# IRIDeS collaborative research

TOHOKU UNIVERSITY
IRIDeS
International Research Institute of Disaster Science

# Accurate measurement of tsunami boulders at the Sanriku coast

Tsunamis inundate large coastal areas and cause severe damage. Size of past tsunamis can be reconstructed from tsunami deposits. Tsunami boulder is a type of tsunami deposit, and the energy required to transport it can be used to reconstruct the magnitude of tsunami. In April 2023, researchers from IRIDeS and University of Plymouth measured tsunami boulders precisely by using state-of-the-art instruments such as a drone and LIDAR. The results of the measurements are expected to provide more detailed information on the relationship between the boulders and the tsunami hydrodynamics.


**(A) Tsunami boulder at Raga**
The boulder was transported by the 1896 Meiji-Sanriku tsunami. We measured the volume and shape of the boulder using Lidar.

**(B) Tsunami boulder at Karakuwa**
Many boulders were transported by the 2011 tsunami at karakuwa. At this site we used a drone to efficiently measure the tsunami boulders by aerial photography. After the measurements, a group photo was taken in front of the tsunami boulders.


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UNIVERSITY OF PLYMOUTH

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# APRU （Association of Pacific Rim Universities）Multi-Hazards Program

**APRU is a university network consisting of 60 universities in the Pacific Rim. Under the network, the Multi-Hazards (MH) Program was established in 2013 in collaboration with Tohoku University and APRU. IRIDeS hosts its secretariat and provides coordination and administrative services.**

The program aims to:

- harness the collective capabilities of APRU universities for cutting-edge research on disaster science
- contribute to international and regional discussions to make influence a disaster risk reduction policy

## (A) EDUCATION

1. **Summer school:** to learn about the 2011 tsunami disaster and international disaster risk reduction(DRR) strategy.
2. **Webinar series**: to share and discuss current disaster science topics


## (B) RESEARCH

1. **Progress in Disaster Science**：an international journal published by Elsevier
2. **Research symposium**: to share research outcomes and discuss collaborative opportunities


## (C) CONTRIBUTION TO POLICY-MAKING PROCESS

1. **UN Science and Technology Conference on DRR:** to promote the application of science and technology in DRR
2. **Collaboration with international/regional organizations:** to bring the academic voices to the discussion at international/regional levels

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APRU Multi-Hazards

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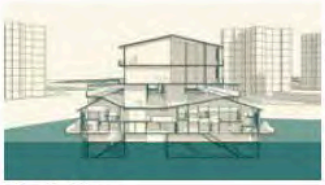
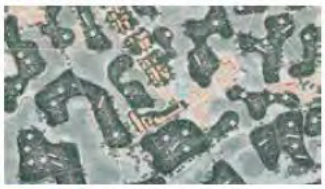
# Designing with Disaster Stories from Seven Regenerative Cities



1 水成都市
Hydroactive City



2 群島都市
Archipelagic City

3 時制都市
Chronosystemic City

4 火成都市
Pyroactive City

5 共生都市
Biophilic City

6 遊牧都市
Nomadic City


7 対話都市
Dialogic City

These conferences, which were held in Tokyo in 2022 and in LA in 2023, drafted the Sendai Framework for Disaster Risk Reduction 2015-2030 which outlined targets and priorities for action to prevent new and reduce existing disaster risks worldwide. Based on the Sendai Framework, UCLA xLAB and Tohoku University's IRIDeS collaborated with 11 Pacific Rim universities on a new initiative named ArcDR3 (Architecture and Urban Design for Disaster Risk Reduction and Resilience). Design studios linked to research at each university have been exploring ways to respond to disasters and build new disaster-resilient environments around the world. This exhibition presented exciting proposals for Seven Regenerative Cities inspired by that exploration.



(A) Seven Regenerative Cities proposed by 11 Pacific Rim universities

(B) Scenery of the Exhibition

(C) Commemorative Photo with Gene D Block (UCLA Chancellor), Hideo Ohno (Tohoku Univ. President), Fumio Imamura (IRIDeS Director), and Hitoshi Abe (Director, xLab)

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UCLA Architecture and Urban Design

xLAB

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# Development of antiviral drugs against SARS-CoV-2

The novel coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has continually been serious threat to public health worldwide. At present, only four anti-SARS-CoV-2 therapeutics (remdesivir, molnupiravir, nirmatrelvir and ensitrelvir) targeting viral polymerase and main protease ($M^{pro}$) have been clinically available. However, the antiviral potency of these three compounds does not seem to be sufficient enough. We have developed novel antiviral drugs against SARS-CoV-2 and identified two promising agents (TKB245 and TKB248) that exhibited stronger antiviral activity and better pharmacokinetics than nirmatrelvir, which is one of the most effective therapeutics for COVID-19 targeting $M^{pro}$. TKB245 and TKB248 might serve as potential therapeutics for COVID-19 and shed light upon further optimization to develop more potent and safer anti-SARS-CoV-2 therapeutics.

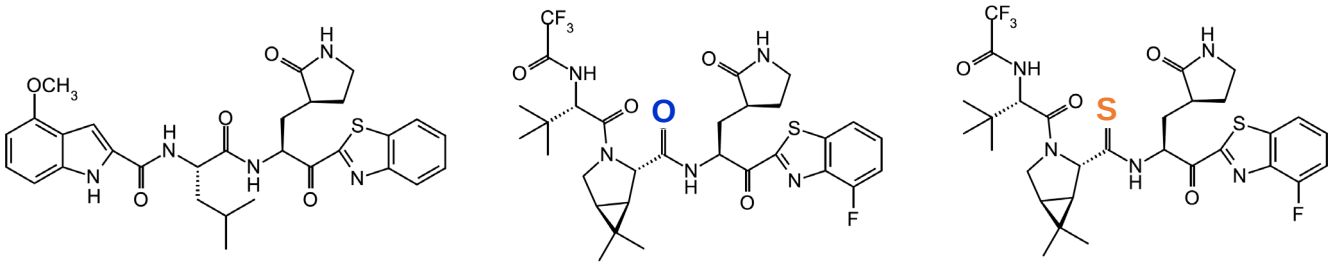


**Fig. 1 Chemical structure of antiviral drugs against SARS-CoV-2.** TKB245 and 248 were developed based on GRL2420/h. TKB245 shows **30 times stronger antiviral activity** against COVID-19 than nirmatrelvir. TKB248 has not only stronger antiviral activity but also **better pharmacokinetics** than nirmatrelvir. (***Nat. Commun***. 2021, doi: 10.1038/s41467-021-20900-6 and ***Nat. Commun***. 2023, doi: 10.1038/s41467-023-36729-0)

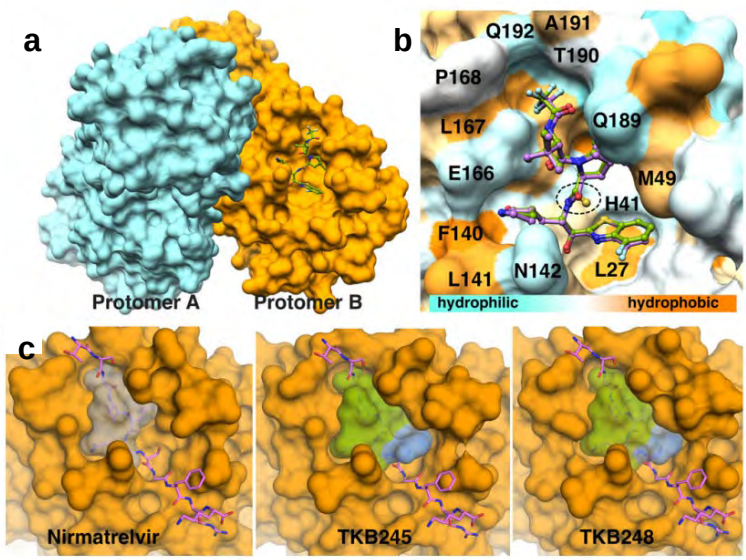


**Fig. 2 Co-crystal structures of TKB245 and TKB248 with SARS-CoV-2 $M^{pro}$.** **a** Overview of $M^{pro}$ dimer in complex with TKB245. Molecular surface of protomer A is colored in cyan and protomer B in orange. **b** Superimposition of TKB245 in green onto TKB248 in purple exhibits identical binding mode. $M^{pro}$ binding pocket is colored according to hydrophobicity scale. **c** Side-by-side comparison of nirmatrelvir vs TKB-245 and TKB-248 (as shown in transparent surface) onto the polyprotein substrate shown in sticks. Blue color indicates the 4-fluorobenzothiazole ring of TKB245 and TKB248 that effectively fill the S1'subsite compared to nirmatrelvir.

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National Institutes of Health
Turning Discovery Into Health

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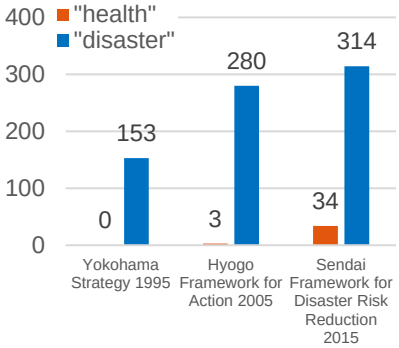
NCGM

# Disaster Medicine and Public Health

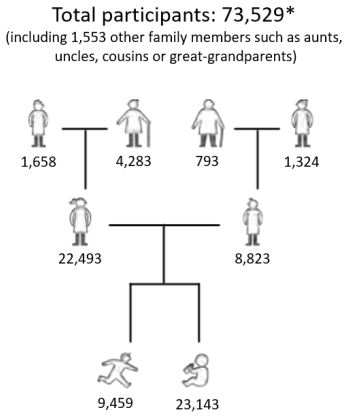
After the 2011 Great East Japan Earthquake, IRIDeS incorporated the disaster medical science division for its transdisciplinary approach with medical responders and creative reconstruction of regional medical and public health resilience. Improved nationwide disaster medical system and Tohoku Medical Megabank cohort project has been implemented. In COVID-19 pandemic, the improved system played a significant role in the detection, prevention, and effective response to the pandemic. IRIDeS is playing a leading role in the scientific improvement of research, education, and genome-based tailored medicine and public health locally, nationally and globally.

