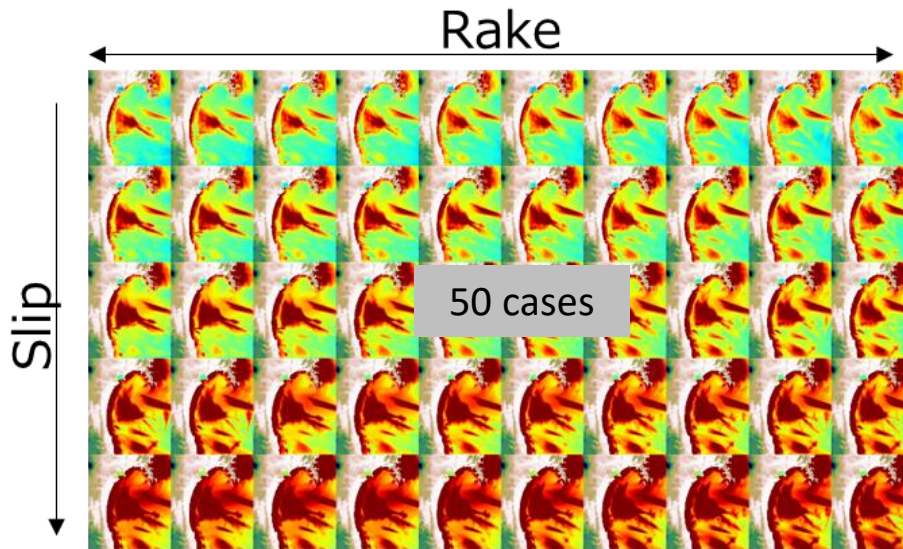
Simulation-based disaster risk analysis using data science techniques

Shuji Moriguchi, Kenjiro Terada, Hasuka Kanno and Kenta Tozato

Rockfall risk analysis using GMM (Gaussian Mixture Model)



Tsunami risk analysis using PCA (Principal Component Analysis)





Advisory Board – 30+
Examples:

- Public (BLM, USDA FS, DNR...)
- RS Industry (Quantum...)
- Private (Weyerhaeuser...)
- Non-profit (TNC, Forterra...)

PFC Affiliates 10+
Examples:

- H-E.Andersen, B. McGaughey, J. Strunk – PNW USDS Forest Service
- A. Hudak – USDA Forest service
- C. Turgenson, A. Johnston – USGS
- J. Lutz – Utah State

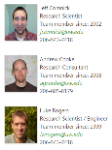
0.5 PFC FTE
Administrative
Specialist – Megan
O’Shea

0 PFC FTE
RS Research
Specialists/Scientists –
Dr. Meghan Halabisky &
Jonathan Kane

1 PFC FTE
Remote Sensing &
Geospatial Analysis
Lab – RSGAL
Dr. L. M. Moskal +8



Natural Resource
Spatial Informatics
Group – NRSIG
L. Rogers 3



1 PFC FTE
Spatial Optimization
Lab – SOL
Dr. S. Toth +5



0.05 PFC FTE (Teaching)
Forest Resilience
Lab – FRL
Dr. V. Kane +7



Mike Motley

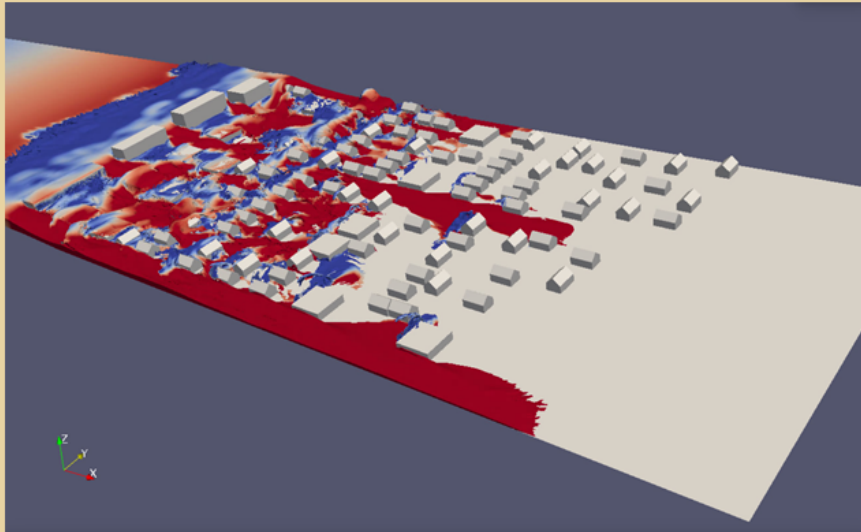


University of Washington

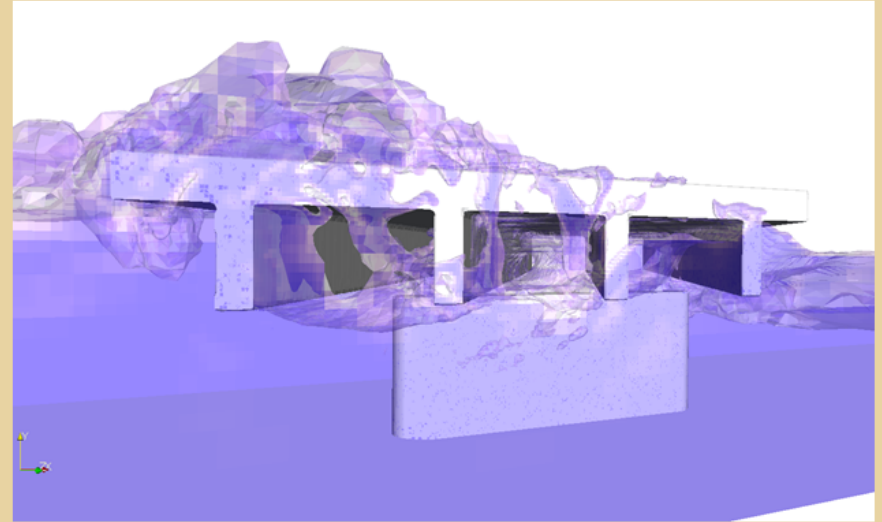
Email: mrmotley@uw.edu

Web: <https://www.ce.washington.edu>

Community-Scale Inundation and Force



Structure-Scale Force Prediction





Luis Moya H.

