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Survey Report:

Advances of International Collaboration on M9 Disaster Science: Scientific Session Report

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The goal of the Scientific Session: "Advances of International Collaboration on M9 Disaster Science" at the 2nd World Bosai Forum (WBF) in Sendai in November 2019 was to share progress on research projects and findings related to an M9 mega-disaster event, building on outcomes from a March 2019 collaborative workshop on M9 disaster science between research partners from the International Research Institute of Disaster Science (IRIDeS)/Tohoku University, University of Washington-Seattle (UW), and the Research Center for Integrated Disaster Risk Management (CIGIDEN). This paper reports on the presentations during the WBF Scientific Session, which shared updates and outputs of research collaborations from different disciplines, following the themes of risk-based planning, structural engineering, tsunami observation and early warning, and tsunami simulation and probabilistic tsunami risk assessment. This international and cross-disciplinary collaboration has led to the advancement of a number of specific research projects in different fields, as well as a robust network of researchers in the three countries. Based in coastal regions facing similar risks of massive earthquakes and tsunami in Japan, the United States, and Chile, it is hoped that ongoing and future collaboration within this network will continue to advance knowledge of disaster science and international disaster risk reduction.

Keywords: international research collaboration, M9 Cascadia Earthquake, disaster prevention, earthquake, tsunami

1. Introduction

A megathrust magnitude 9 earthquake on the Cascadia fault, which runs off the western coast of the United States, would cause devastation to the region including intense shaking, liquefaction, and tsunamis. At the University of Washington in Seattle, the multi-year M9 Project brought together a team of experts from multiple disciplines, to reduce catastrophic impacts on the social, built, and natural environments from this Cascadia earthquake through advancing methodologies, early warning, and community planning [1]. Following the M9 Project Final Stakeholders Workshop, the "Project Definition Workshop on M9 Disaster Risk Science" brought together researchers who study potential M9 events on the Cascadia Subduction Zone with potential collaborators having similar interests from Japan and Chile, with the goal of initiating new international collaborations on M9 Disaster Science.

The Scientific Session, "Advances of International Collaboration on M9 Disaster Science: Progress Report" at the World Bosai Forum (WBF) in November 2019 was a follow-up event to share the progress on research projects and findings from these research collaborations between partners from the International Research Institute of Disaster Science (IRIDeS)/Tohoku University in Japan, University of Washington-Seattle (UW) in the United States, and the Research Center for Integrated Disaster Risk Management (CIGIDEN) in Chile. The ongoing collaborations include research on the themes of adaptive planning pre- and post-disaster; Probabilistic Tsunami Hazard Analysis; real-time tsunami inundation and damage forecasts; evaluation of tsunami loads on vertical evacuation structures; simulation-based surrogate models for probabilistic tsunami risk assessment and two-scale tsunami simulation; and robust adaptive planning and anticipatory

action for coastal communities. This paper reports on the presentations during the scientific session in Sendai at the 2nd WBF in November 2019, and the progress and findings from the ongoing collaboration between the research team members from coastal regions with similar risks of massive earthquake and tsunami in Japan, the United States, and Chile.

2. The Previous Project Definition Workshop on M9 Disaster Science

Through advancing methods, modeling and knowledge in the geosciences, engineering, early warning, and community planning, the multi-year M9 Project at the University of Washington in Seattle brought together a team of experts from multiple disciplines, to reduce catastrophic impacts on the social, built, and natural environments from a megathrust magnitude 9 Cascadia earthquake on the west coast of the United States. Immediately following the M9 Project Final Stakeholders Workshop in Seattle on March 12, 2019, the "Project Definition Workshop on M9 Disaster Risk Science" brought together researchers who study potential M9 events in the Cascadia Subduction Zone with potential collaborators having similar interests from IRIDeS in Japan and CIGIDEN in Chile. The goal of the two-day workshop on March 13 and 14 was to initiate new international collaborations on particular aspects of M9 Disaster Science, on topics related to a magnitude 9 subduction zone earthquake and the resulting tsunami and landslides, including scientific, engineering, and community planning aspects.

