TECHNICAL DEEP DIVE ON

SEISMIC RISK AND RESILIENCE

SUMMARY REPORT

THE WORLD BANK
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GFDRR
Global Facility for Disaster Reduction and Recovery

Tokyo Development Learning Center

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TECHNICAL DEEP DIVE (TDD) ON SEISMIC RISK AND RESILIENCE

MARCH 12–16, 2018

This Technical Deep Dive (TDD) was jointly organized by the World Bank Disaster Risk Management (DRM) Hub, Tokyo, and the Tokyo Development Learning Center (TDLC), in partnership with the Government of Japan (the Ministry of Finance; the Cabinet Office; the Ministry of Land, Infrastructure, Transport and Tourism [MLIT]; the Japan International Cooperation Agency [JICA]; the Japan Meteorological Agency [JMA]; Sendai City; and Kobe City). The TDD was organized in collaboration with the Building Regulations for Resilience, Climate Change Adaptation, and Mitigation Knowledge Silo Breaker.

CONCEPT: THE TECHNICAL DEEP DIVE (TDD)

Technical Deep Dives (TDDs) bring together experts and practitioners through workshops, site visits, peer-to-peer knowledge sharing, and action planning. The objective is to provide specific support to World Bank clients and their projects by addressing thematic topics of high client demand. Typically, reference is drawn from Japan, which offers relevant experience and solutions for a wide range of topics. TDDs offer firsthand knowledge-exchange opportunities and enable developing countries to deepen their knowledge and identify operational solutions through intensive study tours and peer learning. Client demand is determined through a survey conducted by the World Bank. Demand is met by offering participants structured learning before they arrive in Japan, and by providing ongoing support to connect them to technical experts and best practices in close collaboration with the World Bank's Communities of Practice (CoPs).

TDDs have four core elements:

- **A challenge-driven approach**, which reflects the demand-driven nature of the program and involves problem solving and technical assistance, including expert consultation and expert visits to client nations.

- **Knowledge development for operational development**, which involves knowledge exchange, just-in-time assistance, and potential technical assistance for clients and World Bank task teams.

- **Structured learning**, which is delivered to clients and partners through e-learning courses and a package of selected knowledge-exchange instruments before, during, and after the TDD in Japan.

- **Application to knowledge networks**, which involves contributing relevant inputs to CoPs to support the development of case studies as well as best-practice lessons and to diffuse knowledge to the broader community.

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ACKNOWLEDGEMENTS

This summary report is produced by the World Bank DRM Hub, Tokyo, through the Japan-World Bank Program for Mainstreaming DRM and Global Facility for Disaster Reduction and Recovery (GFDRR). The report was developed by James (Jay) Newman (DRM Specialist, GFDRR), Louisa Barker (Urban DRM Consultant, GFDRR & Social Urban Rural and Resilience [SURR] Global Practice), and Hope Steele (Consultant, GFDRR).

The report greatly benefited from the information, support, and feedback provided by the Government of Japan, specifically: the Cabinet Office; the Ministry of Land, Infrastructure, Transport and Tourism (MLIT); the Japan International Cooperation Agency (JICA); the Japan Meteorological Agency (JMA); Sendai City; and Kobe City. We are also grateful to the Building Regulations for Resilience, Climate Change Adaptation, and Mitigation Knowledge Silo Breaker; the JICA Research Institute; Tohoku University; and the National Research Institute for Earth Science and Disaster Resilience (NIED).

We thank the speakers, participating officials, and project task teams for their presentations, active involvement, and knowledge sharing.

The team gratefully acknowledges the peer review, feedback, and input from: Hiroyuki Fujita, Rashmin Gunasekera, Satoshi Harada, Ushio Hashiura, Sawako Hirano, Fumi Imamura, Haruka Imoto, Mikio Ishiwatari, Philip E. Karp, Naohisa Koide, Daniel Levine, Taisuke Matsuzaki, Satoru Mimura, Tetsuya Mizutani, Thomas Moullier, Go Mukai, Yumi Nakajima, Haruko Nakamatsu, Akiko Nakasone, Paul Nelson, Atsushi Okada, Diana Marcela Rubiano Vargas, Keiko Sakoda, Keiko Saito, Tomoki Suzuki, Akira Takahashi, Suma Taisuke, Shouichi Tawaki, Jian Vun, and Vittoria Zanuso.

ACRONYMS AND ABBREVIATIONS

BRR	Building Regulation for Resilience
CoP	Community of Practice
CPP	City Partnership Strategy
DRI	Disaster Reduction and Human Renovation Institution
DRM	disaster risk management
DRR	disaster risk reduction
EOC	Emergency Operations Center
EPOS	Earthquake Phenomena Observation System
EWS	early warning system
FDMA	Fire and Disaster Management Agency
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	Geographical Information System
GSURR	Global Practice for Social Urban Rural Resilience
IPF	Investment Project Financing
IRIDeS	International Research Institute of Disaster Science
ISMEP	Istanbul Seismic Mitigation and Emergency Preparedness Project
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MoF	Ministry of Finance
NEC	Ecuadorian Building Code
NIED	National Research Institute for Earth Science and Disaster Resilience
PPP	public-private partnership
SWU	Sendai Wastewater Utility
TA	technical assistance
TDD	Technical Deep Dive
TDLC	Tokyo Development Learning Center
TMG	Tokyo Metropolitan Government
100RC	100 Resilient Cities

Tokyo Rinkai Disaster Prevention Park:
Earthquake Simulation
Photo: World Bank

EXECUTIVE SUMMARY

Technical Deep Dive on Seismic Risk and Resilience

Every year, approximately 70,000 people die worldwide from natural disasters. Most of these deaths are caused by building collapse during earthquakes, and the great majority occur in developing countries.[1] Earthquakes also push approximately 4 million people into extreme poverty every year.[2] Earthquakes test the strength of societies, governments, and the built environment.

Integrating seismic risk into development planning and investment can reduce the impacts of seismic hazards by ensuring that buildings and infrastructure are constructed and managed appropriately and people are prepared for the events ahead.

On March 12–16, 2018, the Seismic Risk and Resilience Technical Deep Dive (TDD) brought together officials from Bangladesh, Ecuador, India, Indonesia, Kenya, Malawi, Myanmar, Nepal, Peru, and the Philippines with World Bank project team leaders and key Japanese and international experts. The TDD aimed to inform countries' ongoing and planned investments and focused on identifying solutions to key challenges faced by participants.

The objectives of the TDD were to support clients and World Bank teams to address the following aspects of their projects (Figure 1):

Figure 1. Objectives of the TDD

1. What Are the Facts to Make the Case?
Confirming the importance, economic arguments, and feasibility of investing in seismic resilience.

2. What Are the Investment Options to Plan and Design?
Opening the range of interventions and investments available to take on seismic risk.

3. What Are the Technical Details to Implement?
Connecting the expertise, solutions, and technical and policy details that can support and enhance interventions and investments.

1 Data from the *World Disaster Report (2006-2015)*, International Federation of the Red Cross and Red Crescent Societies (IFRC).

2 Hallegatte, Stephane, Adrien Vogt-Schlib, Mook Bangalore, and Julie Rozenberg. 2017. *Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters*. Climate Change and Development Series. Washington, DC: World Bank.

The participating clients represented infrastructure and public works departments, urban development departments, education departments, and agencies responsible for disaster risk management (DRM) and seismic hazard monitoring.

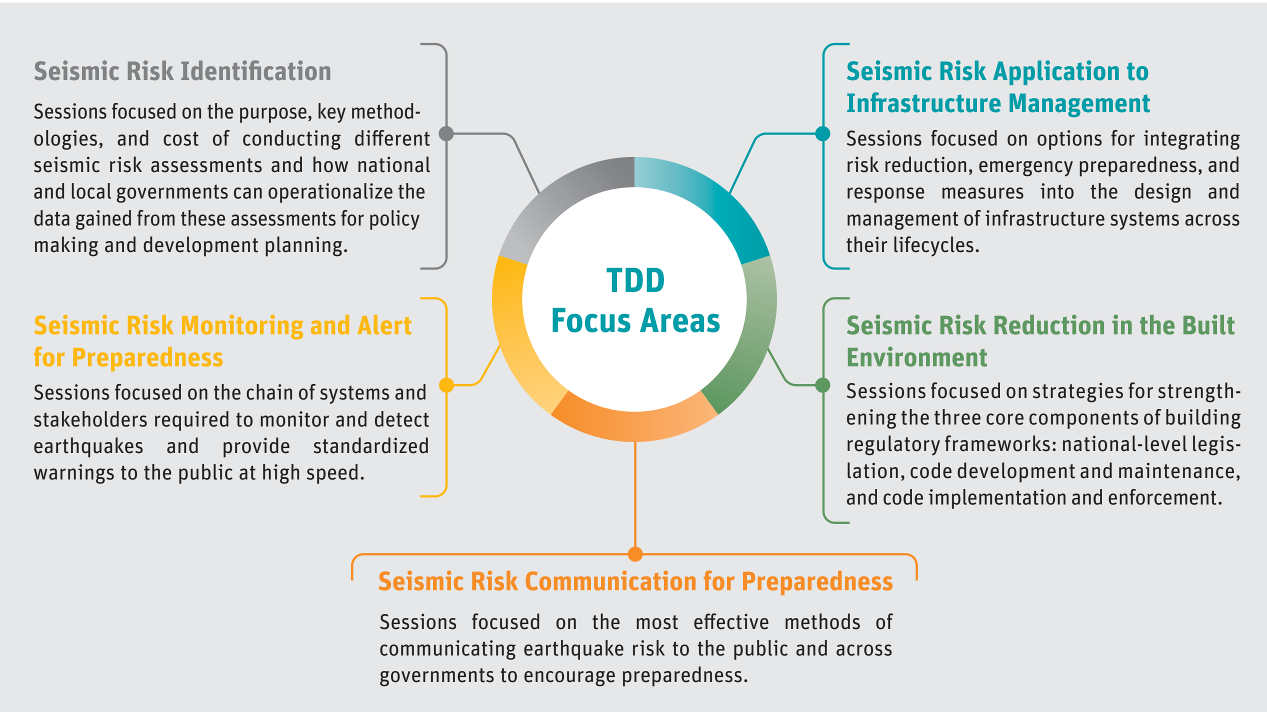
The event enabled participating countries to learn from Japan's wealth of experience and expertise in the generation, communication, and application of risk information to reduce the human and economic losses caused by earthquakes and tsunamis. Japanese experts and practitioners from the public sector, private sector, and academia led interactive sessions and field visits in the cities of Tokyo, Kobe, and Sendai.

Although the Seismic Risk and Resilience TDD covered a broad range of topics, spanning the DRM cycle, particular attention was given to seismic risk reduction in the built environment. The TDD drew on the work of the Building Regulation for Resilience (BRR) Program, a global initiative working to strengthen the building regulatory capacity of developing countries. Japan is a world leader in integrating seismic risk information into the design of the built environment; country participants had the opportunity to tap into this experience through a series of thematic sessions and site visits.

Structure of the TDD

The TDD was structured around five key focus areas (Figure 2). These areas were selected based on client demand.

Figure 2. TDD Focus Areas



TDD Participants at the Hyogo Earthquake Engineering Research Center (“E-Defense”)
Photo: World Bank

Participants’ Profile and Challenges Faced

The countries participating in the TDD, including Japan, have over 1.3 million people exposed to intensity VI seismic hazards (on the Modified Mercalli Intensity Scale). These countries are implementing critical resilience investments worth over US$2.5 billion with the support of the World Bank and other partners (see Figure 3 for a list of projects by country).

Figure 3. World Bank Projects Led by TTD-Participating Countries

Country	Projects
Bangladesh	▪ Multipurpose Disaster Shelter Project (P146464) ▪ Bangladesh Urban Resilience Project (P149493) ▪ Bangladesh Weather and Climate Services Regional Project (P150220)
Ecuador	▪ Ecuador Risk Mitigation and Emergency Recovery Project (P157324)
India	▪ Uttarakhand Disaster Recovery Project (P146653) ▪ Uttarakhand Disaster Recovery Project (P164058)
Indonesia	▪ Ongoing DRM Technical Assistance Program (P156711)
Kenya	▪ Kenya CAT DDO (P161562)
Malawi	▪ Malawi CAT-DDO (P165056)
Myanmar	▪ Myanmar SEA DRM Project (P160931)
Nepal	▪ MDTF funding for EHRP (P162067) ▪ Nepal EHRP Additional Financing (P163593) ▪ Earthquake Housing Reconst Project (P155969)
Peru	▪ Improving Disaster Risk Management in Peru (P165816)
Philippines	▪ Reducing Vulnerability to Natural Disaster (P148631) ▪ Second Disaster Risk Management Development Policy Loan with a CAT-DDO (P155656)

PARTICIPATING TEAMS' PROFILE

75%

of participants reported that they have a seismic risk assessment for their city/country

They plan to use it for urban/land-use planning, targeting building regulation/retrofit, emergency preparedness and response, and critical infrastructure. However, many countries noted challenges in operationalizing the risk assessments and applying the outcomes preparedness, response, and risk reduction activities.

50%

of participants reported that their city/country undertakes seismic and/or tsunami preparedness training for residents and communities

Many have established a national preparedness day – for example, Japan designates September 1 and Indonesia designates April 26 for this purpose.

85%

of participants reported that seismic risk is integrated into their building regulation (codes and standards)

However, countries reported a low rate of building code implementation. This is the result of limited seismic expertise, a lack of local capacity to enforce the building code, and a lack of strategies to incentivize compliance – for example, building public awareness and subsidy programs.

50%

of participants reported that their city/country has a seismic monitoring and alert system

However, participants noted varying levels of system effectiveness:

- 20% reported that their system was effective in the last earthquake
- 60% reported that their system was not effective in the last earthquake
- 20% reported that their system was partially effective in the last earthquake

90%

of participants reported that, to some degree, their city/country integrates resilience into the design and maintenance of infrastructure

Nevertheless, countries reported operational challenges, including a lack of data to support the prioritization and planning of resilient infrastructure and a lack of technical capacity and inter-agency coordination.

Key Takeaways

The action planning discussions generated the following key takeaways:

Risk assessments should be directly linked to policy making and development planning.