lmoyah@irides.tohoku.ac.jp

https://www.researchgate.net/profile/Luis_Moya_Huallpa



TOHOKU UNIVERSITY



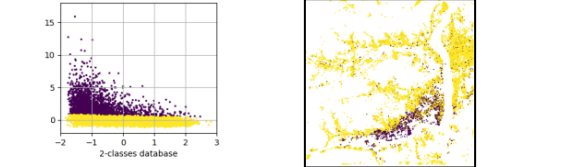
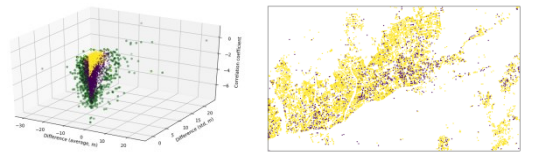
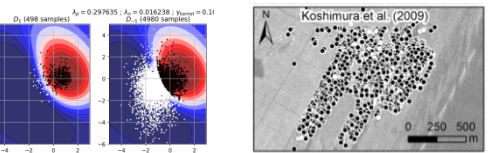
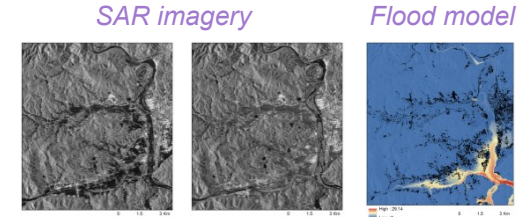
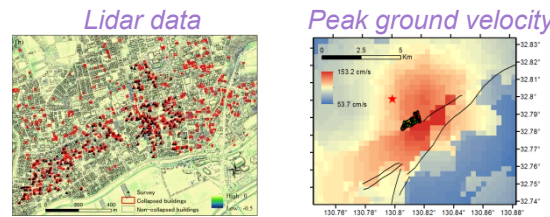
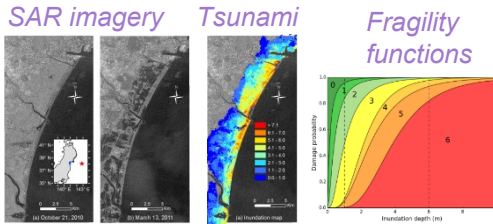
International Research Institute of Disaster Science
災害科学国際研究所

TOHOKU UNIVERSITY

International Research Institute of Disaster Science
Laboratory of Remote Sensing and Geoinformatics for Disaster Management

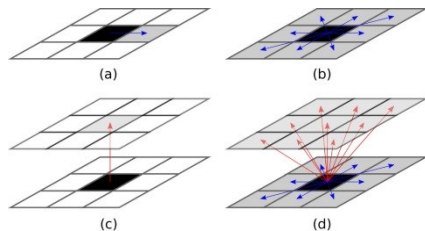
RESEARCH INTERESTS:

- Fusion of earth observation technologies, numerical simulations, hazard and risk analysis

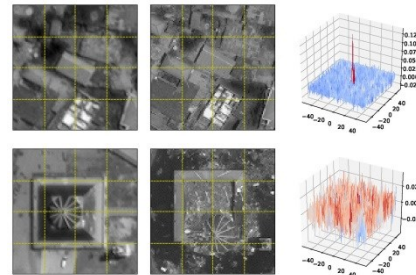


- Image analysis and applied machine learning for disaster mitigation

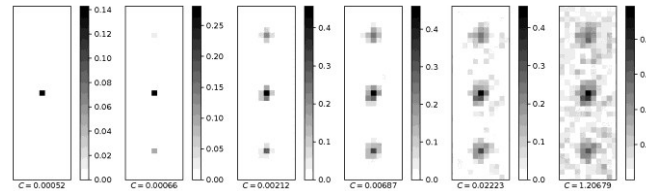
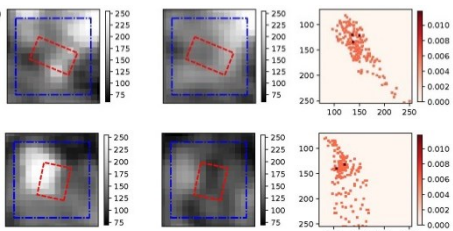
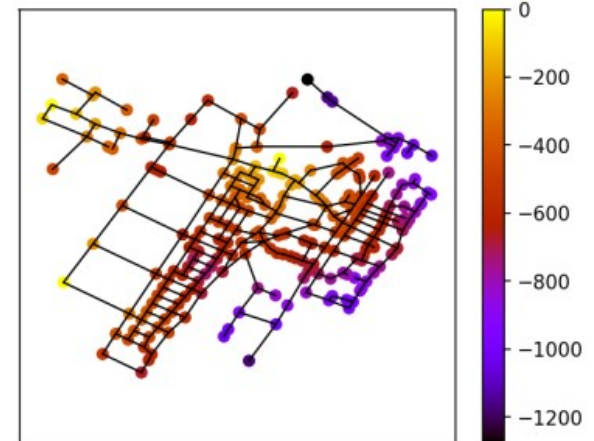
Three-dimensional texture



Statistical learning with sparsity



Reinforcement learning for evacuation



Sparse feature analysis

Lan T. Nguyen
PhD student
Urban Design and
Planning
University of
Washington

Disaster Science Interests

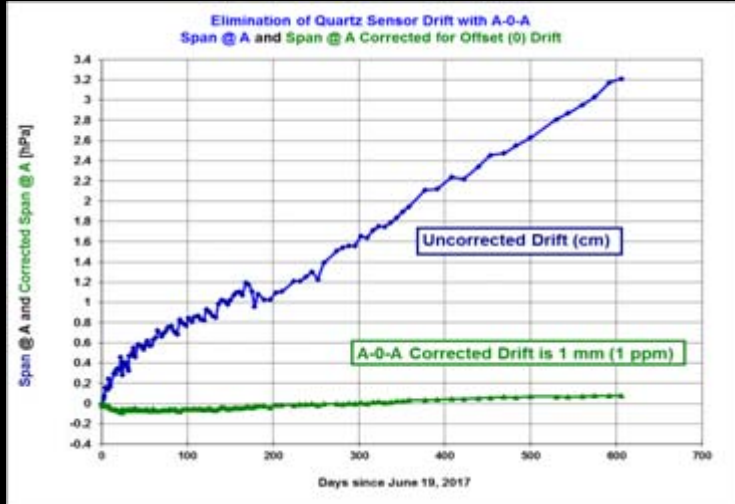
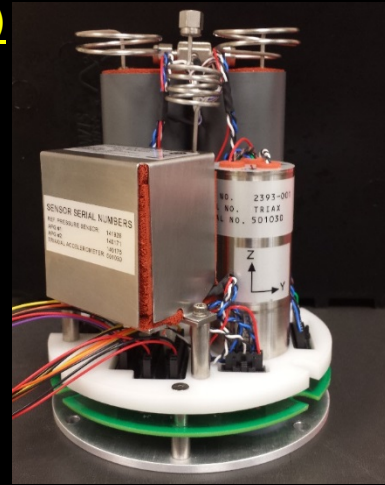
- Community resilience to disasters with a focus on:
 - Measuring disaster preparedness at a community level to understand individual level preparedness
 - Building resilience for and with vulnerable populations
 - Scenario planning for an uncertain future
- Pre- and post-disaster recovery planning including immediate- and long-term recovery operations

