Hyogo Framework for Action
2005-2015:
Building the Resilience of Nations
and Communities to Disasters

HFA IRIDeS Review Preliminary Report

Focusing on 2011 Great East Japan Earthquake

October, 2013

International Research Institute of Disaster Science
Tohoku University
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Preface

Having experienced the catastrophic disaster in 2011, Tohoku University has founded the International Research Institute of Disaster Science (IRIDeS). Together with collaborating organizations from many countries and staff with a broad array of specializations, IRIDeS conducts world-leading research on natural disaster science and disaster mitigation. Based on the lessons from the 2011 Great East Japan (Tohoku) Earthquake and Tsunami disaster, IRIDeS aims to become a world center for the study of disasters and disaster mitigation, learning from and building upon past lessons in disaster management from Japan and around the world. Throughout, IRIDeS will contribute to on-going recovery/reconstruction efforts in areas affected by the 2011 tsunami, conducting action-oriented research and pursuing effective disaster management to build a sustainable and resilient society.

The 3rd United Nations World Conference on Disaster Risk Reduction 2015 will be held in Sendai City, one of the areas seriously damaged due to the 2011 Great East Japan Earthquake and Tsunami. IRIDeS will play an important role for the conference as an academic organization located in the hosting city. Drafting of this report, focusing on the 2011 Great East Japan Earthquake and Tsunami in terms of the core indicators of the Hyogo Framework for Action 2005-2015, is one of the contributory activities to the forthcoming event.
This publication is the preliminary report toward the final issue, which will be released in March 2014. We hope that the Japanese experience of past disasters including the Great East Japan Earthquake and Tsunami will be shared among national/local governments, the private sector, and citizens all over the world.

Arata Hirakawa

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Ensure that disaster risk reduction is a national and a local priority
with a strong institutional basis for implementation

HFA Priority for Action 2 13
Identify, assess and monitor disaster risks and enhance early warning

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Use knowledge, innovation and education
to build a culture of safety and resilience at all levels

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Reduce the underlying risk factors

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Strengthen disaster preparedness for effective response at all levels

1. Introduction

Japan has one of the highest levels of urban risk of natural disaster in the world because all the three values determining the risk—hazard, vulnerability, and exposed value—are very high. Thus, Japanese society has struggled against natural disasters throughout history.

In this context, the UN World Conference on Natural Disaster Reduction was held in Yokohama in May 1994 as a part of a mid-term review of the International Decade for Natural Disaster Reduction (IDNDR). However, the most tragically disastrous event in Japanese history since World War II, the 1995 Great Kobe Earthquake, occurred the next year.

The earthquake led the 2005 World Conference on Disaster Reduction (WCDR) to select Kobe City, Hyogo Prefecture, as its location for demonstrating the city's remarkable recovery from the earthquake. The Hyogo Declaration was adopted at the conference, and the Hyogo Framework for Action 2005–2015 (HFA) was built as a 10-year plan to safeguard the world from natural hazards. The HFA consists of the following five priorities for action, which would serve as guidelines to reduce future disaster damage for every country or region.

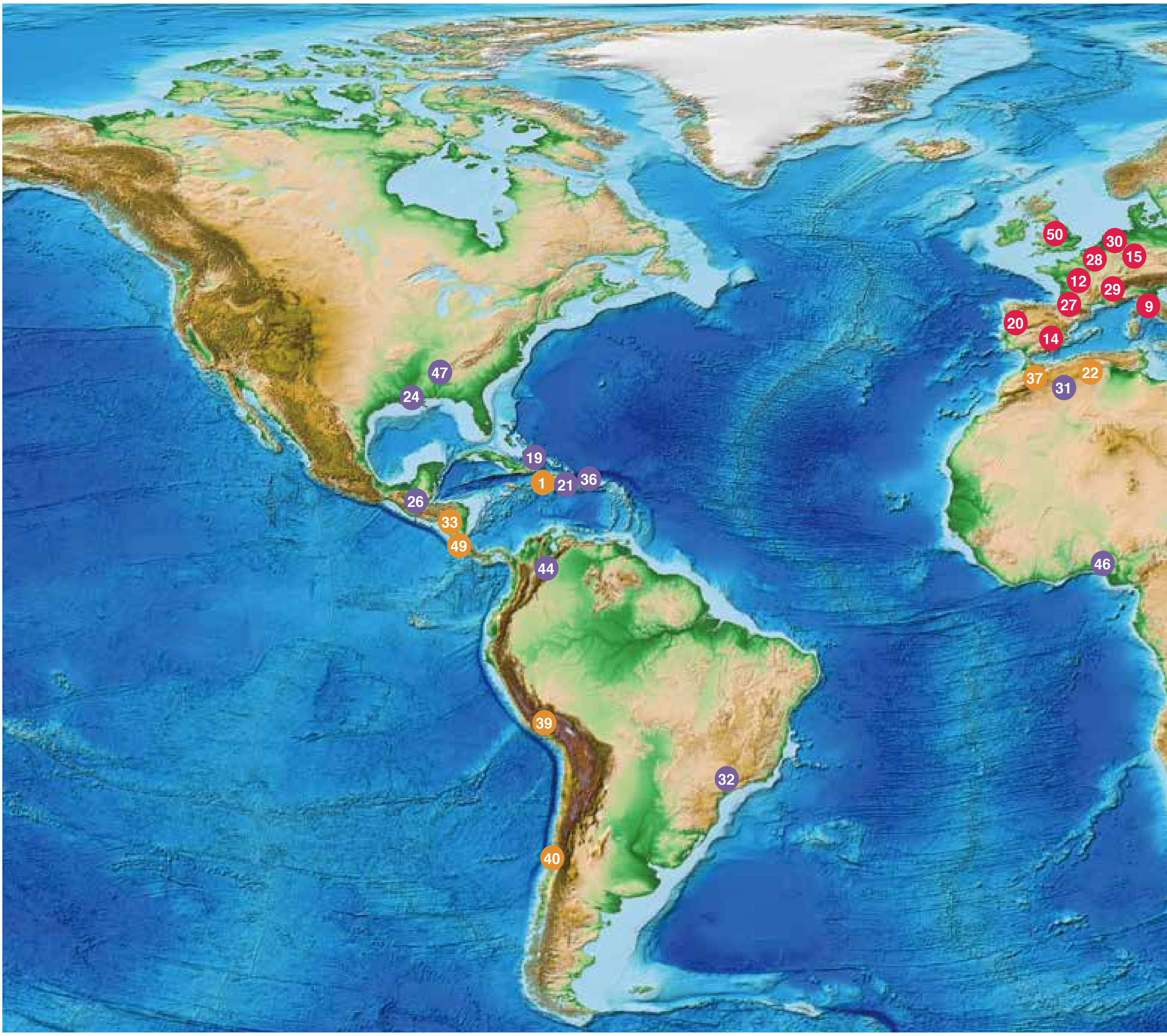
Priorities for action 2005–2015:

1. Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation.
2. Identify, assess, and monitor disaster risks and enhance early warning.
3. Use knowledge, innovation, and education to build a culture of safety and resilience at all levels.
4. Reduce the underlying risk factors.
5. Strengthen disaster preparedness for effective response at all levels.

During that decade, the Great East Japan Earthquake with Mw 9.0 occurred on March 11, 2011. We must learn from such devastating experiences for the sake of future societies. This report focuses on topics related to the earthquake and tsunami in terms of HFA guidelines from the academic viewpoints of professors at the International Research Institute of Disaster Science (IRIDeS), Tohoku University, to disseminate the event's lessons learned.

Each topic deals with a specific case, contains ***context***, the situation ***before*** and ***after*** the event, ***good practices***, and ***problems***, followed by ***future recommendations*** summarized at the end of each priority section.