**(A)**



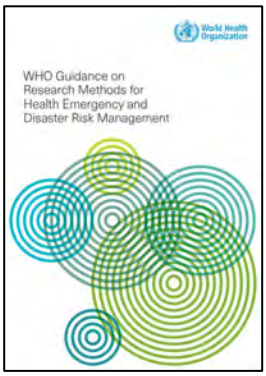

Increase of word numbers of “health” in disaster risk reduction frameworks.

**(B)**



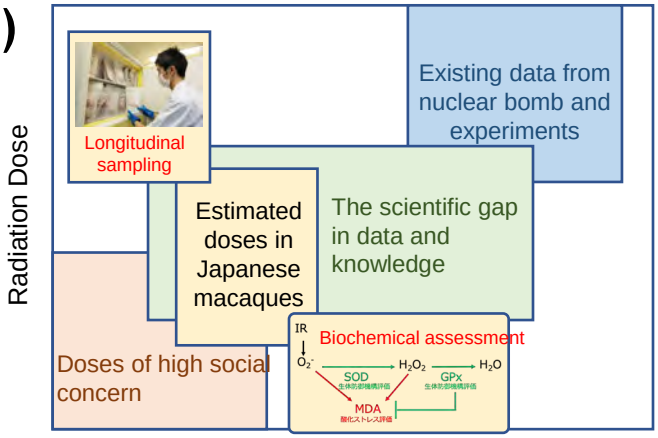

Birth and Three-Generation Cohort Study (TMM BirThree Cohort Study) for long-term assessment in the disaster-affected population

**(C)**




Translation of the WHO Guidance of Research Methods in Health- Emergency and Disaster Risk Management into Japanese for research promotion

**(D)**




Assessment of the long-term biological effect of low-dose radiation exposure with a longitudinal sampling of wild Japanese macaques and experimental biochemical assessment using innovative technology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# Environmental and technological vulnerabilities, and public representations in a post-disaster context

Global climate changes degrade ecosystems causing natural disorders and hazards events in Europe, Japan or North America, and other world regions. The exposure of human communities to significant risks such as floods, soil erosion, major fires, earthquakes, tidal waves and tsunamis, with their devastating effects on infrastructure and industrial facilities and their consequences for people and property, is a factor in the crisis of confidence in the countries most affected by these events. These natural events tend to increase in magnitude, making these territories more vulnerable to technological hazards.

This research aims to identify:

1) Local environmental vulnerabilities and infrastructural responses
2) Local risk representations and communication in disaster museums, memorials, and other public spaces.
3) The capacities of local inhabitants and civil society to influence public decision-making to consolidate risk prevention and promote global responses to environmental vulnerabilities.

"Imagining the Aftermath: Lessons from the 2011 Tohoku Disasters and future issues from Interdisciplinary Science", Lyon-Tohoku Workshop, French Embassy in Tokyo, Japan


Reseearch on environmtal and technological vulnerability in disaster museums, The Great East Japan Earthquake and Nuclear Disaster Memorial Museum

Fieldwork on infrastructure, Tsunami Walls and Coastal Reconstruction

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Prof. Dr. Pierre (Lyon University, CNRS)

ÉCOLE NATIONALE SUPÉRIEURE ARCHITECTURE LYON
Fondation Jean Jaurès
cnrs
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# Graduate Training Program: Multidisciplinary Coastal Zone Hazards Institutes – US, Japan, France, Indonesia

As coastal areas become more densely populated, they become increasingly exposed to climate change, which, combined with natural hazards and human-driven landscape transformation, can amplify the destruction and loss of ecosystem services, life, and property.

In this program, we develop an interdisciplinary graduate training program to educate young researchers to understand coastal phenomena using modern technologies such as earth observation and artificial intelligence, and in combination with fieldwork activities.

## Advanced Studies Institutes (ASI) Partnership

BOSTON UNIVERSITY

NAU NORTHERN ARIZONA UNIVERSITY

UAF UNIVERSITY OF ALASKA FAIRBANKS

TOHOKU UNIVERSITY IRIDeS International Research Institute of Disaster Science

Université Bretagne Sud ubs

UNIVERSITAS GADJAH MADA

UNIVERSITAS DIPONEGORO SEMARANG

First **US-Japan** remote sensing webinar on Advances in Disaster Science hosted by the Remote Sensing MDPI Journal (Webinar ID: 822 7632 9470)



The first ASI Program in Advanced Studies of Coastal Marine Environments will be held at South Brittany University, **France**, from 5th to 17th of June 2023.

Participants are U.S. graduate students enrolled in M.S. or Ph.D. programs in Earth, disaster, data, and social sciences applied to coastal zone hazards and disaster resilience.

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  - Assoc. Prof. Dr. Bruno Adriano, adriano@irides.tohoku.ac.jp
- Boston University
  - Prof. Dr. Magaly Koch, mkoch@bu.edu

Contact

# Implementation of the Sendai Framework for Disaster Risk Reduction: Global Centre for Disaster Statistics (GCDS)

[Website]
https://irides.tohoku.ac.jp/eng/organization/gcds/gcds.html

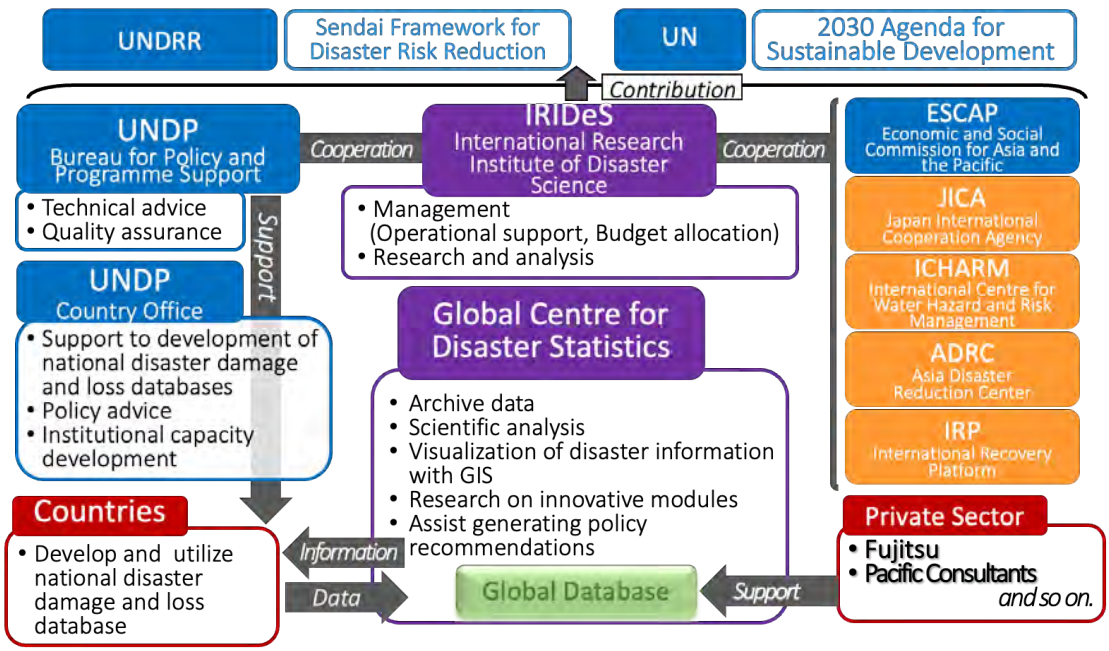
United Nations Development Program (UNDP) and the International Research Institute of Disaster Science (IRIDeS) at Tohoku University jointly announced the establishment of the Global Centre for Disaster Statistics (GCDS) in March 2015 during the Third UN World Conference on Disaster Risk Reduction (WCDRR) in Sendai. Voices of support and expectation to this initiative were received, including the UN Secretary-General Ban Ki-moon.

The GCDS contributes to sustainable development based on evidence-based policy making.

