International Research Institute of Disaster Science, Tohoku University
災害科学国際研究所 IRIDeS

Knowledge of disaster science for a secure and prosperous future

# IRIDeS QUARTERLY

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## Feature Articles



## *Story* Towards the Tohoku of the Future

**As a fishing boat unloads its catch, fish scales glisten in the morning light.**

The Marine Products Regional Wholesale Market in Sakanamachi, Ishinomaki City, suffered catastrophic damage from the tsunami. A makeshift tent was set up and delivery of fresh fish restarted only 4 months after the disaster. With its industrious spirit and pride as one of Japan's leading fishing ports for both size of catch and sales turnover, Ishinomaki realized a quick resumption of business. On the day the photo was taken (May 5, 2013), the fishing boat Sohomaru 63 was unloading its catch of bonito from the seas near Hachioji Island. Before being auctioned, the fish were checked for radiation and a nearby monitor displayed the results for all to see. Safety as well as freshness is guaranteed.

Photo: Hayato Ikegami (Wakabayashi-ku, Sendai City).

# Knowledge and Technology: from IRIDeS to the world United Nations World Conference on Disaster Reduction 2015

## - Sendai Hosting Confirmed -


(Photo 1) View of Second UN World Conference on Disaster Reduction held in Kobe City, Hyogo Prefecture, Japan, in January 2005. Jan Egeland, UN Under-Secretary-General for Humanitarian Affairs (at that time) appears on screen.

(Photo 2) Sendai International Centre and new adjacent conference facilities are scheduled to be used as the main conference venue. Plans include the use of the adjacent Tohoku University Centennial Hall (Kawauchi Hagi Hall) and Sendai Civic Auditorium for related events such as symposiums and seminars.
(Photo courtesy of Sendai Tourism and Exchange Office)

### Disasters have no borders. How to reduce human suffering and damage to society, economy, and the environment.

Between 600 and 800 disasters caused by natural hazards occur worldwide each year, causing great damage to human society. The immeasurable impact of disasters includes not only the loss of precious human lives but also the sudden destruction of assiduously built social infrastructure and the ruining of people's livelihoods. The economic losses due to disasters in 2011 are estimated to have exceeded 365 billion dollars (36 trillion yen), the largest in the last 10 years. About 60% of these losses were due to the Great East Japan Earthquake. (Figures from "World Disaster Report 2012," published by the International Federation of Red Cross and Red Crescent Societies).

With the goal of maintaining national and regional sustainable development, a forum for discussing guidelines for international efforts directed at disaster reduction and mitigation activities is provided by the World Conference on Disaster Reduction, hosted by the United Nations. The two previous Conferences on Disaster Reduction were held in Japan. The first Conference on Disaster Reduction, which took place in Yokohama in May, 1994, adopted a "Yokohama Strategy" comprising 2 basic understandings and a 6 point plan of action.

### As a university located in a disaster area, Tohoku is providing the world with knowledge and technology built up through harsh experience.

The second Conference on Disaster Reduction, held in Kobe City, Hyogo Prefecture, Japan, in January 2005, 10 years after the Great Hanshin-Awaji Earthquake (January 17, 1995) was influenced by the Sumatra–Andaman earthquake and Indian Ocean tsunami that had occurred just weeks earlier, on December 26, 2004. The conference showed a determination to tackle disaster reduction by combining the strengths of the international community. Over 4,000 people participated in the main conference, including 168 UN member countries, 78 UN and international organizations, 161 NGOs and the media, and over 40,000 people participated in forums open to the general public. Based on a review of the Yokohama Strategy, the conference adopted a "Hyogo Declaration" incorporating the following principles into a "Hyogo Framework for Action 2005-2015" as guidelines for the following 10 years: "All countries take primary responsibility for disaster reduction," "Residents and volunteers cooperate to build disaster resilient regions," and "Tsunami hazard maps are to be created to build warning systems." In addition, before concluding the conference a decision was taken to establish an International Recovery Platform based in Kobe and to build a regional Indian Ocean Tsunami Early Warning System.

In December, 2012, the UN General Assembly plenary session made a decision to convene the third World Conference on Disaster Reduction in Japan, in order to evaluate the Hyogo Framework for Action and formulate a global disaster reduction strategy for 2015 and beyond. Sendai City, which experienced the Great East Japan Earthquake, had already announced its candidature for hosting the conference, and the decision to hold the conference in Sendai was formally taken at the Global Platform for Disaster Risk Reduction organized by the UN International Strategy for Disaster Reduction, held in Geneva, Switzerland, from May 19 to 23, 2013.

A strategy with real force is needed in order to substantially reduce human suffering and damage caused by disasters to society, the economy and the environment. As a university located in a disaster area, Tohoku University, through the International Research Institute of Disaster Science (IRIDeS), has a vital role and high expectations to fulfill in linking its harsh experience of disasters to high level knowledge and technology, and in maintaining efforts to further accumulate knowledge for sharing with humanity. We at IRIDeS are redoubling our efforts to link our results to global disaster risk reduction.

Assistance and photo courtesy of Professor Yuichi Ono (International Research Institute of Disaster Science, Tohoku University)

# Weaving Our Hopes into Determination

IRIDeS Research Team Members ❷

## *Walking the disaster areas to see the depths of the catastrophe, How to build a disaster reduction strategy leaving no vulnerable people and minimizing damage.*

With a career in full bloom in US academia and then the United Nations, Yuichi Ono's 18-year overseas professional life reached a turning point with the Great East Japan Earthquake. He had to assist in some way. He moved to IRIDeS and set about using his wide personal network to provide powerful support for bringing the 2015 World Conference on Disaster Reduction to Sendai. As a result of his tireless efforts Sendai was selected as conference host (see also page 2). The World Conference on Disaster Reduction is expected to attract about 60,000 participants from all over the world. Much is anticipated from Professor Ono's career and his network of contacts throughout the world. (Reporting conducted: May 16, 2013).

**Yuichi Ono**

**Professor, International and Regional Cooperation Office, Disaster Information Management and Public Collaboration Division of the International Research Institute of Disaster Science, Tohoku University**

On March 11, 2011, when the Great East Japan Earthquake occurred, I was flying to Thailand from a business meeting in Nagoya. On arriving at Suvarnabhumi International Airport in the evening, I felt that there was something different from normal. In the car headed towards my place of work at the Economic and Social Commission for Asia and the Pacific (ESCAP) I got fragmentary information and understood that something terrible had happened in my home country.

Everyone remembers the tsunami that occurred after the Sumatra-Andaman earthquake in December, 2004. Immediately after that tsunami I was assigned to lead the building of the Regional Indian Ocean Tsunami Early Warning System. Because of its geology and geography, Japan has experienced many disasters caused by natural hazards and for this reason has become a leading country in the field of disaster-reduction, with a culture and technology in which the concept of "preparedness" is instilled. Thus the Indian Ocean Tsunami Warning System is receiving technical support from Japan. However, in spite of Japan's preparedness, many human lives were lost when nature showed its fury on that day in March, 2011. Even in the sweltering heat of Bangkok I felt a cold sweat running down my back.