2. World's 21st Century Natural Disasters

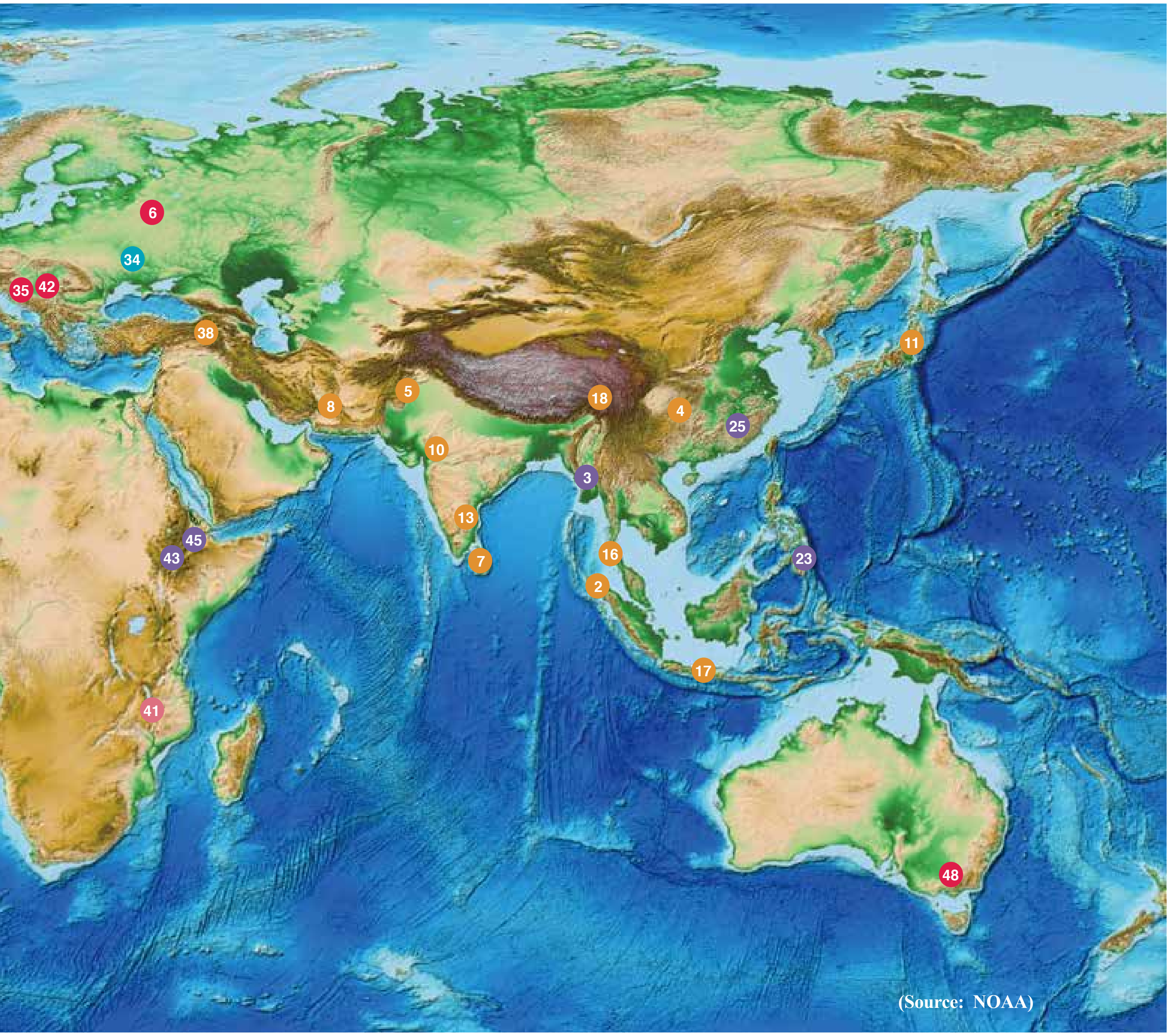


No.	Month/Year	Disaster Type	Country	Killed	Total Affected	Estimated Damage (US$ Million)
1	January 2010	Earthquake	Haiti	222,570	3,700,000	8,000
2	December 2004	Earthquake	Indonesia	165,708	532,898	4,452
3	May 2008	Storm	Myanmar	138,366	2,420,000	4,000
4	May 2008	Earthquake	China	87,476	45,976,596	85,000
5	October 2005	Earthquake	Pakistan	73,338	5,128,309	5,200
6	June-August 2010	Heat wave	Russia	55,736		400
7	December 2004	Earthquake	Sri Lanka	35,399	1,019,306	1,317
8	December 2003	Earthquake	Iran	26,796	267,628	500
9	July-August 2003	Heat wave	Italy	20,089		4,400
10	January 2001	Earthquake	India	20,005	6,321,812	2,623
11	March 2011	Earthquake	Japan	19,846	368,820	210,000
12	August 2003	Heat wave	France	19,490		4,400
13	December 2004	Earthquake	India	16,389	654,512	1,023

No.	Month/Year	Disaster Type	Country	Killed	Total Affected	Estimated Damage (US$ Million)
14	August 2003	Heat wave	Spain	15,090		880
15	August 2003	Heat wave	Germany	9,355		1,650
16	December 2004	Earthquake	Thailand	8,345	67,007	1,000
17	May 2006	Earthquake	Indonesia	5,778	3,177,923	3,100
18	April 2010	Earthquake	China	2,968	112,000	500
19	September 2004	Storm	Haiti	2,754	315,594	50
20	August 2003	Heat wave	Portugal	2,696		
21	May-June 2004	Flood	Haiti	2,665	31,283	
22	May 2003	Earthquake	Algeria	2,266	210,261	5,000
23	December 2012	Storm	Philippines	1,901	6,246,664	1,693
24	August-September 2005	Storm	United States	1,833	500,000	125,000
25	May-August 2010	Flood	China	1,691	134,000,000	18,000
26	October 2005	Storm	Guatemala	1,513	475,314	988

This map indicates the fifty worst disasters between 2001 and 2012. These disasters are categorized into five types.

- Earthquake
- Windstorm, Flood
- Drought
- Heat wave
- Extreme winter conditions



No.	Month/Year	Disaster Type	Country	Killed	Total Affected	Estimated Damage (US$ Million)
27	July 2006	Heat wave	France	1,388		
28	August 2003	Heat wave	Belgium	1,175		
29	July 2003	Heat wave	Switzerland	1,039		280
30	July 2006	Heat wave	Netherlands	1,000		
31	November 2001	Flood	Algeria	921	45,423	300
32	January 2011	Flood	Brazil	900	45,000	1,000
33	January 2001	Earthquake	El Salvador	844	1,334,529	1,500
34	January-February 2006	Extreme winter Conditions	Ukraine	801	59,600	
35	July 2003	Heat wave	Croatia	788		
36	May-June 2004	Flood	Dominica	688	10,002	
37	February 2004	Earthquake	Morocco	628	13,465	400
38	October 2011	Earthquake	Turkey	604	32,938	1,500

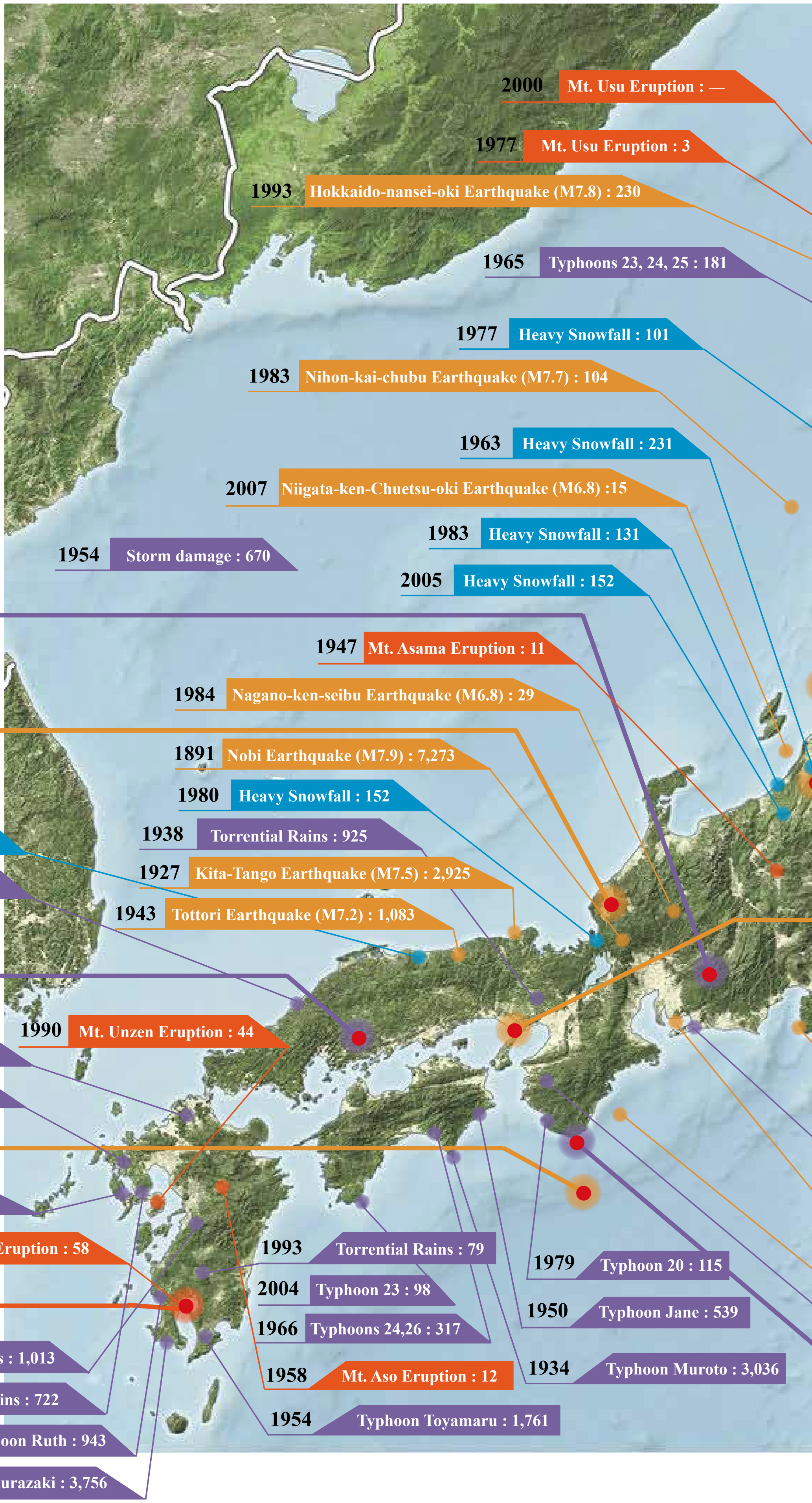
No.	Month/Year	Disaster Type	Country	Killed	Total Affected	Estimated Damage (US$ Million)
39	August 2007	Earthquake	Peru	593	658,331	600
40	February 2010	Earthquake	Chile	562	2,671,556	30,000
41	February 2002	Drought	Malawi	500	2,829,435	
42	July 2007	Heat wave	Hungary	500		
43	August 2006	Flood	Ethiopia	498	10,096	3
44	April 2010-March 2011	Flood	Colombia	418	2,791,999	1,000
45	August-September 2006	Flood	Ethiopia	364	8,000	
46	July-October 2012	Flood	Nigeria	363	7,000,867	500
47	April 2011	Storm	United States	354	17,200	11,000
48	January-February 2009	Heat wave	Australia	347	2,000	
49	February 2001	Earthquake	El Salvador	315	256,021	349
50	July 2003	Heat wave	United Kingdom	301		

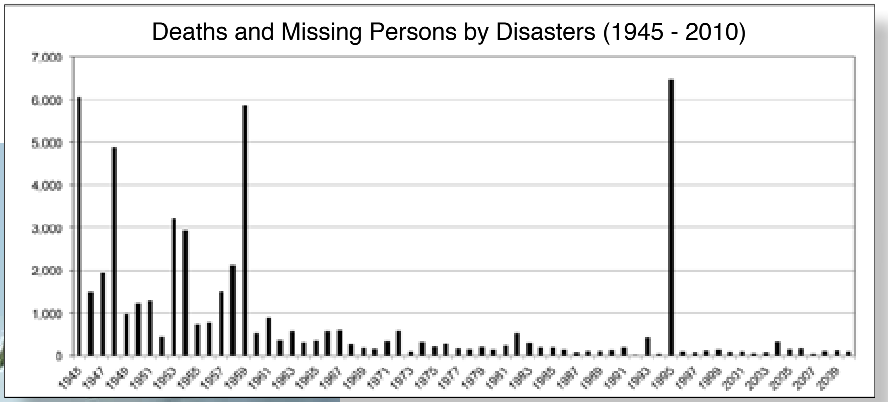
Data Source: EM-DAT: The OFDA/CRED International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