- Support the United Nations Office for Disaster Risk Reduction (UNDRR) and countries for monitoring the progress of the Sendai Framework for Disaster Risk Reduction and 2030 Agenda for Sustainable Development
- Provide scientific analysis and technical advice on their disaster loss and damage data
- Provide policy advice to build capacities of national/local governments based on their demands


**Basic concept of the GCDS**

**UN Secretary-General Ban Ki-moon's speech at Tohoku University Symposium Forum held in the WCDRR**




**Detailed scheme of the GCDS**

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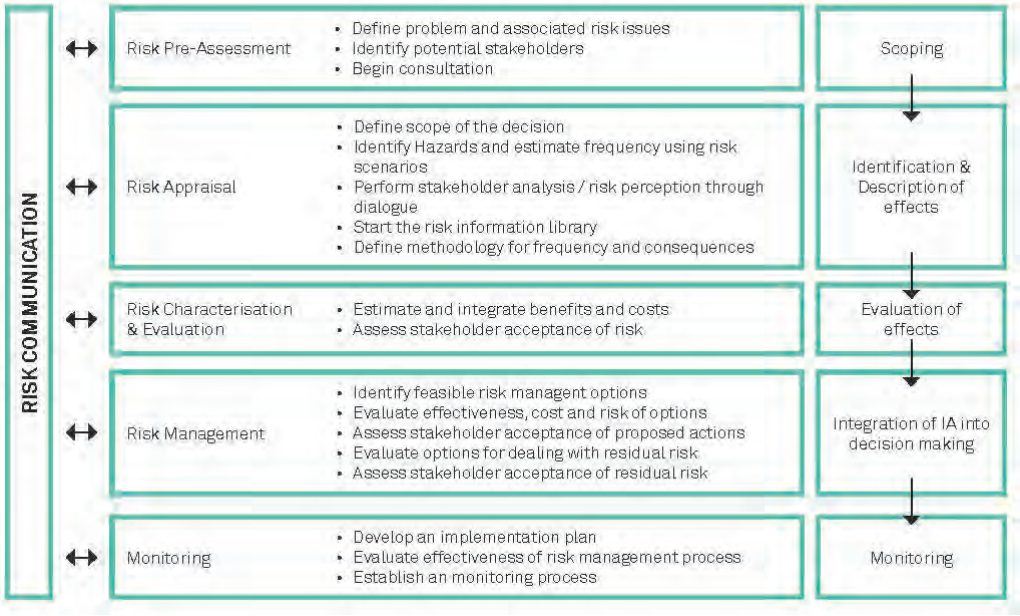
# Increasing Resilience of Urban Planning

Climate change is increasing the risk of natural disasters in cities, including floods, and the role of urban planning to cope with such disasters is also increasing.

The objectives of this study are (1) to develop a theory of urban planning and land use planning that addresses disaster risk by applying the risk management process to the urban planning process (an integrated approach), and to demonstrate its potential for use, and (2) to develop a vision of the ideal form of urban planning for reconstruction by investigating, comparing, and examining the actual urban planning responses to disaster risk and the resulting urban form in the reconstruction period after severe disasters in various countries around the world.

We developed handbooks on disaster resilient urban planning that combines the previous experiences of all three countries, Germany, Slovakia and Japan, with the newly created knowledge and offered assistance for practitioners. We have also compiled a collection of case studies on recovery from major disasters in various countries, analyzed the issues, and published them in a book.

**(A)** Structure of Risk Governance





**(B) "**The Spatial planning and resilience following disasters" (2016)

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Jaroslav Tesliar (Agency for regional development support Kosice) jaroslav.tesliar@arr.sk

technische universität dortmund

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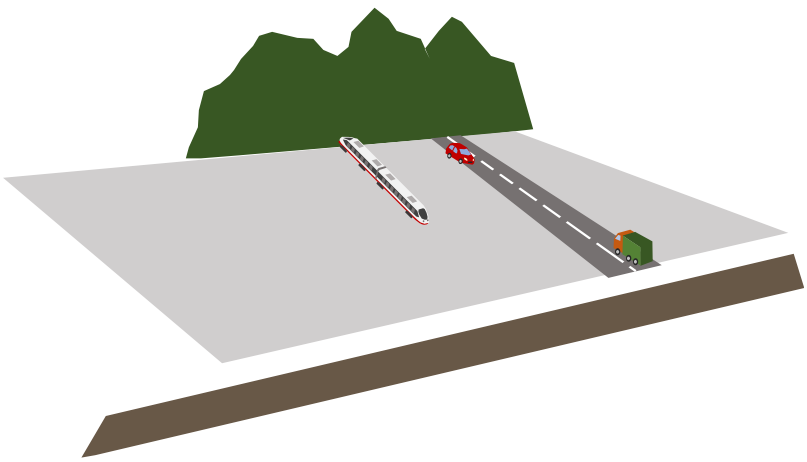
Agency for support of the regional development Kosice, non profit organisation

# International Standards (ISO) for Smart Community Infrastructures for Disaster Risk reduction

As the global population continues to grow, many urban communities face increasing pressure from population growth. In order to manage the greater demand on resources, many municipalities are adopting smart community infrastructure. However at the same time, ongoing climate change may lead to increasing intensity and/or frequency of hazard events. In order to reduce disaster risk, members of IRIDeS have collaborated with international experts as well as international organizations such as the United Nations Development Programme and the Asian Development Bank, to develop International Standards that could be utilized by communities across the world, to strengthen the resiliency of their community's infrastructure.



**Benefits of Standardization**

- Provides guidelines that could be used globally
- Promotes technology transfers from developed countries to developing countries
- Strengthens disaster resiliency in communities

**Standards being developed under Smart Community Infrastrucutres for Disaster Risk Reduction**

- ISO TR 6030 –Survey results and gap analysis of global infrastructure
- ISO IS 37174 –Guidelines for implementing seismometer systems (In progress)
- ISO IS 37179 –Basic framework for the implementation of disaster risk reduction (In progress)

**Project Leader:**
Specially Appointed Associate Professor
Dr. David N. Nguyen
University of Hawaii Alumni, East-West Center Alumni
Ph.D. from Tohoku University
Specialization in Urban Planning, Tourism Planning, Disaster Management

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ISO UNDP ADB ASIAN DEVELOPMENT BANK

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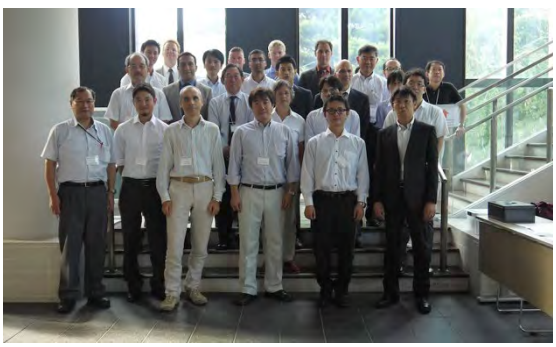
# International Workshop Series on Remote Sensing for Disaster Management

International Workshop on Remote Sensing for Disaster Response was jointly organized at Tohoku University. The host department was International Research Institute of Disaster Science, Tohoku University. The workshop provides an opportunity for experts, researchers, and practitioners to exchange ideas and present the recent advances in the field of disaster management, response and recovery using remote sensing and geo-science technology. Among all other topics, participants are encouraged to focus on topics such as rapid regional damage assessment, crowd-sourcing, multi-platform data integration and application of machine learning. Close to 30 participants from six countries (U.S., Japan, UK, Italy, Germany, and the Netherlands) delivered 23 presentations on a broad set of topics dealing with Disaster Monitoring and Emergency Response, Hurricane, Flood and Landslide Monitoring and Application, Urban Remote Sensing, Tsunami, and Disaster Risk Reduction.

The workshop participants strongly agreed that this workshop series, in an enhanced form, should continue albeit on a two-year basis. The participants have expressed their enjoyment in the meeting in the current setting where they can track and share on a regular basis progress in long-term research programs. However, the group also agreed that the workshop can effectively be enhanced by adding a third day that focuses on policy or implementation issues, much like was done at the 2011 Stanford Workshop. Other considerations include moving towards a peer-review paper format where researchers can more easily get credit for the papers presented and published.



Group photos at the workshop venue and the field trip.

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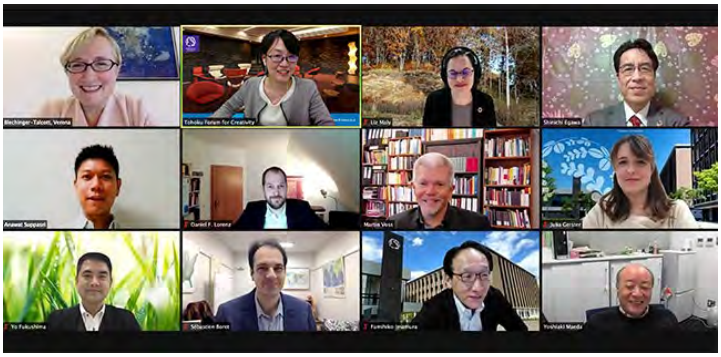
# Investigating the transmission of disaster memory

The transmission of disaster memory to future generations is vital in disaster education and risk reduction. In various joint research projects with counterparts in the G7 countries, IRIDeS analyzes whose disaster lessons are passed on to what kind of audience and what needs to be done to create more inclusive disaster education. Taking examples of oral history or disaster storytelling, museums and exhibitions, archives, negative heritage preservation, or various art forms, several projects investigate how various forms of disaster memory transmission affect recipients differently. We hope that the research insights are helpful not only in disaster education but also regarding memory transmission of all kinds of traumatic events.

(A)



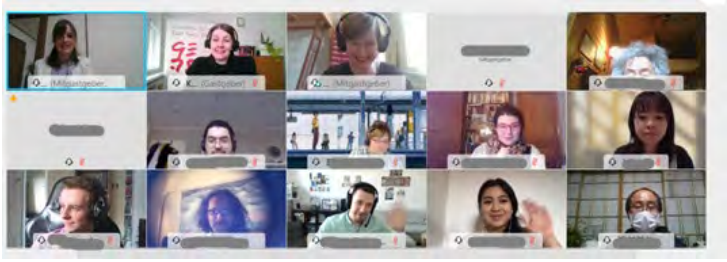
**(A)** As part of Berlin Science Week 2020, Tohoku University held a joint public lecture with Free University of Berlin, to discuss ways to build resilient societies from the lessons of recent disasters**.**


**(B)** LMU Munich held a workshop on disaster memory together with faculty of IRIDeS and Fuyubi Nakamura, Assistant Professor at the University of British Columbia and curator of the “A future for memory exhibition.”