My career plan had initially been to search for an explanation of the mechanism of tornado formation as a research scientist at a US university, but after visiting and walking through disaster-hit areas both within and outside the US, I turned my attention to the phenomenon of disasters that take away human life and cause great damage to society. On seeing the terrible scenes with my own eyes and meeting face-to-face with disaster victims, I noticed that there was considerable disparity in the level of damage suffered even within the same region. What forms the dividing line between life and death in a disaster? Clearly there are various interconnected reasons and no simple answer can be given, but in the first place, evacuation behavior may be cited. However, in the case of disasters that extend over a wide area, such as hurricanes, those in danger may have to remain where they are for economic reasons, even if they would prefer to evacuate. Moreover, in developing countries, the various types of warning system may not be established or there may not be sufficient information to make a judgment concerning evacuation. Unfortunately, it must be said that the present level of disaster literacy is not high. I believe that my embracing of the idea—close to a mission—to give more attention to "disaster vulnerable people" throughout the world was a turning point for me as a researcher.

Previous strategies to reduce disaster risk gave weight to rehabilitation and reconstruction after the disaster, but in recent years there has been an international consensus that vulnerabilities must be minimized in advance, emphasizing the importance of disaster reduction investment from the viewpoint of reduction and mitigation of disaster. However, due to lack of funding in some countries and regions, it cannot be said that present strategies are adequate.

At the UN World Conference on Disaster Reduction to be held in Sendai in 2015, in addition to an action policy directed towards disaster reduction in each country, it is planned to work towards the setting of more forceful numerical targets. Furthermore, it is hoped to attract international disaster reduction organizations to Tohoku as a base for transmitting special knowledge and technology from the disaster region. I hope to use my experience of being responsible for the secretariat at the Second UN World Conference on Disaster Reduction (Hyogo, 2005) and the human network I have built up over many years of service at the UN to provide important support for these plans.

**Yuichi Ono** received a Ph.D. in Geography (Climatology and Hazard) at Kent State University, Ohio, U.S.A. in 2001. He was a Junior Professional Officer at the World Meteorological Organization (WMO) in Geneva (2002-03), a senior officer at the United Nations International Strategy for Disaster Reduction (ISDR) in Geneva and Bonn (2003-09), and chief of the Disaster Risk Reduction Section, United Nations Economic and Social Commission for Asia and Pacific (ESCAP) in Bangkok (2009-12), before moving to his current position in November 2012.

◀Yuichi as he enters "Tornado Shelter No. 1" installed in Bangladesh (2012).

▲The International and Regional Cooperation Office is managed by Professor Ono and 5 staff members. The photo shows Yuichi meeting with Assistant Professor Ikeda.

# What magnifies the damage due to floods? The complex reasons for flood damage are examined from a scientific viewpoint

## - Jakarta (Indonesia) on-site survey of flood damage -

(Photo 1) View of Jakarta flooding, January, 2013. The floods were due to the complex interaction of various factors such as global warming, land subsidence, urbanization of upstream areas, insufficient urban sewage capability, and deterioration of drainage capacity due to the accumulation of sediment and garbage in waterways.

### Floods strike one of Southeast Asia's leading cities. Emergency flooding assessment team dispatched to study the causes.

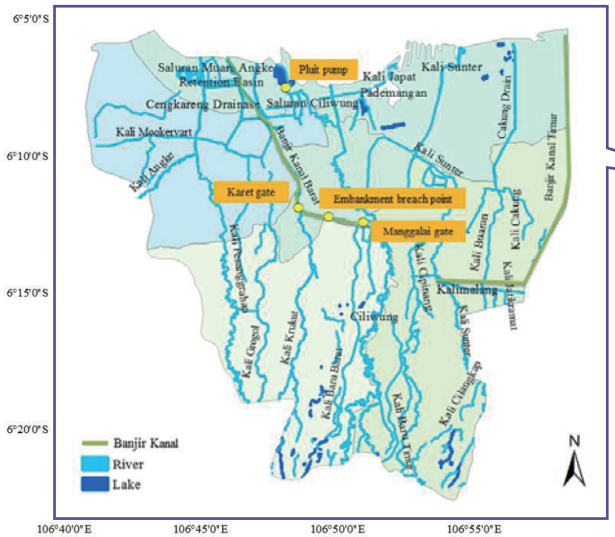
The Special Capital Region of Jakarta (referred to below as Jakarta) is Indonesia's capital and one of Southeast Asia's foremost cities. The metropolis lies just south of the equator, to the western side of the island of Java, with the Java Sea to the north. Over 9.6 million inhabitants live in an area of approximately 662 square kilometers. For reference, the 23 wards of Tokyo cover an area of 621 square kilometers and have a population of 9 million (estimate of Tokyo Metropolitan Government, Bureau of General Affairs), so that the two cities may be considered similar in scale.

While Jakarta has experienced dramatic economic growth in recent years and there has been rapid urban development, many problems have arisen due to delays in the development of social infrastructure, such as electrical power, transportation (roads, railways and buses), rivers, water supply and sewage system, and garbage and waste treatment plants. In addition, frequent large-scale flooding paralyzes urban functions and economic activity, threatening the safety and comfort of the inhabitants. Considerable flood damage was caused by the heavy rains brought by tropical monsoons in January of this year (January 15-18, 2013). Over 40 lives were lost in the floods, an area of 41 square kilometers (about 877 times the size of Tokyo Dome) was inundated, and over 45,000 people were forced to evacuate. Such large-scale flooding also occurred in 2002 and 2007, and it is feared that the urbanization of the drainage basin and increasing heavy rains caused by global warming will further increase the scale and frequency of such flooding. The International Research Institute of Disaster Science of Tohoku University dispatched an emergency flood damage assessment team to begin an investigation into the flood generation mechanism between February 10 and 14. Its goal is to propose various flood control measures to the Jakarta administrative agencies through surveys and analyses. An introduction is given below concerning characteristics of the 2013 Jakarta floods, outlining factors that have become evident based on the survey results.

### Rainfall concentrated in January and February. Various factors combine to worsen the flooding damage.

Jakarta has a tropical monsoon climate (Köppen climate classification), with an average daily maximum temperature of 31°C and an average minimum temperature of 24°C. While there is almost no variation through the year, the climate is clearly divided into a rainy season (November to June) and a dry season (July to October). The rainfall is heaviest in January and February, with these two months accounting for about 30% of the annual rainfall (approximately 1700 millimeters). (For comparison, the annual rainfall in Sendai is 1254 millimeters, based on figures from the Japanese Meteorological Agency). The large-scale flooding in Jakarta in recent years (2002, 2007 and 2013) occurred in the months of January and February. While Jakarta has 13 rivers, large and small, most of the flooding in the city area is due to overflow from the Ciliwung River that passes roughly through the center of the city region (Ciliwung River catchment area: 485 square kilometers; river length: 145 kilometers).