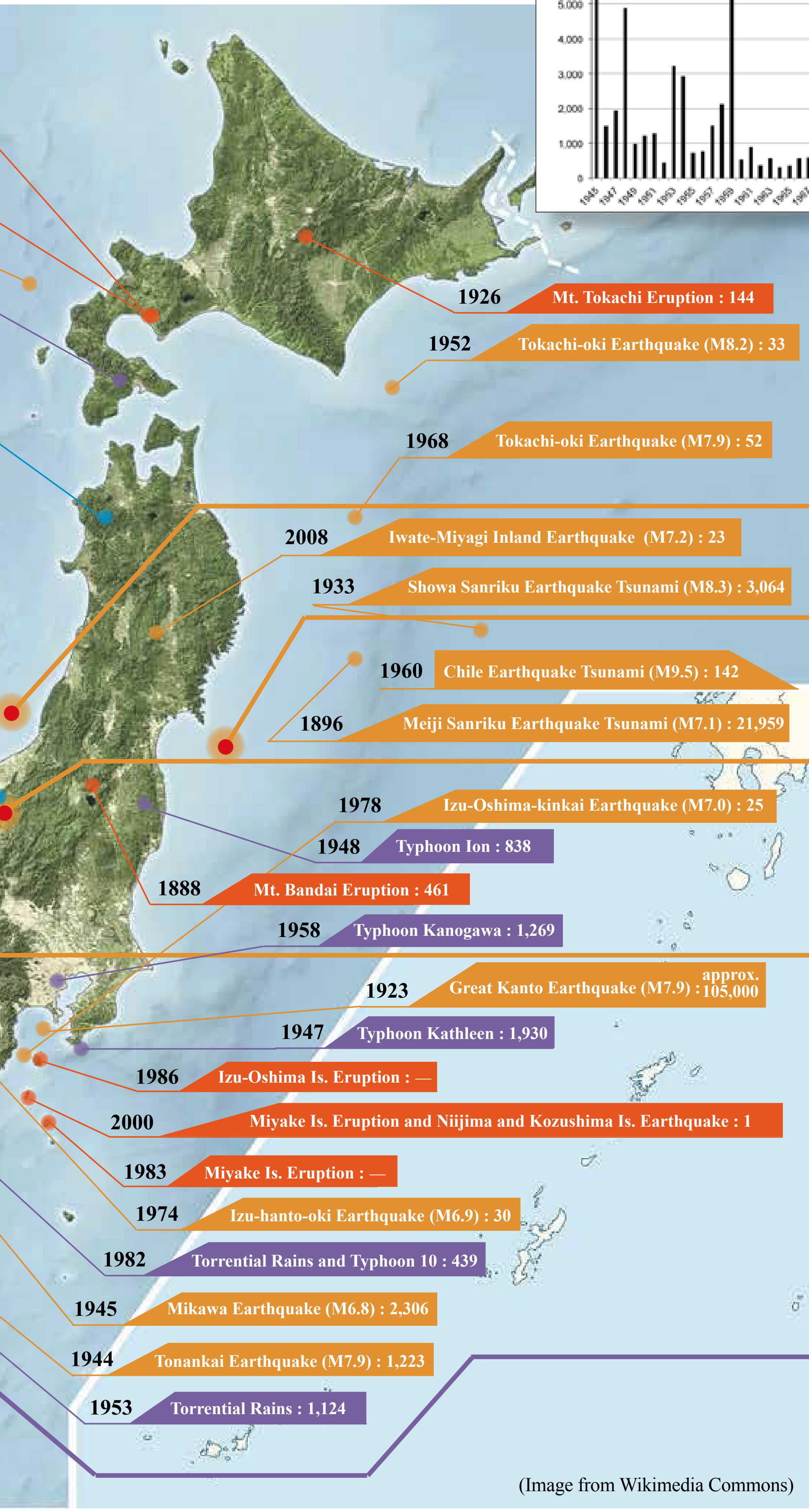
3. History of Natural Disasters in Japan (1888 - 2010)

Japan is located in one of the most disaster-prone areas in the world, and we Japanese have experienced many disastrous events throughout history. Thus Japanese society and cities are skilled at disaster management. Each disaster has helped develop and strengthen our disaster management system. Although we occasionally experience catastrophic disasters, the number of deaths and missing persons due to disasters has been declining as a result of gradual improvement of the various aspects of our disaster management system.

This map displays the distribution of major disasters in Japan from 1888 to 2010. About sixty disasters are classified into four types: earthquake or tsunami, volcanic disaster, windstorm or flood, and heavy snowfall.







(Image from Wikimedia Commons)

Year / Disaster (Magnitude) : Number of Deaths and Missing

- Earthquake (epicenters marked), Tsunami
- Volcanic disaster
- Windstorm (landed places marked), Flood
- Heavy snowfall (places with highest seasonal total marked)

1964 Niigata Earthquake (M7.5) : 26

→ 1966 • Act on Earthquake Insurance Insurance

1978 Miyagi-ken-oki Earthquake (M7.4) : 28

→ 1981 • Amendment of Building Standard LawInsurance

2004 Niigata-ken-Chuetsu Earthquake (M6.8) : 67

→ 2005 • Amendment of Act on Promotion of the Earthquake-proof Retrofit of Buildings
- Amendment of Flood Control Act
- Amendment of Act on Promotion of Sediment Disaster Countermeasures for Sediment Disaster Prone Areas

1995 Great Hanshin-Awaji Earthquake (M7.3) : 6,437

→ 1995 • Act on Special Measures for Earthquake Disaster Countermeasures
- Act on Promotion of the Earthwuake-proof Retrofit of Buildings
- Amendment of Disaster Countermeasures Basic Act
- Amendment of Act on Special Measures for Large-scale Earthquakes

→ 1996 • Act on Special Measures for Preservation of Rights and Profits of the Victims of Specified Disasters

→ 1997 • Act on Promotion of Disaster Resilience Improvement in Densely Inhabited Areas

→ 1998 • Act on Support for Livelihood Recovery of Disaster Victims

1959 Typhoon Ise-wan : 5,098

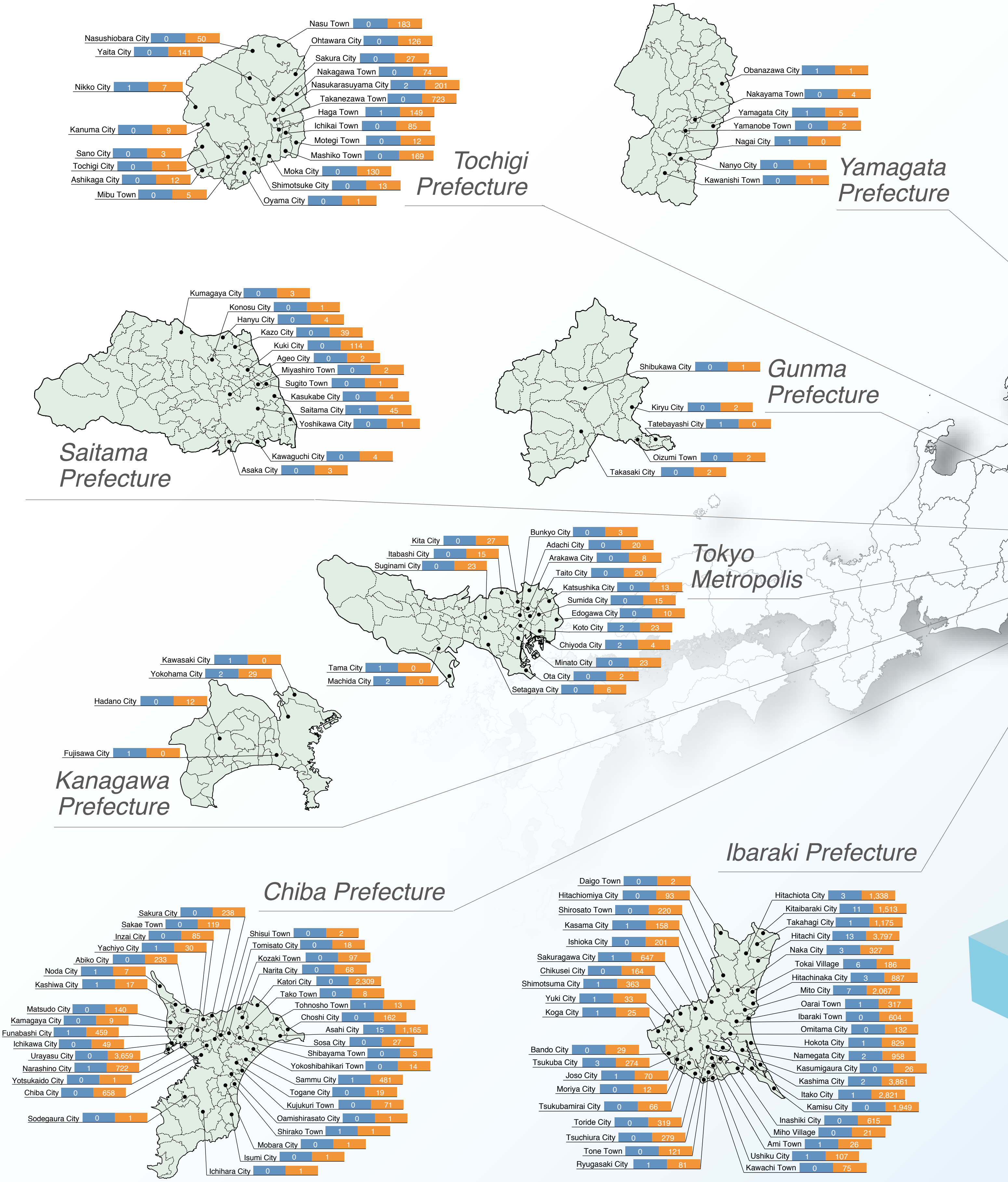
→ 1960 • Soil Conservation and Flood Control Urgent Measures Act