(C)

**(C**) A joint project with Stanford University analyzes the merits of traditional Japanese paper theater (Kamishibai) as a hybrid form of collective and cultural memory, in particular regarding the 2011 nuclear disaster. (Machimonogatari Sakusei Iinkai, Munen)

(D)



**(D**) IRIDeS faculty held workshops with students from Free University of Berlin and LMU Munich discussing disaster memory with survivors of the 2011 Great East Japan Earthquake, tsunami and nuclear disaster.

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# IRIDeS faculty member dispatching to UCL

***Bridging Japan and UK`s knowledge on disaster to the world!***

Period: April to December 2023
University College London (UCL)
Institute for Risk and Disaster Reduction (IRDR) and
Earthquake and People Interaction Centre (EPICENTRE)

## Planned events and activities

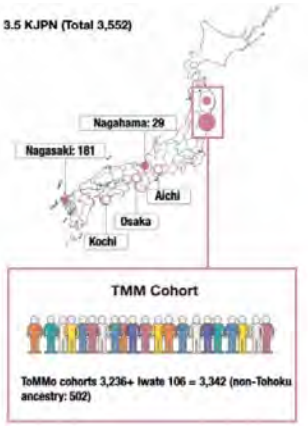
To strengthen collaboration with UCL not only ongoing interdisciplinary research on disaster but also co-supervision of PhD students (with expected joint publications) and other related activities for double degree (DD) with UCL.

- April: IRDR Spring academy → networking
- June: IRDR annual symposium
- July: Youth challenge → UCL-TU hosted high school students exchange program
- August: Internship students from IRDR to IRIDeS
- October: Extension of university level MOU

**Earthquake science**

**Engineering damage assessment**

## Joint research topics




**Public health and medical megabank**

**Joint fieldwork in disaster affected area**

**Social study on gender and disaster**

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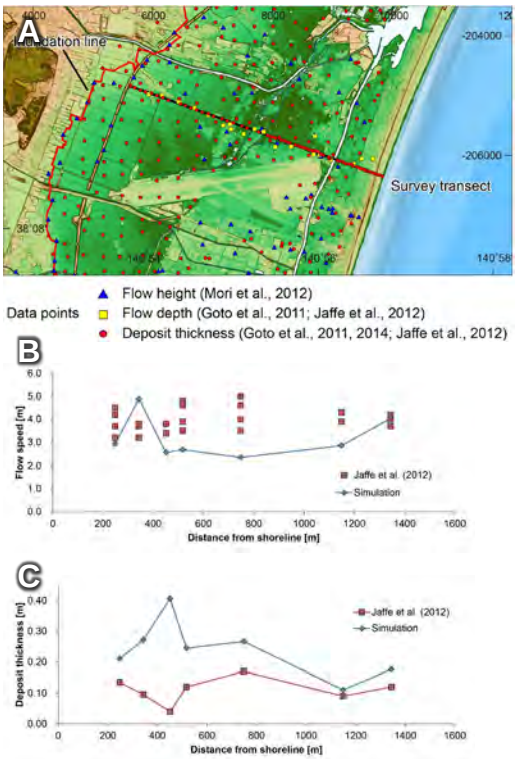
# IRIDeS-USGS collaborative researches on tsunami deposits and sediment transport modeling

Lessons learned from the 2011 Great East Japan Earthquake is the importance of geological evidences of past disaster, such as tsunami deposits. They infer recurrence intervals and sizes of infrequent large earthquakes and tsunamis. Researchers from IRIDeS and USGS have jointly conducted post-tsunami surveys after the 2011 Tohoku-oki earthquake and investigations of paleotsunami deposits. We also dedicated much efforts for developing numerical modeling of tsunami sediment transport, to extract more information from the deposits. Outcomes have been published in several co-authored papers and presentations.


Post-tsunami geological survey at Natori City, Miyagi Prefecture (May. 5, 2011)


Post-tsunami geological survey at Minami-soma City, Fukushima Prefecture (Nov. 14, 2014)


Paleotsunami deposit coring at Kauai Island, Hawaii (Nov. 15, 2015)





Marine Geology

Numerical models of tsunami sediment transport – Current understanding and future directions

Daisuke Sugawara, Kazuhisa Goto, Bruce E. Jaffe

Sugawara et al. (2014) Mar. Geol. 352


Uncertainty in Tsunami Sediment Transport Modeling

Bruce Jaffe, Kazuhisa Goto, Daisuke Sugawara, Guy Gelfenbaum, and Scott Paul La Selle

Jaffe et al. (2016) J.Disaster Res. 11 (4)

Map of the coastal area of Natori and Iwanuma Cities [A] and comparison of [B] flow speed and [C] deposit thickness generated by forward modeling of tsunami sediment transport and inverse modeling of tsunami deposit along the transect in [A]. (Sugawara et al., 2015, Coastal Sediments 2015)

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USGS science for a changing world

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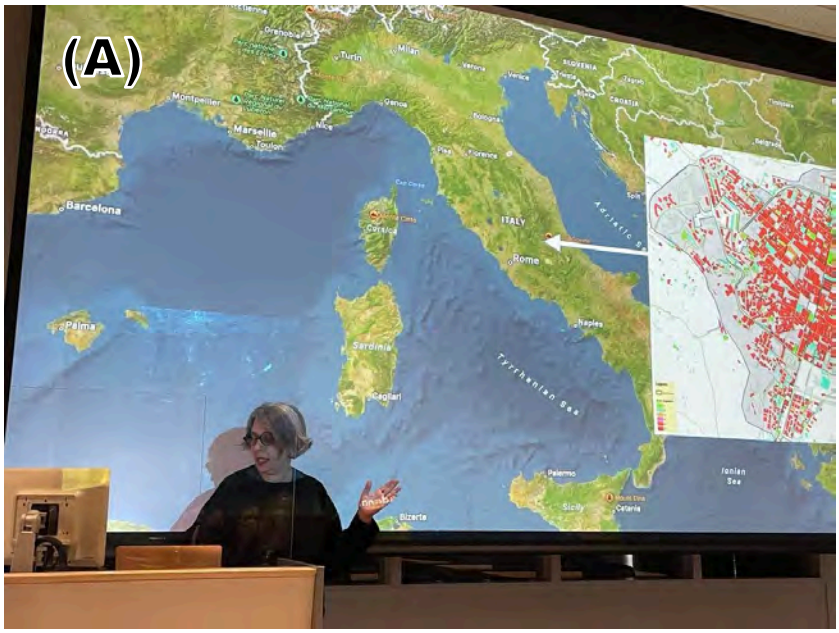
# Learning from diverse experiences: Case Studies from L'Aquila and Tohoku

IRIDeS faculty works closely together Historian Lucia Patrizio Gunning and urbanist Paola Rizzi, who continuously stress the importance of social aspects of reconstruction and the need to go beyond merely physical approaches to recovery. The researchers discussed, amongst others, examples from L'Aquila and Tohoku that are included in their recently published edited volume «Invisible Reconstruction» at the World Bosai Forum 2023 and related sessions at IRIDeS. Future joint research projects will continue to explore the "interconnection of people, culture, and environment and on constructive approaches to strengthening the intangible ties to increase resilience and reduce vulnerability" (Gunning and Rizzi 2022).






**(C)** Prof. Gunning introduces an archive project that was conducted after the 2009 L'Aquila earthquake in Italy as a way to contribute to cultural recovery, or "invisible reconstruction."

**(A)** Prof. Lucia Patrizio Gunning explains the background of the 2009 L'Aquila Earthquake in Italy.

**(B)** A joint research forum was held at IRIDeS after the 2023 World Bosai Forum to discuss recovery case studies from Italy, England, and Japan. A special focus of the forum was on gender and diversity in memory transmission.

**Contact:** Assistant Professor Miwako Kitamura (Tohoku Univ.), miwako.kitamura.b8@tohoku.ac.jp

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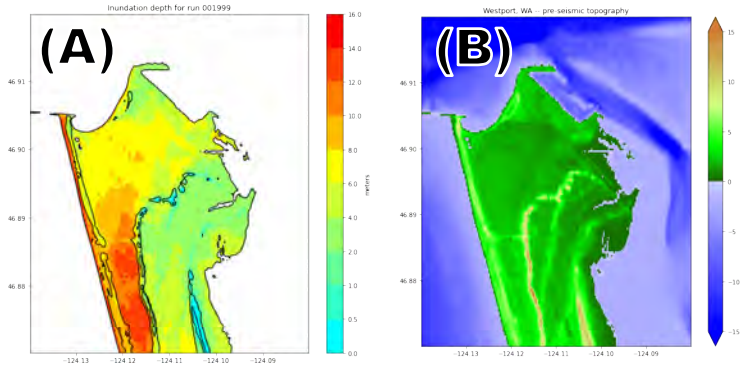
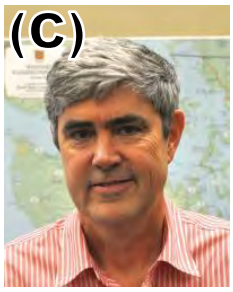
# Machine Learning approaches for real-time tsunami forecasting

Real-time tsunami predictions will unquestionably contribute to the prompt evacuation of people living in onshore areas. Recent machine learning (ML) algorithms are expected to further accelerate the process of real-time and its reliability. We are collaborating with a research team in the U.S. to develop a new real-time tsunami forecasting method based on ML. In this project, we target two sites both threatened by future tsunami risk in U.S. and Japan, Westport and Kochi.