Researchers separated into the following break-out groups based on their fields and interests:

Group 1: Observations and early warning
Group 2: Remote sensing
Group 3: Planning and risk assessment
Group 4: Tsunami modeling
Group 5: Landslide/rockslide modeling
Group 6: Subduction zone seismology, tsunami sources, PTHA
Group 7: Structural engineering

These groupings functioned as a way to facilitate discussion between international researchers from different countries with shared interests and develop collaborative projects. Participation in these groups was flexible and fluid, leading to collaboration within and across breakout groups.

3. Scientific Session: Advances of International Collaboration on M9 Disaster Science

The "Advances of International Collaboration on M9 Disaster Science: Progress Report" was held on November 12 as a Scientific Session in the 2nd World Bosai Forum, in Sendai, Japan. The session started with opening remarks from Randall J. LeVeque, who provided the context for this event, including an overview of the Project Definition Workshop on M9 Disaster Science in Seattle in March 2019. The following sections explain the contents of the presentations that shared updates and outputs of research collaborations within the themes of risk-based planning, structural engineering, tsunami observations and early warning, and tsunami simulation and probabilistic tsunami risk assessment.

3.1. Risk-Based Planning

Naoko Kuriyama gave the first presentation introducing an international framework for comparing risk-based planning in coastal areas in Japan, the United States, and Chile. Developed by the members of *Group 3: Planning and risk assessment*, the presentation was entitled "Towards a comparative framework of adaptive planning and anticipatory action regimes in Chile, Japan, and the U.S.: an exploration of multiple contexts informing risk-based planning and relocation in coastal areas." This initial background research clarifies the key points regarding multiple contexts of the three countries and provides an outline for future comparative analysis through shared similarities and contrasts. The focal themes included: an introduction of disaster and recovery contexts in the three countries; social contexts in the target areas in the three countries; comparison of the roles of multiple levels of government in non-disaster and recovery phases; and the policy contexts of post-disaster housing support, land use and regulations, and buyouts. Along with the introduction of the case studies from the three countries – Chile, Japan, and Washington State in the United States, relevant experience from Japan during the 2011 Great East Japan Earthquake was also introduced.

Following this overview of the three-country comparison, Daniel Abramson and Lan Nguyen shared their research with Ann Bostrom at the University of Washington working with communities on coastal Washington, in a presentation entitled "Robust Adaptive Plans, using both Gradual and Sudden Coastal Change Scenarios in Washington State: Integrating Sea Level Rise and Tsunami Inundation Models at the Community Level." To contextualize the localization of hazard mitigation planning and integration of hazards into comprehensive planning, they first explained how comprehensive plans articulate the long-term vision of a community and are intended to guide day-to-day decisions of elected officials and planners. They noted that although hazard mitigation planning is required by FEMA to qualify for non-emergency disaster assistance, hazards are not incorporated into comprehensive planning. They explored approaching community planning based on the research questions: What kinds of robust adaptive strategies are applicable to multiple hazard scenarios? What kinds of robust adaptive strategies can also promote on-going community development goals? What conflicts exist between mitigation and

community development goals? Experience with coastal communities in Washington suggests that robust adaptive plans for multiple time scales: involve values-driven, asset-based participatory planning for both gradual and sudden hazards; include robust land-use strategies in comprehensive plans to address multiple, low- to high-severity hazard scenarios; go beyond a focus on only very severe (but low-probability) existential threats and the limited set of strategies appropriate only to those threats; respect community identity; and reduce precarity and vulnerability across the community.

Sharing the experiences from Chile, Jorge León's presentation "Chile after the 2010 earthquake and tsunami: reconstruction efforts and paths to the future," explained what happened during and after the second-largest earthquake in Chile's history. Before 2010, tsunami hazards were not included in national- or local-level planning schemes and policies. Tsunami flood maps had been developed in 1997 by the Chilean Navy, but there was no integrated system for planning, regulation, and management for coastal areas, and municipalities designated land use through zoning plans, which may or may not include protection and hazard zones. Planning schemes lacked a clear definition of exposure and assessment of "risk" and its mainstreaming into planning policies.