Through a series of detailed research activities, including information and data gathering from Jakarta government agencies and jurisdictional authorities, observations and



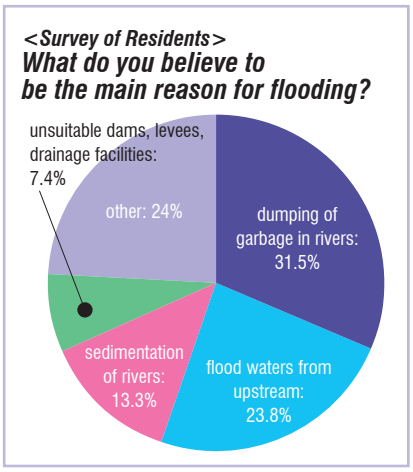


(Figure 2) Survey locations are indicated by yellow circles. Much of Jakarta's flooding is caused by the Ciliwung River that flows through the central part of the city, separating into the Western Floodway and the Old Ciliwung River. Since the presidential palace and other important buildings are located in the vicinity of the Old Ciliwung River, flows into the Old Ciliwung River are continuously controlled by the Manggarai sluice gate.

surveys of sluice gates, pumps, flood levee failure locations, and questionnaires completed by residents who were victims of the flooding, the emergency flood disaster assessment team of the International Research Institute of Disaster Science has further strengthened their view that various factors outside of the torrential rainfall accompanying the monsoons interacted to magnify the flood damage of January, 2013.

(Photo 3) On the left, Associate Professor Bricker (Hazard and Risk Evaluation Research Division) on a site visit to Manggarai sluice gate. Dr. Farid of Bandung Institute of Technology explains the sluice gate operation at time of flooding.

(Photo 4) Accumulated garbage at Karet sluice gate (photo: courtesy of Deltares). 30% of residents living in the river basin use the river for garbage disposal on a daily basis due to the garbage dump being far away, leading to serious social problems.




(Figure 5) A survey among 154 randomly selected residents living near the Ciliwung River indicates that 30% of the respondents believe the main reason for flooding in Jakarta to be due to garbage.

## Reasons for magnification of damage due to 2013 Jakarta flooding.

### (1) Effect of Upstream Urbanization

Accompanying the rapid urbanization of the drainage basin, hilly regions and green districts which the rainfall previously passed through have changed into impermeable areas with concrete and asphalt surfaces, and with less rainfall soaked up, the discharge response has become faster. That is, the flood water volume is increasing and the flood waters move downstream more quickly.

### (2) Effect of Land Subsidence

It is reported that from 1974 to the present there has been an accumulated land subsidence of up to 4 meters in the downstream coastal zone of the northern part of Jakarta. With the elevation of most of the northern downstream coastal zone being lower than average sea level (an elevation of 0 meters), rain water and flood waters tend to collect, and drainage to the sea and water channels is difficult.

### (3) Insufficient Municipal Effluent Capacity

One of the 3 pump houses at the Pluit Pump Station that is responsible for the drainage of about 80% of the Jakarta central district, the East Pump Station (having a drainage capacity of 18 cubic meters per second) was being repaired when the flooding occurred. In addition, another of the pump houses (Central Pump Station, having a drainage capacity of 16 cubic meters per second) was incapacitated due to inundation of the pump station itself, while the remaining pump house (West Pump Station, having a drainage capacity of 13.3 cubic meters per second) lost power due to flooding of its external power supply, so that the entire rainwater drainage capacity of the Pluit Pump Station was temporarily halted. Henceforth it will be important to ensure drainage capability within Jakarta city through the maintenance of pump stations and through robust countermeasures against inundation of facilities and external power supplies.

### (4) Accumulation of sediment and garbage

With the accumulation of sediment and garbage in river channels and waterways, there has been a large deterioration in drainage capacity (Photo 4). Basically, the river basins on the island of Java experience much erosion, with considerable discharge to river channels and consequent accumulation. Consequently, in order to have water drainage capacities in accordance with design specifications, periodic dredging is necessary. However, according to interviews conducted, such dredging has not been carried out for over 10 years.

### (5) Local failure of river levees

The flood damage to the Jakarta central district was magnified by a break in the levee of the Western Floodway. Basically, the height of the levee at the location of the failure in the flood control channel is lower than at other locations, and it is possible that flood discharges built up and eventually overtopped the levee or seeped along a structure built improperly upon it, causing the levee to fail.

## Urgent Upgrading by Government and Municipalities. Flood Control Aided by Scientific Knowledge.

A number of Nikkei listed companies with operations in Jakarta have implemented their own flooding countermeasures, from the maintenance of concrete levees and provision of drainage pumps to the preparation of sandbags and warning systems, and thus avoided flood damage. However, it cannot be said that the residents and communities living along the rivers have separately prepared in a practical way for flooding risks, and thus river upgrading and flood disaster prevention measures are left to the government and municipalities.

By employing various types of analysis using further survey data collection and rainfall run-off and flooding models (Farid, Mano, Udo: Journal of Disaster Research, 2012) to develop related expertise, the International Research Institute of Disaster Science of Tohoku University hopes to link effective and efficient flood control measures with quantitative evaluation. Jakarta is now enjoying economic development in what may be called a “golden period of growth.” For further prosperity, the building of a city that is resilient against flooding is an urgent task.

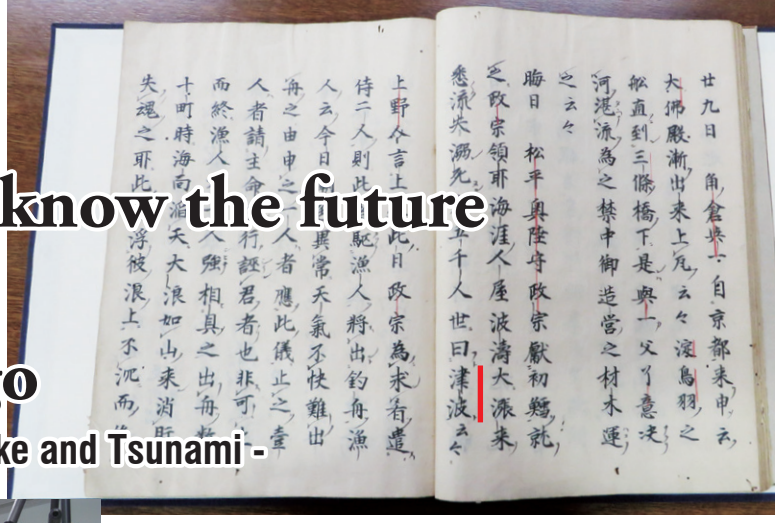
Figure and photo provided by: Shuichi Kure (Assistant Professor), J. D. Bricker (Associate Professor), Dr. Abdul Muhari (Hazard and Risk Evaluation Research Division) and Yo Fukutani (Research Associate, Endowed Research Division.)

