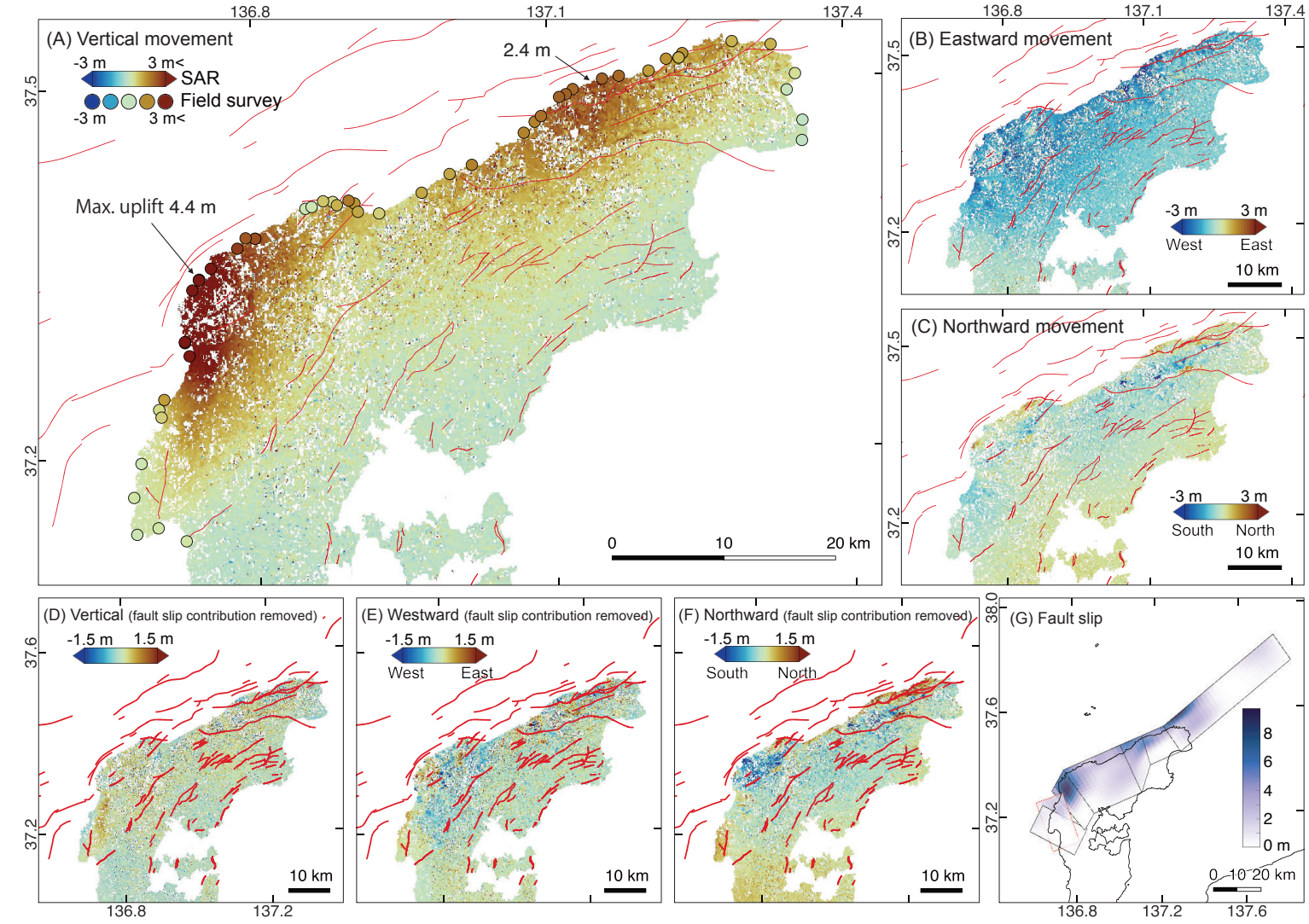
IRIDeS Newsletter

2025

International Research Institute of Disaster Science
Tohoku University

TOHOKU UNIVERSITY IRIDeS
International Research Institute of Disaster Science



From a published paper, "Landscape changes caused by the 2024 Noto Peninsula earthquake in Japan" (see p.3)