In 2011, national-level planning and building schemes were updated to include tsunami flood zones as risk areas in Chile; 42 municipalities required to either update or modify their local planning schemes were supported by private consultants and universities. Tsunami impact mitigation policies and actions proposed in these plans included: new or updated tsunami flood maps; evacuation systems (training, routes, and shelters); "anti-tsunami" infrastructure and housing; local planning schemes regarding tsunami-resistant construction standards; tsunami risk zoning and land-use restrictions; relocation of housing and critical infrastructure; vertical evacuation; and mandatory insurance in tsunami risk zones.

As the reconstructions plans were non-binding and served only as a reference, planning schemes for reconstruction varied greatly across municipalities. Reconstruction processes focused strongly on housing; evacuation strategies focused on education and training without updating the required infrastructure. There was no standardized definition of "risk" and assessment mechanisms, or method for tsunami flood maps. The definition of tsunami-risk areas did not lead to general land-use restrictions and mandatory relocation. Local governments had limited financial autonomy, coordination, and professional resources to implement the plans, and it was difficult to modify pre-2010 landownership patterns even within tsunami-flooded areas.

Paths to address future issues include the needs to bridge existing gaps between science, planning policies, and the community; mainstream a clear definition of the "risk" concept (and methods to assess and operationalize it) into local and national planning schemes; improve public participation in planning processes; develop clear processes for the relocation of housing and critical infrastructure, including mechanisms and funds for expropriation; and modify planning schemes to encompass a range of mandatory actions for supporting the disaster management process of mitigation, response, and recovery.

3.2. Structural Engineering

Addressing the theme of *Group 7: Structural Engineering*, Michael Motley's presentation, "Experimental and numerical evaluation of tsunami loads on vertical evacuation structures," explained work on multi-scale modeling of tsunami forces, community-scale inundation and force prediction structure-scale force prediction, and wave-induced debris impact.

Detailed structural models provided insight into the dynamic fluid forces that a vertical evacuation structure may experience to permit capacity analysis. Models require extensive validation for acceptance in the engineering community, but data is often insufficient. Collaborative discussions stressed the need for proper benchmark testing and data sharing.

3.3. Tsunami Observations and Early Warning

Members of *Group 1: Observations and early warning* gave several presentations related to tsunami early warning and prediction in Japan and Chile. Patricio Catalan was not able to join in person but contributed with a prerecorded presentation "Incorporating PTHA methods in a tsunami early warning system," dealing with the topic in Chile, supported in person by Jorge León.

The earthquakes and tsunamis of 2010, 2014, and 2015 in Chile have prompted a new tsunami warning system, now operational since 2016, with a modular design that allows for the incorporation of new research and methods. Owing to the short arrival times, precomputed scenarios are to be used for the first hazard assessment, but later updates will be based on near real-time models as a way to improve the forecast and constrain the duration of evacuation. One of the areas of development is to account for epistemic uncertainty in tsunami source models in these near real-time hazard assessments, which can have a large effect on inundation estimates.

Shunichi Koshimura's presentation entitled "Advances of real-time tsunami inundation and damage forecast – present and future" aimed to provide some background discussion of real-time tsunami inundation forecasting and discussed future perspectives for enhancing the use of real-time tsunami inundation forecasting information.

Learning lessons from the 2011 Great East Japan Earthquake and Tsunami disaster, a novel real-time tsunami inundation and damage forecast system was developed in 2017 and the system has been under operation as a function of the emergency response of the Cabinet Office of Japan since 2018. The forecast system consists of tsunami source modeling, propagation and inundation simulation, and damage mapping with a High-Performance Computing Infrastructure. The target is the tsunamigenic earthquakes that occur along the Nankai Trough and in its vicinity. Especially, the target of most concern is the

Nankai Trough earthquake, which is estimated to occur in the next 30 years with an 80% probability based on the long-term evaluation of seismic activity in Japan.

3.4. Tsunami Simulation and Probabilistic Tsunami Risk Assessment

The final presentation by Kenjiro Terada and Shuji Moriguchi shared several ongoing research projects involving collaborations between members from multiple break-out groups including *Group 4: Tsunami modeling*, *Group 5: Landslide/rockslide modeling*, *Group 6: Subduction zone seismology, tsunami sources, PTHA*, and *Group 7: Structural engineering*. First as a summary, in the presentation "Simulation-based surrogate model for probabilistic tsunami risk assessment and two-scale tsunami simulation," they outlined several ongoing research projects in progress and related outputs, on the themes of PTHA [2], landslide modeling [3], and tsunami modeling [4].