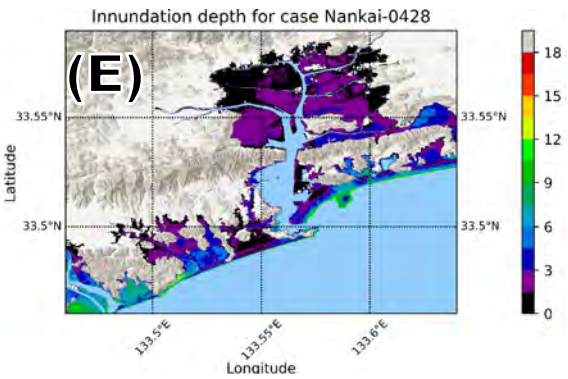


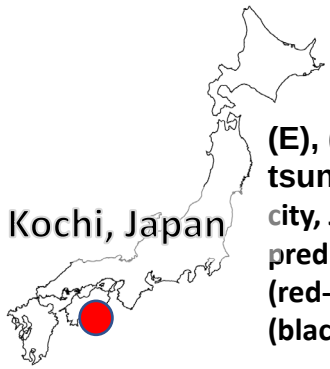

**(A) ML based real-time tsunami risk evaluation in Westport (WA, USA)**
**(B) Tsunami simulation targeting the Westport. These data are for training ML algorithm.**


**Collaborators:**
**(C) Prof. Emer. R. J. LeVeque, University of Washington**
**(D) Asst. Prof D. Rim, Washington University in St. Louis**

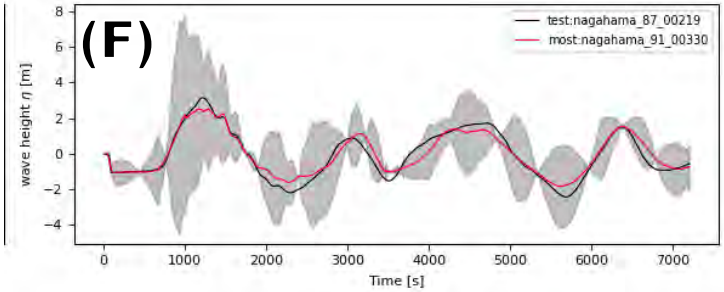







**(E), (F) ML based real-time tsunami risk evaluation in Kochi city, JPN: Inundation risk map and predicted tsunami wave history (red-lines) against actual tsunami (black line)**

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UNIVERSITY of WASHINGTON

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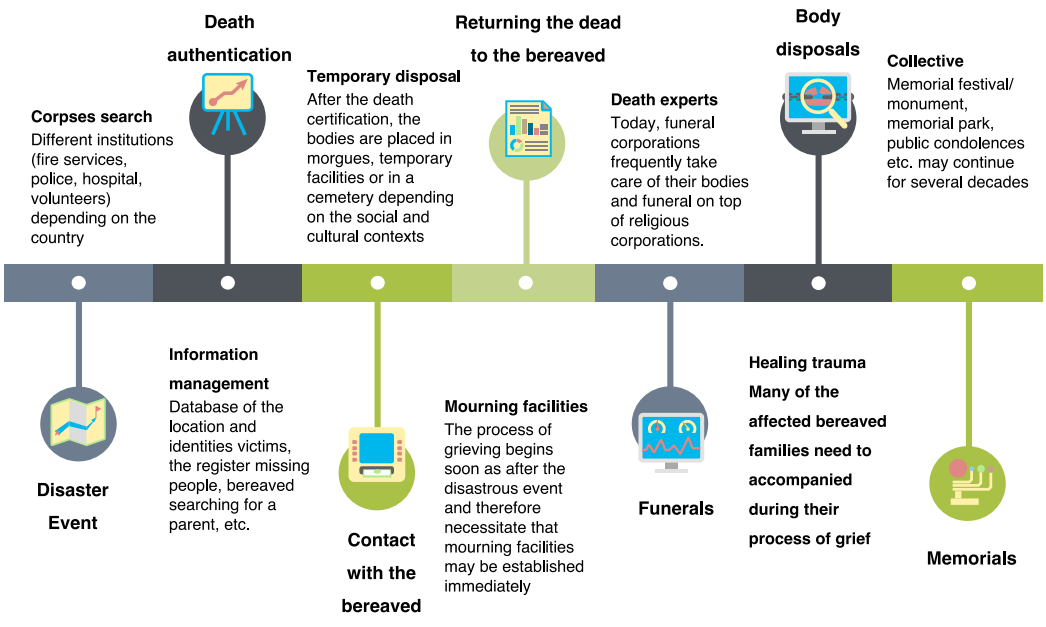
# Managing Mass Death and Grief in Disaster Communities

Human experience and recovery from disasters vary with the vulnerability level to individuals and groups. Some vulnerabilities pre-exist the catastrophe, such as for people with special needs and other minorities. Other vulnerabilities result from the disaster itself. New vulnerabilities include the grief and trauma of those bereaved individuals and families who experienced the loss of family members or a community that suffered mass death. In both cases, vulnerability is not a fatality. The better society prepares for handling the victims of disasters and their bereaved families, the lesser the impact of disasters in the short and long term.

The aim of this research is to :
1) provide a sociocultural understanding of each step of management of mass death from the recovery of the bodies to the collective memorial monuments.
2) draw “lessons” by assessing the successes and the failures of the management of past mass death,
3) apply the findings by designing a framework for managing mass death.
4) reduce the social and psychological impact of mass death.

## Timeline for the management of Disaster Death




Mass grave for the victims of the 2011 Tohoku earthquake

Monuments for the bereaved of the 2011 Tohoku Earthquake

**Contact:** Dr. Sébastien P. Boret (Tohoku Univ.), boret@irides.tohoku.ac.jp
Prof. Dr. Elisabeth Anstett (ADES. CNRS), Mr Sora Duly, (Aix-Marseille University)

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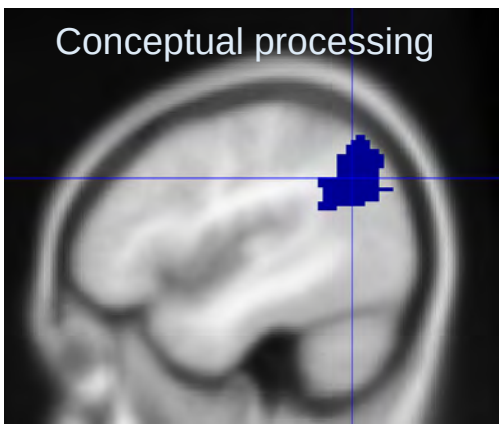
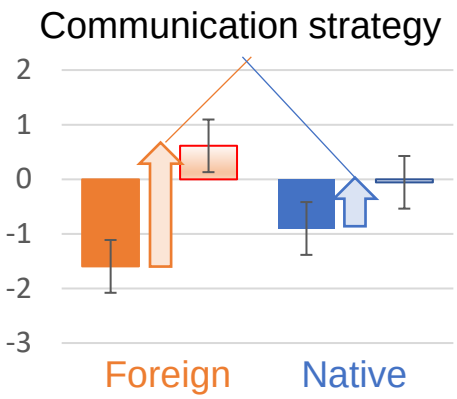
# Neuroscience of Disaster Communication in Multilingual Contexts

Successful communication among disaster victims and responders is crucial in disaster response. In multilingual contexts, this requires not only effective communication strategies but also foreign language skills. Our brain data in disaster communication show that foreign language use increases not only linguistic but also the conceptual processing load of strategic processes. This suggests the usefulness of disaster communication-specific foreign language teaching and learning.


**(A)** Each participant in the MRI scanner was asked to select four out of eight items to take to the shelter in the event of a flood warning and to explain their choices.


**(B)** In the strategic process of communication, the activity of the angular gyrus involved in conceptual processing was more elevated during foreign language use.

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**Contact:**
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Prof. Andrea Révész
a.revesz@ucl.ac.uk

# Promoting Seismic Protective Systems for Resilient Societies

## Pacific Rim Earthquake Engineering Mitigation Protective Technologies International Virtual Environment (PREEMPTIVE)

The purpose of this PREEMPTIVE Virtual Institute is to build a community for researchers who share interest in understanding, promoting and accelerating the adoption of protective systems for multi-hazard protection of buildings throughout the Pacific Rim to provide for resilient and sustainable societies. The virtual institute brings together a team of 10 NSF funded investigators and Chilean, New Zealander, and Japanese counterpart teams in the areas of protective systems, to form long term global professional relationships, through a virtual research hub, regular workshops and an innovative educational component. Recent earthquakes around the Pacific Rim in Chile (M8.8, February 27, 2010), New Zealand (M6.3, February 22, 2011) and Japan (M9.0, March 11, 2011) provide poignant opportunities to explore the seismic and multi-hazard (e.g., tsunami) performance of protective systems and better understand the demands and necessary capacity required of these protective systems.

Principal Investigators: Prof. R. Christenson, UCONN, Prof. E. Johnson, USC, Prof. G. Ragusa, USC
Japan side collaborators: Prof. K. Ikago, IRIDeS, Tohoku Univ., Prof. T. Okazaki, Hokkaido Univ.