- To be useful for decision making, risk assessments should have a well-defined purpose and target end-users. The appropriate risk assessment methodology should be selected in line with the project objective, budget, and technical capacity – both to conduct the assessment and to understand and operationalize the output.

Effective seismic monitoring and alert systems require multi-stakeholder coordination.

- Developing and managing seismic monitoring and disaster alert systems requires a government-led, focused coordination effort of stakeholders, including local governments, research institutions, technical agencies, communities, and the private sector.

To communicate earthquake risk to the public, a sustained and multi-tiered approach should be taken.

- Raising and maintaining risk awareness is particularly challenging for low-frequency high-severity events. To promote a culture of citizen preparedness, governments can adopt multiple strategies, such as disaster drills, integrating risk-information into school curriculums, establishing disaster memorials and education centers, and disseminating evacuation guides and maps.

Risk information should be integrated into the management of infrastructure across its life cycle, as well as into spatial planning generally.

- Asset management systems can support the integration of disaster risk considerations into the prioritization of infrastructure investments, including construction, maintenance, rehabilitation, and reconstruction. Hazard maps and other risk information can inform spatial planning, particularly for new development.

Governments should prioritize investment into building regulatory capacity at the local/municipal level.

- A coordinated effort toward disaster risk reduction should address the need for adequate funding, staffing, and training necessary to implement building and land-use regulation at the local level.

ACTION PLANNING

To close the TDD, participating countries presented (i) lessons learned that could be implemented in their countries; (ii) action plans, including follow-up requests for support from the World Bank and other development partners; and (iii) challenges and barriers to implementation. Participants presented their cases and discussed them with a panel of experts.

Mr. Stern Mwakalimi Kita, Chief Mitigation Officer, Department of Disaster Management Affairs, presenting Malawi's Action Plan

OPENING AND WELCOME

> Japan has proven that – against the powerful and destructive force of earthquakes – effective disaster risk management is possible.
>
> Mr. Go Mukai

Mr. Go Mukai

Senior Deputy Director, Multilateral Development Banks Division, International Bureau, Ministry of Finance, Government of Japan

This TDD provides an opportunity to learn from Japan's experience in strengthening its seismic resilience over the last century.

Japan is one of the most seismically active countries on Earth and has experienced some of the world's worst disasters, such as the 1995 Great Hanshin-Awaji Earthquake and the 2011 Great East Japan Earthquake.

The Japanese government has continuously sought to develop and implement best practices in disaster risk management (DRM) precisely because it has lived through such devastating disasters. Japan takes advantage of science, technology, and innovation in its disaster risk reduction and management efforts to strengthen the resilience of its people, infrastructure, and governance systems.

Japan has forged a resilient development path and promoted the importance of mainstreaming DRM. For example:

- Japan works hard to ensure that its seismic risk assessments are comprehensive and actionable, leading to preparedness and risk reduction investments;
- the country has invested in a robust seismic and tsunami monitoring network and trains residents so they know how to respond; and
- it designs, operates, and maintains its infrastructure and function through earthquakes and tsunamis.

Japan has made resilient development and quality infrastructure central to its own domestic development and has played a leading role in advocating for both to be integrated into international development policy frameworks. Through frameworks such as the Sendai Framework for Disaster Risk Reduction (2015), Japan has promoted the mainstreaming of DRM in developing countries. Furthermore, under Japan's president, the 2017 G7 Summit adopted the G7 Ise Shima Principles of Promoting Quality Infrastructure Investment, in which resilience against natural disasters is one of the key considerations.

Japan's Ministry of Finance is collaborating with the World Bank DRM Hub and the Tokyo Development Learning Center (TDLC) to support this agenda.

> Two decades ago, the World Bank significantly shifted its approach from disaster response to disaster risk management.
>
> Mr. Christoph Pusch

Mr. Christoph Pusch

DRM and Climate Change Practice Manager, South Asia Region, World Bank

Over the last two decades, the World Bank and other development partners have significantly strengthened their technical expertise and investment in DRM. To meet growing demand and facilitate a shift from a pattern of disaster response to one of disaster risk management, World Bank teams conducted in-depth research in Japan and other key countries with extensive experience in mainstreaming DRM into their development.

The İzmit, or Marmara, Earthquake in Turkey in 1999 claimed over 18,000 lives and cost the country an estimated US$5 billion. Fortunately, it proved a turning point.

Following that disaster, the World Bank and the Government of Turkey broke from a previous cycle of responding to earthquakes with reconstruction projects alone and designed a holistic DRM investment program – the Istanbul Seismic Mitigation and Emergency Preparedness Project (ISMEP).

This multi-phased project has enabled the construction of more resilient infrastructure and building stock, established risk-financing mechanisms, and strengthened emergency preparedness. The knowledge, technical expertise, and experience of Japan was a critical input in the design of the ISMEP project in Turkey and has also, more generally, informed the World Bank's approach to DRM.

This TDD provides an opportunity for participants to discuss common challenges, identify potential solutions, and implement lessons learned in ongoing and future investments.

Detail from photo of participants at the Great Hanshin-Awaji Earthquake Memorial Museum

Photo: World Bank

SEISMIC RISK IDENTIFICATION

Understanding Seismic Risk

Dr. Rashmin Gunasekera

DRM Specialist, Urban DRM, GSURR, World Bank

Several kinds of risk assessment are available to policy makers and technical staff across ministries. This session provided an overview of the different types of assessments (or products) available to meet different risk management objectives and their respective parameters (e.g., scale, data requirements, cost) (Figure 4). To be useful for decision making, risk assessments should have a well-defined purpose and target end-user.

For example, a hazard or risk index can be used to initiate DRM dialogue at a national scale. Risk assessments in this style are easy to understand and can be conducted quickly, particularly given the number of pre-existing global indices on which clients can draw. However, the information may be subjective and may not be appropriate for making risk-informed policy and development planning decisions.

To effectively manage seismic risk before a hazard occurs, decision makers need to formulate answers to the following key questions:

- How much is at risk?
- What would it take to reduce the risk?
- Where and what can we prioritize as interventions?
- What are the costs and benefits?

To answer these questions, it is necessary to quantify the seismic risk. Such quantification includes estimating the likelihood of potential property, infrastructure, monetary, or casualty losses caused by seismic hazards in a specific area.

Different methodologies of risk quantification (e.g., historical scenario and probabilistic models) can be utilized to quantify risk: the pros and cons of these approaches should be evaluated in line with the objective, budget, and technical capacity available – both to conduct the assessment and to understand and operationalize the output (Figure 5).

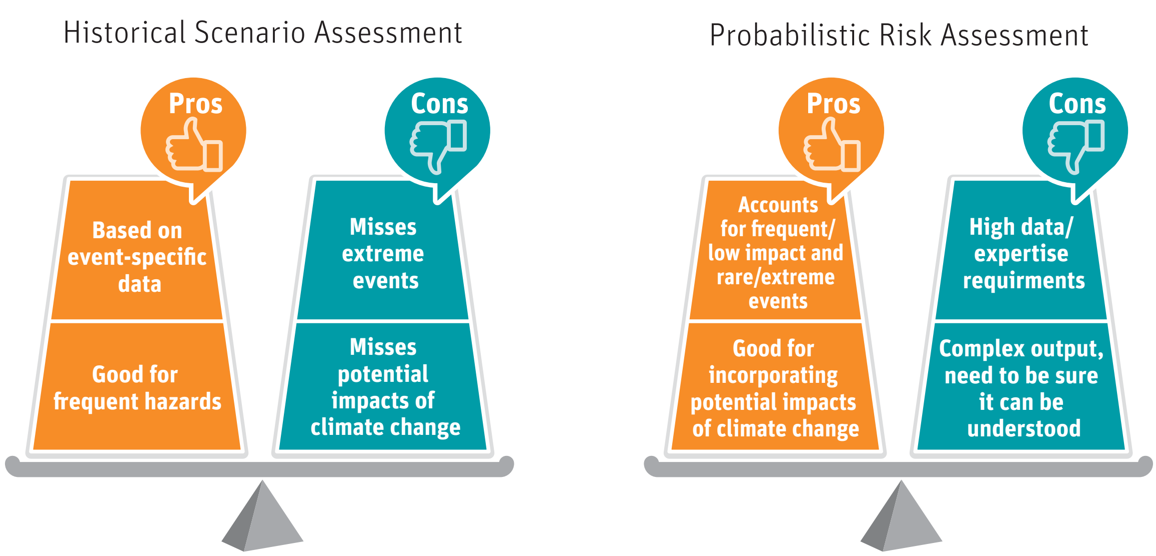
Figure 4. Different Risk Assessment Products

Product	Purpose	Scale	Data Requirements	Cost*
Qualitative national risk profile	For advocacy and initiation of DRM dialogue	National	Low: Requires global, regional, and/or national data sets	$
Community-based disaster risk assessment	To engage communities, communicate risk, and promote local action	Community level	Low: Typically based on historical disaster events	$
Quantitative national risk profile	For advocacy and initiation of DRM dialogue based on quantitative assessment	National	Low-moderate: Requires global, regional, and/or national data sets	$$
Asset-level risk assessments, including cost-benefit and engineering analysis	To inform design of building-level/asset-level risk reduction activities and promote avoidance of new risk	Building / infrastructure level	Moderate-high: Requires high-resolution local data for large spatial areas with clear articulation	$$
Macro-level risk assessment for risk reduction, including cost-benefit analysis	To inform urban/regional risk reduction measures	Urban, regional, national	Moderate-high: Requires moderate to high resolution across large spatial areas	$$$
Risk identification to identify critical infrastructure and establish early warning systems	To inform preparedness and risk reduction, based on understanding of potential damage at the regional/local level	Urban, regional, national	Moderate-high: Requires asset-level information across large spatial areas	$$-$$$ (broad range depending on geographic scope)
Catastrophic risk assessment for financial planning	For financial and fiscal assessment of disasters and to catalyze catastrophe risk insurance market growth	National to multi-country	High: Requires high-resolution, high-quality data of uncertainty	$$$

Source: World Bank. 2014. *Understanding Risk in an Evolving World*. Washington, DC: World Bank. https://www.gfdrr.org/sites/gfdrr/files/publication/Understanding_Risk-Web_Version-rev_1.8.0.pdf

* Rough cost estimates: $ = up to US$50,000; $$ = US$50,000–US$500,000; $$$ = US$500,000 or more.

Figure 5. Pros and Cons of Historical and Probabilistic Risk Assessments



Applying Risk Assessments to Risk Reduction and Preparedness Strategies

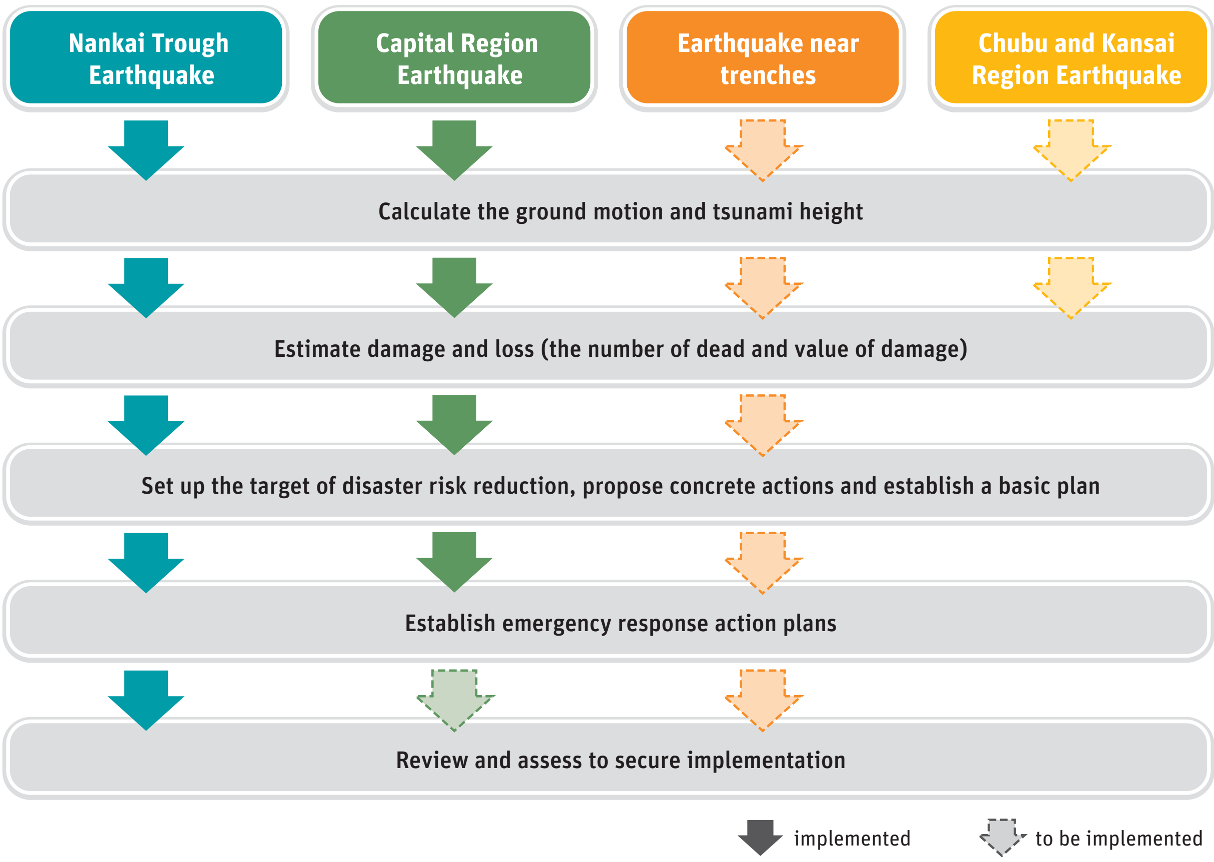
Ms. Setsuko Saya

Director, International Cooperation Division, Disaster Risk Management Burau, Cabinet Office, Government of Japan

Japan has developed a strong legal, institutional, and regulatory framework to support DRM. Ms. Saya provided a comprehensive overview of the DRM system in Japan, with particular attention given to the National Basic Plan for Disaster Risk Management. The Basic DRM Plan, updated and approved by the National DRM Council on an annual basis, aims to improve preparedness, support emergency-response planning, and facilitate recovery and reconstruction.