Seismic + Oceanic Sensors (SOS)

Earthquake & Tsunami Warnings

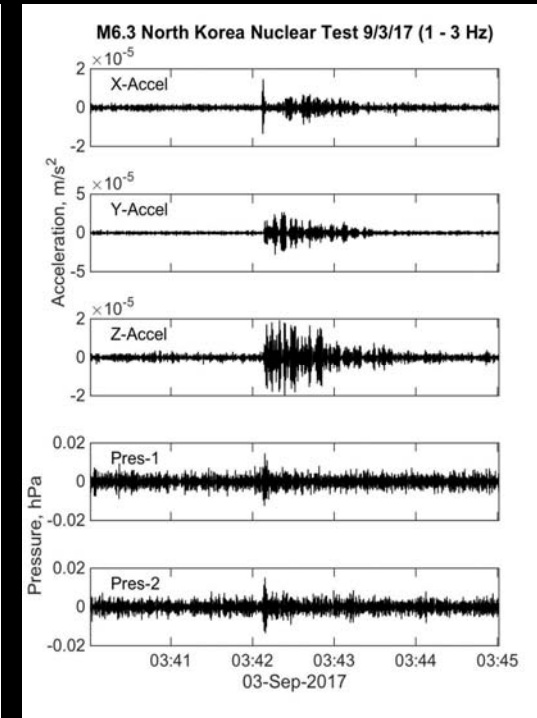
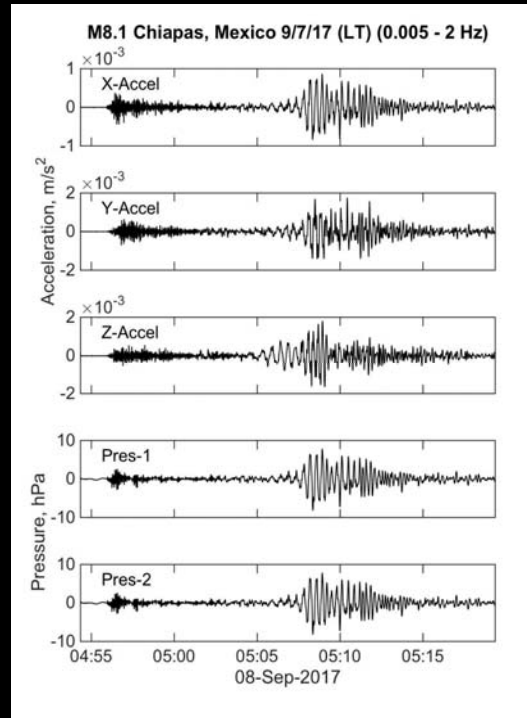
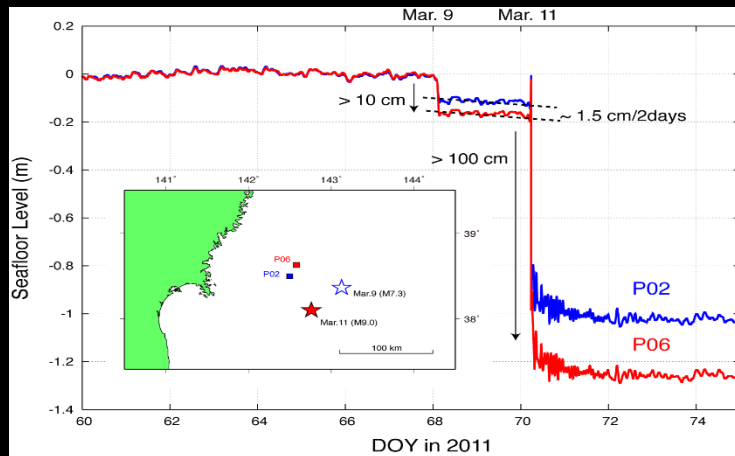
Climate Change (Sea Level Changes)

Geodetic Measurements of Secular Strain



Co-located Seismic – Pressure - Geodesy Measurements

3-9 Precursor to 3-11 Tsunami





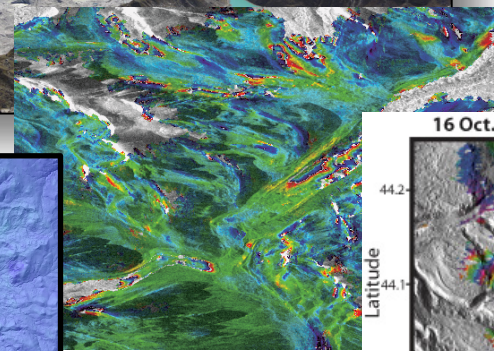
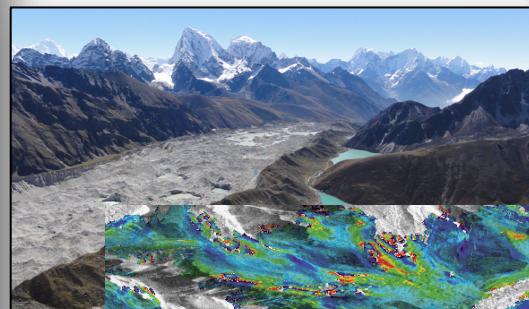
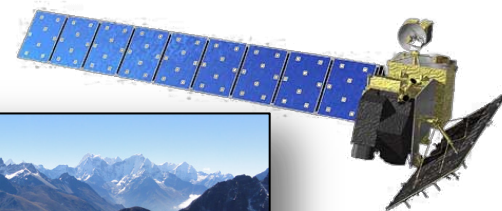
David Schmidt
 Earth and Space Sciences
 University of Washington

- Crustal Deformation
- Satellite Radar
- Seafloor Geodesy
- Subduction Processes
- Natural Hazards

Ground Portable
 Radar Interferometer

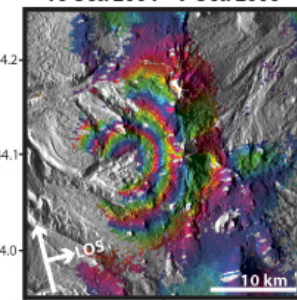


Satellite Radar
 (InSAR)