NSF UCONN SCHOOL OF ENGINEERING

USC UNIVERSITY OF SOUTHERN CALIFORNIA

IRIDeS hosted the first PREEMPTIVE Workshop and will host another in July, 2023.

## Exchange of Researchers between Japan and the UK in the field of Earthquake Engineering

University of Sheffield

Prof. Ikago of IRIDeS gave a talk at a mini symposium held at University of Sheffield (May, 2019)

Photo: Laboratory for Verification and Validation (LVV), Sheffield, UK

IRIDeS is going to accept Dr. Predaricka Deastra (the one on the far left of the photo) who received PhD degree from University of Sheffield as a JSPS postdoctoral fellow from late September, 2023.
A PhD student of IRIDeS will visit Sheffield for six months from May, 2023.

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**Contact:** Prof. Dr. Kohju Ikago (Tohoku Univ.),
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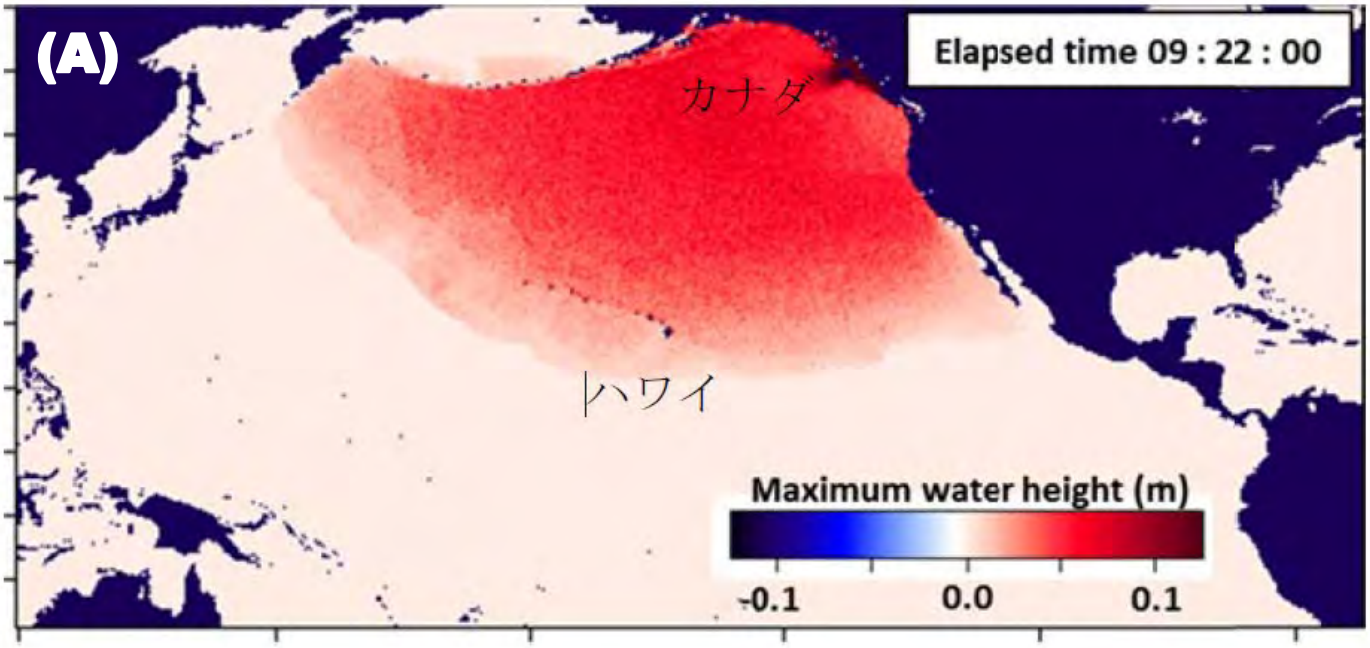
# Queen Charlotte Islands (Haida Gwaii), British Columbia Tsunami, 2012

On October 27, 2012, an Mw 7.8 earthquake occurred 202km SSW of Prince Rupert, Canada, and triggered the Queen Charlotte Islands (Haida Gwaii), British Columbia tsunami. The tsunami reached 44cm in Canada and 76 in Hawai'i. IRIDeS faculty analyzed the earthquake and tsunami immediately after their occurrence.




**(A)** A model of the 2012 Queen Charlotte Islands tsunami published on a special IRIDeS website updating the public about the earthquake and tsunami.

https://irides.tohoku.ac.jp/research/prompt_investigation/queencharlotte-eq.html

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Assoc. Prof. Shosuke Sato, ssato@irides.tohoku.ac.jp
Assoc. Prof. Anawat Suppasri, suppasri@irides.tohoku.ac.jp

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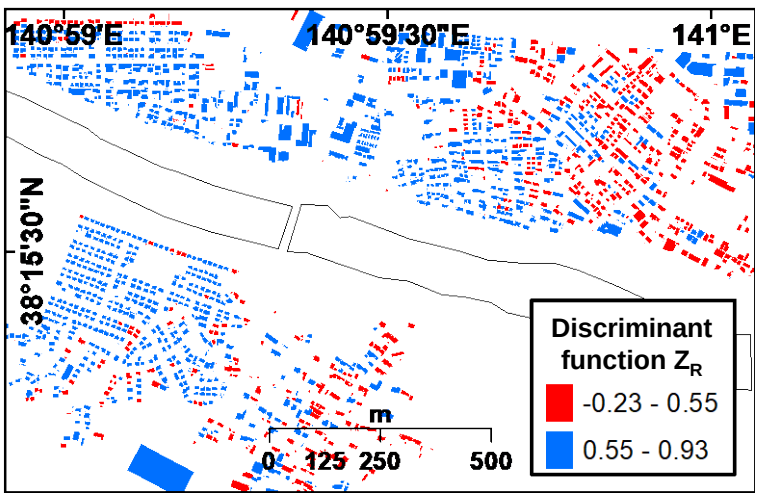
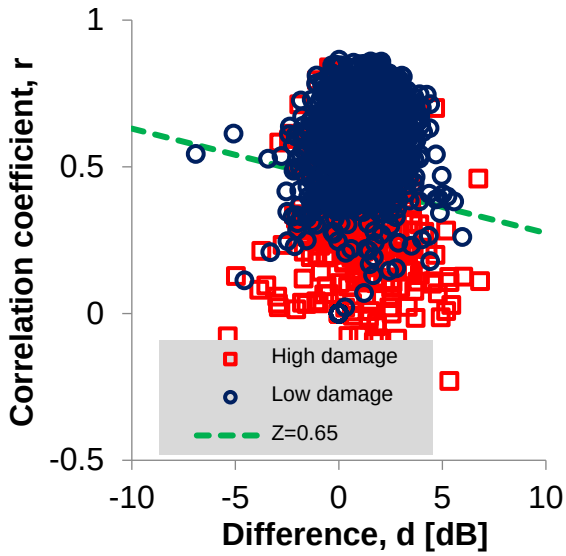
# Radar-based Building Damage Recognition

A prompt recognition of damages buildings and social infrastructure, as well as details on their spatial distribution, is essential for effective disaster response and recovery efforts. Remote monitoring of natural disasters from space is useful to grasp the impact. Synthetic Aperture Radar (SAR) is especially useful among remote sensors because its capability to observe the Earth's surface regardless of weather conditions. Therefore, SAR images have been gaining prominence as a reliable tool for grasping the overall picture of damage from disasters, and anticipating to help a quick and effective response. Through the collaboration with the University of Waterloo, We developed a radar-based remote sensing analysis in order to estimate the measure of building damage level in the tsunami-affected areas.


**Left** :TerraSAR-X* image in Sendai, 12 March, 2011
**Lower Left**: Discriminated building damage (red: destroyed, blue: surviving).
**Bottom**: Scatter diagram of the difference in backscattering coefficients and correlation coefficients, and the line of discriminant regression function




**Contact:** Prof. Dr. Shunichi Koshimura (Tohoku Univ.), koshimura@irides.tohoku.ac.jp
Prof. Stephen G. Evans (Waterloo)