AIWEST-DR 2024

Children experimenting with how an earthquake occurs

Volunteer activity for a flood-damaged house in Noto

Topics

- Repeated large earthquakes have formed the modern landscape of the Noto Peninsula
- Working hard as a coordinator of reconstruction planning of the disaster-stricken city of Wajima, Noto Peninsula
- Reanalysis of existing weather data: towards a better understanding of climate change by reproducing extreme weather events

Looking back on 30 years of major disasters, and looking forward to tomorrow

We continue to face severe disasters. An earthquake of Magnitude 7.6 hit the Noto Peninsula around 4:10 p.m. on January 1, 2024. IRIDeS members gathered at the IRIDeS building around 4:30 p.m immediately after the earthquake to grasp the situation and sent a fact-finding team to the affected areas on January 4. IRIDeS held a debriefing session on January 9 to share our findings and expertise on the Noto Peninsula Earthquake and disseminated healthcare information such as how to prevent hypothermia and economy class syndrome, and precautionary measures to maintain mental health. Today we are still working with the people of the affected areas to make our support and expertise readily available.

Shinichi Kuriyama, Director
IRIDeS, Tohoku University

The years 2024 and 2025 have provided opportunities to reflect on past major disasters. On December 26, 2004, the Indian Ocean earthquake and tsunami occurred off the coast of Sumatra, Indonesia, killing an estimated 230,000 to 280,000 people. The 2nd UNESCO IOC Global Tsunami Symposium was held in November 2024 to commemorate the 20th anniversary of this occurrence. Many IRIDeS members participated in the symposium, giving presentations and discussing what disaster risk reduction measures need to be implemented based on the lessons learned.

January 17, 2025 marks the 30th anniversary of the Great Hanshin-Awaji Earthquake in Kobe. At that time, about 80% of deaths were due to houses collapsing or people being trapped under fallen furniture. We need to take this opportunity to rethink what are our priorities on our list for disaster preparedness. Furthermore, not only do we need to know what is essential, we need measures for implementation. I propose that we reconsider these points and put them into action as disaster risk reduction.

Activity

IRIDeS members spoke at the UNESCO-IOC Global Tsunami Symposium

Yuichi Ono

On the occasion of the 20th memorial of the 2004 Indian Ocean earthquake and tsunami disaster, the UNESCO Intergovernmental Oceanographic Commission (IOC) held the 2nd UNESCO IOC Global Tsunami Symposium from November 11 to 14, 2024, in Banda Aceh, Indonesia, bringing together stakeholders from governments and international organizations. From IRIDeS, Director Shinichi Kuriyama, Professor Yuichi Ono (2030 Global DRR Agenda Office), and Professor Shunichi Koshimura (Disaster Geo-informatics Lab) participated and spoke at the event.

Kuriyama talked about the Great East Japan Earthquake and Tsunami, the damage it caused, and lessons learned that can also be useful for other parts of the world. Ono shared his experience as a UN official setting up an early warning system for tsunamis using the framework of humanitarian assistance in the aftermath of the Indian Ocean tsunami.

Koshimura proposed the expansion of the "Real-time Tsunami Inundation Forecast System" developed by his research team as well as its forecast distribution service "TsunamiCast." This system uses a supercomputer to quickly estimate the conditions after an earthquake and deliver the information, including the location of expected tsunami occurrence, inundation areas, run-ups, and damage. In Japan, the system has been adopted by the Cabinet Office for disaster risk reduction measures and is being introduced to local governments through RTi-cast, a university-based start-up, in which Koshimura serves as the chief technology officer (CTO). "We are ready to provide its service for Indonesia and other countries," Koshimura said. Amazon Web Services (AWS), a leading cloud service provider, will cooperate in its overseas expansion.