# We look to the past to know the future New Interpretation of a Disaster 400 years ago

## - Historical analysis of the Keicho Earthquake and Tsunami -

▲(Photo 1)Survey of tsunami deposits at Matsukawaura, Soma City, Fukushima Prefecture

▲(Photo 2)Assistant Professor Ebina surveys Edo-era manuscripts in Iwate Prefectural Library



▲(Photo 3)Sunpu Political Records" (Tohoku University Library Collection). The oldest documented example of the word "tsunami", which has now become an international word.

▶(Photo 4) (A portion of) the equestrian statue of Date Masamune. After the Keicho Earthquake and Tsunami, Masamune encouraged the development of new rice fields and salt farm businesses. These policies are considered to relate to rehabilitation of the disaster affected areas. (Photo courtesy of the Sendai Tourism and Exchange Office)

### The Keicho Earthquake and Tsunami disaster experienced by Masumune is explained through contemporary historical records.

The feudal lord, Date Masamune (1567-1636) sought direct trade with Mexico (ruled by Spain at that time), and dispatched Hasekura Tsunenaga to Europe (Keicho mission to Europe). In June 2013, the 400th anniversary of when the ships put to sea, records of the mission held by Japan and Spain were registered in UNESCO's "Memory of the World Program". This event is now attracting attention as a pioneering mission in diplomatic relations with Europe.

Two years before the departure of the delegation, on October 28, 1611 (Keicho year 16), the Tohoku region was struck by the Keicho Earthquake and Tsunami (referred to below as Keicho Tsunami). A foundation for historical discussion as to the scale of the disaster and the extent of the damage is provided by historical resources that record events of the time. Contemporary historical records (written at the time) concerning the Keicho Tsunami include: "Sunpuki" in which the personal attendant of Tokugawa Ieyasu recorded the tsunami damage related by Masamune, diaries of court nobles staying in Edo, and the "Vizcaino report" written by the Spanish explorer Sebastian Vizcaino (1551-1615) who encountered the tsunami at sea (Vizcaino received support from Masamune to survey the Sanriku coast. After completing his work in Japan he boarded a ship in the European mission described above and returned to his native country.) Some tsunami researchers, however, believe that the testimony of Masamune and Vizcaino is fictitious, and that the Keicho Tsunami may not have been accurately analyzed and evaluated. In the field of Preservation of Historical Materials, in the International Research Institute of Disaster Science, a reassessment has been made of contemporary historical records of doubtful authenticity in view of the historical background at the time. Thus a description of the Keicho Tsunami emerges that is different from the previously accepted one.

### Messages (historical records) from predecessors who survived the disaster should be used to provide insight and predictions for the future.

Among the historical records so far reassessed is the Sengan-matsu legend that appears in the Sunpu political records. According to the legend, "Fishermen were out at sea catching fish for Masamune when the tsunami struck. Miraculously their boat didn't sink and they were washed ashore as far as a pine tree at the summit of Mount Sengan in present day Iwanuma City, Miyagi Prefecture. They tied their boat to the pine tree and escaped, and when the tsunami receded, the boat was left on the treetop." Mount Sengan is located 8 kilometers inland from the coast and has an elevation of 186 meters. It would be hard to imagine the occurrence of a tsunami that could reach this far, and it is said that this story is Masamune's creation in which he linked the Jogan tsunami (869) and the Keicho tsunami. However, on reviewing the historical terrain from ancient pictorial maps and other historical resources, the old Abukuma River is understood to have branched near Mount Sengan, with the original flow being close to Mount Sengan. A situation could well be conceived in which a tsunami flowing upstream along the old river channel could reach the foot of Mount Sengan.

The scale of the earthquake that caused the Keicho Tsunami appears to be of magnitude 8.1, similar to that of the Showa Sanriku Earthquake (1933). However, based on multiple reviews of historical resources where only shallow analysis was performed, it is believed that the earthquake was of the same scale as the Great East Japan Earthquake, with a magnitude exceeding 8.5. Based on the collaboration of humanities and science researchers, including tsunami deposits survey results (photo 1) and numerical simulation based on numerical analysis, it is anticipated that further details will be clarified.

Subsequent to the Great East Japan Earthquake, the expression "a disaster that occurs once in 1000 years" was frequently used. However, if the Keicho Tsunami that occurred 400 years ago is taken to be of the same level as the recent disaster, a shorter frequency of recurrence must be considered. History consists of "reflecting on the past to ponder the future." We must look into the future, by studying the messages left by our predecessors about their experience of disasters, without dogma or prejudice.

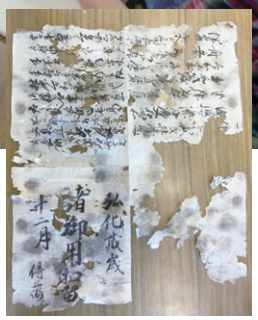
Assistance and photo 2 provided by Assistant Professor Yuichi Ebina (Human and Social Response Research Division, Preservation of Historical Materials)

# Rescue of dormant treasures of the region

## - Preservation of historical matter damaged in the disaster -

▶ (Photo 1)Restored ancient documents are photographed one by one by a digital camera to be stored in a database. The task has been undertaken by volunteers of the Miyagi Network for Preserving Historical Materials NPO.

◀ (Photo 2)Document rescue site at Shizugawa, Minami-sanriku-cho, Miyagi Prefecture, June, 2011. Old houses built over 300 years ago were damaged by the tsunami, and large amounts of stored ancient documents were on the verge of being ruined. The owner and Prof Hirakawa stand near the entrance of the house.



▶ (Photo 3)Damaged ancient documents in Ishinomaki City, Miyagi Prefecture. There is a constant search for methods of efficiently and accurately repairing ancient documents that have been damaged or degraded.

### Unmatched in the world, both in quality and quantity. Archives that communicate ancient politics, economy, and living culture to the present.

In a storehouse of patrimonial treasures where antiquities are set out for appraisal, if you see someone scrutinizing ancient manuscripts written in black ink, that person is probably an historian. For someone who researches the antiquities, ancient manuscripts are treasures that provide new information for historical interpretation.

The study of history is based on historical resources that include textual information and drawings written on paper, wood strips and lithographs, as well as relics and artifacts, and orally transmitted narratives. Among these, documents created in the past, generically referred to as ancient manuscripts, are the keys to opening up historical research. In Japan, past records created between the Warring States period and the Edo period remain in regional communities and exhibit a diversity and richness in both quality and quality not seen in other countries or regions. The reason for this would appear to be the high literacy rate of early modern Japan.

The preservation and transfer of ancient manuscripts was the responsibility of former influential personages and communities. However, in recent years with the falling interest in historical resources, generational changes, and the rebuilding or disposing of houses and land, such items have often been scattered and lost. This has been further exacerbated by natural disasters such as earthquakes, tsunamis, and storm and flood damage. After a disaster, recovery and rebuilding of livelihoods are given top priority, and large amounts of precious historical resources are often discarded.

Among historical resources that may disappear are records of past disasters, with information about what calamities a region has suffered and how hardships were faced or overcome. By rescuing and preserving historical resources for analysis, the experience and wisdom of our ancestors must continue to be passed on.