The first part of this presentation, entitled 'Probabilistic tsunami hazard assessment with simulation-based response surface (RS), pursued the objective to 'optimize the locations of important systems to minimize tsunami damage.' Combining numerical simulation and probabilistic risk analysis, a framework was developed for correlation analysis of tsunami risk for multiple coastal cities by 1) evaluating the tsunami risk in each coastal city, and 2) evaluating risk correlation among multiple cities. This framework was then applied to a tsunami risk evaluation assuming the occurrence of the 2011 Tohoku earthquake, targeting the cities of Sendai, Ishinomaki, and Kamaishi. Part of this study has been published in the journal Coastal Engineering [2]. It presents the proposed method, which quantifies uncertainties in key simulation variables and propagates those uncertainties to the target output through the RS in a computationally efficient Monte Carlo simulation (MCS). The proposed method enabled the estimation of coastal tsunami heights while considering uncertainties in the fault slip and rake as well as the modeling error associated with the numerical simulation. Also, the MCS allowed the estimation of the probability density functions of the tsunami height at the target locations and the quantification of the contribution of each source of uncertainty to the overall uncertainty in the target output and thus facilitates engineering decision-making. Future work for this research aims towards the validation of the proposed framework with a larger number of target cities, and uncertainties.

In the second part of the presentation, "Solid-liquid coupled material point method (MPM) for simulation of ground collapse," Shuji Moriguchi shared the progress of another research collaboration on ground collapse related to progressive failures, deep-seated landslides, predictive simulation for sediment disaster, and dike collapse by water flow. More specifically, an improved version of the solid-liquid coupled material point method was proposed to simulate ground collapses with fluidization involving transition processes from soil structures to flowing mixture [3]. A water-saturated soil was assumed based on porous media theory and the physical quantities of the soil and water phases were assigned to two separate sets of material points. The main contribution of this study emphasized the introduction of the fractional-step projection method for the time-discretization of the momentum equation of the water phase on the assumption of incompressibility. Because of this feature, the proposed solid-liquid coupled MPM was capable of suppressing the pressure oscillations caused by the weak incompressibility of water and of representing the wide range of behavior of the soil-water mixture at a relatively low computational cost. Several numerical tests were presented to demonstrate the performance of the proposed method and the capability of reproducing a model experiment of wave collision to sandpile that exhibits the water flow-induced fluidization process of soil involving scouring, transportation, and sedimentation.

Finally, ongoing collaborative research on a method for determining the drag parameter on the 2D shallow water (SW) equation for flows through a coastal forest by conducting a series of 3D direct numerical simulations (3D DNSs) [4] was briefly summarized. Following multiscale modeling theory, a procedure for the evaluation method was proposed. A local test domain that contains a sufficient number of trees to constitute a part of a coastal forest was first prepared. Then 3D DNSs were conducted in the test domain with various inflow conditions. Based on each of the numerical results, the momentum losses over the test domain were converted into the drag parameter for the global SW equation. A response surface for the drag parameter was then constructed as a function of the flow conditions. The stabilized finite element method was adopted for both the local and global numerical simulations; the phase-field method was a tool to represent 3D free surfaces. Comparisons between the 2D SW calculation results and the 3D DNS results were also performed to verify the validity of the proposed method.

4. Deepening Research Collaboration During the 2019 World Bosai Forum

Along with their participation in the Scientific Session, research collaborators from the United States and Chile joined Japanese counterparts and participated in various sessions and activities during the 2019 WBF in Sendai. These included: events with the local community for disaster education training; the WBF Poster session, and participation in the 12th AIWEST-DR (Aceh International Workshop on Sustainable Tsunami Disaster Recovery) academic conference at IRIDeS. Held as a WBF Related Event, with the theme of "Sharing Tohoku-Aceh Experience, Knowledge and Culture," several members presented their research findings and ongoing progress in international research during AIWEST-DR 2019, deepening knowledge of not only Japan's experience, but also learning from colleagues from Indonesia and other countries.