This Basic DRM Plan is informed by a rigorous scientific understanding of the country's risk to geological, hydrometeorological, and human-made disasters. As part of the Plan, the Government of Japan has undertaken seismic risk assessments to create scenario-based planning frameworks for four types of anticipated large-scale earthquakes (Figure 6). The outcomes of these risk assessments have successfully been translated into a series of risk reduction investments and emergency response plans.

Figure 6. Japan's Scenario Planning for Large-Scale Earthquakes



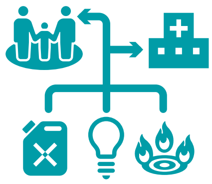
The government has completed the full risk assessment and corresponding planning process for the Nankai Trough Earthquake scenario and is nearly finished with the Capital Region Earthquake scenario. The other earthquake scenarios have existing plans, which require updates and improvements to integrate lessons learned from the 2011 Great East Japan Earthquake. This exemplifies the fact that the Plan is an evolving document, regularly being updated and improved. Japan's Basic DRM Plan is available at http://www.bousai.go.jp/en/documentation/white_paper/index.html.

Based on the estimated damage and loss by a Nankai Trough Earthquake, the Government of Japan has developed a specific emergency response plan that covers the elements shown in Figure 7.

Figure 7. Emergency Response Plan Elements

First responders and medical support
(the number of personnel required and the prefectures from which they will be deployed)

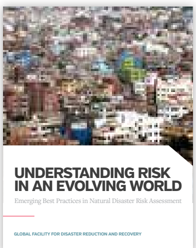
Goods
(including the amount of basic supplies, such as food, water, sanitary products, etc.) that need to be procured

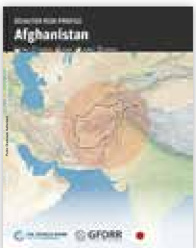


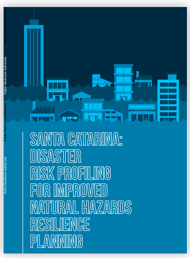
Fuel, electricity, and gas
(priority supply to identified important facilities)

Emergency transportation routes and disaster management bases
(location and personnel)

Knowledge Resources: Highlights



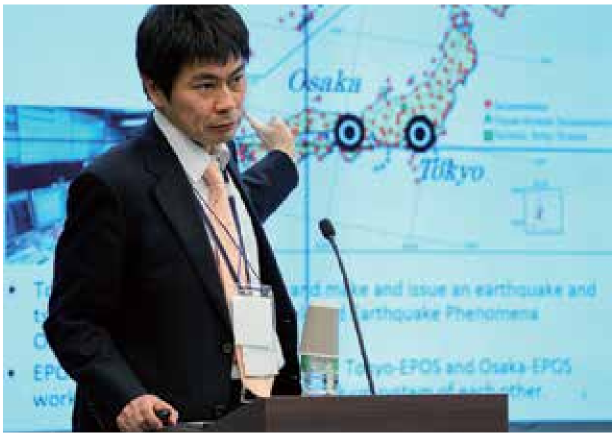




- Understanding Risk in an Evolving World: Emerging Best Practices in Natural Disaster Assessment
- Disaster Risk Profile Afghanistan
- Santa Catarina: Disaster Risk Profiling for Improved Natural Hazards Resilience Planning

SEISMIC RISK MONITORING AND ALERT FOR PREPAREDNESS

Japan’s Seismic Monitoring and Early Warning System



> To mitigate earthquake and tsunami disasters, maintaining a network of reliable and real-time seismometers is indispensable.
>
> Mr. Satoshi Harada

Mr. Satoshi Harada

Senior Coordinator for International Earthquake and Tsunami Information, Earthquake and Tsunami Observation Division, Seismology and Volcanology Department, Japan Meteorological Agency (JMA)

Facilitation by Mr. Naohisa Koide, Senior Scientific Officer, Officer of International Affairs, JMA

In Japan, JMA is responsible for seismic monitoring and early earthquake and tsunami warning (Figure 8). To monitor earthquakes, JMA maintains a reliable and real-time network of seismometer stations and seismic intensity stations. This network includes 1,300 seismometer stations and 4,400 seismic intensity stations. A large number of these are run by universities and the National Research Institute for Earth Science and Disaster Resilience (NIED). To monitor tsunamis, JMA maintains a real-time tsunami monitoring network of tide gauges, global positioning system buoys, and ocean bottom pressure sensors.

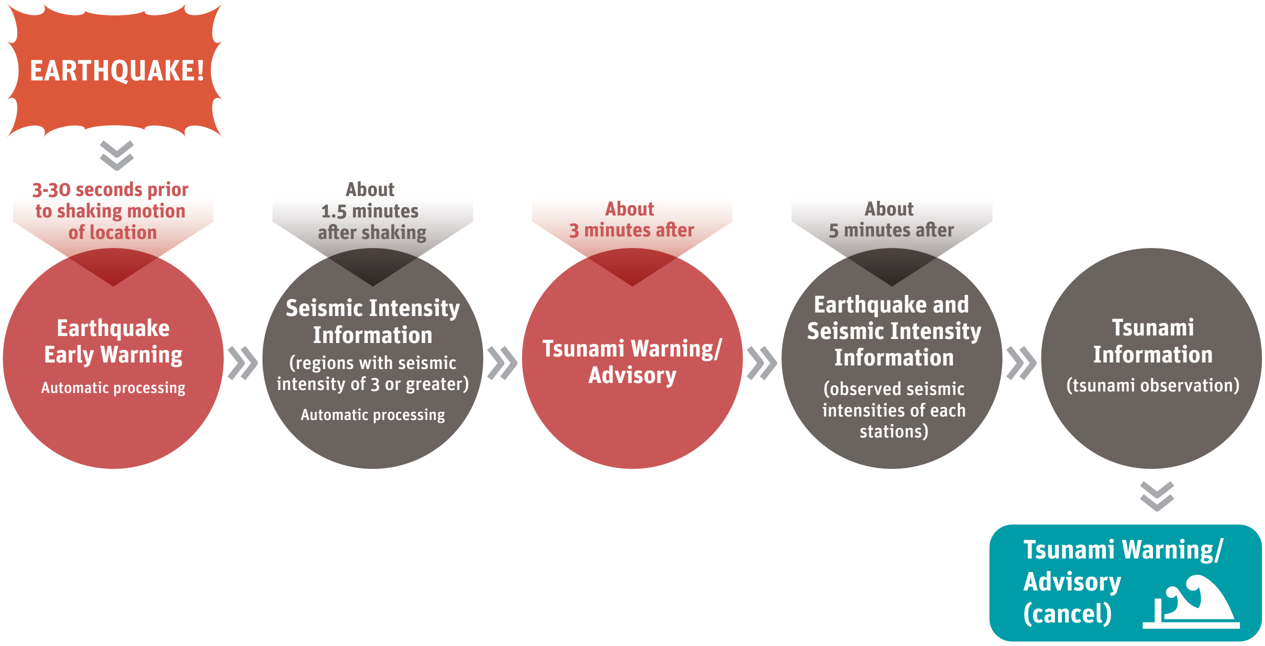
Data from these stations are automatically transmitted to the data processing system, the Earthquake Phenomena Observation System (EPOS). Using these data, JMA can determine the locations and magnitudes of even very small earthquakes and tsunamis and, when necessary, issue earthquake and tsunami warnings.

JMA’s early warning system is based on three core principles. Information should be:

1. Announced quickly
2. As simple as possible
3. Operational for DRM

Early earthquake warnings are triggered automatically and are typically issued within seconds of the earthquake occurring. Approximately three minutes later, JMA issues a tsunami warning advisory and updates information accordingly.

Figure 8. Typical Service Standard for Issuing Early Warning Information



Tsunami warnings must be issued quickly, before they reach the coast, so that people can respond in sufficient time. To increase service speed, JMA has developed a "database method." Initiating a computer simulation after the occurrence of an earthquake to determine tsunami risk can take too much time. Instead, JMA developed a database that holds information on approximately 100,000 simulated earthquake scenarios; when an earthquake occurs, the location and magnitude are quickly estimated and the database system matches this with the closest simulated scenario. Warnings are issued based on this scenario.

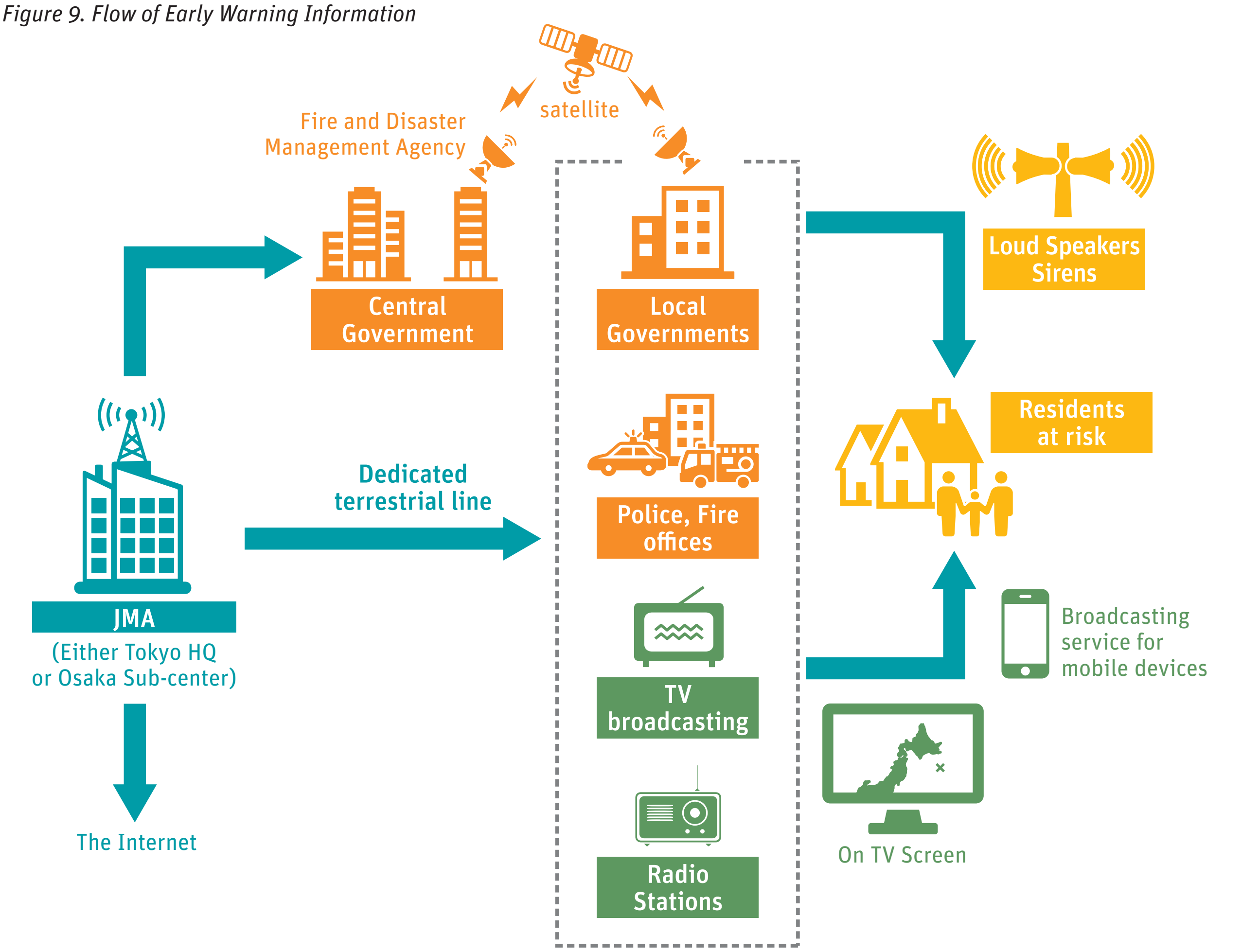
To ensure the warning is simple and operational for DRM, JMA's warnings have a standardized format. For earthquakes, seismic intensity information is issued. JMA's seismic intensity scale is different from other global earthquake intensity scales; however, the population is familiar with this scale – it has been used in Japan for over 100 years. For tsunamis, JMA has set three categories of warning according to the predicted height. Different responses from the central and local government authorities are triggered according to the severity of the warning, and the public have been educated in how to respond accordingly.

The warning information is transmitted directly to the central and local government, police and fire officers, and information broadcasters via landline (satellite information is used as a backup). Alerts reach the public through loud speaker sirens, their mobile devices, TV, and radio (Figure 9).

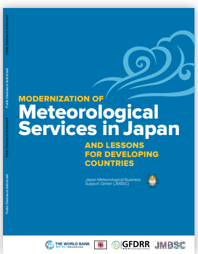
All municipalities across Japan have installed the J-Alert receiver. It took three years to roll this out across the country. The delay was in large part due to installation and maintenance costs. The Fire and Disaster Management Agency (FDMA) provided grants to cover the full costs of installing the equipment.

To ensure Japan's international residents and visitors can understand the warning, all warnings are broadcast in five languages (Japanese, English, Mandarin, Korean, and Portuguese).

Figure 9. Flow of Early Warning Information



Knowledge Resources: Highlights



- Modernization of Meteorological Services in Japan and Lessons for Developing Countries

SEISMIC RISK COMMUNICATION FOR PREPAREDNESS

Sendai City's Preparedness Strategy

Presentation by Mr. Akira Takahashi

Senior Director, Disaster-Resilient and Environmentally-Friendly City Promotion Office, City of Sendai

In Sendai, there is a high level of seismic risk awareness, particularly in the wake of the 1978 Miyagi Earthquake and the 2011 Great East Japan Earthquake. In Sendai City alone, the Great East Japan Earthquake (M9) resulted in 904 fatalities and the collapse of 139,643 buildings. The Sendai City Disaster Prevention Plan lays out a series of actions to build back better and prepare the city for low-frequency high-severity risks.

Presentation by Mr. Tomoki Suzuki

Director, Disaster Prevention Planning Section, Crisis Management Department, City of Sendai

Panelists: Mr. Shoichi Tawaki, Director, Disaster Prevention Planning Section, Crisis Management Department, City of Sendai, and Mr. Satoru Mimura, Deputy Director General, JICA Tohoku, Executive Senior Research Fellow, JICA Research Institute

Over the last four centuries, Sendai has implemented structural and non-structural tsunami preparedness measures. The city systematically captures lessons learned from disasters and integrates these into its preparedness plans. Mr. Suzuki emphasized the importance of strengthening both physical and social resilience and preparedness.