→ 1961 • Disaster Countermeasures Basic Act

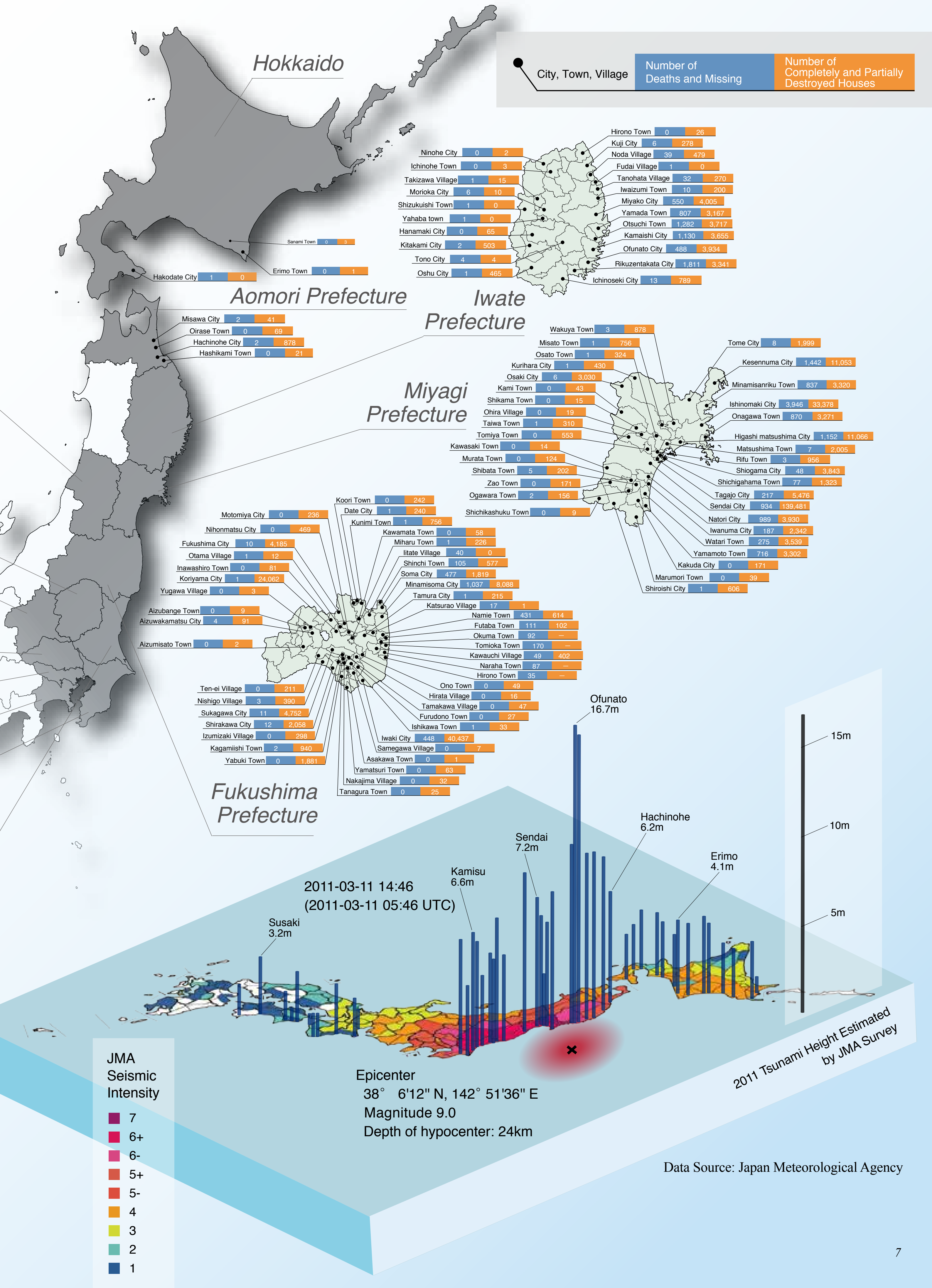
→ 1962 • Act on Special Financial Support to Deal with Extremely Severe Disasters

Data Source: "*Disaster Management in Japan*" (Cabinet Office, Government of Japan, 2011)

4. Damage due to 2011 Great East Japan Earthquake and Tsunami



Data Source: Fire and Disaster Management Agency, (as of March 26, 2013)



Data Source: Japan Meteorological Agency

5. 2011 Great East Japan Earthquake Review

HFA Priority for Action 1:

Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation

HFA Core Indicator 1.1:
National policy and legal frameworks for disaster risk reduction exist and include decentralized responsibilities and capacities at all levels.

Institutional Structure in Japan

Keywords:
institutional structure, disaster management plans, disaster management acts

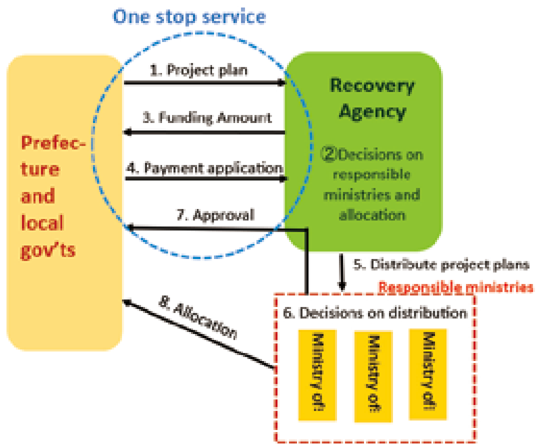
Context:
Japan's national institutional and legislative frameworks, originating in the 1880s, are well developed and have been refined after each large-scale disaster, in order to function at all national, regional, and local levels. The current disaster management framework is specified by the Disaster Countermeasures Basic Act of 1961, after the Isewan Typhoon of 1951, which caused severe damage. In the wake of the 2011 Great East Japan Earthquake (hereinafter GEJE), new laws have been enacted to create a new institution for reconstruction and laws to ensure rebuilding for future resiliency.

Institutional structure 1: Key national players for disaster risk reduction and management: Cabinet Office, national ministries, and Central Disaster Management Council

Before:
A modern disaster management system has been introduced at the national level in 1961, and several national key players have taken central roles since then. The Cabinet's Disaster Management Section centrally manages coordination and collaboration among ministries and other relevant national organizations, and the section Director-General is tasked with undertaking basic disaster management policies, responding to large-scale disasters, and coordinating with ministries relevant to disaster management[1]. In the Cabinet office, the Central Disaster Management Council (established in 1962) discusses, evaluates, and decides upon crucial disaster management policy contexts. The Minister chairs the council, and 25 members represent ministries, quasi-governmental organizations, and distinguished academics. This council has Committees for Technical Investigation, which investigate topics that require further research and assessment for scientific inputs.

Since 2005, topics handled by the Central Disaster Management Council have focused primarily on preparation against mega-earthquakes (target regions: Tokyo metropolitan, Tokai and Tonankai, Japan trench-Chishima Trench, and Chubu-Kinki) as continuing efforts to include lessons learned from the 1995 Hyogoken-Nanbu Earthquake (Kobe Earthquake), and to a lesser extent, large-scale flooding and volcano eruptions.

After:
The devastation of the Tohoku region after March 11, 2011, has led to the creation of a new reconstruction agency for the third time in Japanese history following the 1923 Great Kanto Earthquake and World War II. The Reconstruction Agency officially debuted on February 10, 2012, a 10-year operation reporting directly to the Cabinet, to support and execute the responsibilities of the Director-General. Created under two relevant laws—the Basic Law of Reconstruction from the Great East Japan Earthquake (June 23, 2011) and the Law Establishing the Reconstruction Agency—this agency is primarily responsible for coordinating various ministries' budgetary and reconstruction procedures so that reconstruction efforts in all localities can proceed timely (Fig. 1.1).



Source: recreated from the Prime Minister and the Cabinet, available at: http://www.kantei.go.jp/fukkou/organization/reconstructiongrant.html
Fig. 1.1 Role of the National Reconstruction Agency

Concerns regarding disaster reduction at the Central Disaster Management Council have also led to the creation of two committees for technical investigation following the GEJE. On April 27, 2011, a committee on earthquake and tsunami measures learned from the GEJE was established to scientifically assess and integrate the lessons learned from the GEJE Earthquake and Tsunami. Later in October of the same year, the evaluation committee on disaster management promotion was established, followed by two new working groups for detailed analysis on the Nankai Trough and Tokyo metropolitan earthquakes and their countermeasures.

Institutional structure 2: Managing disasters with plans

Before:
Disaster management plans are tools for disaster preparedness in three disaster phases: mitigation and preparation, response, and reconstruction and recovery. There are three types of such plans: Basic Disaster Management Plan, Disaster Management Operation Plan, and Local Disaster Management Plan, prepared by the Central Government, Ministries and Quasi-Governmental Agencies, as well as prefectures and municipalities. The plan is organized by disaster type, for example, four sections—earthquake, winds and floods, volcanoes, and snow storms in the natural disaster category—and is

[1] Ministries of Internal Affairs and Communications; Justice; Foreign Affairs; Finance; Education, Culture, Sports, Science and Technology; Health, labor and Welfare; Agriculture, Forestry and Fisheries; Economy, Trade and Industry; Land, Infrastructure, Transport and Tourism; Environment; and Defense.

sequenced by disaster phases. It also articulates the roles of national, prefectural, and local governments and local residents.

The plan was first adopted in 1963 at the national level and has since then been guiding the country's disaster management. Its contents are revised as needed, with more frequent revisions in recent years. Three revisions have occurred since 2005, including entire chapter reviews in the same year, corresponding to increasing water-related disasters worldwide and their countermeasures. More recently, in 2008, the plan expanded to include measures for response to nuclear-power disasters.