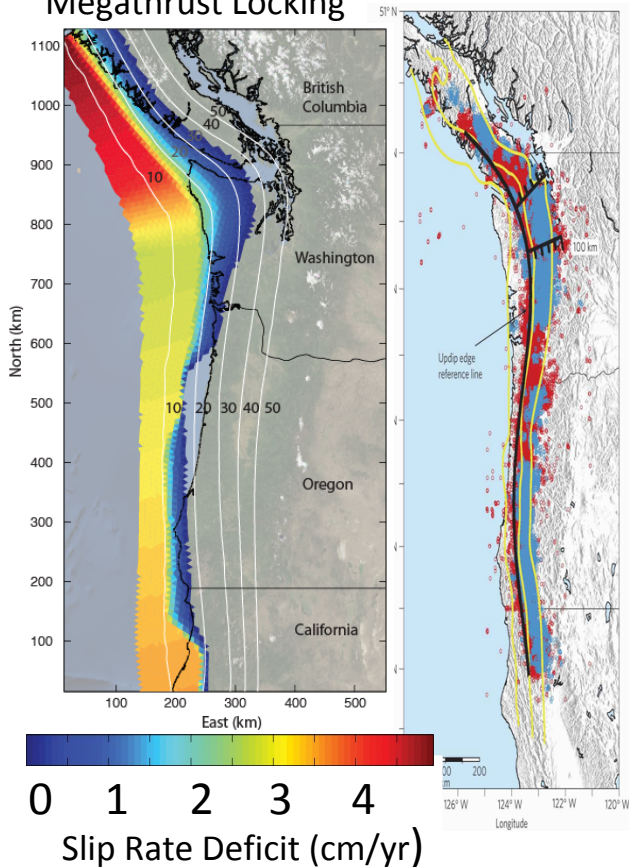


Volcanoes

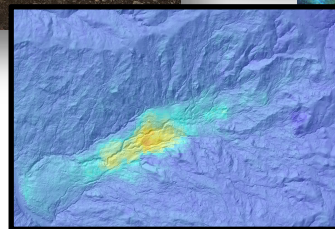
16 Oct. 2004 – 7 Oct. 2000



Megathrust Locking

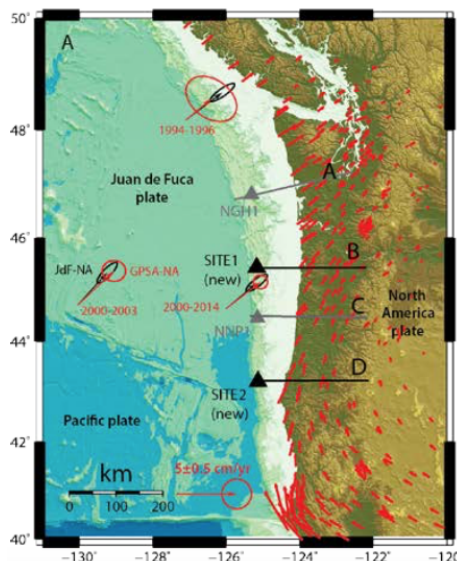


Slow Slip
 & Tremor



Landslides & Glaciers

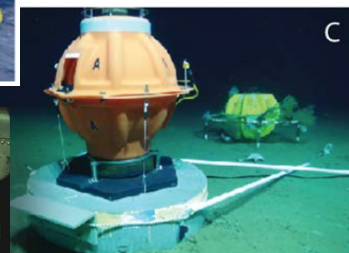
Tectonics



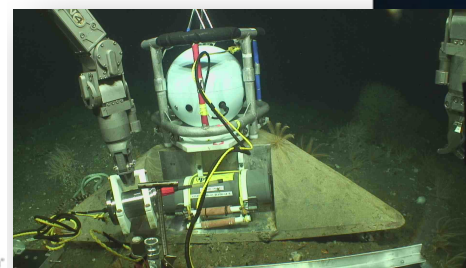
Wave Glider



GPS-A Transponder
 and Benchmark



Seafloor Pressure



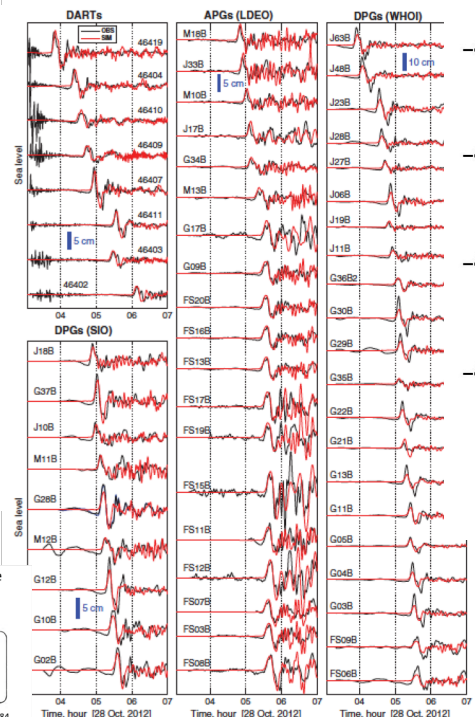
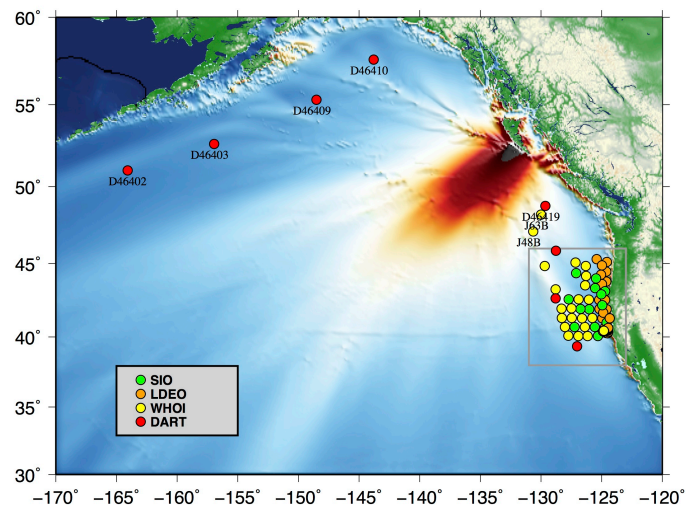


Anne Sheehan
 University of Colorado Boulder, USA
 CIRES and Department of Geological Sciences
 Anne.Sheehan@Colorado.edu