UNIVERSITY OF WATERLOO

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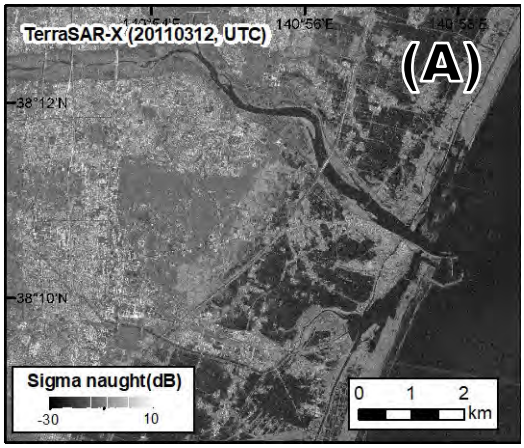
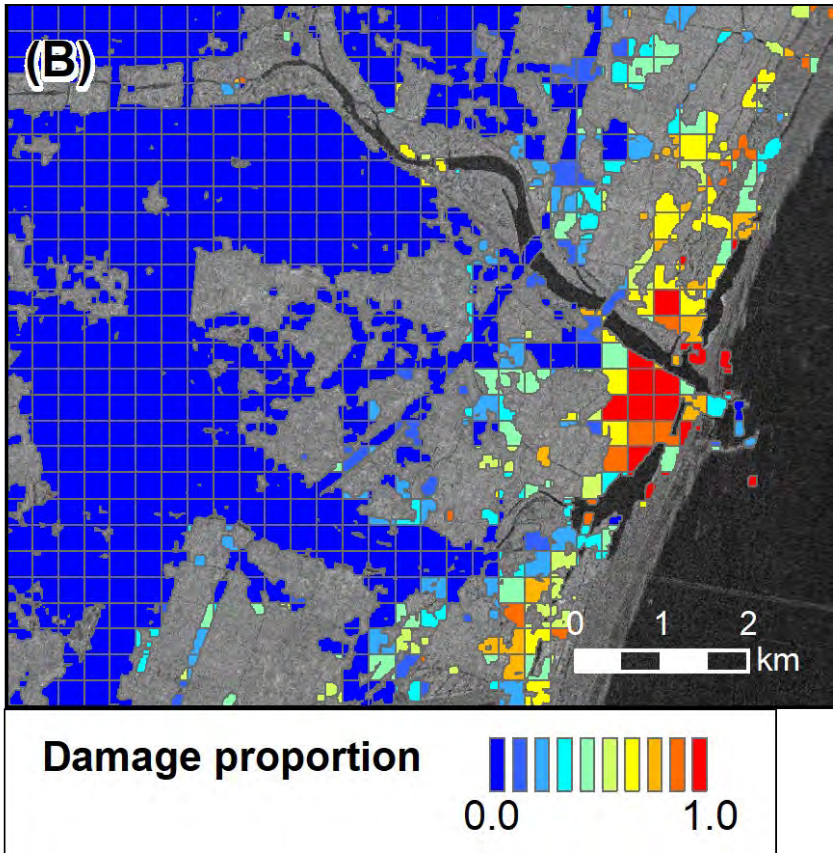
# Remote Sensing and Geo-informatics for Mapping Disaster Impact

In the aftermath of catastrophic natural disasters, such as earthquakes and tsunamis, our society tends to experience significant difficulties in assessing disaster impact within the limited period of time available. In recent years, however, the quality of satellite sensors and access to, and use of satellite imagery and services, has greatly improved. More and more space agencies have embraced data-sharing policies that facilitate access to archived and up-to-date imagery. We developed a semi-automated method to estimate building damage using high-resolution synthetic aperture radar data.




**(A)** TerraSAR-X* image in Sendai, 12 March, 2011
*Imaging radar Earth observation satellite, German Aerospace Center (DLR)




**(B)** Estimated building damage by machine learning methods developed through collaboration.


**(C)** The Global Partnership on Space Technology Applications for Disaster Risk Reduction (GP-STAR), a platform fostering the use of Earth observation and Space-based Technologies and Applications to contribute to the implementation of the Sendai Framework for Disaster Risk Reduction.

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Prof. Dr. Günter Strunz (German Aerospace Center), Guenter.Strunz@dlr.de

Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

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# Research on the 2009 L'Aquila earthquake

In December 2020, Professor Osamu Murao (Tohoku University) and architect and Professor Shigeru Ban (Keio University) took the lead in creating a "Study Group on the Establishment and Operation of Disaster Response Spaces". They held several research meetings, including on the “Post-disaster Response Activities in the Italian Civil Protection Department." Italy is said to be one of the most advanced countries in the world in terms of post-disaster support for disaster victims, and the purpose of the workshop was to gain a deeper understanding of such a system. As in the first meeting, Kimio Meguro, Professor at the University of Tokyo, joined experts from the Institute in various fields vital for the theme of the workshop, and the two groups exchanged information on differences in Italian and Japanese disaster preparedness and response as well as cultural differences, for instance in the operation of emergency shelters etc. Due to the Covid-19 pandemic, the research meetings were held online with partners joining from Italy as well.

**(A)**


**(A)** A screenshot of the online research meeting with faculty from Japan and Italy**.**

**Contact:** Prof. Osamu Murao (Tohoku Univ.),
murao@irides.tohoku.ac.jp

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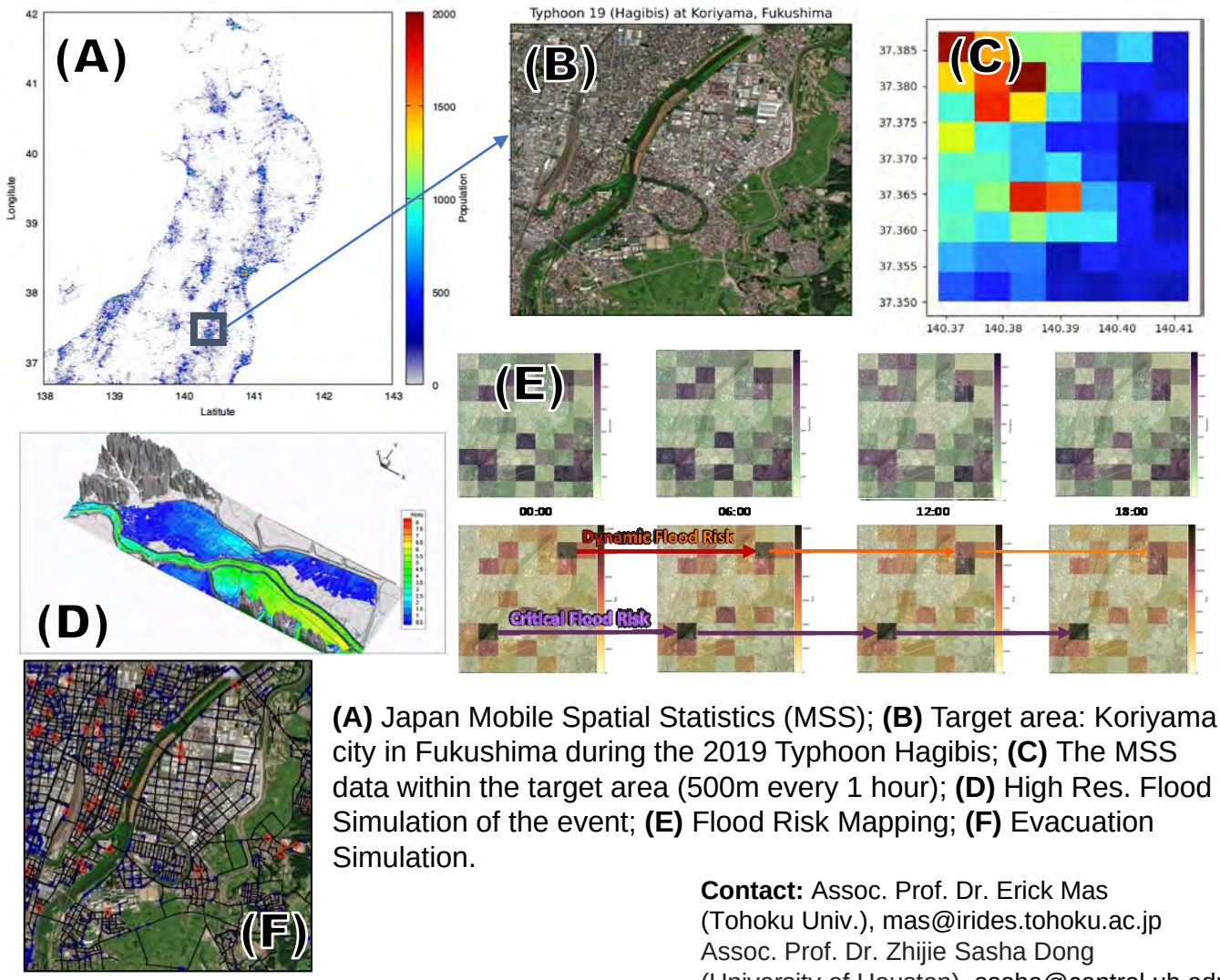
# Resilience Research for Human-Centered Data applied on Flood Risk Reduction

In this project, we aim to identify optimal evacuation advisory timings under various population exposure and flooding conditions. We used mobile spatial statistical data and flooding scenarios to map and evaluate worse-case scenarios of population exposure and evacuation advisory based on reinforcement learning in evacuation simulations and a stochastic programming approach. We discussed the advantages and limitations of operational research and machine learning methods to propose a practical example of an integrated framework known as sequential decision analytics.




**(A)** Japan Mobile Spatial Statistics (MSS); **(B)** Target area: Koriyama city in Fukushima during the 2019 Typhoon Hagibis; **(C)** The MSS data within the target area (500m every 1 hour); **(D)** High Res. Flood Simulation of the event; **(E)** Flood Risk Mapping; **(F)** Evacuation Simulation.


**Contact:** Assoc. Prof. Dr. Erick Mas (Tohoku Univ.), mas@irides.tohoku.ac.jp
Assoc. Prof. Dr. Zhijie Sasha Dong (University of Houston), sasha@central.uh.edu

**Collaborators:** Prof. Dr. Shunichi Koshimura (Tohoku Univ.),
Prof. Dr. Tatsuhito Kono (Tohoku Univ.),
Assoc. Prof. Dr. Bruno Adriano (Tohoku Univ.),
Assoc. Prof. Dr. Masakazu Hashimoto (Kansai Univ.),
Assist. Prof. Dr. Luis Moya (PUCP, Peru)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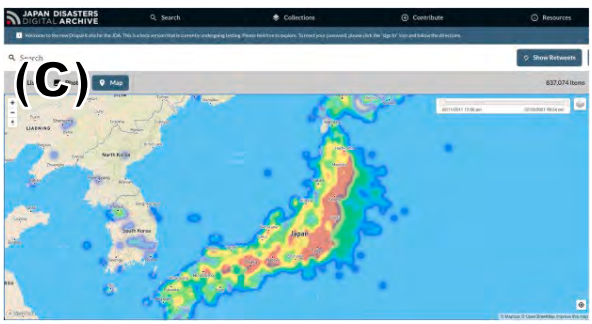
# Teaching the Japan Disaster Digital Archive (JDA): Insights from Japan

Since 2015, IRIDeS has been working closely together with the Japan Disasters Digital Archive (JDA) of Harvard University's Edwin O. Reischauer Institute of Japanese Studies. Regular workshops have been held in the U.S. and Japan, in which the participants learned about the importance of disaster digital archives, how to use them, and how to contribute to the JDA, for instance, by creating collections on specific disaster-related topics. Further, a joint research project with faculty of the universities of Harvard, Princeton and Tohoku investigated the merits of geo-located archive data in disaster education.