After:
The major feature revised after the GEJE in the Basic Disaster Management Plan is the response to a large-scale tsunami. Previously, response to tsunamis had been overlooked in the plan as building damage was the main focus of earthquake damage. In addition, the unprecedented magnitude of the earthquake led to reassessing damages from potential mega-earthquakes, specifically in the Nankai Trough and Tokyo metropolitan areas, which were subsequently reflected in the national plan. These fundamental changes at the national level have caused modifications to the Disaster Management Operation Plan as well as the Local Disaster Management Plan.

Legislative structure 1: Disaster Management Acts

Before:
Since the disaster relief act of 1947, one of the oldest disaster-related acts in modern legislation, Japan has passed various laws and acts on the management of and response to disasters. These laws' content varies depending on targets, such as striving to reduce damages from earthquakes (e.g., the Building Standards Act (1950)) and floods (e.g., the Flood Control Act (1949)), and more recently, to minimally secure the livelihoods of affected families (e.g., the Act on Support for Reconstructing the Livelihoods of Disaster Victims (1998)). No new laws have been created since 2005, except for several amendments to laws on flood contr¬ol and earthquake damage mitigation as a response to floods and earthquakes that had previously occurred.

After:
One of the major disaster management laws that passed the Diet after the GEJE is the Law on Regional Development for Tsunami Disaster Management (enacted December 14, 2011). Addressing the unprecedented scale of the tsunami, this law strives to promote regional development that is resilient to future tsunamis in various localities nationwide by combining both structural and non-structural measures. This law has been the basis for reconstruction following the GEJE. An adjustment to the 1961 Disaster Countermeasures Basic Act was adopted on April 12, 2013, mainly to i) strengthen response capacity for large-area mega-disasters, ii) secure residents' safe and smooth evacuation, iii) improve long-term evacuation capacity and quality, and iv) improve learning disaster management procedures during normal periods. mega-disasters; ii) secure safe and smooth evacuation of residents; iii) improve quality of long-term evacuation, and iv) stipulate disaster management effort during normalcy.

HFA Core Indicator 1.2:
Dedicated and adequate resources are available to implement disaster risk reduction activities at all administrative levels.

Dedicated and Adequate Resources for Disaster Management in Japan

Keywords:
budgetary resources, human resources, informational resources

Context:
Japan is a unique country in that it invests ample resources in disaster management. The budget for disaster management is annually secured, and abundant supplemental budgets have been provided for rebuilding in the aftermath of the GEJE disaster. Additionally, given that Japan is aging and losing population, new forms of collaboration have been emerging to secure adequate human resources from the decreasing pool to fill the gap. Such collaboration efforts have accelerated further after the GEJE. Disaster white papers since 1963 are another form of useful resource for the national, regional, and local administrations, as well as private citizens.

Budgetary resources

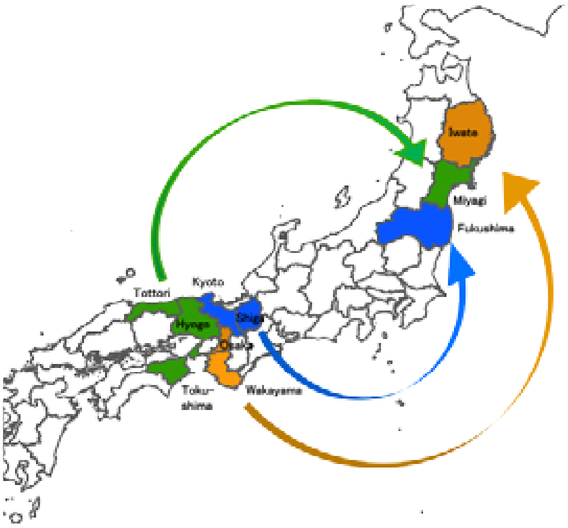
Before:
Although the proportion of the budget allocated for disaster management in the general account budget was decreasing prior to the GEJE, from 8% in 1997 to 3.5% in 2010, 1.24 trillion yen were appropriated for disaster management in 2010[2]. In addition, abundant supplemental budgets have often been provided for rebuilding public infrastructures after significant disasters.

After:
The GEJE's direct economic damage is calculated as 16.9 trillion yen. As of July 2013, budgets for rebuilding post-GEJE are calculated to cover around 23.5 trillion yen for total direct losses[3].

Human resources

Before:
Inter-prefecture and -locality partnerships for mutual help, including objectives to share human resources, have been encouraged since 1995. Such partnerships have largely involved exchanging agreements. More recently, as a goal of decentralized governance, the Kansai Large-Area Coalition (Kansai Koiki Rengo) was formed on October 27, 2010, the first such organization in modern government administrations. This coalition comprises seven participating prefectures of the Kansai region. One of the seven administrative goals of this coalition is to establish a large-area disaster management system so that participating prefectures can provide or receive support for emergencies resulting from disasters beyond their own control. This coalition also strives to secure sufficient human and other resources for potential disasters.

2 Cabinet Office, Government of Japan, 2011. "Disaster Management in Japan."
3 Reconstruction Agency, 2013. "Reconstruction progress and issues."



Source: http://blog.kahoku.co.jp/saisei/2012/03/post-33.html

Fig. 1.2: Counterpart Support by the Kansai Large-area Coalition

After:

For the first time in disaster management history, the large-area administrative coalition is supporting the affected large-area regions. As part of the "counterpart system approach," Osaka and Wakayama Prefectures partner with Iwate; Hyogo, Tottori, and Tokushima partner with Miyagi; and Shiga and Kyoto partner with Fukushima, each partnership including the dispatching of volunteers and specialists for short-term response and long-term rebuilding (Fig. 1.2). As of August 30, 2013, 136,000 man days in total have been dispatched. Additionally, the prefectures temporarily host evacuees from other prefectures[4].

Informational resources

Since 1963, the Cabinet has published an annual disaster white paper structured to report significant disaster data for damages, responses, and changes affecting disaster management. This paper is a useful resource for national, regional, and local administrations as it reports the relevant statistics on disasters and their management, budget, and related laws and institutions. Administrations refer this paper for updating disaster management plans that they need to review annually. Since the GEJE, statistics and revised laws and regulations have been updated annually.

HFA Core Indicator 1.3:
Community participation and decentralization are ensured by delegating authority and resources to local levels.

Community Participation in Japan

Keywords:

voluntary community organization, business communities

Context:

Japan has a long history of community participation in disaster reduction activities. The notions of "self-help," "mutual-help," and "public-help" have been widely shared, especially after the 1995 Hyogoken-Nanbu Earthquake. The voluntary community organization for disaster management, represented by firefighting activities, is considered especially important for self-help and mutual help actions. Business communities have also begun preparing business continuity plans since 2005, when the Central Disaster Management Council prepared a guideline on this topic.

Voluntary community organization for disaster management

Before:

Voluntary community organizations for disaster management are regulated in the Disaster Countermeasures Basic Act of 1961, number 5, article 2. According to the statistics of the Fire and Disaster Management Agency, 139,000 voluntary community organizations existed in 1,658 localities in 2009, and their activities covered 73.5% of all households across the nation[5].

After:

Various communities that were significantly affected by the GEJE and had practiced their volunteer activities during normal periods in preparation for emergency response found their preparedness functional and effective. For example, creating a list of the population needing help (handicapped and elderly) was useful when evacuating them. Rules adopted prior to the GEJE to inform the community about individuals' safety during significant disasters have also helped community members to identify those who were missing. Nevertheless, various issues emerged: for example, in the relationship between local governments and voluntary community organizations, some were unofficial and inhibited direct work, such as when goods and supplies for temporary evacuees were available only to those in designated evacuation shelters, whereas, in reality, evacuation shelters existed in many other places as demand was high after the GEJE's unexpected size[6]. Currently, many activities led by voluntary community organizations are being reviewed and assessed for better operations in the future.

[4] Kansai Large-Area Coalition. "Response of Kansai Large-Area Coalition on the Great East Japan Earthquake of 2011. Retrieved September 3, 2013, from http://www.kouiki-kansai.jp/contents.php?id=219.

[5] Fire and Disaster Management Agency, 2009. "Chapter 4 Disaster management activities by self-help and regional resilience creation to disasters." Firefighting White Paper, retrieved September 29, 2013, from http://www.fdma.go.jp/html/hakusho/h21/h21/index2.html#dai4.

[6] Fire and Disaster Management Agency, 2009. "Chapter 4 Disaster management activities by self-help and regional resilience to disasters." Firefighting White Paper. Retrieved September 29, 2013, from http://www.fdma.go.jp/html/hakusho/h21/h21/index2.html#dai4.

Business communities preparing for disaster

Before:

The Special Committee of the Central Disaster Management Council in 2005 developed and began promoting Business Continuity Plans (BCPs), which enable private corporations to prepare for disasters to mitigate damages and to continue operations during the response and recovery stage. Targeting large and medium enterprises in particular, this effort was expected to enable sustained business operations even in emergencies.

After:

The business community has researched the effectiveness of BCPs during and immediately after the GEJE. According to web-based research led by NTT data (the national telecom company)[7], 44.7% of corporations either had or were developing a BCP when the GEJE struck, among which 45% of large corporations already had BCPs. Regarding BCP operation, 65.7% of 263 corporations reported that the BCP either had problems in functioning, partially or completely, with the GEJE's impact to the global supply chain, which extended beyond the size of "expected" disasters. A complete review is currently on-going in business communities to revise the contents of BCPs to operate more efficiently in future disasters.

HFA Core Indicator 1.4:
A national multi-sectoral platform for disaster risk reduction is functioning.

Japan's Multi-sectral Platform for Disaster Risk Reduction

Keywords:

Disaster Countermeasures Basic Act, volunteer activities, wide-area response and mutual support between municipalities

Context:

Japan's multi-sector platform for disaster risk reduction is functioning under the 1961 Disaster Countermeasures Basic Act. However, the GEJE and Tsunami have proven that there is no perfect system resilient to all types and sizes of disaster, regardless of how well the platform is established and operated. The national government response was limited, incapable of quickly responding to the needs of the affected local government as it was difficult for them to investigate the overall damage. Meanwhile, having a multi-sector platform has also proven that support from non-structured segments, such as volunteer efforts, could be quite useful. The platform then incorporates these lessons via modification of the Disaster Countermeasures Basic Act, in order to improve response capacity against future mega-disasters.