### As signposts for restoring the culture and characteristics of the disaster areas, historical resources form community memories.

The activities of the International Research Institute of Disaster Science in the Preservation of Historical Materials field began with the earthquake of northern Miyagi in July, 2003. Preservation activates after a disaster strikes are sometimes chaotic, so in normal times it is vital to confirm the whereabouts of ancient documents. Therefore, a mechanism has been built to share information on locations containing historical resources (with the approval of the owners) with local government personnel, cultural property protection committee members and local historians, so that rescue of historical resources can be performed swiftly and cooperatively when there is a disaster. At the same time, there has been an expansion of staff with historical knowledge and the ability to read ancient documents, so as to provide consultation concerning preservation and transfer of resources. By actually reading the ancient documents and conveying information on the content and value to the owners, motivation to protect the resources is rekindled.

In the Iwate-Miyagi Nairiku Earthquake of 2008, by entering the area promptly after the quake a survey team was able to rescue and preserve valuable historical resources. The historical resource preservation technologies developed in this field include information sharing and repair (particularly flood damage and desalination), and digital recording. This strategy has become known nationally as the “Miyagi Method” and has been embraced in similar activities in various regions.

The Great East Japan Earthquake of March, 2011 brought catastrophic damage to many areas, to the extent that no traces of the previous state remain. It is as if the destroyed areas had their history stopped, while in adjoining areas history proceeded normally. However, the historical resources that managed to survive can transmit former lifestyles, culture and folk customs. The records left by predecessors form the memory of communities, and provide important links for restoring the personality, charm and natural features of the area in bygone days. We should listen carefully to what our historical resources tell us. They form a link between the past and future.

Assistance and photos 2 and 3 courtesy of Assistant Professor Masashi Amano (Human and Social Response Research Division, Preservation of Historical Materials)

# Weaving Our Hopes into Determination

IRIDeS Research Team Members ❸

## *History is a type of romance—an "everlasting hypothesis" floating in the sea of time. With ancient documents as our guide, we steadily compile analyses and proofs*

In projects undertaken by our predecessors, including selection of sites for castles, maintenance of roads and town construction, the impact of natural disasters was carefully considered. This historical observation has been getting attention more than ever after the Great East Japan Earthquake. The hints provided by the experience and wisdom of our predecessors are to be found in ancient documents recording the events of the time, a field of study where the International Research Institute of Disaster Science is involved in conservation. Professor Hirakawa, an expert in the history of early modern Japanese political economy, describes the difficulties and the appeal of historical research. (Interview conducted: June 24, 2013).


**Arata Hirakawa** | Professor
Director, International Research Institute of Disaster Science
(Human and Social Response Research Division, Preservation of Historical Materials)


It is said that our thoughts and perceptions are formed by our experiences. Thus, experience has meaning and significance not only at the time of an event but also in our subsequent behavior. For me personally, a formative experience that opened my eyes to history was an "ancestor festival" held by the Hirakawa family. Once a year our relatives gathered to remember ancestors, studying the family tree and listening to heroic tales and chronicles that enthusiastically describe the family heritage. Thinking about it now, I realize that creative additions were probably made to these orally transmitted stories, but they awakened in my child's mind the fact that I was a member of the unbroken Hirakawa family line.

This narrow interest in my family tree and local history developed into a wider historical perspective when I came into contact with ancient documents after entering university. In history there are certainly huge amounts of prior work, and students learn about thinking modes based on the work of pioneers. When analyzing ancient documents, it came to my notice that there were places in certain established theories where interpretations are possible that differ from conventional views of history. At that time, I was in my third year as an undergraduate. To raise an objection to mainstream theory requires courage, but when I made a presentation in my laboratory, I received unexpected appreciation from my academic supervisor, who commented, "This is very interesting. You should continue your research." In the ten odd years that followed, there were many trials and tribulations, including some severe criticism, but fortunately many people expressed interest in my ideas. I believe my tough battle has been rewarded.

**Arata Hirakawa** Professor, Tohoku University, Director of the International Research Institute of Disaster Science, received a Master's Degree in the Faculty of Arts, Tohoku University, in 1980. He worked as a Research Assistant in the same department, before being appointed Assistant Professor at Miyagi Gakuin Women's University, then Assistant Professor in the Faculty of Arts in Tohoku University, Professor at the Center for Northeast Asian Studies in Tohoku University in 1996, and Director of the Center from 2005 to 2007. He moved to his present position in April, 2012. He holds a PhD in literature and specializes in history of early modern Japanese political economy. Originally from Fukuoka, he serves as Director of the Miyagi Network for Preserving Historical Materials NPO and enthusiastically engages in many extramural activities.

Historical research is said to be a conversation with the past. While ancient documents that are primary historical sources (contemporary records) are guides, clearly this does not mean that primary historical records contain only facts. Historical researchers must always be very careful with regard to proof and criticism, but certainly primary historical sources constitute a lifeline that provides new information for solving historical problems. This is the reason that the research field concerning the preservation of historical materials in our research laboratory is passionately focused on the rescue and conservation of historical resources affected by disaster (editorial note: details are provided on page 7 of this newsletter).

Historical interpretations are destined to take on value judgments particular to the times they are made in. That is, since historical researchers live in the "present," they cannot escape from the characteristics of their time (modernity). Nevertheless, in facing the challenge of history an approach is required that looks hard at ancient documents and materials without bias, prejudice or preconceptions. No matter how trivial, should something out of place or something noticeable be found, thought must be given to its sources. I believe this is what provides originality in historical interpretation.

Much of history is not settled, and many historical facts have been rewritten by the discovery of new primary historical sources with high credibility. History is an "everlasting hypothesis" that may well be revised in the future. "The romance of history" may be a somewhat clichéd expression, but as long as there are unsolved mysteries, the romance will continue.

▲Survey of earthquake-damaged storehouse (Kurihara City, Miyagi Prefecture).

▲The piles of cardboard boxes contain historical materials rescued from areas affected by the disaster in the Great East Japan Earthquake. With over 50,000 items, it is estimated that the task of cleaning and photographing each one for storing in a database will take at least 5 more years. On a national level, there are huge numbers of "dormant" historical materials.

# Front Line Research 01


Professor Masuda speaks at an international conference related to the Great East Japan Earthquake, held in Seoul University on March 11, 2013. He introduces four uncertainties affecting reconstruction of the Tohoku economy.


**Satoru Masuda**

Professor, Regional Planning and Economic Policy, Graduate School of Economics and Management;
International Research Institute of Disaster Science, Social Systems for Disaster Mitigation (concurrent), Tohoku University


Satoru Masuda graduated from the University of Tokyo, Department of Urban Engineering, in 1982 and received a Ph.D. in Urban Engineering from the same university in 1987, before joining Mitsubishi Research Institute as a research scientist. After becoming a lecturer in the Faculty of General Education, Tohoku University, in 1990, he was appointed Assistant Professor in the Graduate School of Information Sciences, Tohoku University, in 1993, before moving to his current position in 2000. He serves as representative director of the Urban Policy Forum, representative director of the Tohoku PPP/PFI Association, and representative director of the Tohoku Community Consortium.