The IOC is promoting the "Tsunami Ready" initiative in areas at risk of tsunamis in response to the call of the United Nations Secretary-General António Guterres's initiative "Early Warnings for All" (EW4All) to provide early warning systems for all by the end of 2027. The Tsunami Ready programme will help build tsunami resilience through awareness and preparedness strategies that will protect life, livelihoods, and property from tsunamis. Koshimura said, "There are only five years left until 2030, the target year for the Sendai Framework for Disaster Risk Reduction. We want to implement TsunamiCast in as many countries as possible, to make EW4All and the UNESCO vision of Tsunami Ready a reality." IRIDeS will continue its commitment to building tsunami-resilient communities throughout the world.

Shunichi Koshimura

Photos courtesy of BMKG. Copyright by Public Relations of BMKG.

Participating in AIWEST-DR 2024 held in Indonesia

Activity

The Aceh International Workshop and Expo on Sustainable Tsunami Disaster Recovery (AIWEST-DR) is held regularly to share the lessons learned from the 2004 Indian Ocean Tsunami, with the participation of researchers and practitioners from various countries. The 16th AIWEST-DR meeting was hosted by the Tsunami and Disaster Mitigation Research Center of Syiah Kuala University in Banda Aceh, Indonesia, on November 8-9, 2024, and about 20 faculty members from IRIDeS participated.

Among IRIDeS participants, Associate Professor Anawat Suppasri (Tsunami Engineering Lab) participated in a panel session on the first day, discussing tsunami countermeasures in his home country, Thailand, and in Tohoku. Associate Professor Sébastien Boret (International Research Collaboration Office) and Assistant Professor Hyejeong Park (International Cooperation for Disaster Medicine Lab) organized a special session on inclusive disaster risk reduction, disability, and education in Banda Aceh.

In addition, IRIDeS members and graduate students made 27 presentations, with Specially Appointed Professor Kozo Nagami (2030 Global DRR Agenda Office) and Associate Professor Elizabeth Maly (International Research Collaboration Office) receiving awards for the best presentations.

Elizabeth Maly (third from right) and Kozo Nagami (second from right) received awards for the best presentations.

IRIDeS faculty members taught about earthquake mechanisms in a public science event

Activity

IRIDeS faculty led by Associate Professor Shosuke Sato (Disaster Resilient Society Promotion Lab) have provided public lectures and events for the Miyagi 3.11 Tsunami Disaster Memorial Museum located in Ishinomaki City, Miyagi as part of a joint project between IRIDeS and Miyagi Prefecture entitled "Joint Research on Enhancing the Functions of the Miyagi 3.11 Tsunami Disaster Memorial Museum". On November 24, 2024, the prefecture and IRIDeS organized a public science event for children and parents, "Bosai Kids Park: How does an earthquake occur?," and Associate Professors Yo Fukushima (Inland Earthquake and Volcano Lab) and Ryuta Enokida (Earthquake Engineering Lab) served as lecturers. About 30 elementary school children and their parents attended.

Fukushima set up an experiment titled "Understanding how an earthquake occurs using odds and ends." In the experiment, the participants filled a box with pebbles and pulled it using rubber bands, as an analogy of plate subduction. Participants learned that the box slipped slowly and steadily when the box was light (an analogy to faults that do not generate earthquakes) but moved suddenly when the box was heavy (an analogy of earthquake generation).

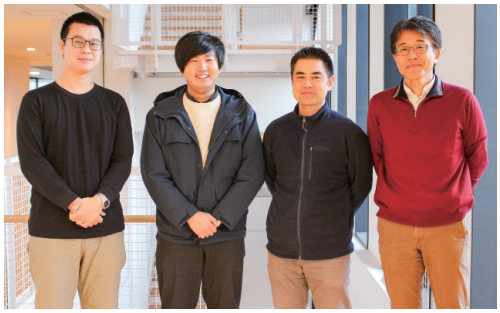
Enokida (center) conducting his experiment with participants on the natural period.