The Sendai City Prevention Plan promotes preparedness through three core work streams: self-help, mutual aid, and public assistance (Figure 10).

Figure 10. Sendai Community Preparedness Strategy

Sendai City takes a multi-tiered approach to promoting self-help, including: establishing disaster memorials and education centers (see the site visit to Arahama Elementary School, p. 25), instituting education campaigns at schools, practicing disaster drills, and disseminating evacuation guides and preparedness maps to each household (Figure 11).

Figure 11. Sample Community Risk Maps and Communication Guidelines

Emergency Response Simulation Training

Mr. Taisuke Matsuzaki

Director, ICT Promotion Department, Planning and Coordination Bureau, City of Kobe

Participants took part in an emergency response simulation training, designed by Kobe City, to improve the emergency response capabilities of government staff.

Mr. Matsuzaki stressed that Kobe has designed its training programs so that the lessons learned and capacity built in the response and recovery efforts of the Great Hanshin-Awaji Earthquake

A B: Emergency Response Simulation Training
Photos: Tokyo Development Learning Center

> 50% or more of Kobe City staff have never gone through a serious earthquake. They have never had to operate under those circumstances.
>
> Mr. Matsuzaki

should not be lost over time with the turnover of government staff.

The interactive training session made participants think through the challenges local governments face and the decisions they must make in response to large-scale earthquakes and tsunamis, often with limited information available and a depleted number of staff. As part of the emergency simulation, participants were split into teams, and assigned roles (e.g., director, communications lead, operations manager, etc.). They were provided with a disaster scenario including information on the status of damages and preliminary responses and had to work as a team to respond to the requests of the Director and the press.

Kobe City has integrated this activity into their municipal training program. Over the last 15 years, they have conducted the training with more than 3,000 government staff in Kobe. The training is conducted across multiple departments to ensure inter-agency cooperation.

TDD participants considered how they could design training programs to increase the preparedness of local governments in their own countries.

TDD Interactive Training Session Photo: World Bank

Education and Outreach

Japan invests significant time and resources to memorialize disasters. These memorials, scattered across the country, are designed to spur DRM awareness and encourage government and citizen preparedness. Many TDD participants expressed the importance of making the emotional case for citizen preparedness as well as the need to preserve the memory of major disasters so that citizens do not become complacent with disaster preparedness.

Memorializing Disasters

Site Visit: Arahama Elementary School

This is one of the ruins of the Great East Japan Earthquake still open to the public. The area surrounding Arahama Elementary School was inundated by the tsunami. The school was used as an evacuation site for 320 residents, students, and school staff. The building has been preserved to raise awareness of the risks of tsunamis, both for the local community and across the country.

Visitors can see the damage to the interior and exterior of the building and view an exhibition, including a documentary featuring interviews with the school principal at the time of the tsunami and the head of the local neighborhood association.

Visit to the Arahama Elementary School
Photo: World Bank

Damage to the Interior of the Arahama Elementary School
Photo: World Bank

Indication of the Height of the Tsunami at the Arahama Elementary School
Photo: World Bank

Site Visit: The Great Hanshin-Awaji Earthquake Memorial Museum

The Disaster Reduction and Human Renovation Institution (DRI) was established in Kobe in 2002 to raise disaster awareness, enhance local capacity for disaster management, support the development of disaster management policies, and promote community preparedness.

The DRI opened the Great Hanshin-Awaji Earthquake Memorial as a central facility to support this agenda. The Memorial captures the effects and lessons learned from the Great Hanshin-Awaji Earthquake. Tours are led by "storytellers" – volunteers who experienced the earthquake and would like to share their memories and advice. Every year, 80,000 people visit the Memorial (50,000 from Japan and 30,000 from abroad).

Visitors to the Great Hanshin-Awaji Earthquake Memorial Museum Photo: World Bank

Learning Centers

Site Visits: The Tokyo Rinkai Disaster Prevention Park and the Kobe Exhibition Room for Disaster Prevention

Every level of government invests time, money, and human resources to raise and maintain public awareness about disaster risks and promote citizen preparedness.

Both learning centers visited as part of the TDD provide citizens with simple and practical information on how to prepare for disasters at the household level (e.g., what should be included in an evacuation kit and what items households should stock to survive the first 72 hours following a disaster – 72 hours is the average amount of time for Japan to complete search and rescue missions).

Both learning centers have targeted educational resources for children.

> “The likelihood of a large-scale earthquake striking Japan in the next 30 years is over 80 percent and growing. Citizens must be prepared and remain calm when it happens.
>
> Rinkai Park Tour Guide”

The Tokyo Rinkai Disaster Prevention Park also contains an interactive “experience center” that includes emergency simulations and training.

Several TDD participants are assessing the feasibility of establishing learning facilities in their own country.

Kobe Exhibition Room for Disaster Prevention: Highlighting the Evacuation Routes and Centers

Photo: World Bank

Detail from photo of Tokyo Rinkai Disaster Prevention Park: Earthquake Simulation

Photo: World Bank

Tokyo Rinkai Disaster Prevention Park: Post-Disaster Simulation and Survival Quiz

Photo: World Bank

Tokyo Rinkai Disaster Prevention Park: Earthquake Simulation

Photo: World Bank

Emergency Operations Centers

Japan has invested in well-equipped and resilient facilities to coordinate emergency response activities at the national, regional, and local level.

Site Visit: The Tokyo Rinkai Disaster Prevention Park Emergency Operations Center

TDD participants had the opportunity to visit the Tokyo Rinkai Disaster Prevention Park. The Park is an Emergency Operations Center (EOC) that serves as a central base for disaster response operations in the event of a large-scale disaster (such as an earthquake stronger than intensity VI) in the Tokyo Metropolitan Area.

The Prevention Park is equipped with facilities and equipment to bring together national, prefectural, and city-level officials to jointly respond to large-scale disasters that may affect millions of lives and assets in the highly concentrated urban areas of the Tokyo Metropolitan Area.

The Park works in coordination with another site, the Higashi Ogijima, located on the waterfront of Kawasaki City.

Tokyo Rinkai Disaster Prevention Park

Area: 13 hectares

Year of establishment: 2011 (planning and construction initiated in 2001)

Managed by: MLIT, Tokyo Metropolitan Government (TMG), and Cabinet Office

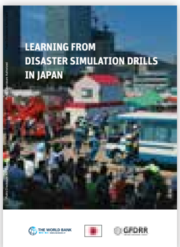
Cost: 118 billion yen (for two sites); Operation and maintenance approximately 52.63 million yen per year

Functions: Equipped with local DRM headquarters for national and regional public organizations

Site Visit: Kobe City Emergency Operations Center

In Kobe, the city's EOC allows relevant agencies to quickly collect needed information, monitor situations in real time, receive key information through the J-Alert terminal on-site, and plan and execute response options.

Knowledge Resources: Highlights



- Learning from Disaster Simulation Drills in Japan
- Preparedness Map for Community Resilience: Earthquakes: Experience of Japan

SEISMIC RISK APPLICATION TO INFRASTRUCTURE MANAGEMENT

Utilizing Infrastructure for Risk Reduction

Prof. Fumihiko Imamura

Professor of Tsunami Engineering and Director of the International Research Institute of Disaster Science (IRIDeS), Tohoku University

During the Great East Japan Earthquake (2011) and consequent tsunami, the area of inundation in Sendai City far exceeded that indicated in the municipal hazard map.

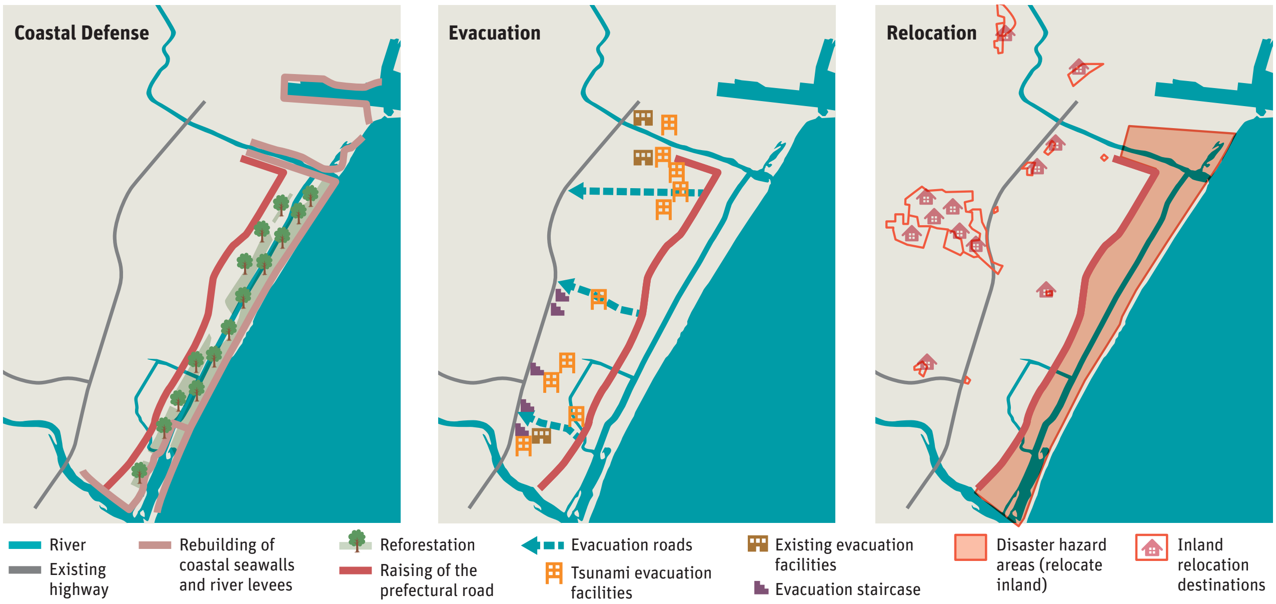
Following the earthquake, a review committee was established to integrate lessons learned into a series of structural and non-structural tsunami protection measures.

Three core risk reduction measures are currently under implementation in the Sendai Plain area (Figure 12):

- Evacuation routes
- Relocation
- Multi-layer coastal defense

Professor Imamura highlighted the value of multi-purpose infrastructure that can enable disaster risk reduction and/or response efforts. For example, the review committee found that the coastal highway had significantly decreased the impact of the tsunami; the highway both

Figure 12. Structural and Non-Structural Preparedness Measures



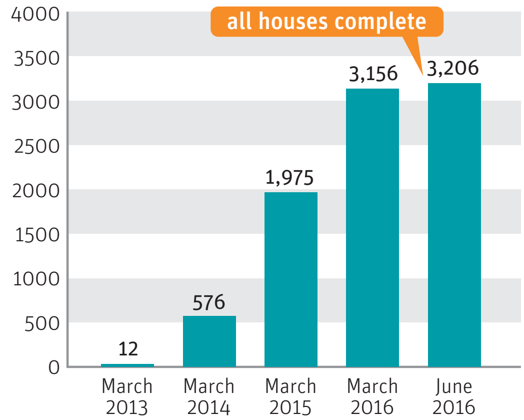
reduced the speed of the tsunami and acted as a barrier for most of the drift carried in the water. During the re-construction process, the highway was raised from 2 meters to 5 meters and now doubles as a levee.

Coastal forestation is one non-structural tsunami counter-measure being implemented along the Sendai Plain. The multiple benefits of this nature-based solution include reducing tsunami inundation, reducing the drift of materials with the tsunami, and providing a back-up structure for people climb if they do not reach evacuation facilities in time. After the 2011 tsunami, the committee looked into why some trees remained standing and others were destroyed. They concluded that trees with long roots had survived. As such, during the forestation process, more soil is being added to increase the ground level.

TDD participants were very interested to hear about the Disaster Prevention Collection Relocation Promotion Project. All citizens with houses in the high-risk hazard area were legally obliged to relocate (see Figure 13). It is important to note that 90 percent of houses in this area were destroyed during the tsunami. Ex-residents were given two options: money to build a new house or an apartment in a municipal housing block. Over a three-year period, over 3,000 apartments were built for those affected by the disaster.

Professor Imamura also highlighted the valuable role universities and research institutes can play in providing governments with cutting-edge information for disaster risk management. IRIDeS, for example, provides the Government of Japan with inter-disciplinary and expert analysis across 36 DRM-related fields.

Figure 13. The Number of Households Relocated to Municipal Housing



Site Visit: Tsunami Evacuation Tower

Based on lessons learned from the Great East Japan Earthquake, the City of Sendai invested in the construction of 13 Tsunami Evacuation Towers.

TDD participants visited the first evacuation tower to be constructed, completed in 2016. The tower can accommodate 300 people and its finished floor is 9.9 meters from the ground – the highest recorded wave of the 2011 tsunami was 9.3 meters. Features include emergency food and water for 24 hours, disabled access, toilet facilities, solar-powered LED, and a portable generator.

The tower is a steel structure and is supported by 24-meter piles. The depth of the piles was decided based on the liquefaction experienced in the 2011 earthquake.

Tsunami Evacuation Tower in Sendai

Photo: World Bank

The tower cost approximately US$2 million to install and has a life cycle of 50 years. TDD participants considered options for investing in such preparedness measures in their own countries, including how to manage the high cost and long return periods by ensuring multi-functional use (e.g., recreation, community engagement, etc.), as well as potential alternatives, such as evacuation hills.

Infrastructure Planning during Disaster Recovery and Reconstruction

Mr. Keisuke Inoue

Mr. Keisuke Inoue, Deputy Director Planning Department, MLIT Tohoku

Panelist: Mr. Junji Kimura, Regional Planning Chief, Planning Division, Planning Department, MLIT Tohoku

In the Tohoku region, core infrastructure sustained significant damages during the Great East Japan Earthquake. In the immediate aftermath, one of the government's main priorities was to re-open critical roads necessary for evacuation and the transportation of humanitarian supplies. Approximately 20 percent of the roads running along the Sendai coastline were impassible due to debris.

In order to clear the debris and re-open critical roads, the Tohoku Regional Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) initiated Operation Comb. The national highway running north-south was cleared, followed by 16 important routes from east to west. Within a week, almost all the identified roads had been cleared and were open to traffic.