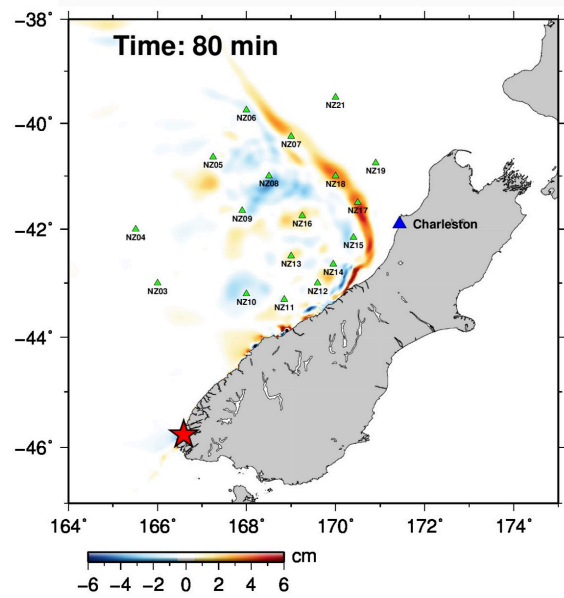
New types of data for
 tsunami data assimilation

Use of pressure gauge data from ocean bottom
 seismic experiments for tsunami studies

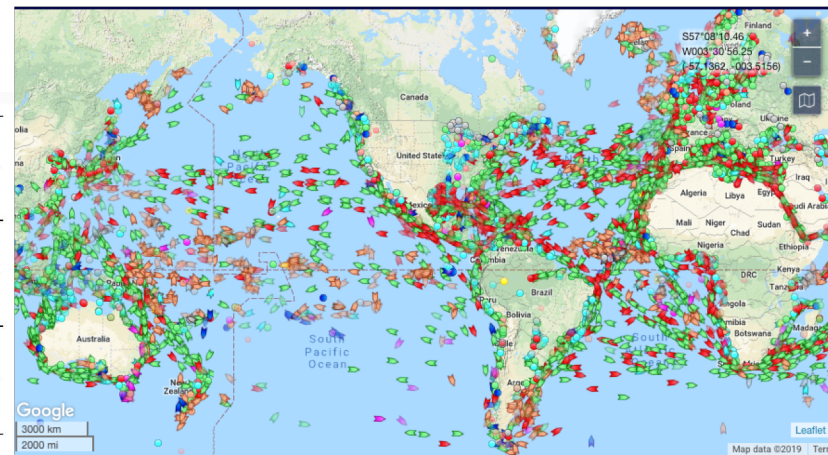


Sheehan et al., SRL, 2015

Tsunami Data assimilation



Maeda et al., GRL, 2015
 Gusman et al., GRL, 2016
 Mulia et al., JGR, 2017
 Sheehan et al., JGR, 2019
 Wang et al., GRL, 2019



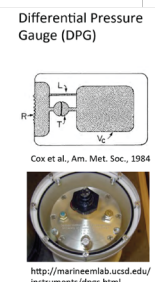
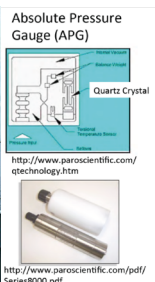
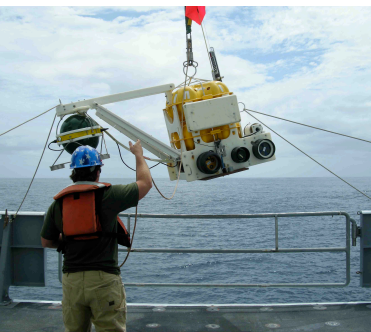
Marinetraffic.com

Improving tsunami warning using commercial ships
 James H. Foster,¹ Benjamin A. Brooks,¹ Dailin Wang,² Glenn S. Carter,¹
 and Mark A. Merrifield¹
 Received 16 February 2012; revised 29 March 2012;

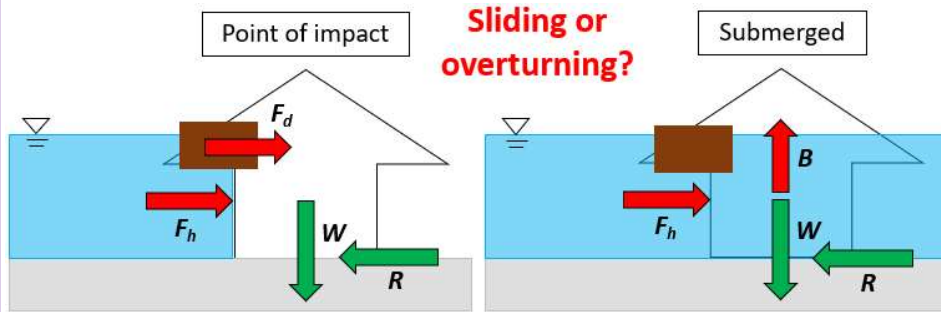
RESEARCH LETTER Open Access

Assessment of GNSS-based height data of multiple ships for measuring and forecasting great tsunamis