Participants also joined a two-day field study tour of

tsunami-affected areas, learning about disaster evacuation, education, memorialization, infrastructure reconstruction, and community recovery by observing the local situation directly. Several members also joined an additional research meeting and tour focusing on the ongoing recovery in Fukushima. Through both formal and informal discussions during these activities, researchers had many opportunities to exchange ideas and opinions, discuss research and develop and advance current and future collaborations.

4.1. Tsunami Deposits and Modeling

Connected by the Pacific Rim of Fire, Japan and the west coast of the Americas are linked through the shared history of past tsunamis and informed by knowledge from the records and investigation of tsunami events in each country. During the WBF poster session, Carrie Garrison-Laney gave a presentation entitled "Using tsunami deposits and modeling to study tsunami history and sources in Washington State, USA." Although Washington State has many tsunami sources, including the Cascadia subduction zone, shallow faults that cross waterways, submarine, and subaerial landslides, and distant source trans-Pacific tsunamis, Washington has experienced very few tsunamis in the last 150 years. Assessments of future tsunami size and frequency must rely on the study of paleotsunami deposits and the modeling of tsunami flow and sediment transport. There are at least nine distinct tsunami deposits spanning the last 2,500 years in the marsh deposits at Discovery Bay along the Strait of Juan de Fuca. Some of these deposits are inferred to be from Cascadia earthquakes, including the most recent 1700 CE event, but the number of deposits suggest other tsunami sources are recorded as well. Tsunami deposits can be used to provide estimates of tsunami inundation extent, flow depths, and current velocities, which can be compared to output from tsunami inundation and sediment transport models.

Currently, the Tohoku University sediment transport model is being applied to explain the sediment process of the 1964 Alaska Tsunami in Discovery Bay. Results fit well with the surveyed tsunami deposits and additional insights on deposition and sedimentation in Discovery Bay. There are plans to test other tsunami sources in order to explain the sources of the many identified the surveyed tsunami deposits in Discovery Bay, tsunami flow parameters will be modeled based on tsunami sediment characteristics.

4.2. Tsunami Evacuation Models

Following the two-day workshop on March 13 and 14, an active collaboration between researchers from Chile and Japan was initiated for the development of calibration methods for tsunami evacuation models using real-world data collected from mobile call detail records. Preliminary results from this study were presented at the 12th AIWEST-DR held in Sendai as a side event to the WBF [5, 6].

Here, a case study of an evacuation at La Serena, Chile was simulated using agent-based modeling and compared to the mobile records of population movement from hazard to safe areas. This research collaboration team plans to expand and continue evaluating other areas in Chile, Japan, and the United States, based on data availability, to provide effective feedback to the models. These studies will enhance the accuracy of evacuation simulation tools to aid disaster management, increase tsunami awareness, and help the team design better evacuation plans with adequate evacuees' behaviors in order to reduce tsunami fatalities.

5. Conclusion and Future Directions

The Scientific Session on Advances in M9 Disaster Science at the 2019 WBF shared the progress in ongoing research collaborations between members from Japan, the U.S., and Chile, which grew out of the March 2019 Project Definition Workshop on M9 Disaster Risk Science in Seattle. This international and cross-disciplinary collaboration has led to the advancement of a number of specific research projects in different fields. It also has contributed to building a robust network of researchers in the three countries, and created opportunities for students, researchers, and faculty to deepen their knowledge and learn from each other.

These research collaborations have also led to plans for future international collaborative research on data assimilation for tsunami forecasting with sparse networks; planning and risk assessment; comparisons of earthquake early warning perceptions; subduction zones and stochastic tsunami sources; response-surface-based probabilistic tsunami hazard assessment with extensive use of numerical simulations; tsunami test problems and benchmarks; data sharing; modeling sediment transport during tsunamis; and studying the effect of coastal forests on tsunamis. Meaningful collaborations were developed between researchers from multiple disciplines in Japan and Chile and those who study potential M9 events on the Cascadia Subduction Zone in the United States. Through shared experiences in the three countries, connected across the Pacific Rim of Fire, we face the risks of a M9 event in Cascadia in the U.S. or an earthquake/tsunami mega disaster in Chile or Japan. It is hoped that ongoing and future collaborations within this international network will continue to advance and lead to not only increased knowledge and understanding of disasters but also to concrete contributions to disaster risk reduction within and beyond our three countries.