**(A)** A JDA workshop with teachers from the U.S. and students from Tohoku University was held at the Reischauer Institute in 2019.


**(B)** Tohoku University students explore geo-located archive data in the Miyagi Recovery park.




**(C)** The "heat map" of the Japan Disasters Digital Archive (JDA) displays the amount of specific geo-located data and its locations. Similar to other map services, users can zoom into the map until the data points are displayed one by one.


**(D)** During the Covid-19 pandemic, joint-research activities and student seminars were continued online or in hybrid forms –opening new possibilities to explore disaster digital archives.

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Assist. Prof Julia Gerster (Tohoku Univ.), gerster@irides.tohoku.ac.jp

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J. Gerster, S. Boret, R. Morimoto, A. Gordon, A. Shibayama,The potential of disaster digital archives in disaster education: The case of the Japan disasters digital archive (JDA) and its geo-location functions,International Journal of Disaster Risk Reduction, Vol 77, 2022.

# World BOSAI Forum 2023/IDRC2023 in SENDAI

World BOSAI Forum 2023/IDRC2023 in SENDAI was held from March 10 to 12, 2023, with a total of 5,412 participants from 40 countries. The main conference consisted of 30 oral sessions, 2 workshops, and a workshop on disaster risk reduction. The main conference featured 30 oral sessions, 7 presentations, 55 poster presentations, and 33 mini presentations, and an exhibition called the World BOSAI EXPO showcased the technologies and activities of private companies and organizations in disaster risk reduction products.


【Opening】
The World BOSAI Prize was established to honor those who have contributed to disaster reduction. The prize was awarded to Calvin Coolidge, the 30th president of the United States and Yukitake Wamura, former mayor of Fudai Village in Iwate Prefecture.

【Session】
The participants voiced their desire to see conflicts around the world resolved as soon as possible, as conflict is the greatest impediment to disaster risk reduction. On the other hand, international cooperation could be beneficial in resolving conflicts, this forum emphasized.

【Excursions】
We observed the reconstruction of two locations, Yuriage in Natori City and Minamisanriku Town, both of which were severely damaged by the Great East Japan Earthquake.


【Closing】
Mr. Yuichi Ono, President of the World BOSAI Forum, presented the "World BOSAI Forum Sendai Proposal 2023" and handed it to Ms. Mami Mizutori, Special Representative of the UN Secretary-General for Disaster Reduction and Head of the UNDRR.

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E 501,International Research Institute of Disaster Science,
Tohoku University

World BOSAI Forum

# STRUCTURE


The logo of IRIDeS is the kanji 災(disaster) turned upside down, showing our determination to "turn disaster into good fortune."

## Risk Evaluation and Disaster Mitigation Research Division

- Subduction Earthquake Lab
- Inland Earthquake and Volcano Lab
- Earthquake Engineering Lab
- Computational Safety Engineering Lab
- Tsunami Engineering Lab
- Disaster Geo-informatics Lab
- Oceanic, Atmospheric and Outer Space Disaster Lab
- Disaster Robotics Lab

## Disaster Humanities and Social Science Division

- Disaster Culture and Archive Studies
- Preservation of Historical and Cultural Heritage Lab
- Cognitive Sciences Lab
- International Strategy for Disaster Mitigation Lab
- Regional Resilience Planning Lab
- Spatial Design Strategies Lab

## Disaster Medical Science Division

- International Cooperation for Disaster Medicine Lab
- Disaster Medical Informatics Lab
- Radiological Disasters and Medical Science Lab
- Disaster Psychiatry Lab
- Disaster Obstetrics and Gynecology Lab
- Disaster Public Health Lab
- Infectious Diseases lab
- Oral Health and Disaster Medicine Lab

## Practical Research and Collaboration Division

- Disaster Education Research and Implementation Lab
- Disaster Resilient Society Promotion Lab
- International Research Collaboration Office
- 2030 Global DRR Agenda Office
- Resilient EICT Research Promotion Office

## Endowed Research Division

- Earthquake Induced Tsunami Risk Evaluation Lab (Tokio Marine and Nichido Fire Insurance)
- Earthquake Disaster Prevention for Urban Areas Lab (OYO Corporation)

## Joint Research Division

- AEON Disaster-Resilient and Environment-Friendly City Creation Joint Research Lab
- Nippon Koei Resilient City with Digital Twin Technologies Joint Research Lab

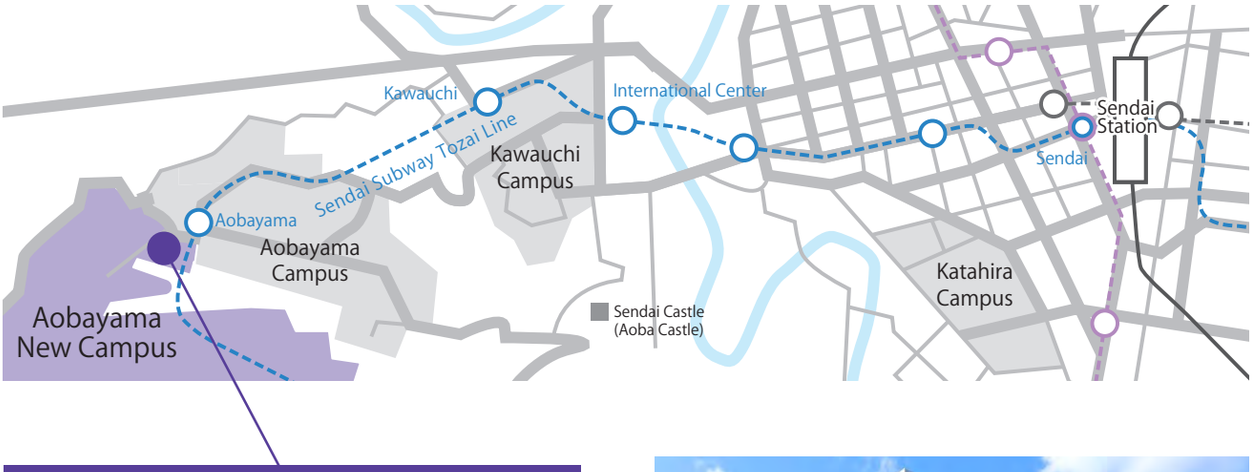
| | | | | |
|---|---|---|---|---|
| Co-creation Center for Disaster Resilience | Global Centre for Disaster Statistics | Kesennuma Satellite Office | Administration Office | Public Relations Office |

# TIMELINE

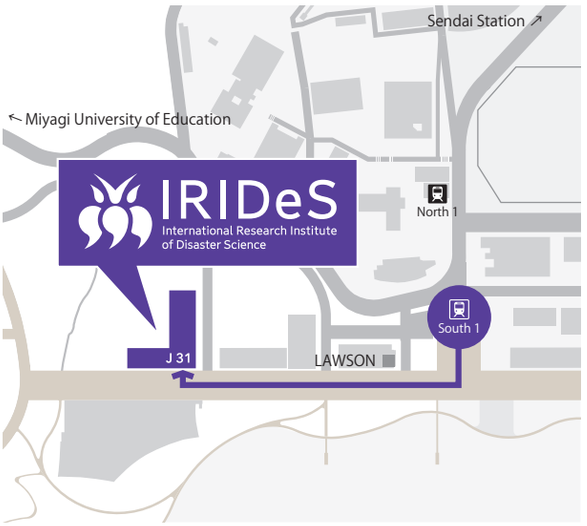
| | |
|---|---|
| April 2012 | IRIDeS established at Tohoku University, with Prof. Arata Hirakawa as its first Director |
| April 2013 | Satellite Office was established in Kesennuma City, Miyagi Prefecture |
| April 2014 | Prof. Fumihiko Imamura becomes the second Director of IRIDeS |
| March 2015 | Supported The Third UN World Conference on Disaster Risk Reduction held in Sendai. Sendai |
| April 2015 | Framework for Disaster Risk Reduction 2015-2030 became international policies.<br>IRIDeS and United Nations Development Programme (UNDP) establish the Global Centre for Disaster Statistics |
| From 2017 | The "World Bosai Forum/ International Disaster Risk Conference" starts to be held in Sendai City biannually |
| April 2022 | Co-creation Center for Disaster Resilience was established at IRIDeS |
| April 2023 | Prof. Shinichi Kuriyama becomes the third Director of IRIDeS |

# ACCESS

## Aobayama New Campus, Tohoku University




## IRIDeS Building




SUBWAY
Take the Sendai Subway Tozai Line from Sendai Sta., get off at Aobayama Sta. and walk for 3 min. from South 1 Exit.

TAXI
20 min. from Sendai Sta. by taxi (approx. 1,600 yen, depending on conditions).

TOHOKU UNIVERSITY


## IRIDeS, Tohoku University

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| | |
|---|---|
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