Following the publication of "Great East Japan Earthquake and Tsunami Reconstruction Planning Research Vol. I" in March, 2012, a second volume was published in March, 2013. These publications cover research results in the main working groups of the Regional Industry Reconstruction Research Project (Research Center headed by Satoru Masuda) Graduate School of Economics and Management, Disaster Reconstruction Center, (Japanese website: http://www.econ.tohoku.ac.jp/rirc/shinsai/).

## Disparities in reconstruction seen in many areas. Regional problems that were becoming apparent prior to the disaster are proving obstacles.

Two and a half years have passed since the Great East Japan Earthquake. From the chaos and economic decline caused by the disaster, the economy of the Tohoku region began to recover six months later due to disaster-related emergency demand for construction and a resumption of economic activity in some of the disaster areas. From the start of 2012—set as year-one for recovery—a large increase in public investment was noted along with demand for rebuilding of housing in the disaster areas. At the start of 2013, there was a lull in the recovery, but the slowdown in production stopped in April, and the recovery is continuing (Bank of Japan, Regional Economic Report). However, if we turn to the local economy in towns and villages, industrial parks, and shopping districts, a sharp contrast emerges, with some areas returning to a level of activity they had prior to the disaster, but other areas showing stagnation or decline. Looking at industrial categories, disparities have increased between business sectors such as construction and real estate where the situation is better than prior to the disaster, and other sectors such as agriculture, forestry and fisheries where there has been significant deterioration (refer to part 1 of the above document: Earthquake Reconstruction Business Survey, 2013).

Basically many regions in Tohoku have problems such as regional economic decline and impoverishment due to the decreasing birth rate and aging society, the outflow of population and shortage of people able to take on roles of responsibility, in addition to deterioration in public services accompanying the scaling down of administrative and fiscal functions. It has been pointed out that this structural background has made reconstruction even more difficult.

## Real reconstruction cannot be achieved without innovation. Adoption of a new departure, while embracing outside support.

In the disaster areas, we come across cases where the older generation has abandoned resumption of business due to the lack of successors. As has been reported in the media, this trend is particularly strong in agriculture, fisheries and marine product processing industries in coastal areas. In the midst of this attrition in the basic economic strength of the region it is not possible to open up a new future by clinging to former ways, without innovation and new departures. Furthermore, the possibilities are limited with only internal efforts in the disaster areas.

At present, the economy of the Tohoku region is being dragged along by special reconstruction demand. In order that this activity does not turn out to be a temporary measure, it is necessary to consider policies for stimulation by private investment and outside support—for example, non-government manpower with immediate work potential. Of great value are those with coordination skills and knowhow together with experience in business planning and implementation, who can wake up the potential of the disaster areas. Support funding and branding of local products in reconstruction regions has already started in some areas. In order to speed up this action, the "Regional Innovation Producer School" of the Graduate School of Economics and Management, Tohoku University, has begun the training of people with the motivation and ability to create social change in the various parts of Tohoku.

In the reconstruction of disaster areas confronted with many complex problems an approach is required that questions conventional value assumptions. A university is the natural place to carry out reconstruction research and provide innovative policy proposals with a new flexible view different from that of government and the private sector, aimed at finding long-term sustainable solutions to regional problems. Our work will continue to provide academic knowledge contributing to the reconstruction of regional industry.

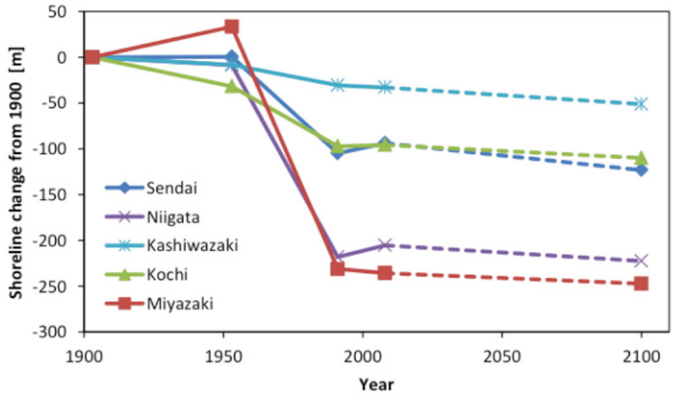
***The third year of reconstruction is a crucial time. As a university in the disaster region, we must provide innovative reconstruction research and policy proposals to create new "regional value".***

## Five papers related to Coastal Engineering published in the Journal of Coastal Research. Scientific expertise directed at climate change policies in Japan.

01

The 12th International Coastal Symposium (referred to below as ICS 2013) took place in Plymouth (UK) from April 8 to 12, 2013. Five research papers by Professor Akira Mano and Associate Professor Keiko Udo (both affiliated with the Hazard and Risk Evaluation Research Division) were presented. The ICS is held every 2 years, and in 2013, 369 full (academic) papers were accepted from approximately 800 paper abstracts. Symposium participants included researchers and experts from not only coastal engineering, but also those from fields dealing with nature and life, and economics, and the themes discussed covered the entire domain of coastal research.

Among the 5 papers presented at ICS 2013, "Potential impact of climate change at five Japanese beaches" used past sandy-beach data and future data predicted with rising sea levels at 5 coastal areas, Sendai, Niigata, Kashiwazaki, Kochi and Miyazaki, to comprehend sand erosion in Japan from the beginning of the 20th century to the end of the 21st century, and to forecast future erosion. The impact of sand erosion due to the 2011 tsunami along the coast of Sendai was also evaluated, and it was made clear that the impact was significant in comparison with past erosion. Furthermore, it was predicted that by the end of the 21st century, erosion of between 10 meters and several times that amount will occur along these coasts. These results will be used as scientific grounding for climate change policies in Japan.




Change in shoreline (full line) and predicted shoreline change to the end of the 21st century (broken line) along the coast of Sendai, Niigata, Kashiwazaki, Kochi and Miyazaki, from 1900 to 2008. The phenomenon of receding shorelines due to factors such as postwar rapid coastal development and dam construction was observed, but in recent years the shoreline has been relatively stable due to the effect of shoreline erosion countermeasures. It would appear that rising sea levels accompanying climate change will be the principal trigger for future shoreline erosion.

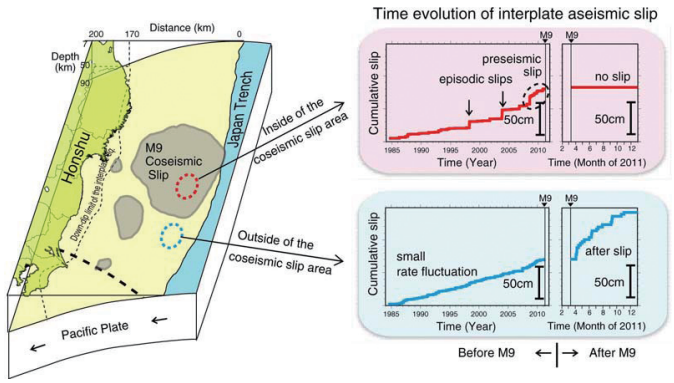
Potential impact of climate change at five Japanese beaches, Journal of Coastal Research (2013), Sp. Iss. 65, 2185-2190, Yoshida, J., K . Udo, Y. Takeda, and A. Mano. 778

## Estimation of spatiotemporal variation of aseismic slip. Manifestation of conspicuously different motion before and after 2011 Tohoku-oki Earthquake.