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Selected Publications:
• A. Bostrom, A. L. Hayes, and K. M. Crosman, "Efficacy, Action, and Support for Reducing Climate Change Risks," Risk Analysis, Vol.39, No.4, pp. 805-828, doi: 10.1111/risa.13210, 2019.
• P. T. Dunn, A. Y. E. Ahn, A. Bostrom, and J. E. Vidale, "Perceptions of earthquake early warnings on the U.S. West Coast," Int. J. of Disaster Risk Reduction, Vol.20, pp. 112-122, 2016.

Academic Societies & Scientific Organizations:
• American Association for the Advancement of Science (AAAS)
• Association for Public Policy Analysis and Management (APPAM)
• Society for Judgment and Decision Making (SJDM)
• Society for Risk Analysis (SRA)

Name:
Jorge León

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Professor, Departamento de Arquitectura, Universidad Técnica Federico Santa María

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Brief Career:
2002 Received B.S. degree from the Universidad Santa María
2015 Received Ph.D. degree in Architecture and Urban Planning from the University of Melbourne
2015- Professor, Departamento de Arquitectura, Universidad Técnica Federico Santa María
2015- Associate Researcher, Research Center for Integrated Disaster Risk Management (CIGIDEN)

Selected Publications:
• J. León, S. Castro, C. Mokrani, and A. Gubler, "Tsunami evacuation analysis in the urban built environment: a multi-scale perspective through two modeling approaches in Viña del Mar, Chile," Coastal Engineering J., Vol.62, No.3, pp. 389-404, doi: 10.1080/21664250.2020.1738073, 2020.
• J. León and A. March, "Urban morphology as a tool for supporting tsunami rapid resilience: A case study of Talcahuano, Chile," Habitat Int., Vol.43, pp. 250-262, 2014.
• Research interests are related to populations' responses to rapid onset disasters like tsunamis and wildfires, and the role played by urban forms in these processes

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Michael Motley

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Brief Career:
2011-2012 Postdoctoral Fellow, Department of Naval Architecture and Marine Engineering, University of Michigan
2012-2018 Assistant Professor, Department of Civil and Environmental Engineering, University of Washington
2018- Associate Professor, Department of Civil and Environmental Engineering, University of Washington

Selected Publications:
• A. O. Winter, M. S. Alam, K. Shekhar, M. R. Motley, M. O. Eberhard, A. R. Barbosa, P. Lomonaco, P. Arduino, and D. T. Cox, "Tsunami-Like Wave Forces on an Elevated Coastal Structure: Effects of Flow Shielding and Channeling," J. of Waterway, Port, Coastal, and Ocean Engineering, Vol.146, No.4, 2020.
• X. Qin, M. R. Motley, and N. A. Marafi, "Three-Dimensional Modeling of Tsunami Forces on Coastal Communities," Coastal Engineering, Vol.140, pp. 43-59, 2018.
• A. O. Winter, M. R. Motley, and M. O. Eberhard, "Tsunami-like Wave Loading of Individual Bridge Components," J. of Bridge Engineering, Vol.23, No.2, 04017137, 2018.

Academic Societies & Scientific Organizations:
• American Society of Civil Engineers (ASCE)

Name:
Patricio A. Catalan

Affiliation:
Professor, Departamento de Obras Civiles, Universidad Técnica Federico Santa María

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Brief Career:
1997 Received the B.S. degree from the Universidad Santa María
2001- Professor, Departamento de Obras Civiles, Universidad Santa María
2005 M.Oc.E. degree in Civil Engineering from Oregon State University
2008 Ph.D. degrees in Civil Engineering from Oregon State University
2012- Associate Researcher, Research Center for Integrated Disaster Risk Management (CIGIDEN)