Enokida demonstrated how buildings are shaken by earthquakes, with a small experiment using pendulums of different lengths. This was conducted to let the participating children learn about the natural period, which is closely related to the influence of earthquakes on buildings. The experiment showed the participants that buildings behave differently depending on their height due to the different periods: high-rise buildings sway a lot under a long-period seismic motion, while low-rise buildings, such as regular detached houses, shake and rattle under a short-period seismic motion. The children were asked to calculate the natural periods with the help of the parents and then measure the actual periods of the pendulums.

Research

Repeated large earthquakes have formed the modern landscape of the Noto Peninsula

The Noto Peninsula is characterized by developed marine terraces, elevated steep cliffs on the northwest side, a gentle decrease of elevation toward the southeast, and numerous traces of landslides in the mountainous areas. Associate Professor Yo Fukushima and eight other researchers (affiliations: IRIDeS, Graduate School of Science, Tohoku University, Tokyo Metropolitan University, Oita University, and the German Research Center for Geosciences) examined topographic changes caused by the Noto Peninsula Earthquake that occurred on January 1, 2024. As a result, they found that the main geomorphic characteristics of the Noto Peninsula could be explained by repeated occurrence of earthquakes of the same kind. This finding was published in Science Advances on December 4, 2024.



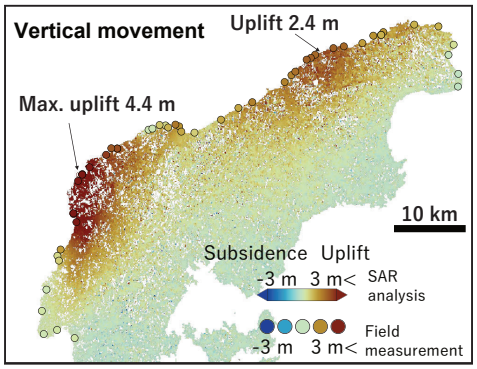
(From left) Chi-Hsien Tang, Takayuki Takahashi, Yo Fukushima, and Shinji Toda

Results achieved through a combination of satellite "birds eyes" and field "insects' eyes"

Team members specialized in geodesy, seismology, and geomorphology collaborated to obtain the results through a combination of satellite radar image analysis, fault-slip analysis, and field surveys. From IRIDeS, Fukushima took part in the geodesy team, Assistant Professor Takayuki Takahashi in the geomorphology team, Assistant Professor Chi-Hsien Tang in the seismology team, and Professor Shinji Toda in the seismology and geomorphology teams.

The geodetic team used the images of the Japan Aerospace Exploration Agency (JAXA) satellite ALOS-2 taken from different positions, directions, and incidence angles to construct maps of the three-dimensional displacements caused by the Noto Peninsula earthquake. The results showed more than 4 m of uplift along the northern coast of the peninsula, westward movement of the whole North Noto, and geophysical signals on the slopes in mountainous areas. The geomorphology team went into the field and measured the amount of uplift at 52 sites along a 120-km section of the Noto Peninsula coastline. The uplift distribution was in a good agreement with the results of the satellite image analysis, supporting their accuracy. The fault-slip model estimated by the seismology team could well explain the uplift and westward displacement patterns.

After subtracting the displacements due to the fault slip, the signals in the mountainous areas became clearer. They indicated movements of up to approximately 2 m over a wide area in the slope direction, suggesting that these signals were hillslope slumps. One moving block unit extended as far as nearly 20 km. Such wide-area slumps could only be captured by the satellite radar image analysis thanks to its ability to measure the movement of units whose surface features were unchanged. Along the Wakayama River valley, the deformation maps indicated slumps from both sides of the slopes and localized uplift. The geomorphology team conducted a field survey in the area and found scarps and signs of compressional deformation, consistent with the satellite radar image analysis.



Vertical displacements derived from the satellite radar image analysis.