02

An earthquake is a phenomenon that rapidly releases strain energy accumulated in the earth's crust or mantle. According to research in recent years, it is known that aseismic slip (slow slip) at plate boundaries, part of long-term inter-plate motion (displacement) is closely related to the mechanism that causes major earthquakes.

Assistant Professor Naoki Uchida's group (Research Center for Prediction of Earthquakes and Volcanic Eruptions, Graduate School of Science, Tohoku University; Seismic Hazard Research, Disaster Science Division, International Research Institute of Disaster Science (concurrent)) has attempted an estimation of spatiotemporal variation of "aseismic slip" over a period of approximately 30 years before and after the Tohoku-oki Earthquake of March 11, 2011 (magnitude 9). Their research clarified that: a state with weak interplate coupling was observed in the approximately 3 years preceding the earthquake around the source region (upper right graph); aseismic slip in the coseismic slip region at the time of the 2011 earthquake stopped after the main shock (upper right graph); and in the surroundings, a large after-slip of up to 1.6 meters occurred in the 9 months following the main shock (lower right graph). These points are considered to represent differences in frictional properties inside and outside the coseismic slip region at the time of the earthquake, and the release of strain energy due to the main shock. Gradually and steadily proceeding aseismic slip around the earthquake source may represent the precursor for an earthquake, and further results are anticipated from ongoing research.




Schematic view (left) of slip distribution at time of earthquake at plate boundary and estimated aseismic slip in the coseismic slip region of the Tohoku-oki earthquake (pink) and outside of the region (blue). While slip is observed prior to the M9 earthquake within the slip area at the time of the Tohoku-oki earthquake, a large slip is observed after the earthquake outside the source area.

Paper title: Pre-and post-seismic slow slip surrounding the 2011 Tohoku-oki earthquake rupture
Authors: Uchida, N., and T. Matsuzawa
Journal : Earth and Planetary Science Letters
The complete paper is available at:
http://www.sciencedirect.com/science/article/pii/S0012821X13002665

## Explaining tsunami damage to buildings according to structural materials and location characteristics: an important pointer towards future disaster reduction planning. 03

About 400,000 buildings were partly or totally destroyed by the tsunami caused by the Great East Japan Earthquake. Including buildings suffering some damage, the total rises to over 1,150,000 (Report by Fire and Disaster Management Agency, Disaster Control Headquarters, March 2013). Associate Professor Anawat Suppasri's group (Earthquake Induced Tsunami Risk Evaluation Division) studied how buildings were damaged according to the depth of flooding due to the tsunami, based on tsunami inundation depth and building damage data (approximately 250,000 buildings) collected by the Ministry of Land, Infrastructure, Transport and Tourism. His group also studied related fragility functions. This research differs from similar previous surveys by clarifying for the first time the influence of structural materials and number of stories of buildings, in addition to coastal topography (ria or plain).

According to the research, reinforced concrete and steel buildings are more resistant to a tsunami than wood or masonry buildings, and buildings of three stories or more were confirmed to be stronger. For the same tsunami inundation depth, the extent of damage to buildings on the Sanriku ria coast was much greater than that on the coastal plain of Sendai. It is anticipated that these findings will be useful in future building damage assessments, land use management and disaster reduction strategies. It is to be noted that this research was carried out with the Institute for Risk and Disaster Reduction, University College London, which exchanged a memorandum for joint research in March, 2012. This may be cited as an accomplishment of Japan-UK academic exchange.

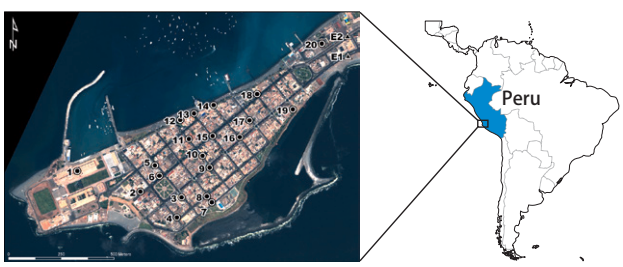
Paper Title：Building damage characteristics based on surveyed data and fragility curves of the 2011 Great East Japan tsunami
Authors：Anawat Suppasri, Erick Mas, Ingrid Charvet, Rashmin Gunasekera, Kentaro Imai, Yo Fukutani, Yoshi Abe, Fumihiko Imamura
Journal：“Natural Hazards” March 2013
The complete paper is available at: http://link.springer.com/article/10.1007%2Fs11069-012-0487-8#

## Evacuation is the best defense. A casualty evaluation and evacuation model independently developed by our research laboratory provides strong support for disaster reduction planning in tsunami risk regions. 04

The tsunami caused by the Tohoku and Pacific Ocean earthquake destroyed or overran counter-tsunami structures such as breakwaters, seawalls, and coastal dykes, inundating many inhabited areas in the region. Nevertheless, about 90% of the inhabitants living in tsunami risk areas survived by quickly evacuating to higher ground or inland areas, showing that evacuation is the most effective defense against a tsunami.

Assistant Professor Erick Mas's group (Laboratory of Remote Sensing and Geoinformatics for Disaster Management, International Research Institute of Disaster Science, Tohoku University) has developed a new evacuation model integrated with numerical simulation for casualty evaluation. The research is distinguished by modeling the complex behavior of people when evacuating (Agent Based Modeling: ABM), and making evacuation predictions, in addition to enabling estimation of human casualties according to depth of inundation and flow velocity. Geographic Information Systems (GIS) are used in association with the model to provide information for evacuation routes and shelter locations.

Professor Mas's group carried out a case study using the model for the La Punta area of Callao, Peru, including distribution of refuge buildings and evaluation of casualties. It is planned to deploy the results of the research to disaster reduction and evacuation planning in this area, which is a low-lying region located on a peninsula surrounded by the Pacific Ocean. The scientific technology and knowhow independently developed by this research institute can be cited as a contribution to international assistance activities.




The La Punta district as seen from the air. This district combined with neighboring areas has 20 tsunami shelters (marked by ◎). ▲ indicates an evacuation route from the district, of which there are 2 in the north-western area. Two types of evacuation are possible: evacuation in a vertical direction (taking refuge in a tall building or the like), and evacuation in a horizontal direction (escaping to outside the district on foot or by car). The evaluation must give consideration to each of these.