Selected Publications:
• "What Can We Do to Forecast Tsunami Hazards in the Near Field Given Large Epistemic Uncertainty in Rapid Seismic Source Inversions?" Geophys. Res. Lett, Vol.45, No.10, pp. 4944-4955, doi: 10.1029/2018GL076998, 2018.
• "Design and operational implementation of the integrated tsunami forecast and warning system in Chile (SIPAT)," Coastal Engineering J., Vol.62, No.3, pp. 373-388, doi: 10.1080/21664250.2020.1727402
• Research interests are related to tsunamis in several aspects, from the fundamental hydrodynamics, to the development of TWS and mitigation strategies

Academic Societies & Scientific Organizations:
• American Geophysical Union (AGU)
• Sociedad Chilena de Ingenieria Hidraulica (SOCHID)

Name:
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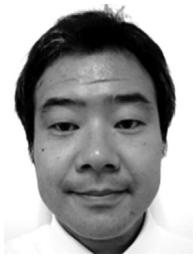
Brief Career:
2000-2002 JSPS Research Fellow
2002-2005 Research Scientist, Disaster Reduction and Human Renovation Institute
2005-2012 Associate Professor, Graduate School of Engineering, Tohoku University
2012- Professor, IRIDeS, Tohoku University

Selected Publications:
• Y. Bai, C. Gao, S. Singh, M. Koch, B. Adriano, E. Mas, and S. Koshimura, "A Framework of Rapid Regional Tsunami Damage Recognition From Post-event TerraSAR-X Imagery Using Deep Neural Networks," IEEE Geoscience and Remote Sensing Letters, Vol.15, No.1, pp. 43-47, 2018.
• S. Koshimura, "Fusion of real-time disaster simulation and big data assimilation – Recent progress," J. Disaster Res., Vol.12, No.2, pp. 226-232, doi: 10.20965/jdr.2017.p0226, 2017.
• Y. Bai, B. Adriano, E. Mas, and S. Koshimura, "Machine learning based building damage mapping from the ALOS-2/PALSAR-2 SAR imagery: Case study of 2016 Kumamoto earthquake," J. Disaster Res., Vol.12, No.Sp, pp. 646-655, doi: 10.20965/jdr.2017.p0646, 2017.

Academic Societies & Scientific Organizations:
• Japan Society of Civil Engineers (JSCE)
• Institute of Social Safety Science (ISSS)
• Japan Society for Computational Engineering and Science (JSCES)
• Japan Association for Earthquake Engineering (JAEE)
• American Geophysical Union (AGU)



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Brief Career:
2005 Received Ph.D. degree from Gifu University
2013- Associate Professor, Tohoku University

Selected Publications:
• S. Moriguchi, R. I. Borja, A. Yashima, and K. Sawada, "Estimating the impact force generated by granular flow on a rigid obstruction," Acta Geotechnica, Vol.4, No.1, pp. 57-71, doi: 10.1007/s11440-009-0084-5, 2009.
• S. Moriguchi, A. Yashima, K. Sawada, R. Uzuoka, and M. Ito, "Numerical simulation of flow failure of Geomaterials based on fluid dynamics," Soils and Foundations, Vol.45, No.2, pp. 155-166, doi: 10.3208/sandf.45.2_155, 2005.
• Research interests are related to numerical simulations of slope disasters

Academic Societies & Scientific Organizations:
• Japanese Geotechnical Society (JGS)
• Japan Society for Computational Engineering and Science (JSCES)

Name:
Yuya Yamaguchi

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Brief Career:
2018- Research Associate, Tohoku University

Selected Publications:
• "Solid–liquid coupled material point method for simulation of ground collapse with fluidization," Computational Particle Mechanics, Vol.7, No.2, pp. 209-223, 2020.

Academic Societies & Scientific Organizations:
• Japan Society of Civil Engineers (JSCE)
• Japan Society for Computational Engineering and Science (JSCES)
• Japanese Geotechnical Society (JGS)

Name:
Carrie Garrison-Laney

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Brief Career:
1993 B.S. degree in Geosciences from San Francisco State University
1998 M.S. degree in Environmental Systems from Humboldt State University
2012 M.S. degree in Human Centered Design and Engineering from University of Washington
2017 Ph.D. degree in Earth and Space Sciences from University of Washington
2017- Washington Sea Grant