Before:

Under the 1961 Disaster Countermeasures Basic Act, the national government, local governments, Japan Red Cross, other key semi-governmental and humanitarian organizations and communities were prepared to function under emergency conditions throughout the response stage. The Act was significantly revised to further strengthen functions of emergency response headquarters and traffic regulations for better emergency management after the 1995 earthquake. At this time, the word "volunteer" was first included in the Act and in national law. Since 2005, the Cabinet office has established the Committee for Disaster-related Volunteer Activities to encourage citizens' greater participation in disaster reduction activities. Various committees were established and meetings held in several cities nationwide, including topics related to wide-area response and networking on disaster management. Encouragement to reach agreements on mutual support during emergencies between neighboring local governments has increased during this period, and in 2010, 90% of local governments across Japan had reached such agreements[8].

Problems:

Although local governments are technically mandated to act centrally for disaster response and management, prefectural and national governments are also required to step in and take the lead in responding to mega-disasters like the GEJE by creating emergency headquarters in their administrations.

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7 Ohashi, K., 2011. "How do we reflect lessons learned from the earthquake? Findings from the survey results of business continuity by corporations affected by the GEJE." Retrieved September 29, 2013, from http://www.keieiken.co.jp/monthly/2011/1109-04/index.html.

8 Fire and Disaster Management Agency, 2007. "Enhancing mutual-supporting system between municipalities." Retrieved August 28, 2013,from http://www.fdma.go.jp/neuter/about/shingi_kento/h24/tikoutai/01/shiryo_02.pdf.

9 National Institute for Educational Policy Research, 2012. Activities by NPOs and volunteers following the Great East Japan Earthquake. Retrieved on September 28, 2013, from http://www.nier.go.jp/jissen/chosa/rejime/2011/02_npo_vol/05_chapter3.pdf.

Nevertheless, because of the size and complexity of the GEJE and Tsunami, national and prefectural government provision of the necessary support to local governments was delayed because local governments' help requests encountered complications resulting from the devastating damage to the usual means of reaching the national government.

Good practices:

Despite the initial difficulties in reaching the affected areas because of an insufficient volume of damage information and avoiding secondary disasters, numerous volunteers and organizations, including international and domestic NGOs, NPOs, and student groups, joined in to provide support in the affected areas (see Fig. 1.3 for volunteer participation six months later in Ishinomaki City). So far, 936,900 people in total have volunteered to support the affected region within the two years after the GEJE[9]. Furthermore, various inter-governmental agreements have effectively supported the affected region by, for example, hosting disaster-affected populations who lost their houses in disasters.

After:

In response to the GEJE disaster, the Disaster Countermeasures Basic Act was amended, effective April 12, 2013. Major revisions include i) strengthening response capacity for large-scale disasters; ii) providing residents with smooth and safe evacuation routes; iii) improving response capacity, and iv) enhancing learning of disaster management procedures in normal periods— all of which emphasize improvement in response to large-scale disasters. Another major focus for change has been public volunteer coalitions for better response capacity for mega-disasters. A unit called the "Coalition Group of Volunteers and Corporations for the Public Interest" was established in the Reconstruction Agency on February 10, 2012, replacing an existing volunteer management unit in the Cabinet office. In addition, the proportion of local governments' mutual support extending beyond prefectural boundaries is increasing. For instance, there were 46.9% extra-prefectural agreements but in 2012, it has increased to 55.1%[10].

Fig. 1.3 Volunteers Camping in a School Field, Six Months after the GEJE

Future recommendations:

- In summary, we offer three main recommendations. First, building a strong institutional basis for promoting disaster risk reduction at all levels, national and local, is a several-decades-long effort. Japan's history of institutionalizing disaster management system highlights several key points: first, national level leadership in establishing a disaster management system helps to organize horizontal and vertical structures effectively; second, creating a law to implement a disaster management system will further legitimize the system and thus support further actions; and third, shaping an institutional basis in which all participating levels of organizations—national, regional, and local—are responsible for creating disaster management plans will enable all to create a disaster management plan, and therefore, that basis should ideally include measures against diverse types of disasters in different sequences of disaster phases. All these actions will take considerable time, but initiating a system and revising it as necessary through post-disaster assessments is critical for improvement.

- Second, various national recovery agencies have been established after mega-disasters. In addition to the Recovery Agency of Japan after the GEJE, examples of recent interim institutions in the national government include the BRR after the Indonesian Ocean tsunami (2004), the ERRA after the Pakistan earthquake (2005), and the CERA after the New Zealand Canterbury earthquake (2011). Although such agencies are often created for an interim period, usually between five and ten years, their responsibility and power are significant. As these agencies often set the stage for long-term rebuilding and future resilience, identifying funding and allocating decision power within the existing relationship of ministries and departments (e.g., public works, building construction, social welfare, and health) prior to mega-disasters are extremely important. As in the case of Japan, starting a new agency causes confusion and disorder, which contribute to delays in the recovery effort.

- Third, in-kind support systems are becoming increasingly important. As we exist in an insecure world, where vulnerabilities to disasters are increasing and single-government financial security and liability are declining, preparing mutual support networks between various players in society is crucial. Such networks include supporting structures among local, prefectural, regional, and national governments, where financial obligations are a non-primary concern. The participation of citizens as well as private sector entities in this in-kind system is also essential, as disaster size and degree are unforeseeable.

[10] Fukumoto, H., 2013. Supporting affected areas by municipalities during emergency – assessing effectiveness of inter-governmental mutual-support agreements –.

HFA Priority for Action 2:
Identify, assess and monitor disaster risks and enhance early warning

HFA Core Indicator 2.1:
National policy and local risk assessments based on hazard data and vulnerability information are available and include risk assessments for key sectors.

HFA Core Indicator 2.2:
Systems are in place to monitor, archive and disseminate data on key hazards and vulnerabilities.

HFA Core Indicator 2.3:
Early warning systems are in place for all major hazards, with outreach to communities.

Improvement in Risk Assessment and Early Warning Systems with Real-time Monitoring: Lessons from the 2011 Tohoku Earthquake and Tsunami Tohoku earthquake and tsunami

Keywords:
hazard map, tsunami early warning, real-time monitoring, earthquake early warning, long-term earthquake forecast

Before:
Tsunami inundation maps produced from the risk evaluation based on historical events over 400 years have been distributed among the residents in coastal communities for utilization in developing their evacuation plans and preparedness procedures. Nevertheless, previous inundations were much smaller than the 2011 Tohoku Earthquake and Tsunami, which caused more casualties without evacuation. Earthquakes followed by tsunamis recurred throughout history in each coastal area. Japan's Cabinet Office Central Disaster Mitigation Council evaluated the earthquakes and tsunamis for the target regions' safety levels, and the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Headquarters for Earthquake Research Promotion (HERP) evaluated seismic activities, which are updated every year. Those results are available for creating hazard maps, conducting disaster response drills, and increasing awareness through the mitigation plan. However, the gap between the estimated and observed inundations was so large that it allowed people to take insufficient action.

Although the tsunami warning was issued roughly 3 min after the earthquake, about 19,000 people (90% of casualties) were killed by the 2011 Tohoku Tsunami within 20–30 min of its arrival at Sanriku and roughly 1 h of its arrival at Sendai bay; only two people were killed by the tsunami on the Pacific Ocean. The warning from the PTWC and Japanese media should have led to immediate Pacific coastal evacuation. Japan's tsunami warning system began in 1952, providing information on the estimated tsunami arrival time and height, which is divided into two categories, depending on the arrival time lesser or greater than 1 h, that is, near or far field, respectively. The first tsunami warning in the 2011 Tohoku Earthquake was underestimated because of the lower earthquake magnitude estimation, and the second was updated using the tsunami data observed by a GPS buoy in real time offshore from Sanriku, Tohoku. Reasons for the large number of casualties due to the tsunami remain under investigation and discussion. Not only the warning's accuracy but also its dissemination, traffic jams on the roads, and wrong directions to safe places have been reported by eyewitnesses.

HERP, a special governmental organization attached to the Prime Minister's office (now part of MEXT) and established in 1995, has been releasing probable seismic hazard maps annually since 2005, compiling thousands of instrumental, historical, and paleoseismological data and numerical models of plausible future earthquake sources. The map released in 2005 was the first publically available probabilistic seismic hazard map of major shaking for various purposes such as city planning and emergency local government response. In the map, the HERP expressed concern about frequent M7-8 earthquakes along the Japan trench (the Sanriku coast to the Boso Peninsula) and announced a 98% chance of an M7.4-8.0 earthquake offshore of Miyagi (Sendai) for the next 30 years, based on 37-year average inter-event time of large subduction earthquakes during the past 200–300 years. Such high probability has effectively stimulated seismic retrofits, better city planning, and disaster drills. However, the extent of the M9.0 2011 Tohoku Earthquake's large shaking areas was much wider than the map estimates, especially in Fukushima and Ibaraki, the southern region of the 2011 source.

Despite the size of the main Tohoku shock and areas of large seismic intensity, numerous buildings collapsed (~400,000), mostly from the tsunami; the number collapsing from shaking was rather limited. Less damage was observed in the newer buildings and houses. The ratio of the death toll associated with the collapses was less than several percent of the total, demonstrating that Japan's building code, regulated since 1981 and reflecting the 1978 Miyagi-oki earthquake, worked effectively.

After the 1995 Kobe Earthquake, the Japanese government funded an enormous budget to deploy thousands of seismometers and GPS stations to monitor seismic and crustal activity. The National Research Institute for Earth Science and Disaster Prevention (NIED) has built three seismic networks (Hi-net, F-net, and K-net) for various purposes, and the Geospatial Information Authority of Japan (GSI) has operated 1,240 permanent GPS stations to monitor near-real-time ground movement. Furthermore, the ALOS satellite launched in 2006 by the Japan Aerospace Exploration Agency (JAXA) has been providing synthetic aperture radar data associated with several devastating earthquakes, including the Tohoku Earthquake, which expanded understanding of the earthquake rupture process. Data circulation and data sharing have improved annually and now allow even foreign scientists and engineers to help us provide better models and warnings. Such dense networks and real-time monitoring systems enable the Japan Meteorological Agency (JMA) to publically announce seismic intensity distribution within 1.5 min and the activity's detailed hypocenter and magnitude information within several minutes, supporting urgent rescue responses and operations. However, the Tohoku Earthquake's size was so great that immediate estimate of magnitude was 7.9 because of magnitude saturation in the high-frequency domains, causing underestimates of the tsunami height.