Daisuke Inazu¹, Takuji Waseda^{1,2}, Toshiyuki Hibiya^{1,3} and Yusaku Ohta⁴

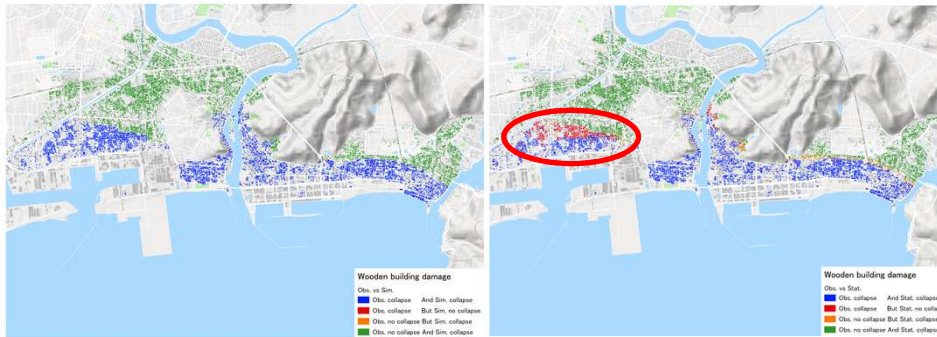


Building damage assessment

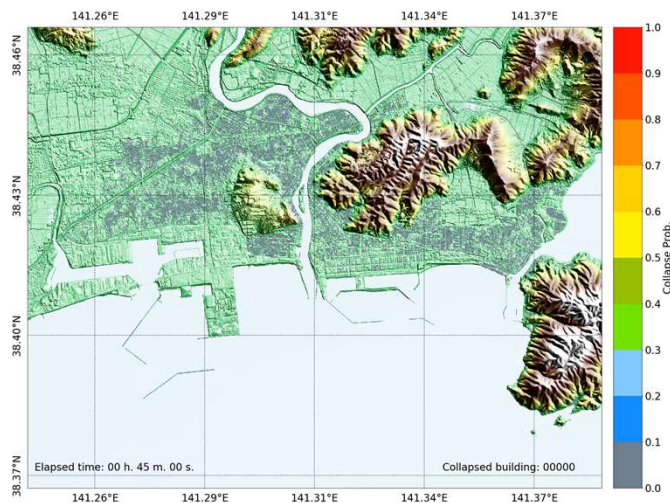


Obs. vs Analytical method

Obs. vs Fragility functions



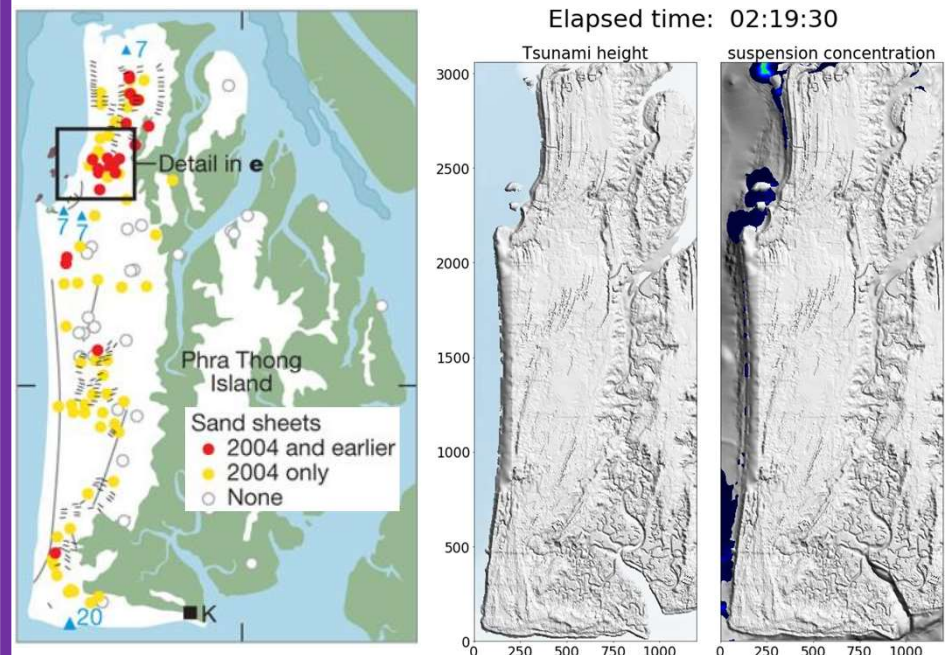
Visualization of the results



Anawat Suppasri,
IRIDeS, Tohoku University

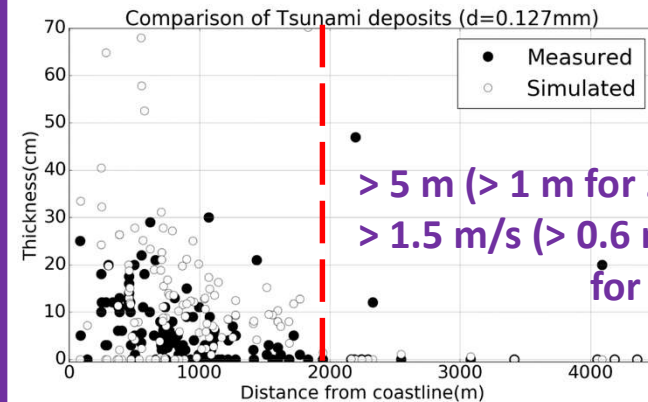


Sediment transport modeling



2004 tsunami deposits

Max. water level
Suspended sediment concentration



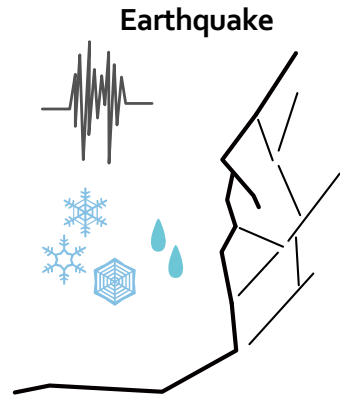
> 5 m (> 1 m for 2011 tsunami)
> 1.5 m/s (> 0.6 m/s for 2011 tsunami)

Multi-stage failure simulations for rock mass failure

Kenjiro Terada, Shuji Moriguchi and Shun Suzuki



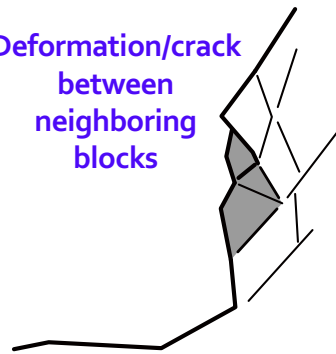
0th Stage



Environmental effect

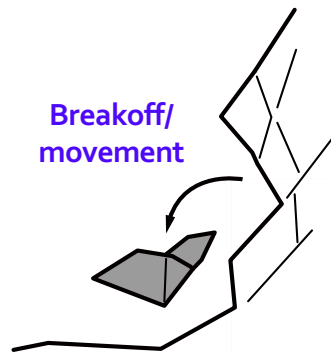
1st Stage

Deformation/crack
between
neighboring
blocks



2nd Stage

Breakoff/
movement

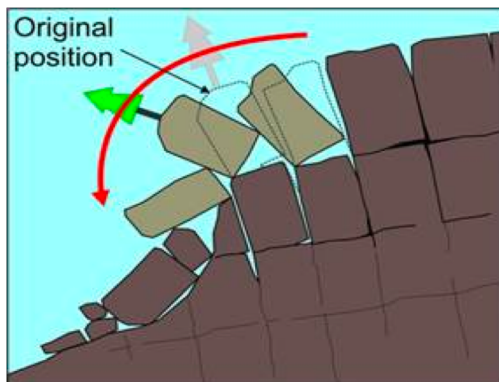
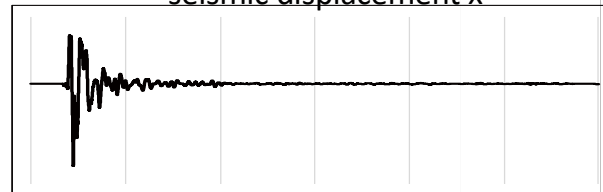