Selected Publications:
• "Tsunami hazards past, present, and future: Deposits, models, and the influence of sea level rise on tsunami hazards along the Salish Sea inner coastline of Washington State," American Geophysical Union Fall Meeting 2018, Abstract NH41C-1014, 2018.
• C. E. Garrison-Laney, "Tsunamis and sea levels of the past millennium in Puget Sound, Washington," Ph.D. Thesis, University of Washington, 2017.
• C. E. Garrison-Laney and I. Miller, "Tsunamis in the Salish Sea: Recurrence, sources, hazards," R. A .Haugerud and H. M. Kelsey (Eds.), "From the Puget Lowland to east of the Cascade Range: Geologic excursions in the Pacific Northwest," Geological Society of America Field Trip Guide, Vol.49, pp. 67-78, 2017.
• Interested in paleotsunami deposits, tsunami modeling, and tsunami outreach

Academic Societies & Scientific Organizations:
• Geological Society of America (GSA)
• American Geophysical Union (AGU)

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2010- Post-Doctoral Research Fellow, Disaster Control Research Center, Tohoku University
2012- Associate Professor, IRIDeS, Tohoku University

Selected Publications:
• A. Suppasri, K. Pakoksung, I. Charvet, C. T. Chua, N. Takahashi, T. Ornthammarath, P. Latcharote, N. Leelawat, and F. Imamura, "Load-resistance analysis: An alternative approach to tsunami damage assessment applied to the 2011 Great East Japan tsunami," Natural Hazards and Earth System Sciences, Vol.19, No.8, pp. 1807-1822, 2019.
• A. Suppasri, K. Fukui, K. Yamashita, N. Leelawat, H. Ohira, and F. Imamura, "Developing fragility functions for aquaculture rafts and eelgrass in the case of the 2011 Great East Japan tsunami," Natural Hazards and Earth System Sciences, Vol.18, No.1, pp. 145-155, 2018.
• A. Suppasri, N. Leelawat, P. Latcharote, V. Roeber, K. Yamashita, A. Hayashi, H. Ohira, K. Fukui, A. Hisamatsu, D. Nguyen, and F. Imamura, "The 2016 Fukushima Earthquake and Tsunami: Local tsunami behavior and recommendations for tsunami disaster risk reduction," Int. J. of Disaster Risk Reduction, Vol.21, pp. 323-330, 2017.

Academic Societies & Scientific Organizations:
• Japan Society of Civil Engineers (JSCE)
• Asia Oceania Geosciences Society (AOGS)
• European Geosciences Union (EGU)

Name:
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Brief Career:
2009-2012 Ph.D. in Civil Engineering and Tsunami Engineering, Tohoku University
2012-2016 Assistant Professor, ReGiD, IRIDeS, Tohoku University
2016- Associate Professor, ReGiD, IRIDeS, Tohoku University

Selected Publications:
• E. Mas, R. Paulik, K. Pakoksung, B. Adriano, L. Moya, A. Suppasri, A. Muhari, R. Khomarudin, N. Yokoya, M. Matsuoka, and S. Koshimura, "Characteristics of Tsunami Fragility Functions Developed Using Different Sources of Damage Data from the 2018 Sulawesi Earthquake and Tsunami," Pure and Applied Geophysics, Vol.177, No.6, pp. 2437-2455, doi: 10.1007/s00024-020-02501-4, 2020.
• E. Mas, D. Felsenstein, L. Moya, A.Y. Grinberger, R. Das, and S. Koshimura, "Dynamic Integrated Model for Disaster Management and Socioeconomic Analysis (DIM2SEA)," J. Disaster Res., Vol.13, No.7, pp. 1257-1271, doi: 10.20965/jdr.2018.p1257, 2018.
• E. Mas, S. Koshimura, F. Imamura, A. Suppasri, A. Muhari, and B. Adriano, "Recent Advances in Agent-Based Tsunami Evacuation Simulations: Case Studies in Indonesia, Thailand, Japan and Peru," Pure and Applied Geophysics, Vol.172, No.12, pp. 3409-3424, doi: 10.1007/s00024-015-1105-y, 2015.

Academic Societies & Scientific Organizations:
• Japan Society of Civil Engineers (JSCE)
• Peruvian Council of Engineers (CIP)
• American Geophysical Union (AGU)