Paper title: An Integrated Simulation of Tsunami Hazard and Human Evacuation in La Punta, Peru
Authors: Erick Mas, Bruno Adriano, Shunichi Koshimura　Journal: Journal of Disaster Research (JDR) (Vol. 8 No. 2)
The complete paper is available at: http://www.sciencedirect.com/science/article/pii/S1342937X12002778

## Scientific model-based land use planning and community rebuilding in the first year following the disaster – sharing knowledge worldwide on planning for post-disaster rebuilding. 05

While speed is needed in rebuilding, deliberation is also required for sharing planning processes and reaching a consensus reflecting local needs. During the first year following the Great East Japan Earthquake, many coastal communities in the Tohoku region showed little progress in rebuilding due to the rise of various complex problems, yet during this time, localities, prefectures, and the national government have been involved in an iterative planning process to develop reconstruction policies and implementation programs for a more resilient future. Associate Professor Kanako Iuchi's group (Human and Social Response Research Division, Comparative Mitigation Society) has examined complex post-disaster planning and management processes, with emphasis on multi-governmental reconstruction planning and management efforts. This research was largely carried out through observations and interviews with local, prefectural, and national government officials as well as residents. The central analyses depend on understanding the processes of land use planning, highly dependent on scientific modeling of future tsunami risk scenarios, and on understanding developments of related policies and implementation strategies. The affected areas had already been facing various regional problems, including population decrease, aging, and inner city decline, even prior to this disaster. While this research clarifies rebuilding constraints due to regional issues, opportunities to foster a more sustainable region through community building (machizukuri) activities and proactive involvement of citizens are suggested. New knowledge gained following the Great East Japan earthquake, on rebuilding processes after mega-disasters, will continue to be shared with the world.

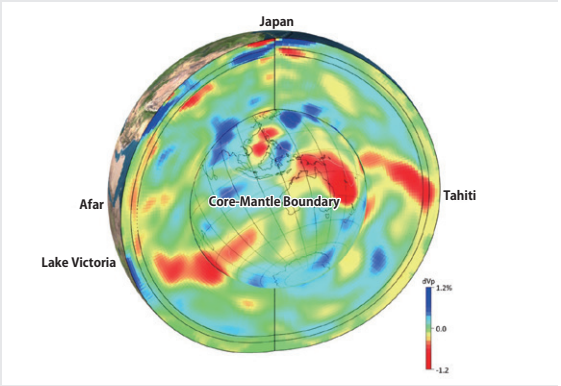
Paper title: Securing Tohoku's Future: Planning for Rebuilding in the First Year Following the Tohoku-Oki Earthquake and Tsunami
Authors: K. Iuchi, L. A. Johnson, and R. B. Olshansky　Journal: Earthquake Spectra
Publication date: Online publication, April 2013
The complete paper is available at: http://www.sciencedirect.com/science/article/pii/S1342937X12002778

06

## Observing the Earth's interior with seismic tomography. Unlocking mutual relationships between seismic and volcanic activity.

The Earth's internal structure consists of an inner core, an outer core, a lower mantle, an upper mantle, and a crust. The mantle is thought to exhibit large-scale convective activity and attempts to observe these variations have increased in recent years.

Professor Dapeng Zhao's group (Disaster Science Division) has employed a unique method called seismic tomography (an inversion technology used in geophysical exploration, similar to the medical CT-scan) to determine three-dimensional variations of seismic velocity in the Earth's whole crust and mantle down to 2900 km depth. This has resulted in findings that hot mantle plumes (mantle upwellings) ascending through the whole mantle are seen beneath major active hotspots (places where magma from deep in the Earth is emitted to the surface causing volcanic activity) such as in the South-Central Pacific, Africa, Hawaii and Iceland, and that weak plumes are visible beneath minor or less active hotspots. In addition, they found that active volcanoes on the East Asian continent are a new type of volcano, caused by the Pacific plate subducting westward toward Beijing. It is thought that the heterogeneous structure and dynamics within the Earth are closely related to seismic and volcanic activity, and attention is being focused on efforts to comprehensively investigate and research the entire Earth as a single system.




Vertical cross-section of P-wave (primary seismic wave) velocity tomography from the surface of the Earth to the core-mantle boundary (2900 km depth). Red, green, and blue represent low velocity, average velocity, and high velocity, respectively.

Paper Title：Global mantle heterogeneity and its influence on teleseismic regional tomography

Authors: Dapeng Zhao, Yoshihiro Yamamoto, Takahiro Yanada

Journal：Gondwana Research, March 2013

The complete paper is available at:
http://www.sciencedirect.com/science/article/pii/S1342937X12002778

## NEW TECHNOLOGY from IRIDeS

Food safety and security relies on prompt and accurate information.

## Radiation measuring instrument developed to perform complete measurement without requiring shredding of sample.

Measuring radioactive substances in food and promptly disclosing the results to the public is crucial in responding to consumer anxiety and insecurity regarding food safety, and preventing harmful rumors concerning producers.

In conventional testing, it was necessary to shred a sample (such as a marine product, meat, or vegetable) with a mixer or a food processor before testing with the measurement instrument. This method required time for preparation, and the shredded sample could only be discarded after testing. An instrument that can perform measurement more easily and efficiently has been long awaited by production and distribution centers that carry out radiation testing and local authorities.

Prof Keizo Ishii (Director, Research Center for Remediation Engineering of Living Environment Contaminated with Radioisotopes, Tohoku University; International Research Institute of Disaster Science, Tohoku University Regional and Urban Reconstruction Research Division, Radiational Decontamination Science (concurrent)) was among the first to engage in development of a radiation measuring instrument that could test a sample non-destructively and without requiring disassembly. Focusing on the structure of conventional measuring instruments, he reconfigured the number and layout of internal sensors, compensated for measurement error, and set a calibration coefficient for deriving accurate data. Operation of the resulting complete sample contamination testing system has already started in the Radiation Monitoring Center of Fukushima City, and Ishinomaki fishing harbor (Ishinomaki City, Miyagi Prefecture).

## REGIONAL News

## 90% used cars to evacuate, 20% delayed by traffic: resident survey sheds light on evacuation issues.

- District of Hanagama, Yamamotocho, Miyagi Prefecture -

The entire district of Hanagama, Yamamotocho, Miyagi Prefecture was damaged by the tsunami accompanying the Tohoku Pacific Ocean Earthquake. The terrain is flat, with high ground far away, and many residents feel anxiety and insecurity regarding means of evacuation.

Research Associate Mari Yasuda (Hazard and Risk Evaluation Research Division, Tsunami Engineering) carried out a survey of evacuation behavior with the cooperation of the above district. The results indicate that subsequent to the disaster of March 11, 2011, when the Sanriku offshore earthquake occurred on December 7, 2012, and a tsunami warning was issued in coastal parts of Miyagi Prefecture, 90% of residents used cars to evacuate, while about 20% said that they were brought to a standstill en route or that too much time was needed to get to a refuge. For this type of region where evacuation by car is unavoidable, the survey has highlighted the need to set out road usage rules for times of emergency and to consolidate refuge buildings. It is planned to use these results in disaster reduction and mitigation strategies for the area.

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