Scarps along the Wakayama River.

Toward understanding of the genesis of earthquakes along the eastern margin of the Sea of Japan

It has been suggested that earthquakes (fault slips) have contributed to the landscape formation of the Noto Peninsula, but the details were unknown. This study showed for the first time that repetition of large earthquakes of the kind that occurred on the New Year's Day of 2024 can explain the landscape buildup. However, direct evidence of past recurrences of such large earthquakes is insufficient. A re-investigation of the terraces along the coast based on the findings of this study may be able to unravel the past earthquake activities.

Many offshore active faults have been identified along the eastern margin of the Sea of Japan. Devastating earthquakes such as the 1964 Niigata earthquake and the 1983 Central Sea of Japan earthquake (off Akita Prefecture) occurred in this zone. The findings of this study will greatly contribute to our understanding of the behavior of the offshore active faults along the Sea of Japan side.

Fukushima said, "We will be able to gain new types of findings as the quality of satellite data improves and as the analysis techniques become more advanced. We would like to unravel the mechanisms of natural phenomena by utilizing new technologies combined with careful field observation."

Published paper : Yo Fukushima, Daisuke Ishimura, Naoya Takahashi, Yoshiya Iwasa, Luca C. Malatesta, Takayuki Takahashi, Chi-Hsien Tang, Keisuke Yoshida, Shinji Toda, "Landscape changes caused by the 2024 Noto Peninsula earthquake in Japan," *Science Advances* Vol.10 No.49, DOI: 10.1126/sciadv.adp9193

Working hard as a coordinator of reconstruction planning of the disaster-stricken city of Wajima, Noto Peninsula

Activity

The Noto Peninsula Earthquake that occurred on January 1, 2024, severely damaged the city of Wajima, Ishikawa Prefecture. Professor Michio Ubaura, who specializes in urban planning, is involved in the city's reconstruction and urban planning. As the chairperson of the Reconstruction and Community Development Plan Review Committee, he is in constant dialogue with the local government and residents, frequently traveling between Wajima and Sendai. IRIDeS Public Relations Office reports on the Committee and Ubaura's efforts.

A collapsed office building, Wajima. October 26, 2024.

In Wajima, the earthquake destroyed more than 6,000 houses, and the ensuing fire burned the morning market, which was a center of tourism. More than 180 people died citywide (immediate deaths caused by the disaster and disaster-related deaths included). In addition, in September, heavy rain caused by the occurrence of linear precipitation bands damaged the city even further.

Stakeholders from local industries and citizens came together in May to start work on preparing The Reconstruction and Community Development Plan, which will serve as a framework for recoverys. At the fifth committee meeting on October 28, 2024, students from Wajima High and Monzen High Schools presented proposals for reconstruction, including "opening the high school grounds to the public" in the first half of the meeting. The details of the proposed reconstruction and community development plan were discussed in the second half. The committee members, presenters, and government officials actively exchanged questions and opinions. As the chairperson,

Ubaura listens to high school students' proposals at the Reconstruction and Community Development Plan Review Committee meeting in Wajima, Ishikawa Prefecture, on October 28, 2024.

Ubaura facilitated the discussion, adding explanations after questions and proposing ideas such as "If we include specific goal levels, such as how far we want to reach in the next three years, citizens can have more hope."

Ubaura has also provided advice regarding urban planning outside of committee meetings. According to him, the role of an expert in reconstruction planning is to facilitate coordination. "The leading players in the recovery process are the local people and not those who temporarily enter the city from the outside. If you want to build up the local people's commitment to a plan, it is essential to keep them involved in the process of formulating it. I place importance on making sure that they are not left out. Although I try to listen to all residents' voices, fulfilling all of them is difficult. Coordinating opinions, examining their validity as an expert, and finding the optimal solution for the whole is also a task expected of an expert," Ubaura says.

Drawing on experiences from East Japan Earthquake and offering wisdom that goes beyond them

Ubaura (left) volunteers with students from his lab cleaning mud from a house in Wajima, Ishikawa Prefecture, on October 27.