Significantly, operations began on the day of the tsunami and before the general tsunami warning was lifted. This contradicted the Regional Disaster Prevention Operations Plan, but it was deemed necessary because of the number of people awaiting rescue along the Pacific coastline. Extra safety precautions were taken: operations occurred only in areas where the workers could evacuate to a safe location within 20 minutes of receiving information about an aftershock. The teams also worked in collaboration with fire departments and police agencies.

Because of advance infrastructure recovery planning, MLIT could quickly mobilize 52 local teams to conduct Operation Comb, including construction firms on a disaster contingency agreement.

To increase the seismic resilience of infrastructure, technical standards are systematically updated based on new data from disaster events. For example, following a review of the impact of the 2011 earthquake and tsunami, the specifications for highway bridges were updated with revisions to correction factors and motion levels. See Figure 14 for the incremental revision of highway bridge specifications since its release in 1972.

Figure 14. Highlights of Incremental Updates to Highway Bridge Standards Based on Disaster Damage Analysis

Released in 1972

4th Revision (1996)
- **Disaster:** 1995 Great Hanshin-Awaji Earthquake
- **Update:** Enforced seismic design standard

6th Revision (2012)
- **Disaster:** 2011 Great East Japan Earthquake
- **Update:** Designed earthquake ground motion levels re-evaluated

7th Revision (2017)
- **Disaster:** 2017 Kumamoto Earthquake
- **Update:** Introduced flexible construction methods and enhanced standards for reasonable longevity of construction

Asset Management for Disaster Risk Reduction

> The utility had to improve its management system to better account for disaster risks and to explain our situation to stakeholders clearly and prioritize activities effectively and efficiently.
>
> Dr. Tetsuya Mizutani

Dr. Tetsuya Mizutani, PhD

Director of Sewerage Pipeline Construction Section, City of Sendai

Panelist: Mr. Akihiko Ostubo Director of Management Strategy Office, Business Planning Section (Sewage Management), City of Sendai

Since 2008, the Sendai Wastewater Utility (SWU) has developed an asset management system in response to budget cuts, personnel reduction, deterioration of the network, and anticipated disaster risks. The system joins financial, contractual, and inventory functions to support infrastructure life-cycle management, both in normal operating conditions and in response to disasters.

The core elements of the water utility asset management system include the re-engineering of business processes and condition monitoring. These elements are supported by the development of an enabling IT system, including a Geographical Information System (GIS) system, staff capacity building, and internal audits resulting in continual improvement (Figure 15). The asset management system feeds into risk and decision-making prioritization, mid-term planning, and long-term cost forecasting. The outcomes of the asset management system include future risk reduction, long-term cost reduction, and a shortening of complaint processing time (see Figure 16).

In order to manage risks across the wastewater system, information is collected on the condition of assets (via staff survey and plotted on GIS) and risks are identified, including pipeline deterioration, earthquakes, and inundation. Each risk is evaluated using a matrix approach that plots potential consequences against the probability of failure to create an overall risk score. The probability of earthquake damage is based on the design standard of earthquake-resistant measures, which are updated incrementally to reflect national standards. Risk mitigation measures are selected according to risk levels and integrated into mid-term business plans.

Figure 15. Mapping the Condition of Assets

Asset risk levels are displayed in GIS to make it easier to plan construction and rehabilitation projects.

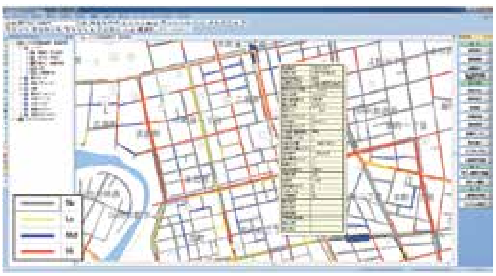


Figure 16. Sendai Wastewater Utility Asset Management System Overview

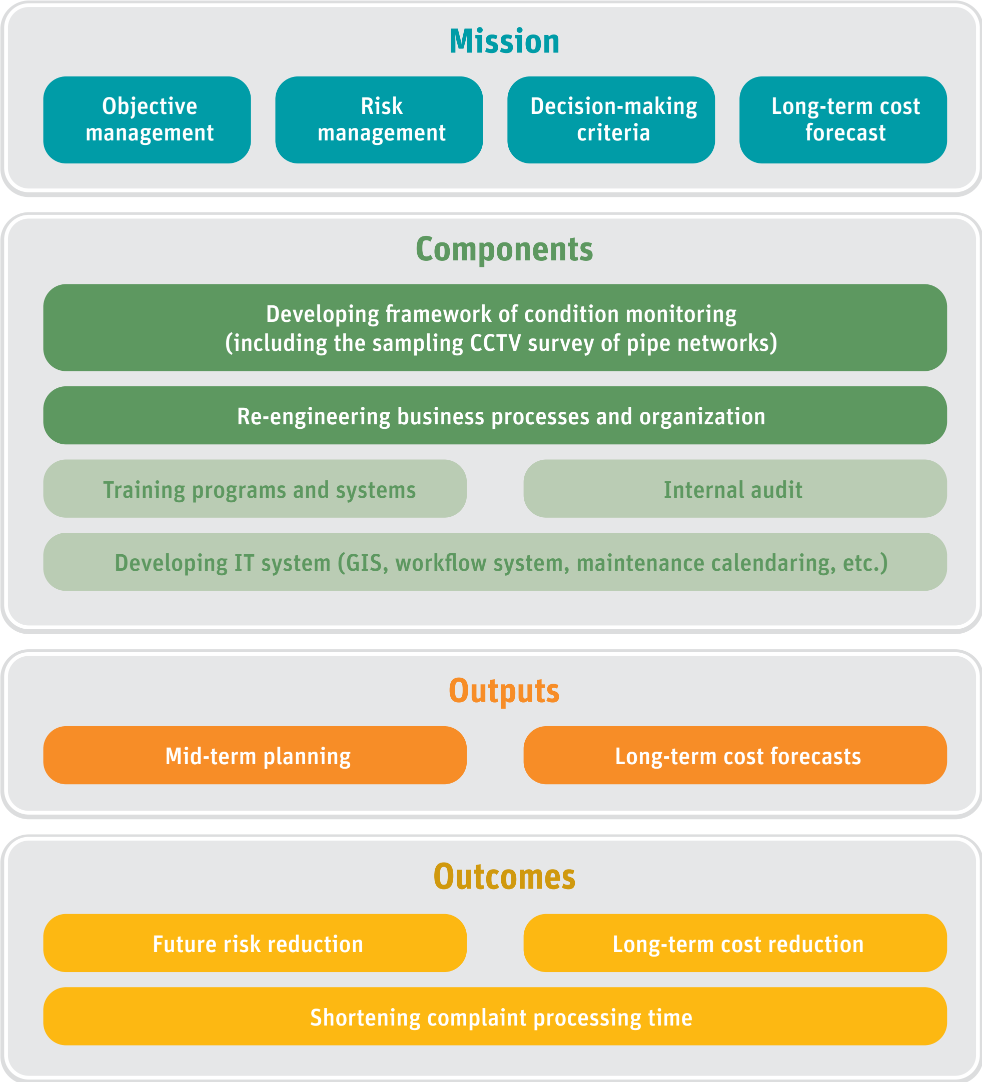
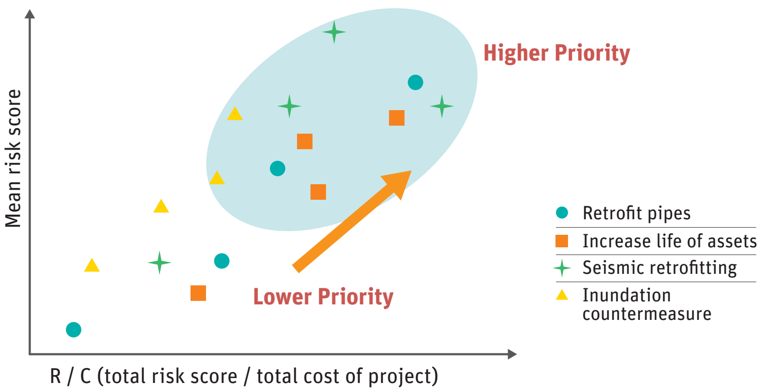


Figure 17. Investment Decision Making for Resilient Asset Management by Sendai City Construction Bureau



Source: ©Sendai City Construction Bureau (SCB) 2015a. Reproduced, with permission, from SCB; further permission required for reuse. English translation by the World Bank; World Bank, 2018, *Resilient Water Supply and Sanitation Services: The Case of Japan*. Washington, DC: World Bank.

Value of the Asset Management System in the Great East Japan Earthquake

When the Great East Japan Earthquake hit in 2011, the asset management system had been operational for three years and yielded significant benefits for disaster preparedness and response.

Preparedness

Several risk reduction measures had been prioritized and implemented. For example, using a national-level subsidy, the Sendai Wastewater Utility (SWU) used pipe lining to reinforce deteriorated pipes. According to the post-disaster damage survey, no lined pipes were damaged.

Other assets – such as the Minamigamo Wastewater Treatment Plant – did, however, sustain significant damage. Just after the tsunami, business continuity plans were operationalized for the plant and the emergency gate was detached to allow discharge and avoid wastewater flows in downtown areas. Based on this experience, business continuity plans were developed in all facilities and built into the asset management system.

Response

The GIS system, business process improvement, and staff-capacity building significantly streamlined the post-disaster damage survey. Following a disaster, a lot of data has to be inputted over a short period of time by a number of organizations. Japan wastewater utilities across the country have a mutual aid agreement to support each other with damage surveys following large-scale disasters.

To maintain disaster response capacity the SWU conducts an emergency survey drill on an annual basis.

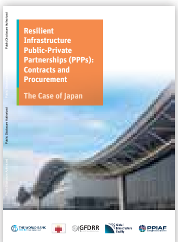
Site Visit: Sendai Airport

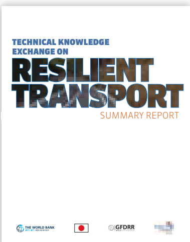
The Sendai Airport Operation was the first airport privatization project in Japan. The tsunami caused by the Great East Japan Earthquake inundated and damaged the electrical and mechanical equipment, ventilation system, and sanitation system in the terminal building. Miyagi Prefecture decided to proceed with the privatization of the airport to help quickly revitalize the local economy.

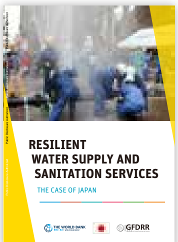
To ensure resilience to future risk, the contract developed for the Sendai Airport re-construction clearly outlines the risks shared between the public and private entities – including risk sharing in the event of a "force majeure." The World Bank DRM Hub developed a series of knowledge products on resilient infrastructure public-private partnerships (PPPs) to document this and other case studies.

Re-constructed Sendai Airport Photo: MediaFOTO / PIXTA

Knowledge Resources: Highlights







- Resilient Infrastructure Public-Private Partnerships (PPPs): Contracts and Procurement – The Case of Japan
- Technical Knowledge Exchange on Resilient Transport Summary Report
- Resilient Water Supply and Sanitation Services: The Case of Japan
- Resilient Industries: Project Brief

SEISMIC RISK REDUCTION IN THE BUILT ENVIRONMENT

Building Regulatory Reform for Effective Risk Reduction

> Building and land-use regulation can be the most effective tool for increasing people's safety at a large scale.
>
> Mr. Thomas Moullier

Mr. Thomas Moullier

Senior Urban Specialist, BRR Program, Global Practice for Social Urban Rural Resilience (GSURR)

Facilitated by Ms. Keiko Sakoda, DRM Specialist, BRR Program, GSURR

Globally, 1 billion new dwellings will be constructed by 2050 and, in low- and middle-income countries alone, building stocks will double in the next 15 to 20 years. The way we build our cities has a profound effect on how vulnerable they are to natural hazards such as earthquakes. Yet much of this urban expansion is occurring in cities with weak capacity to ensure risk-sensitive development and construction.

To facilitate the construction of well-performing and resilient buildings, comprehensive regulatory frameworks are needed. Building codes can reduce vulnerability by specifying adequate standards for construction or retrofit, and land-use plans can reduce exposure by guiding development away from the most hazard-prone areas.

Building regulatory frameworks consist of three core components:

1. National legal and institutional frameworks
2. Code development maintenance
3. Local implementation

Building and land-use regulation can be the most effective mechanism for risk reduction in the built environment. In Ethiopia, for example, compliance with the building code would reduce average annual losses by 30 percent by 2050.[3]

Mr. Moullier also noted the cost-effectiveness of investing in a strong building regulatory

3 World Bank. 2016. "Strengthening City Resilience in Ethiopia: Review of Building Regulatory Framework."

framework, and referenced Japan as a country that has proven this over decades (see http://pubdocs.worldbank.org/en/162361520295760910/jp-publication-drmhubtokyo-convertingdisaster-experience-into-a-safer-built-environment.pdf). A well-functioning building regulatory framework can enable:

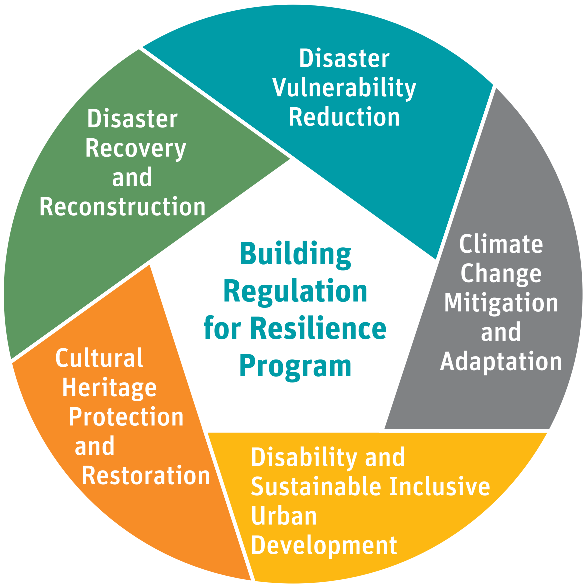
- cost-savings through investment in disaster-risk reduction measures;
- continuity and growth of public revenues through formalization and property taxation; and
- an improved investment climate because of reduced cost of compliance.