3rd Stage

Impact/contact
and collision

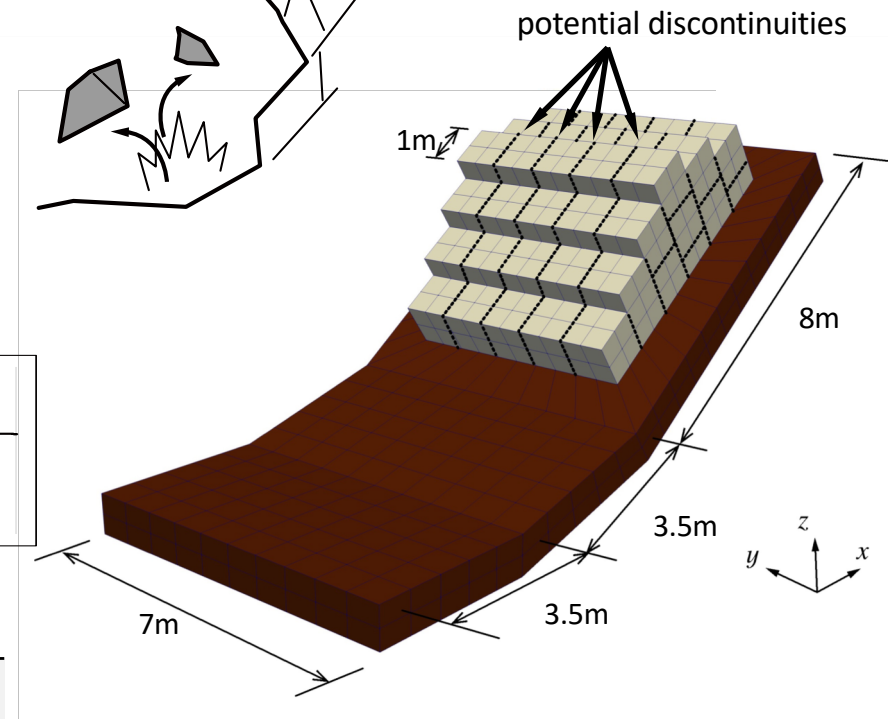


2016 Kumamoto earthquake
seismic displacement x



https://twitter.com/kazue_fgeewara/status/902187310417973248

density	1500
Young modulus [GPa]	1.0
Poisson ratio	0.3
tensile strength [MPa]	0.015
frictional coefficient	0.0



max. principal stress [MPa]
0.0 0.04

5 hours by 32CPUs

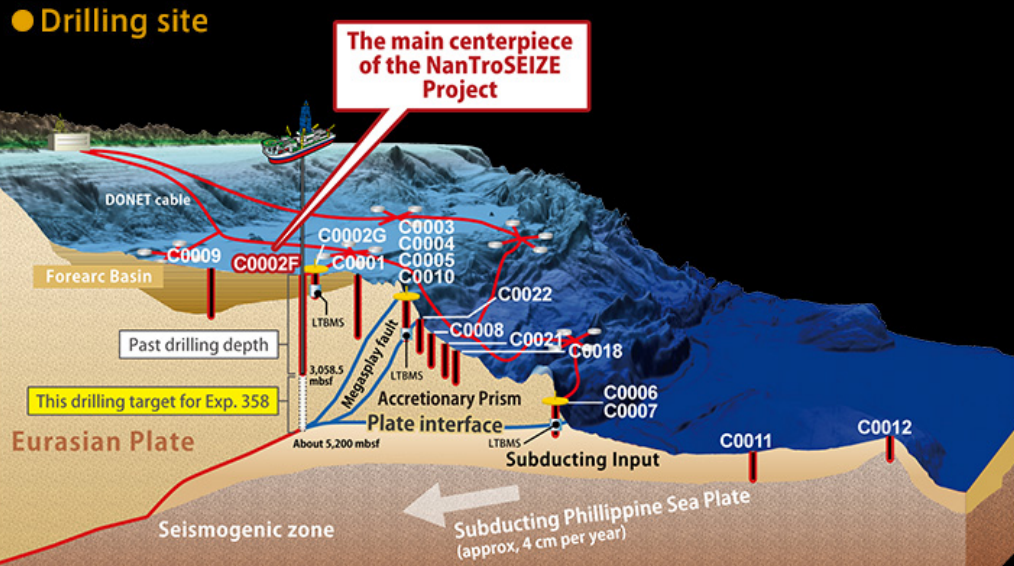
Harold Tobin

University of Washington
Professor of Geophysics
Director - PNSN



Research Interests

- Plate boundary faults:
mechanics, structure, fault physics
- Tectonics of submarine subduction megathrusts and offshore structure
- Leader, NanTroSEIZE Ocean Drilling project at the Nankai Trough, Japan
- Chair, U.S. SZ4D Initiative planning (Subduction Zones in Four Dimensions)