Ubaura has been involved in reconstruction and urban planning in Ishinomaki City, Miyagi Prefecture, and other areas affected by the 2011 Great East Japan Earthquake. Since the damage to Wajima was mainly caused by earthquakes, the perspective of reconstruction and town planning for Wajima is different from that in Miyagi Prefecture, where the major cause of damage was the tsunami. For example, the central theme in tsunami-affected areas might be mass relocation to higher ground and community development at the relocation site. In contrast, in earthquake-affected areas, the agenda may be how to rebuild a safe community at the original location. Another issue that surfaced in 2011 was how to deal with many vacant and abandoned houses and lots in affected areas. Ubaura has examined the factors behind this problem. However, with a further decline in the birthrate and an increasingly aging population, it is even more necessary to correctly assess the demand for housing relocation in Noto. Ubaura says, "As experts, our challenge is how much wisdom we can offer, drawing on the Great East Japan Earthquake and also going beyond this."

Ubaura visits the affected areas as frequently as possible to build trust with the local people. After heavy rains struck there in September 2024, he took time out from his work as a researcher in Sendai to volunteer in Noto, cleaning mud from flood-damaged houses. At the time of writing (December 6, 2024), the community development plan is in its final stage. Ubaura says he hopes to be involved in the long-term recovery of Wajima during the implementation of the plan in the future.

Research

Reanalysis of existing weather data: towards a better understanding of climate change by reproducing extreme weather events

"Reanalysis" is recalculating past weather data with the latest numerical models, enabling the reproduction of weather phenomena that caused disasters in the past and improving the accuracy of climate change forecasts. Professor Takeshi Yamazaki and his team have been working on the Long-Term Regional Reanalysis for Japan (RRJ-Conv)[1]. RRJ-Conv offers homogeneous data covering an extended period, approximately 60 years, from 1958 to the present; its data can reproduce the weather of Japan and its surrounding area within a narrow horizontal mesh spacing of 5 km. Their reanalyzed data is now complete and has been available for academic use since June 4, 2024. A paper on RRJ-Conv was also published on November 20, 2024[2]. Yamazaki talks about RRJ-Conv in an interview with the IRIDeS Public Relations Office.

Takeshi Yamazaki (Oceanic, Atmospheric and Outer Space Disaster Lab)

The creation of long-term, homogeneous, high-resolution reanalysis data completed

The Meteorological Research Institute, Japan Meteorological Agency and Tohoku University began collaborating on RRJ-Conv around 2018. Before that, other organizations, including the Japan Meteorological Agency, had worked on a reanalysis of the entire globe. However, the units of their reanalysis are coarse, such as a 40 km mesh, and thus unsuitable for understanding local weather conditions. Yamazaki and his team limited the scope of their reanalysis to Japan and its surrounding areas to create data with a finer mesh.

Long-term reanalysis data are essential to understand long-term climate change, but the data must also be homogenous over the chosen time span. Thus, Yamazaki and his team decided to use only conventional observation data available in Japan for the past 60 years, such as atmospheric pressure near the ground and weather data at high altitudes from radiosondes. The data would not be homogeneous if recently introduced observation data such as one from satellites and weather radar were included. According to Yamazaki, climate changes typically occur in ten- to twenty-year cycles. This means that 60 years of homogeneous data can provide about three cycles, which helps us to understand long-term fluctuations.

Research advances as supercomputer performance improves

This process of incorporating actual observation data into a numerical model and analyzing it, eliminating the gap between the model and reality, is called "data assimilation." This method has advanced dramatically thanks to improvements in computer performance. RRJ-Conv started out using RIKEN's Fugaku, but now mainly uses Tohoku University's supercomputer AOBA. While the basic data are "point" observations taken at particular locations, data assimilation makes it possible to simulate the weather even in locations with no observation points, such as an uninhabited mountainous area. With RRJ-Conv, it is now possible to reproduce the weather of Japan and its surrounding areas for the past 60 years on a 5 km mesh (and a 25 km mesh outside of the region, see Figure 1).