The benefits of an effective building regulatory framework can also extend beyond disaster risk reduction to address a number of societal objectives, including accessibility and climate change adaptation and mitigation.

For building codes to be effective, they must reflect local construction techniques and materials. For example, in countries where incremental/vernacular housing is common local techniques and materials should be included in the code with associated resilience measures. In many low- and middle-income countries, building codes have been inherited from a colonial past and bear little relation to the current reality on the ground.

TDD participants identified the local implementation of building codes as their greatest challenge. Local implementation refers to the basic interactions of building control

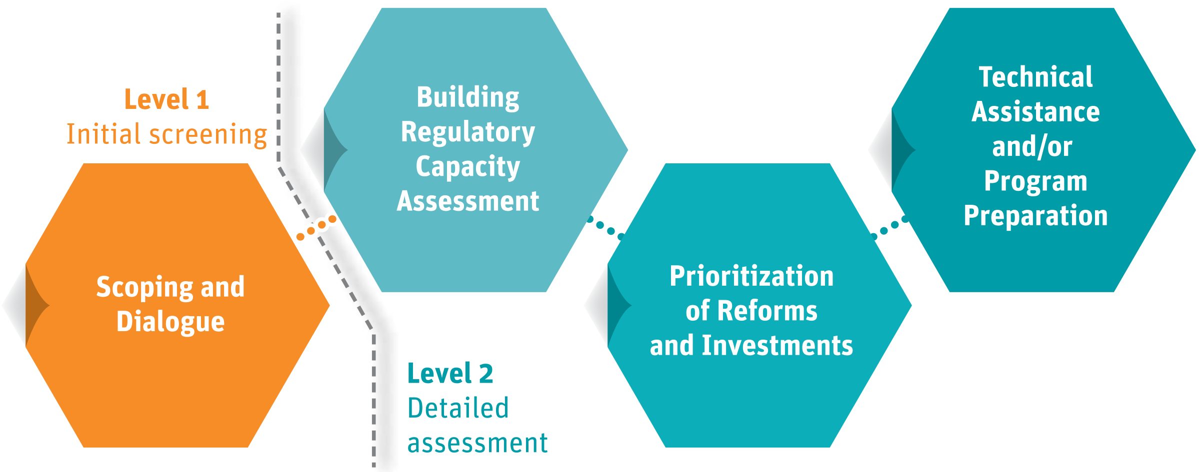
Figure 18. Building Regulatory Reform: Sectors of Engagement



(e.g., plan review and inspection). Building the enforcement capacity of local governments and municipalities is critical, and, as demonstrated in the Philippines, a number of countries are approaching this challenge in innovative ways. Mr. Moullier also noted the value of orienting building code implementation toward compliance advice, support, and incentives rather than top-down coercive actions.

The World Bank's Building Regulation for Resilience Program has a well-established framework and series of tools to help countries initiate regulatory reform. As highlighted in Figure 19, the program has developed a Building Regulatory Capacity Assessment to establish a baseline from which to prioritize reform investments. The program is currently working with more than 10 countries to support this agenda.

Figure 19. Framework for Initiating Building Regulatory Reform



Increasing the Safety of the Built Environment in Japan

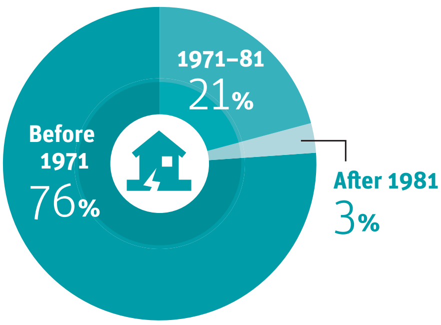
Mr. Hideaki Sato

Director for Building Technology Policy Analysis, Housing Bureau, MLIT

Japan is internationally recognized for its robust structural performance and seismic resistant technologies. This achievement is the result of a century of incremental improvements and learning: Japan collects data and synthesizes lessons from each disaster, and constantly updates building regulations and implementing mechanisms.

Post-disaster damage analysis of building structures in the Great Hanshin-Awaji Earthquake highlighted the success of Japan's regulatory approach. The building code had been significantly revised in 1971 (based on the experience of the 1968 Tokachioki Earthquake) and again in 1981 (based on the experience of the 1978 Miyakiken-oki Earthquake). Buildings constructed to the 1971 standard performed much better than those built to an earlier standard; and those constructed to the 1981 standard performed the best, with only a small share sustaining significant damage (Figure 20).

Figure 20. Buildings Damaged in the Great Hanshin-Awaji Earthquake, by Year of Construction



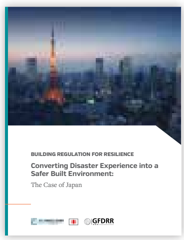
Japan initiated its building regulatory reform under conditions similar to the current situation of some developing countries (with limited technical capacity, poor construction quality, and high demand for affordable housing). Japan's experience can, therefore, provide key lessons for developing countries.

Mr. Sato highlighted some of the key lessons learned from Japan's experience, captured in *Converting Disaster Experience into a Safer Built Environment: The Case of Japan*:

1. **Education, advice, and financial incentives can be an effective way to create an enabling environment for regulatory compliance.** Japan has introduced training and licensing of building professionals and set up loan programs offering tax breaks and other incentives for houses that exceed the mandatory minimum standard.

2. **Formal regulatory systems should recognize prevalent construction practices, including non-engineered construction.** In Japan, wooden housing structures are common. Over time, these originally non-engineered structures have become safer and more earthquake-resilient as a result of the gradual improvement of research in building sciences and large-scale education efforts. The national building code includes standards for wooden structures and the government has invested resources to train carpenters and engineers who specialize in wooden construction.

Public Seminar



On March 12, 2018, the Building Regulation Program held a public seminar to launch a flagship report outlining Japan's experience of building regulatory reform. The report outlines 10 key lessons learned from Japan's experience. It was jointly developed with MLIT and other technical agencies. The seminar was attended by TDD participants, Japanese public and private sector organizations, and academics.

Ms. Akiko Yamada and Mr. Kazuya Nakajima

Building Guidance Department, Housing and Urban Planning Bureau, Kobe City

Kobe City officials provided a comprehensive overview of the quality assurance process for buildings in Japan (Figure 21). In Japan, when a building is constructed, extended, rebuilt, or relocated, the owner must apply for and receive building confirmation and undergo on-site interim and final inspections. The interim inspections are timed to coincide with specific stages of construction so that foundational and structural components can be reviewed.

In Kobe, the proportion of buildings that received a final inspection rose from 44 percent in 1998 to nearly 100 percent in 2014. This signifies a dramatic increase in the rate of compliance.

Kobe City officials highlighted several reasons for this shift:

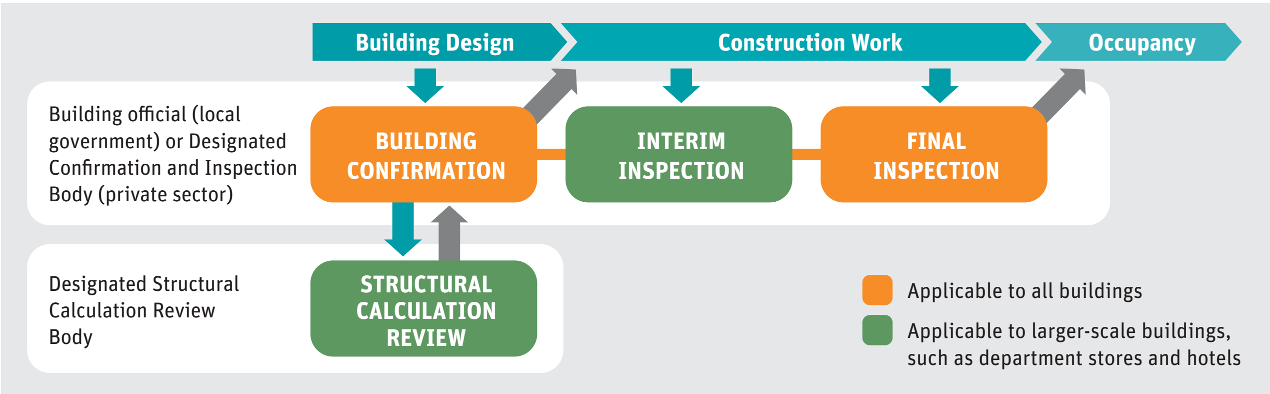
1. **Voluntary compliance spurred by public awareness.** Kobe City sustained significant damage during the Great Hanshin-Awaji Earthquake. Over 120,000 buildings were fully or partially destroyed.

2. **Increased local enforcement capacity through collaboration with the private sector.** Since 1998, the national government has allowed private-sector designated entities to carry out design confirmation and construction inspection. To mitigate associated risks, they have established mechanisms for oversight, fairness, and conflict resolution. Design confirmation and inspection bodies must be designated and registered with MLIT. In Kobe City, in 2016, 96 percent of building confirmations were conducted by design confirmation bodies.

At the time of the Great Hanshin-Awaji Earthquake, Kobe City was responsible for all building confirmations and inspections. During the reconstruction process, immense pressure was placed on the department that is now called the Building Guidance Department. To increase their capacity, Kobe City relied on the support of other prefectures that sent their own employees to assist.

Over time, as the rate of final inspection has improved, the number of newly constructed illegal buildings has declined. In fiscal year 2015 there were 13 cases, compared to 235 in 1999. However, violations through extension work or change of use are more common. Japan has a well-defined process for correcting building violations, including providing thorough guidance and corrective plans. It is very rare for a case to escalate to prosecution and criminal charges.

Figure 21. Quality Assurance Steps for New Buildings in Japan



Kobe City Retrofitting Program

In the wake of the Great Hanshin-Awaji Earthquake (1995), there was significant political momentum to invest in retrofitting. The earthquake highlighted the construction issues that the quality assurance mechanisms in place had not addressed as well as the high resilience of post-1981 construction.

The same year, the national government passed a law to promote seismic retrofitting. It has since been amended to:

- Require prefectural governments to make plans for retrofitting public facilities and housing, including tangible targets (2005).
- Make it mandatory for large-scale buildings of public importance to conduct a seismic diagnosis and report the results to the local government by 2015 (2013).

Kobe City has made impressive progress in its retrofitting agenda. In 2013 the seismic retrofit rate reached 91 percent. This success can be attributed to retrofit subsidy programs and public awareness campaigns.

Targeted buildings of public importance have benefited from national and local government retrofit subsidies. At the same time, private homeowners have taken advantage of a national time-limited subsidy program.

To support the financial incentives provided, Kobe City has invested significant time and resources in raising public awareness to promote seismic retrofit. Its public communication campaign includes newspaper articles, door-to-door visits, and an open house of an earthquake-resistant house, as well as collaboration with civil society groups. To ensure the awareness of future generations, Kobe City has also integrated retrofitting solutions into the school curriculum.

In the latest Kobe City Retrofit Plan (2016–2020), the city has set a retrofit goal of 95 percent of homes. This entails the retrofit of 30,000 houses.

Kenchikushi

Kenchikushi – licensed architect-engineers – are responsible for building design and construction oversight. They are also involved in the periodic inspection of special buildings (including hospitals, hotels, theaters, department stores, offices, apartments, etc.) as well as seismic diagnosis and retrofit planning. Kenchikushi play an important role in ensuring the quality and safety of buildings, including wooden structures.

The Kenchikushi law was enacted in 1950, when there was high demand for housing. To ensure there would be sufficient licensed professionals to design and oversee construction of houses, the law established three levels of Kenchikushi with different qualifications and levels of expertise. To be a certified Kenchikushi, candidates must pass a test with both an academic and a design component. The qualifications that Kenchikushi must hold are stipulated in the Kenchikushi law and differ for the three levels.

Significantly, under the Housing Quality Assurance Act, Kenchikushi are liable for defects in new houses for a period of 10 years. Kenchikushi can also have their licenses suspended for up to a year if they are complicit in building violations.

Several TDD participants were interested in learning more about the Kenchikushi system. The *Converting Disaster Experience into a Safer Built Environment: The Case of Japan* report provides extensive information, including the scope of activities permitted and qualifications required across the three levels of Kenchikushi.

Kobe City Hall Base Isolation and Damper

During the Great Hanshin-Awaji Earthquake, Kobe City Hall complex sustained significant damage: the sixth floor of one of the buildings collapsed.

As noted above, following the earthquake, significant investment was channeled into the retrofitting and resilient rebuilding of public and private buildings. City Hall, home to the Emergency Operations Center (EOC), is a building of particular public significance. Because of this, Kobe City invested in base isolation and damper to strengthen the structure.

Damage to Kobe City Hall in 1995 Great Hanshin-Awaji Earthquake Photo: Mr. Taisuke Matsuzaki / City of Kobe

Seismic Power Isolation at Kobe City Hall Photo: World Bank

Site Visit: E-Defense

TDD participants had the opportunity to visit the world's largest shaking table, located at the Hyogo Earthquake Engineering Research Center and managed by the NIED (National Research Institute for Earth Science and Disaster Resilience).

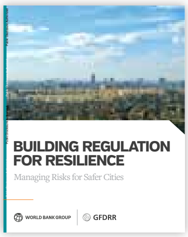
The shaking table can simulate high-level ground motions of the same intensity as the Great Hanshin-Awaji Earthquake. These shaking table tests provide earthquake engineers with the chance to observe and measure the behavior of structural models (of up to 1,200 tons) under simulated earthquake events.

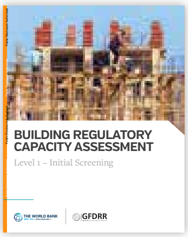
The shaking table is government-owned but used by universities, research institutes, and the private sector. Japan's ongoing improvement of its building standards and construction techniques has depended, in part, on continuing research carried out by scientists and engineers to solve technical problems related to building safety, including valuable data collected at E-Defense.