Since 2007, the JMA has been operating the earthquake early warning system, which provides immediate estimates of strong shaking within seconds to people before the actual seismic wave arrives. People can be informed of the warning via TV, radio, and mobile phone, as well as special devices, when the estimated JMA intensity reaches 5 or higher. Seventeen cases of the early warning through 2010 have proven its validity and efficacy for disaster mitigation, for example, by suggesting that students hide themselves under their desks in school. In the Tohoku Earthquake, the system provided a warning eight seconds before the primary wave arrived at the city of Sendai, and successively stopped bullet trains in the Tohoku area. However, it underestimated ground acceleration in the Tokyo metropolitan area. Furthermore, the Tohoku Earthquake's numerous aftershocks revealed the weakness of the early warning system in that it released a number of false alarms resulting from unexpected remote simultaneous aftershocks and interruptions of data transmission.

The JMA has been announcing advisories about the probabilities of subsequent large shaking (intensities 5 or higher) due to aftershocks since the 2004 Niigata-ken-Chuetsu Earthquake (M6.8). Statistics of well-recorded early aftershocks enable us to extrapolate the subsequent three- or seven-day probability of large aftershocks. It is useful to promote public awareness of the continuing danger. The advisory worked after the Tohoku Earthquake. However, the widespread aftershocks and remotely triggered earthquakes were unprecedented because of its extent of crustal deformation. Several M6 class inland earthquakes have occurred and caused local damage in Akita, Fukushima, Nagano, and Shizuoka Prefectures, located 100 km to 300 km from the locus of high seismic slip.

After:

To overcome the problem of inadequate evacuation due to the map's underestimated inundation, the guideline for creating a tsunami hazard map is undergoing modification and revision. For example, the scenario should include the probable maximum as well as the previous maximum, and should be expanded to several scenarios to avoid a sense of certainty, especially of unjustified safety.

A new offshore network system in the Pacific Ocean, east of Japan, is going to be installed with more than 50 seismic and tsunami monitoring sensors, covering the trough in the deep sea where earthquakes and tsunamis have repeatedly originated. The system enables monitoring them in real time and providing more accurate estimations, even for a large-scale event.

The HERP confirmed the validity of the methodology for creating the probabilistic seismic hazard map by retrospective tests beginning in 1890. The map underestimated the strong ground motion in Tohoku because of the ~200–300-year relatively short period of reliable historical and instrumental data. We may have to consider hypothetical M9 super-cycles by taking pre-historic and paleoseismic data into account. The magnitude of the anticipated large earthquakes along the Nankai trough for southwest Japan has now increased to M9.0, based on the tsunami sediment and paleo-geodesy along the coastal regions.

To overcome the magnitude saturation issue that emerged from the Tohoku Earthquake, the Geospatial Information Authority of Japan (GSI) and Tohoku University have been developing a real-time magnitude determination system using continuous GPS data and a data assimilation technique.

Problems:

Limitation in the deterministic evaluation for a low-frequency event such as the 2011 Tohoku disaster suggests a new approach, combining the statistical method with an inter-disciplinary approach including history, geology, sedimentrology, and physiography. A multi-scenario prediction would reduce the risk of governments and citizens having a false sense of certainty or safety.

Although the tsunami warning for a far field event is effective, the issues in a near field event remain because of having a short evacuation window. An early warning system should trigger the people to evacuate or take mitigating action. This system should be connected or cooperate with the planning of evacuations and systems/facilities in each area, which would require understanding people's reasons for not taking action to move to safe areas despite receiving the warning in the 2011 Tohoku disaster. At the beginning of the earthquake and tsunami generation, errors or indefinite remains can be reduced by monitoring data in real time, indicating a speed–accuracy trade-off. It is important to receive the updated information timely after the event. Then the dissemination system, by combining mass media, ICT, and public information, can ensure people's access to information at any time.

The recent destructive earthquakes including the Tohoku Earthquake raised several critical issues in the probabilistic seismic hazard map. However, the map, averaging probabilities of strong ground motion from various sources in a given place, remains useful for seismic damage mitigation. The larger issue is to avoid people's misunderstanding: the map does not indicate "earthquake probability."

In the Tohoku Earthquake, Japan's recent building code demonstrated its protection against strong seismic motion. However, the domain of seismic acceleration and local intensity at a subduction earthquake is frequently different from that caused by large, shallow, inland earthquakes. Reconstructions and seismic retrofits of the old buildings are strongly recommended.

The earthquake early warning system has been steadily improving since its 2007 initiation. Frequent drills in the immediate action necessary within seconds before a seismic wave arrives have become far more important for protecting human life. Thus, we need to educate people on the warning system's limitations, particularly for large inland earthquakes, and further promote seismic retrofits to prevent the collapse of old buildings.

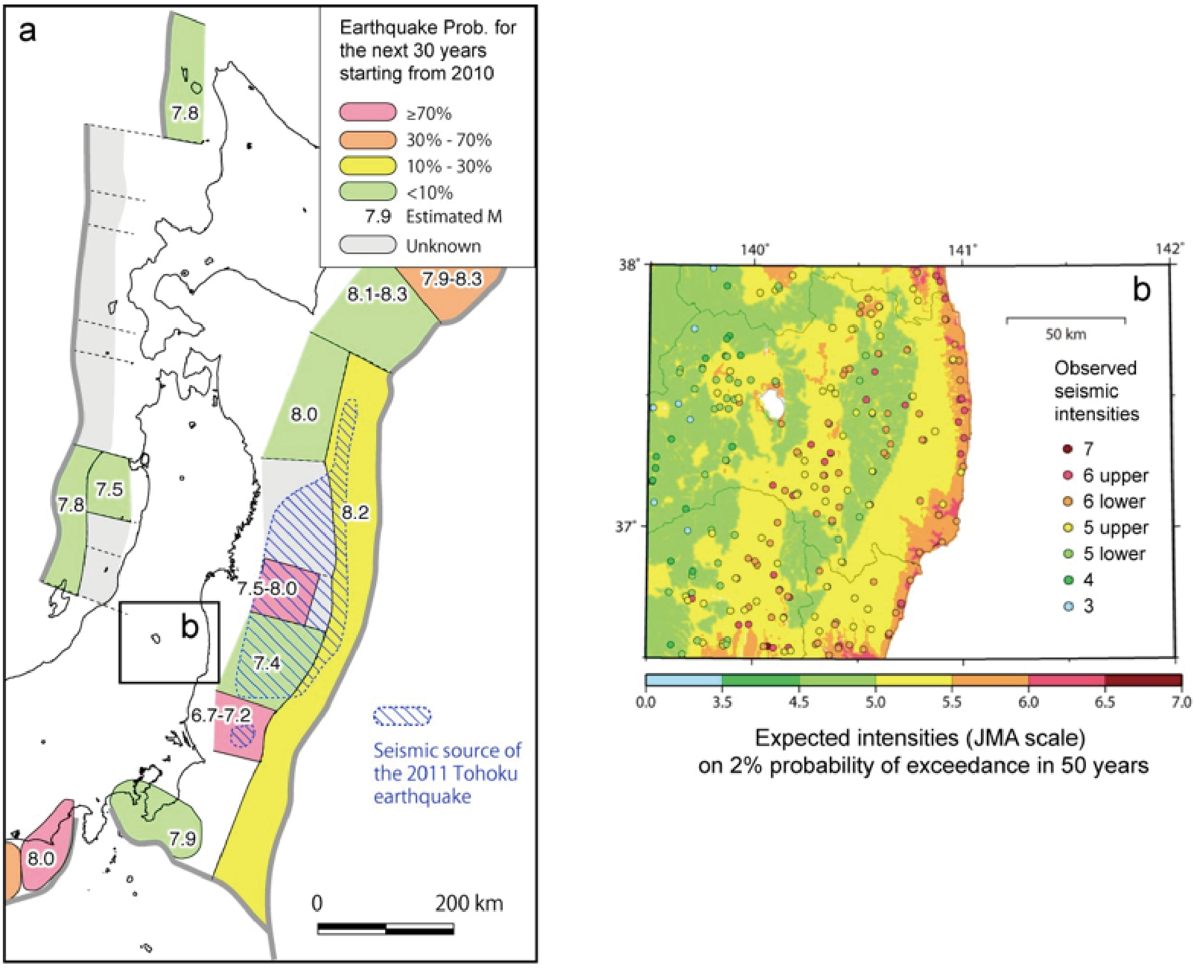

Fig. 2.1 a) Earthquake Probabilities of Subduction Earthquakes for the Next 30 Years (HERP, 2010).
b) A Comparison between the Expected Seismic Intensities Calculated from the Long-term Forecast and Observed Intensities Recorded for the 2011 Tohoku Earthquake.