Alejandro URRUTIA alejandro.urrutia@cigiden.cl

Research Engineer, CIGIDEN

Research Interests

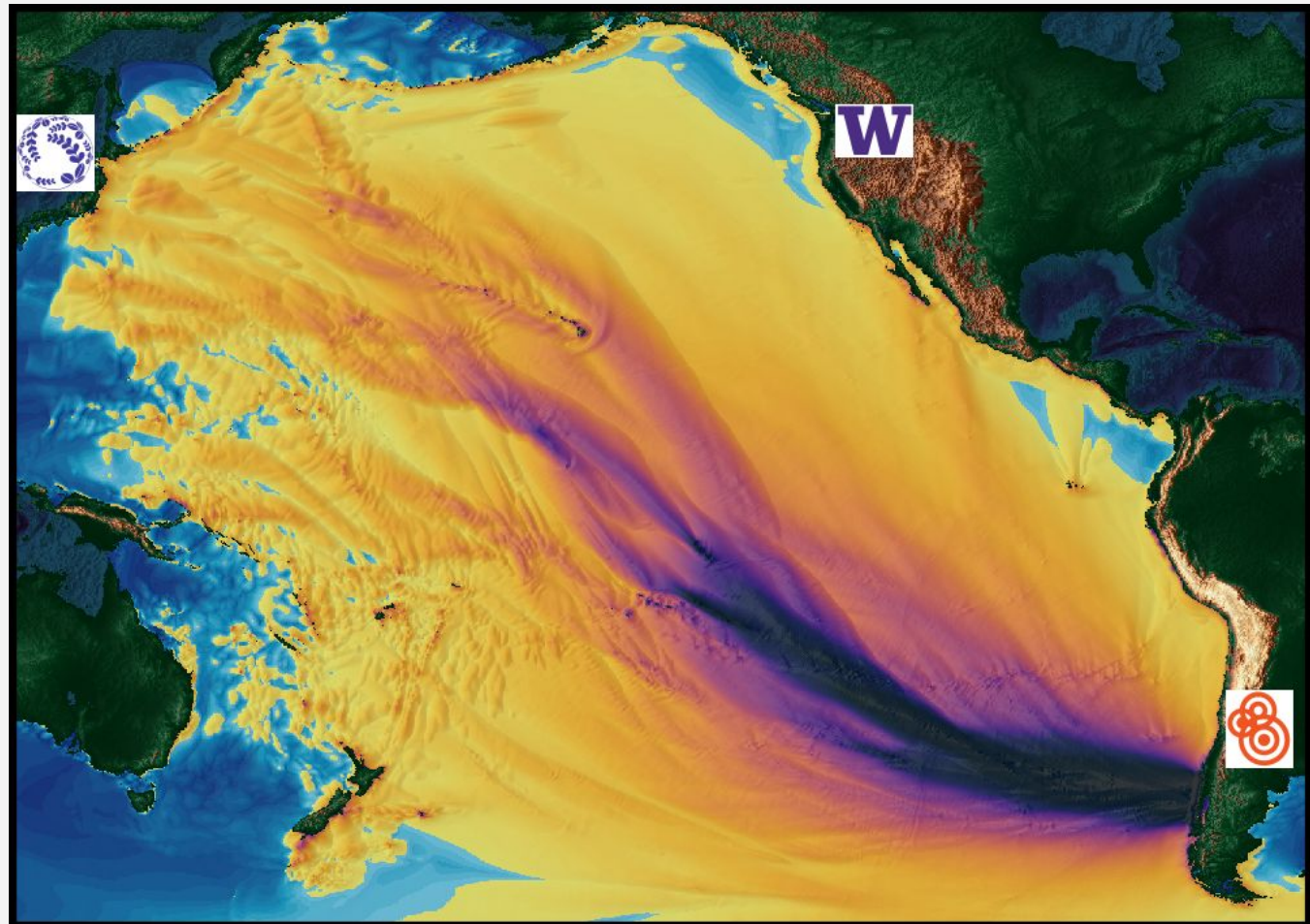
Tsunami modeling

Earthquake simulation

Tsunami early warning

Tsunami evacuation

PTHA with complex subduction ruptures



1960 Mw 9.5

Yuya Yamaguchi

Research associates

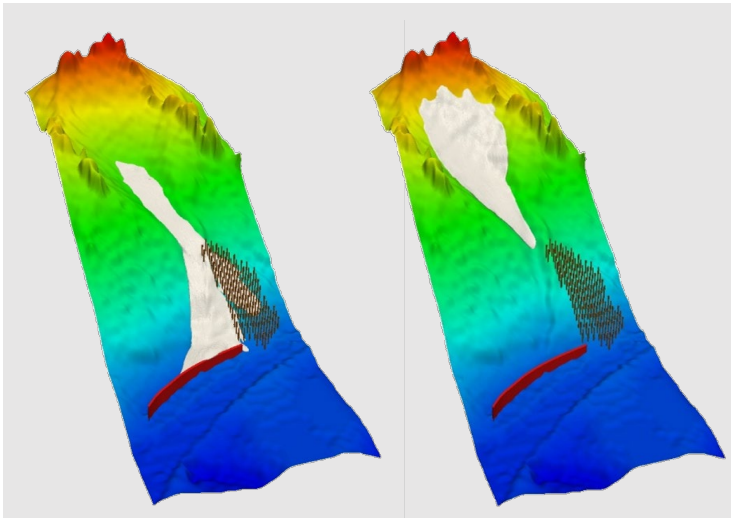
IRIDeS, Tohoku University

yyamaguchi@irides.tohoku.ac.jp

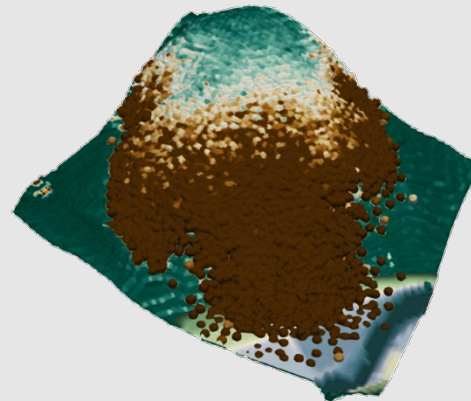


Research interests

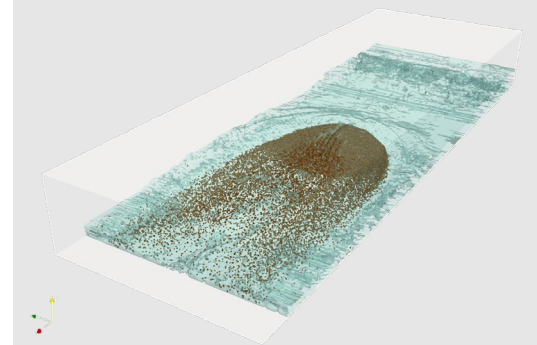
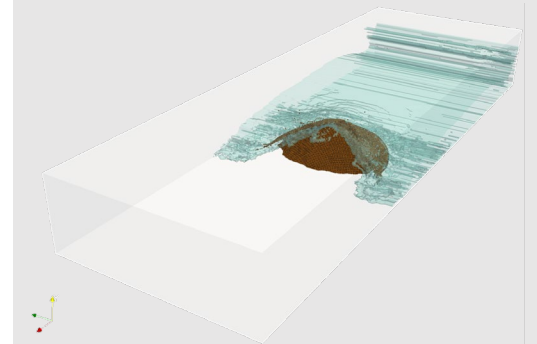
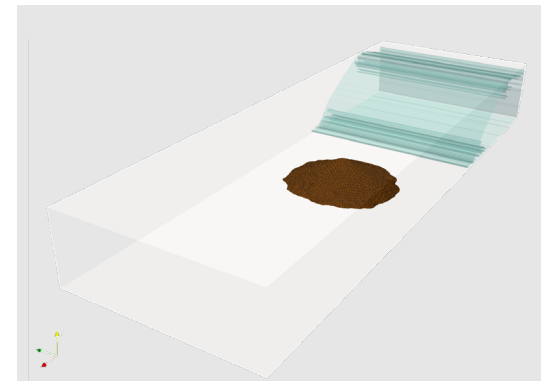
- Simulation of sediment disaster using solid-liquid coupled material point method
- Simulation of snow avalanche using stabilized finite element method



Snow avalanche simulation using FEM



Landslide simulation using material point method



Model experiment of wave collision to sandpile