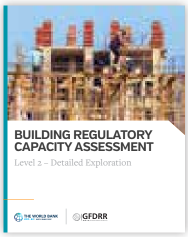
Building Testing Facility at Hyogo Earthquake Engineering Research Center (NIED) Photo: Simpson Strong-Tie http://www.alatown.com/testing-buildings-destruction/

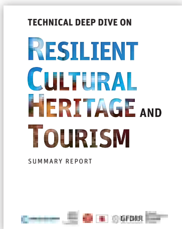
TDD Participants at E-Defense Photo: World Bank

Knowledge Resources: Highlights









- Converting Disaster Experience into a Safer Built Environment: The Case of Japan
- Building Regulation for Resilience: Managing Risks for Safer Cities
- Building Regulatory Capacity Assessment – Level 1, Initial Screening
- Building Regulatory Capacity Assessment – Level 2, Detailed Exploration
- Technical Deep Dive on Resilient Cultural Heritage and Tourism

OUTCOMES AND NEXT STEPS

TDD Participants at Arahama Elementary School
Photo: World Bank

KNOWLEDGE EXCHANGE: CONNECTING WITH 100 RESILIENT CITIES

On the last day of the TDD, participants took part in a video conference between Tokyo and Mexico City, meeting with Dr. Arnoldo Matus Kramer (Chief Resilience Officer for Mexico City) and Mr. Hiroyuki Fujita (Chief Resilience Officer for Kyoto).

100 Resilient Cities, pioneered by the Rockefeller Foundation (100RC),[4] conducted a Seismic Resilience Network Exchange in Mexico City to help the city apply a resilience lens to its seismic strategy. The convening featured city officials from nine 100RC member cities – Cali, Christchurch, Colima, Kyoto, Los Angeles, Quito, San Francisco, Vancouver, Wellington – and partners from the non-profit, private, and public sectors.

The TDD-100RC exchange was an opportunity for both groups to share the lessons and ideas garnered from their respective events. The discussion focused on the following takeaways:

- **In the aftermath of disasters, countries/cities need to understand how to harness social media to** (i) disseminate information to the public, and (ii) receive communications from the public. However, as learned in the 2017 earthquakes in Mexico, it is important to develop strategies to monitor and manage the spread of misinformation.

- **It is important to be cognizant of potential risks and the challenges associated with releasing risk information,** including (i) negative impacts on the real-estate market and (ii) selecting appropriate risk scenarios to share with the public to encourage citizen preparedness but, at the same time, not create an unhealthy level of fear and lack of transparency.

WHAT IS SEISMIC RESILIENCE?

Any city that faces a high risk of earthquakes will take steps to prepare and mitigate their impacts. But cities that pursue seismic resilience will not only increase their ability to withstand seismic shocks, they will simultaneously address the chronic stresses – such as water scarcity, urban sprawl, or inequity – that can exacerbate disasters when they occur. Application of resilience principles ensures that every resource spent on necessary seismic mitigation, preparedness, response, and recovery efforts also generates co-benefits that will bolster the city's ability to thrive daily, and not just in moments of crisis.

Dr. Kramer noted that, despite concerns, the nine cities in attendance reported that disclosing risk information had not negatively impacted their real-estate markets.

Ms. Campos Garcia, Senior DRM specialist at the World Bank, contributed to the debate by sharing the strategic approach Colombia has taken to sharing risk information. Colombia disseminated carefully selected results from micro-zonation studies, including high-risk building typologies, and disseminated this information to the public alongside retrofit solutions and incentives (e.g., tax exemptions).

4 See www.100resilientcities.org for further details.

CLIENT ACTION PLANS

Bangladesh

Seismic Resilience Objectives

- Enforce the building code
- Establish an early warning system (EWS)

Implementation Plan

Short term

- Strengthen building regulatory capacity of all relevant agencies
- Develop an electronic construction permitting system
- Institute professional accreditation program for engineers, architects, planners, bar binders, and masons
- Establish mechanisms for building code enforcement and implementation
- Conduct a vulnerability assessment and retrofit design of essential critical buildings
- Develop a risk-sensitive land-use plan
- Create and operationalize an urban resilience division
- Establish an EWS

Medium term

- Retrofit existing critical infrastructure/buildings
- Conduct a vulnerability assessment and retrofit design of critical infrastructure (gas, water, electricity)
- Strengthen risk communication
- Establish regional collaboration for risk mapping (India, Nepal, Myanmar)

Long term

- Retrofit essential infrastructure
- Ensure resilient new construction

Implementation Challenges

- Low public awareness of seismic risk due to long return periods
- Lack of sensitization and proactive participation of political leaders
- Deficiencies in institutional preparedness and management capacity
- Limited budgetary allocations for proactive measures of disaster risk reduction (DRR) mainstreaming
- Lack of evidence-based policy making
- Absence of publicly available information
- Weak governance for implementation and enforcement

Support Needed

- **World Bank**
  - Investment projects
  - Knowledge sharing, training, and capacity building
- **World Bank DRM Hub**
  - Knowledge sharing, training, and capacity building, including south-south knowledge exchange
- **Knowledge Products**
  - Terms of Reference (ToRs), technical specifications, market survey of firms
  - Case studies and documentation of best practice

Ecuador

Seismic Resilience Objectives

- Conduct national and city-specific risk assessments
- Improve seismic monitoring network
- Strengthen building regulatory capacity
- Evaluate and reinforce buildings of public interest
- Strengthen national planning for disaster response
- Strengthen citizen preparedness, including disaster response drills

Implementation Plan

Short term

- Update National Seismic Hazard Map
- Improve/increase seismic monitoring instrumentation
- Develop a National Response Plan, based on the Response Strategy developed with the World Bank Group
- Conduct disaster response drills at national and local levels
- Develop a handbook with guidelines to regulate and control engineering designs and construction processes

Medium term

- Develop city-specific seismic hazard maps
- Evaluate buildings of public importance
- Train technical staff on the Ecuadorian Building Code (NEC)
- Train brick layers, artisans, etc. on requirements of the NEC
- Train communities on seismic risk
- Build regulatory capacity in line with the Building Regulatory Capacity Assessment conducted in Quito
- Regulate engineering designs and construction processes

Long term

- Execute structural reinforcement of buildings of public significance

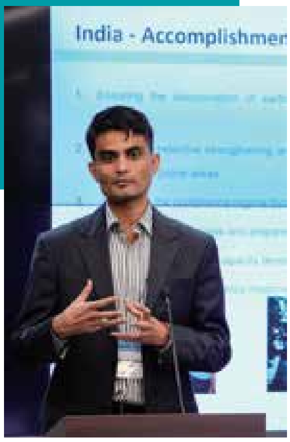
Implementation Challenges

- Budgetary restraints
- Prioritization of needs/ projects of the central government
- Technical staff's familiarity with the NEC and its application
- Community awareness of seismic risk

Support Needed

- **World Bank**
  - Technical assistance and financing
- **World Bank DRM Hub**
  - Technical assistance on DRM/seismic hazards
- **Knowledge Products**
  - Building regulations, seismic preparedness, structural reinforcement, relocation, and other policies implemented after the Great Hanshin-Awaji Earthquake

India



Seismic Resilience Objectives

- Ensure the incorporation of earthquake-resistant design features in new construction
- Prioritize seismic retrofitting of critical structures in earthquake-prone areas
- Strengthen building code compliance through appropriate regulation and enforcement
- Strengthen the awareness and preparedness of all stakeholders
- Introduce capacity development interventions for managing earthquakes
- Strengthen the emergency response capacity in earthquake-prone areas

Implementation Plan

Short term

- Implement realistic and scientifically rigorous seismic zonation
- Standardize the building permit system (pilot in selected urban local bodies)
- Create a National Seismic Safety Policy

Medium term

- Include earthquake engineering in the curriculum of civil engineering and architectural engineering
- Develop and pass Professional Civil Engineer's Bill

Long term

- Establish Center of Innovation on Earthquake Engineering (similar to NIED in Japan)
- Initiate a seismic retrofitting program for critical structures
- Establish regional earthquake early warning system (EWS)

Implementation Challenges

- Lack of risk awareness among various stakeholders
- Inadequate attention to structural mitigation measures in the engineering education syllabus
- Lack of provision and inadequate monitoring and enforcement of earthquake-resistant building codes and town planning by-laws
- Absence of system for licensing engineers and certifying artisans
- Lack of inter-agency coordination

Support Needed

- **World Bank**
  - Technical assistance: risk assessment, building regulation, mitigation, emergency response, critical infrastructure protection, and asset management
  - TDD on seismic risk resilience for policy makers
  - India-Japan collaboration for knowledge sharing
- **Knowledge Products**
  - Seismic safety policy notes from Japan and other countries
  - J-Alert case study
  - Active-passive devices for earthquake-resistant buildings/ regulatory framework
  - Public awareness/education materials

Indonesia

Seismic Resilience Objectives

- Improve government capacity to conduct risk assessments, including micro-zonation maps
- Develop innovative methods of disaster risk financing and investment
- Enhance knowledge management – e.g., documenting lessons learned
- Harmonize the national disaster management master plan with national regulations (e.g., building regulations) and international frameworks
- Improve capacity of local government agencies, particularly in conducting risk assessments and risk management planning
- Increase citizen awareness (education campaigns, drill simulations, building code regulations, community resilience)
- Improve collaboration with private sector, academia, and nongovernmental organizations

Implementation Plan

Short term

- Harmonize the national disaster management master plan (forthcoming) with national regulations (e.g., building regulations) and international frameworks
- Build capacity at local and central levels for risk analysis, risk modeling, and enforcing building regulation

Medium term

- Review and improve disaster risk assessment methodology
- Strengthen knowledge management of DRM practices
- Strengthen capacity of local governments to implement and enforce building codes, including building audits, monitoring, and inspections

Long term

- Identify options for effective disaster risk financing, insurance, and investment
- Develop an effective early warning system (including increasing the numbering of monitoring stations and improving information/ data dissemination)

Implementation Challenges

- Need to build political support
- Need to disseminate data and information effectively (particularly to local governments in remote areas)
- Insufficient budget for disaster risk reduction
- Lack of awareness in local communities
- Lack of coordination/ partnership with the private sector

Support Needed

- **World Bank**
  - DRM Technical assistance – risk assessment methodology
  - Technical training for the national and local government staff
- **Knowledge Products**
  - Building regulation
  - DRM case studies

Kenya

Seismic Resilience Objectives

- Improve seismic network and hazard/risk information
- Strengthen building regulations and implementation capacity
- Create risk awareness

Implementation Plan

Short term

- **Seismic Risk Information**
  - Conduct stakeholder mapping
  - Participate in regional risk information workshop
- **Building Regulation**
  - Consultation and submission of the draft Built Environment Bill and subsequent lobbying, including statistics on cost-benefit analysis
  - Define roadmap for building regulation framework
  - Encourage community sensitization on the main causes of building collapse

Medium term

- **Seismic Risk Information**
  - Create coordination mechanism for seismic risk monitoring
  - Collect existing information and identify gaps for national seismic hazard map to inform building regulations
- **Building Regulation**
  - Develop and disseminate building regulations and standards
  - Assess capacities and gaps of approval process
  - Strengthen audit and inspection of buildings
  - Start capacity building for local government, practitioners, professional bodies, developers, etc.

Long term

- **Seismic Risk Information**
  - Develop a national seismic hazard map to inform building regulations
  - Design a seismic monitoring network and a roadmap
- **Building Regulation**
  - Develop a prototype for the building approval process
  - Continue building regulatory capacity building, including vocational training though a train-the-trainers model
  - Conduct periodic regulation reviews
  - Conduct comprehensive vulnerability assessment of critical buildings
  - Formulate and implement land-use plans at the country level

Implementation Challenges

- Political corruption
- Lack of public awareness about building safety
- Rapid rural-urban migration and associated housing demand
- High poverty rate

Support Needed

- **World Bank**
  - DRM and Urban Policy dialogue through World Bank “CAT DDO”
  - Technical Assistance: seismic hazards, seismic hazard regional workshop, building regulation roadmap, and bill validation workshop
  - Development of risk communication materials
- **DRM Hub**
  - TA to build capacity for building regulation enforcement
  - Capacity building on seismic monitoring linked to JMA
- **Knowledge Products**
  - Seismic hazard/vulnerability studies
  - Support revision and validation of Built Environment Bill

Malawi

Seismic Resilience Objectives

- Build seismic risk management capacity of key stakeholders
- Finalize seismic hazard mapping to guide design of programs and support the design and implementation of regulations
- Build citizen preparedness
- Pass a Building Act
- Finalize building regulations that integrate resilience

Implementation Plan

Short term

- Undertake stakeholder mapping/analysis
- Develop a seismic risk communication strategy and promote public awareness
- Develop building regulatory capacity/assessment and stakeholder mapping
- Participate in regional risk information workshop to share experiences and identify a roadmap for coordinated actions

Medium term

- Boost capacity building and institutional strengthening for building regulation and seismic monitoring
- Finalize building regulations
- Undertake seismic risk assessments/mapping
- Develop a Building Act

Long term

- Review curriculum (primary, secondary, tertiary) to integrate seismic risk and support long-term training programs
- Investment in seismic monitoring systems

Implementation Challenges

- Limited technical capacity
- Limited financial capacity
- Limited political support
- Enforcement failure/corruption

Support Needed

- **World Bank**
  - Regional knowledge-sharing workshop
  - Seismic risk communication strategy and public awareness campaign
  - Capacity assessment on seismic risk (identification, monitoring, early warning, etc.)
  - Seismic risk mapping
  - Building Act and building regulations
  - Facilitate learning through knowledge exchanges
  - Technical support to design programs
- **Knowledge Products**
  - Examples of building regulations/Acts that have integrated seismic resilience
  - Public awareness kits on seismic risk

Myanmar

Seismic Resilience Objectives

- Strengthen and update the building regulatory framework
- Ensure seismic resilience of critical public facilities (high-occupancy buildings, cultural heritage buildings, critical infrastructure)

Implementation Plan

Short term

- Preliminary risk assessment of water supply network and water reservoir intake structure
- Building regulatory capacity assessment

Medium term

- Detailed risk assessment and design of retrofit for water supply system
- Detailed design of retrofit for priority public facilities
- Deploy database of other software solution to enhance permit review and enforcement

Long term

- Retrofit pumping stations, air compressor stations, and water supply infrastructure
- Retrofit priority public facilities
- Implement action/investment plan to strengthen/modernize building regulatory framework
- Assess seismic vulnerability of residential and public buildings
- Develop and pilot retrofit guidelines for existing apartment buildings

Implementation Challenges

- Lack of technical expertise for implementation
- Financial constraints
- Limited human resources capacity
- Poor regulatory enforcement
- Poor coordination (e.g., among government, nongovernmental organizations, universities, development partners)
- Lack of experience with development partners