Meteorological resources to consider climate change adaptation

How can RRJ-Conv be utilized? One crucial application is to reproduce and understand weather phenomena that have caused disasters in the past, such as large typhoons and senjo-kousuitai (quasi-stationary band-shaped precipitation system). A senjo-kousuitai, for example, brings localized heavy rainfall in a short time, and is a phenomenon that was defined in the last few years. Reanalysis data enables us to study whether senjo-kousuitai occurred before it was defined, how the number of occurrences changed over years, and whether there have been regional differences.

Yamazaki and his team also work on future climate projections using a numerical model similar to RRJ-Conv. One of their recently published papers[3] evaluates how hourly and maximum daily precipitation across the Tohoku (Northeastern Honshu) region would change if average temperatures increased by 2 or 4 degrees Celsius, respectively. They predict precipitation increases in both cases. Since Tohoku has not had much experience with heavy rainfall, there are concerns about landslides and other disasters in the future.

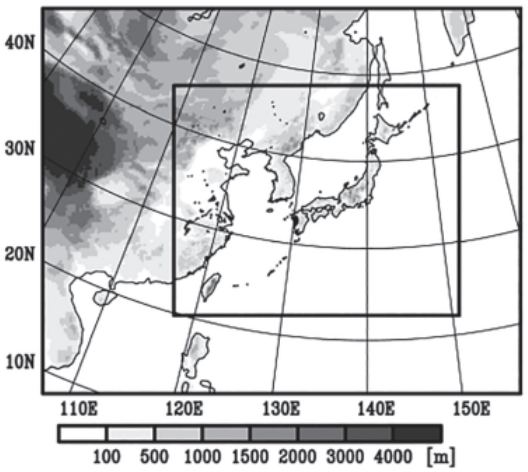


Figure 1 Subject Area.

According to Yamazaki, they would like to further refine their reanalysis, particularly its accuracy and reliability of reproduction. The weather is becoming extreme today. As their research progresses, it will provide an essential basis for considering adaptation measures in climate change in areas such as infrastructure development, water resources, agriculture, and tourism.

1) Web site of RRJ-Conv: https://wind.gp.tohoku.ac.jp/rrj-conv
2) Fukui, S., Shirakawa, E., Soga, D., Ohara, R. Usui, K., Takiguchi, K., Ono, K., Hirose,T., Matsushima, S., Ito, J., Yamazaki, T., Saito, K., Seko, H., and Iwasaki, T, 2024: Long-term regional reanalysis for Japan with assimilating conventional observations (RRJ-Conv). *J. Meteorol. Soc. Jpn.* 102(6), 677–696.
3) Suzuki, S., Morooka, H., Yamazaki, T., and Iwasaki, T., 2024: Future projection of extremely heavy rainfall in the Tohoku District of Japan with large ensemble simulations by 5 km regional climate model. *J. Disaster Res.* 19(6), 991-1005.

INFORMATION

World Bosai Forum 2025

Tohoku University will co-host the World Bosai Forum 2025 held at the Sendai International Center on March 7-9, 2025, with many sessions involving IRIDeS.
https://worldbosaiforum.com/en/

Giving to IRIDeS

Your donation to the IRIDeS Support Fund will help advance our activities in the research on disasters, disaster risk reduction and its social implementation. Please access the following website for details.
https://irides.tohoku.ac.jp/eng/outline/irides_fund.html

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- Nippon Koei Resilient City with Digital Twin Technologies Joint Research Lab

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INQUIRY

IRIDeS Public Relations Office
468-1 Aoba, Aramaki, Aoba-ku, Sendai, Miyagi, Japan 980-8572
Phone : +81-22-752-2049
Email : irides-pr@grp.tohoku.ac.jp
https://irides.tohoku.ac.jp/eng