Support Needed

- **World Bank**
  - Ongoing support through US$117 million Myanmar Southeast Asia DRM project and GFDRR/DRM Hub TA
- **DRM Hub**
  - Facilitate learning through knowledge exchanges
- **Knowledge Products**
  - Examples of building regulations/Acts that have integrated seismic resilience
  - Public awareness kits on seismic risk
  - Extra information on J-Alert

Nepal

Seismic Resilience Objectives

- Regional coordination to assess and manage risks
- Decentralization of DRM to the provincial and local government level and establishment of institutional processes

Implementation Plan

Short term
- Take stock of existing risk assessments and analysis
- Review DRM Act
- Support the decentralization of DRM, including the establishment of local institutions and associated capacity building

Medium term
- Boost capacity building for micro-zonation
- Strengthen community awareness through pilot programs

Long term
- Regional linkages/analysis for risk assessment (Bangladesh, Afghanistan, Myanmar)

Implementation Challenges

- Transition from Unitary to Federal Government
- Rapid unplanned urbanization
- High level of poverty
- Alternative priorities, including affordable housing
- Lack of political momentum and enforcement capacity

Support Needed

- **Knowledge Products**
  - Terms of Reference (ToRs)

Peru

Seismic Resilience Objectives

- Develop hazard and risk maps for major urban areas, prioritizing cities with high populations
- Integrate hazard and risk information into urban/territorial planning
- Strengthen enforcement of building codes by local governments for new and existing buildings
- Develop and implement a national emergency plan

Implementation Plan

Short term

- Prioritize cities to update/develop urban planning, including a risk assessment
- Update hazard information for major cities (>1,000,000)
- Revise and re-launch the National Subsidy Program for Retrofitting
- Conduct capacity building for local governments to enforce building code
- Launch a public awareness campaign (citizens, public employees, private sector)
- Review and update school curriculum to include hazard and risk prevention

Medium term

- Update/develop urban/territorial planning for major cities (>1,000,000)
- Update hazard information for municipalities (>100,000)
- Develop an urban cadaster for major cities (>1,000,000)
- Introduce mandatory vulnerability assessment for private and public existing buildings, and define a subsidy program for financing the assessment and a strategic communications plan
- Update or develop the national emergency response plan and guidance for subnational plans

Long term

- Update/develop urban planning for municipalities (>100,000)
- Develop urban cadaster for municipalities (>100,000)
- Launch a retrofit program and subsidy for existing buildings

Implementation Challenges

- Lack of national and local capacity for conducting risk assessments
- Recent changes to the DRM legal and institutional framework
- Insufficient prioritization of DRM in National Budget

Support Needed

- **World Bank**
  - TA to integrate risk information into urban/territorial planning
  - Initial preparation of Investment Project Financing (IPF), including finance to improve national seismic network
- **DRM Hub**
  - TA to build capacity for building regulation enforcement
  - TA to create public awareness and citizen preparedness TA
- **Knowledge Products**
  - Policy note on DRM to support preparation for IPF

Philippines

Seismic Resilience Objectives

- Collect comprehensive and reliable data on buildings (formal and informal), critical infrastructure, and inhabitants for a vulnerability assessment and sustainable action plan
- Develop a cohesive policy framework on seismic resilience, response, and rehabilitation
- Establish a networked communications system for early warning and pre- and post-earthquakes
- Develop funding and resource base for risk reduction measures and emergency response (e.g., disaster risk financing and insurance)
- Develop and implement an integrated seismic risk and resilience program

Implementation Plan

Short term

- Establish community resilience programs
- Establish a rapid vulnerability assessment of public buildings and critical infrastructure
- Launch a public awareness campaign

Medium term

- Pass a Philippines Building Act and other enabling laws
- Strengthen retrofitting of public buildings and critical infrastructure
- Establish an emergency operations center
- Develop and implement disaster risk financing and insurance

Long term

- Carry out well-established information campaigns
- Institutionalized systems, standards, and protocols for seismic risk response

Implementation Challenges

- Lack of enabling policies and laws to allow full implementation of proposed program
- Lack of financial resources and technical capacity
- Lack of a string agency to lead and manage seismic risk and resilience programs
- High poverty rate
- Political momentum and term limits

Support Needed

- **World Bank**
  - TA to develop a Seismic Risk and Resilience Program
  - Viable financing option to implement the program
  - Foreign financing for expensive seismic technology (shaking tables, dampers, base isolators)
- **DRM Hub**
  - Informal working group to continue engagement with other countries
  - Just-in-time advisory services, deployment of experts, “lease” of shaking tables, etc. for testing key infrastructure projects
- **Knowledge Products**
  - Share ToRs, case studies, policy notes, building regulations (good practices from other countries)
  - Materials on risk communication – establishing disaster memorials and education materials for preparedness

FOLLOW-ON SUPPORT AND NEXT STEPS

Client countries identified the specific assistance they need from the World Bank to strengthen their seismic resilience. Operational support requests are summarized in Table 1 below.

Table 1. Operational Support Requested

	Risk Assessment	Monitoring and Alert	Emergency Preparedness	Resilient Infrastructure	Building Regulation	
	Seismic Hazard and Risk Assessment Guidance	Seismic Monitoring Network and J-Alert Case Study	Community Training and Education Materials	Water Utility Case Study	Capacity Assessment	Training and Qualification Processes
Philippines			×			×
Indonesia	×		×			×
Myanmar		×	×	×	×	×
Bangladesh		×	×			
Nepal			×			
India	×	×	×		×	
Malawi	×	×	×		×	
Kenya	×		×		×	
Ecuador	×		×		×	
Peru	×	×				

Highlights

- **India, Kenya, Ecuador, Myanmar, Malawi, Peru, and the Philippines** expressed interest in technical assistance and/or knowledge products from the World Bank's Building Regulation for Resilience Program. Myanmar is exploring the feasibility of conducting a Building Regulatory Capacity Assessment focused on the resilience of existing buildings, critical public facilities, and cultural heritage sites. This Assessment would support the Myanmar Southeast Asia Disaster Risk Management Project.
- **Myanmar, Indonesia, and the Philippines** expressed interest in Japan's licensed architect-engineers, Kenchikushi. To meet this demand, the World Bank DRM Hub is developing a Knowledge Note on the Kenchikushi system.
- **Bangladesh and India** expressed interest in building a DRM learning facility focused on providing practical knowledge on household preparedness. Both country teams are reaching out to the firm that designed educational materials at the Tokyo Rinkai Disaster Prevention Park.

TDLC and the Tokyo DRM Hub are exploring ways to maintain momentum after the TDD, including through TDLC's City Partnership Program (CPP). One key idea that emerged from the TDD was to create thematic working groups, composed of interested experts and country teams, that will connect virtually on a regular basis and focus on specific challenges. "Hackathons" are one challenge-based approach that could be adopted. The proposed thematic working groups are summarized in Table 2 below, along with those TDD participants who demonstrated interest.

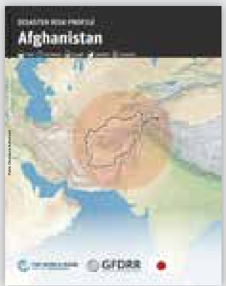
Table 2. Proposed Thematic Working Groups

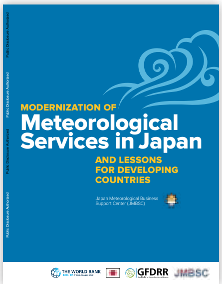
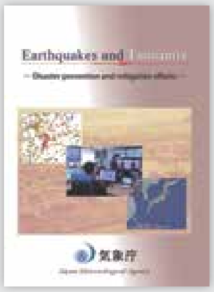
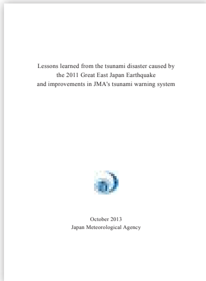
	Building Regulation	Monitoring and Alert Systems	Emergency Preparedness and Response
Philippines	×		×
Indonesia	×		×
Myanmar	×		
Bangladesh	×		
Nepal			×
India	×	×	
Malawi	×		×
Kenya	×	×	×
Ecuador	×	×	×
Peru	×		

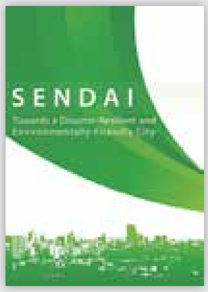
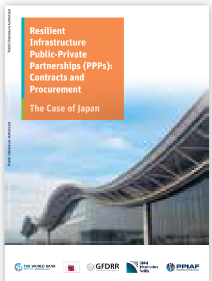
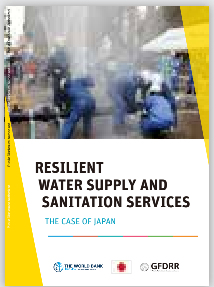
ANNEXES

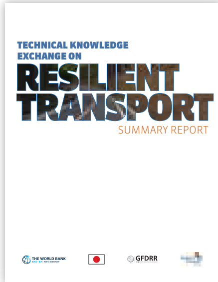
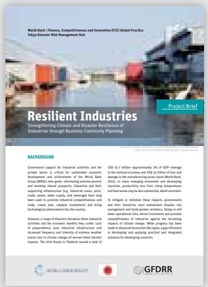
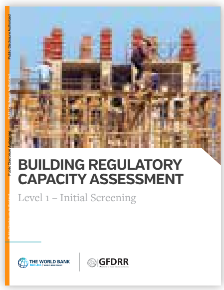
TDD Participants at E-Defense
Photo: World Bank

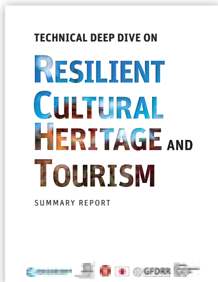
ANNEX 1: RESOURCE LIBRARY

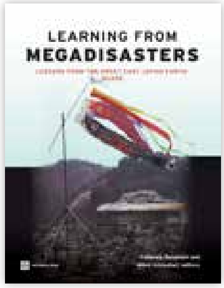
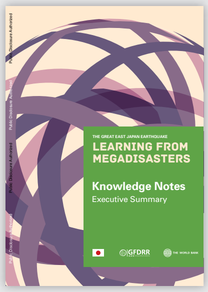
FOCUS AREA	Knowledge Resource Title
Seismic Risk Identification	Understanding Risk in an Evolving World: Emerging Best Practices in Natural Disaster Assessment (report) Understanding Risk in an Evolving World (policy note) 
	Disaster Risk Profile Afghanistan 
	Santa Catarina: Disaster Risk Profiling for Improved Natural Hazards Resilience Planning 
	Think Hazard A simple and quick analytical tool that enables development specialists to determine the potential likelihood of 11 natural hazards. 

FOCUS AREA	Knowledge Resource Title	
Seismic Risk Monitoring and Alert for Preparedness	Modernization of Meteorological Services in Japan and Lessons for Developing Countries	
	Earthquakes and Tsunamis: Disaster Prevention and Mitigation Efforts (JMA)	
	Lessons learned from the tsunami disaster caused by the 2011 Great East Japan Earthquake and improvements in JMA's tsunami warning system	
Seismic Risk Communication for Preparedness	Learning from Disaster Simulation Drills in Japan	
	Preparedness Map for Community Resilience: Earthquakes – Experience of Japan	

FOCUS AREA	Knowledge Resource Title	
Seismic Risk Communication for Preparedness, *continued*	Istanbul Seismic Risk Mitigation and Emergency Preparedness Project (ISMEP) Success Stories	
	Enhancing Seismic Preparedness in Istanbul	
	Sendai: Towards a Disaster-Resilient and Environmentally-Friendly City	
Seismic Risk Application to Infrastructure Management	Resilient Infrastructure Public-Private Partnerships (PPPs): Contracts and Procurement – The Case of Japan	
	Resilient Water Supply and Sanitation Services – The Case of Japan Resilient Water Supply and Sanitation Services (solutions brief)	

FOCUS AREA	Knowledge Resource Title	
Seismic Risk Application to Infrastructure Management, *continued*	Technical Knowledge Exchange on Resilient Transport Summary Report	
	Resilient Industries: Project Brief	
	Road Geohazard Risk Management (solutions brief)	
Seismic Risk Reduction in the Built Environment	Building Regulation for Resilience: Managing Risks for Safer Cities (report) Building Regulation for Resilience: Managing Risks for Safer Cities (executive summary)	
	Building Regulatory Capacity Assessment: Level 1, Initial Screening	

FOCUS AREA	Knowledge Resource Title	
Seismic Risk Reduction in the Built Environment, *continued*	Building Regulatory Capacity Assessment: Level 2, Detailed Exploration	
	Building Regulation for Resilience: Program Profile	
	Converting Disaster Experience into a Safer Built Environment: The Case of Japan (report) Transforming Disaster Experience into a Safer Built Environment: The Case of Japan (solutions brief)	
	Technical Deep Dive on Resilient Cultural Heritage and Tourism Summary Report Resilient Cultural Heritage and Tourism (solutions brief)	

FOCUS AREA	Knowledge Resource Title	
Other	Cabinet Office White Paper - Disaster Management in Japan (summary)	
	Learning from Megadisasters: Lessons from the Great East Japan Earthquake (report)	
	The Great East Japan Earthquake: Learning from Megadisasters (knowledge notes, executive summary)	

ANNEX 2: SPEAKERS, ORGANIZERS, AND PARTICIPATING TEAM

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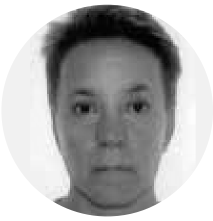

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The World Bank Disaster Risk Management Hub, Tokyo supports developing countries to mainstream DRM in national development planning and investment programs. As part of the Global Facility for Disaster Reduction and Recovery and in coordination with the World Bank Tokyo Office, the DRM Hub provides technical assistance grants and connects Japanese and global DRM expertise and solutions with World Bank teams and government officials. Over 37 countries have benefited from the Hub's technical assistance, knowledge, and capacity building activities. The DRM Hub was established in 2014 through the Japan-World Bank Program for Mainstreaming DRM in Developing Countries – a partnership between Japan's Ministry of Finance and the World Bank.