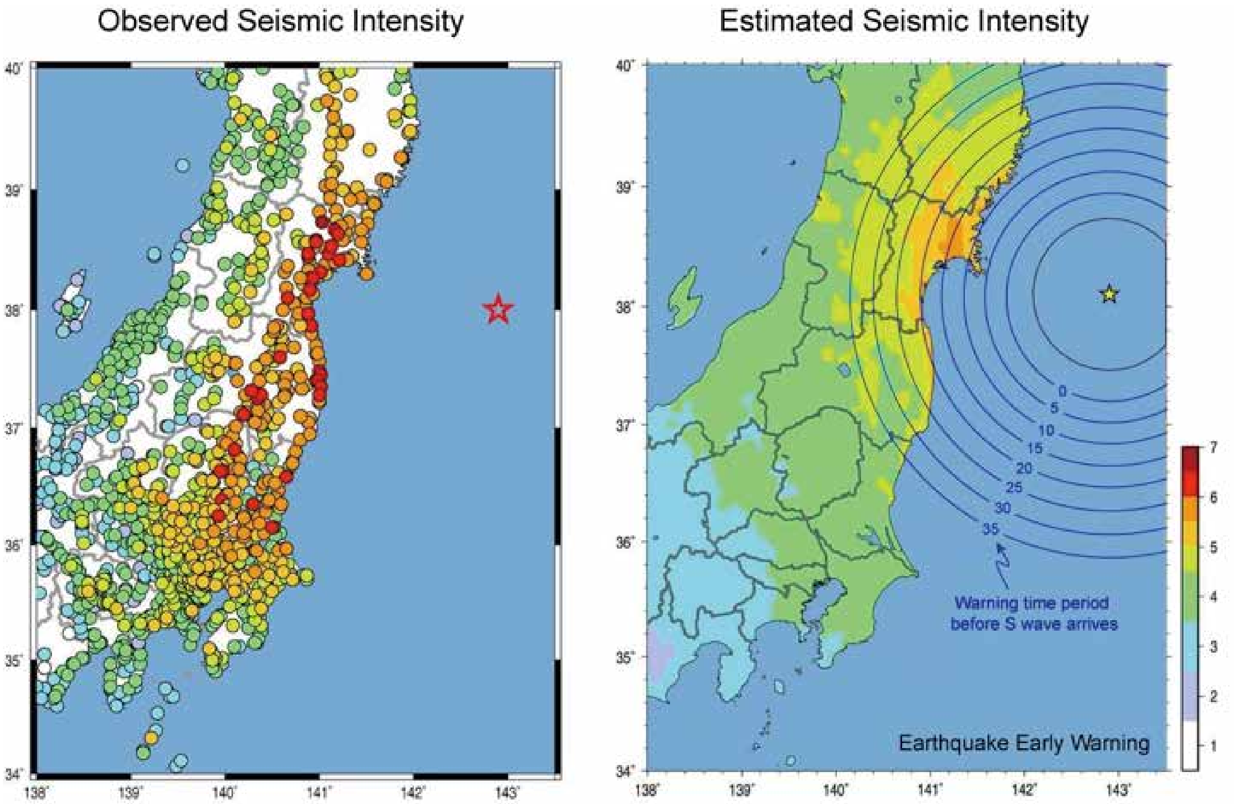

Fig. 2.2 Observed Seismic Intensities of the 2011 Tohoku Earthquake (left) and Intensities Estimated from the JMA Earthquake Early Warning System (right). (Yamada, 2011)

HFA Priority for Action 3:
Use knowledge, innovation and education to build a culture of safety and resilience at all levels

HFA Core Indicator 3.1:
Relevant information on disasters is available and accessible at all levels, to all stakeholders (through networks, development of information sharing systems, etc.)

Information Sharing, Cooperation, and Expert Training provided by Academic Research Institutes for Natural Disasters

Keywords:
academic research institute for natural disasters, background, mission

Context:
Various countermeasures have been implemented on the basis of the experiences of many great natural disasters, including earthquakes, volcanic eruptions, floods, tsunamis, typhoons, landslides, etc. This section focuses on the role of academics suggested by any previous great disaster. HFA Core Indicators in this section are altered from the original indicators, maintaining the original priority.

Before:
First, we summarize the century-long history of the establishment of academic disaster research institutes.
The Tokyo University Earthquake Research Institute (ERI) was established in 1925, two years after the great Kanto earthquake. The principles and goals of scientific research are to promote research of the solid earth, and to pioneer a way to better understand earthquakes and volcanic activities.

The Kyoto University Disaster Prevention Research Institute (DPRI) was founded in 1951 in response to severe damage caused by a huge typhoon that struck Japan that year. Since its establishment, the DPRI has responded to a variety of natural disasters and has promoted research in the disaster sciences, with the goal of mitigating damage. Many researchers and graduate students work in the DPRI, with specialties ranging from natural science, engineering, informatics, to social sciences. It also maintains 15 experimental and observatory facilities outside the campus for unique field investigations, on-site observations, and large experiments.

The National Research Institute for Earth Science and Disaster Prevention (NIED) was established in 1963, motivated by the disastrous 1959 Typhoon Isewan. Originally, an independent administrative institution is defined as one that efficiently and effectively promotes programs that should be securely administered from the public perspective, but always need not be executed by the government itself and cannot be expected to be supported by private enterprises. Research on disaster prevention is one such work.

The Great Hanshin-Awaji Earthquake Memorial Disaster Reduction and Human Renovation Institute (DRI) offers programs in which visitors can learn the effects of that earthquake and lessons learned from the experience that should be shared with younger generations. The DRI began in 1959 as an archive project and after 2002 has also worked to convey expertise and knowledge to the public in an easy-to-understand manner so as to help our cities, communities, and the populace becomes better prepared against disasters. Such efforts are based on the concept that disaster risk management and mitigation requires the involvement of not only the national and local governments but also local communities and individuals.

Table 3.1 List of Great Natural Disasters and Academic Research Institutes for Natural Disasters.

Year.	Event	Locate.
Sep.1923	Great Kanto Earthquake	Tokyo, Chiba, Kanagawa, etc.
Nov.1925	*Earthquake Research Institute* (ERI) established by Tokyo Univ.	Tokyo
Sep.1950	Typhoon Jane	Osaka,Kinki, Shikoku
Apr.1951	*Disaster Prevention Research Institute* (DPRI) established by Kyoto Univ.	Kyoto
Sep.1959	Typhoon Ise-wan	Japan
Apr.1963	*National Research Institute for Earth Science and Disaster Prevention (NIED)* established.	Hyogo,Ibaraki, Niigata, Yamagata
Jan.1995	Great Hanshin-Awaji Earthquake	Hyogo
Apr.2002	*Disaster Reduction and Human Renovation Instiution* (DRI) established.	Hyogo
Jan.2005	*Hyogo Framework for Action(2005-2015)*	
Jan.2005	*Institute for Research of Disaster Area Reconstruction* established by Kwansei Gakuin Univ.	Hyogo
2008	*Institute of Disaster Environmental Science* (IDES) established by K.I.T.	Kanazawa
Mar.2011	Great East Japan Earthquake and Tsunami	Iwate, Miyagi, Fukushima, etc
Apr.2011	*Institute of Disaster Recovery Revitalization* established by Fukushima Univ.	Fukushima
	Research Institute for Natural Hazards & Disaster Recovery (NHDR) established by Niigata Univ.	Niigata
	Research Institute of Disaster Prevention and Emergency Medical System(DPEMS) established by Kokushikan Univ.	Tokyo
May.2011	*Composed Crisis Research Institute* established by Waseda Univ.	Tokyo
Apr.2012	*International Research Institute of Disaster Science* (IRIDeS) established by Tohoku Univ.	Miyagi
Apr.2013	*Institute of Disaster Mitigation for Urban Cultural Heritage* (DMUCH) established by Ritsumeikan Univ.	Kyoto
		etc.

After:
For a hundred years, fundamental science and technology related to disasters has been developed in Japan based on fundamental scientific knowledge, and many experts have emerged. However, our knowledge has proven to be insufficient to save lives, to provide correct information, and to make well-informed decisions, because the damage by the 2011 Great East Japan Earthquake was extraordinarily massive and the damaged area so vast, as never before experienced. Experts in each division are less experienced in connection to that in other divisions. The highest priority is thus an integrated system of knowledge.

Such a system demands consideration of social engineering, social sciences, and humanities in implementing countermeasures. It also requires reinforcing efforts for effective risk communication about a very low frequency great disaster, including its uncertainty, limitation of predicting natural phenomena, and the promotion of integrated research among different fields such as seismology, geology, archeology, history, and practical expert training.

Having experienced the catastrophic disaster in 2011, Tohoku University founded the International Research Institute of Disaster Science (IRIDeS). Along with collaborating organizations from many countries and with broad areas of specialization, the IRIDeS conducts world-leading research on natural disaster science and disaster mitigation. Based on the lessons from the 2011 Great East Japan (Tohoku) Earthquake and Tsunami Disaster, the IRIDeS strives to become a global center for the study of disasters and disaster mitigation, learning from and building on past lessons in disaster management from Japan and around the world. Throughout, the IRIDeS will contribute to ongoing recovery/reconstruction efforts in affected areas by conducting action-oriented research and pursuing effective disaster management to build sustainable and resilient societies. The IRIDeS innovates the previous paradigm of Japan's and the rest of the world's management for catastrophic natural disasters to become a foundation of disaster mitigation management and sciences. Disaster mitigation management seeks to avoid or reduce potential losses from natural hazards, to ensure prompt assistance to victims, to achieve rapid and effective recovery, and to build disaster-resilient and sustainable societies through the five stages of the disaster management cycle: mitigation, preparedness, response, recovery, and reconstruction. The action-oriented research of the IRIDeS addresses each stage in the cycle and integrates and universalizes the scientific discoveries for implementation worldwide.

The Inter-Graduate School Doctoral Degree Program on Science for Global Safety, the Ministry of Education (MEXT) program for Leading Graduate Schools, commenced in 2012, and the IRIDeS contributes to this program. Participating students have an integrated practical program, an all-round resource, called the "Kopeito" (cultivate) model.

Good practices:

Having experienced many catastrophic disasters through history, we have established academic/research institutes and education systems from various aspects.

Problems:

Promotion of integrated research of different fields such as seismology, geology, and archeology was insufficient. The failure to anticipate massive earthquakes and tsunamis by taking every possibility into account was noted.

HFA Core Indicator 3.2:
School curricula, education material and relevant training include disaster risk reduction and recovery concepts and practices.

Education to Build a Culture of Safety and Resilience at All Levels around Academic Research Institutes

Keywords:

outreach, social decisions, personal action, daily training, local media, IT-network, SNS

Before:

For longer than the past decade, there were two main backgrounds for countermeasures for disaster prevention in Japan: science communication and administrative policy.

The White Paper on Science and Technology, 2004 noted the importance of scientists and engineers, as members of society, engaging in exchanges with the people, so as to strengthen mutual trust and to encourage the people to treat science and technology as issues of personal importance. In 2005, on the basis of those backgrounds, programs for science communication had begun at Hokkaido University, Waseda University, and Tokyo University by the Science and Technology Promotion Fund. Science communication programs had then spread across other universities, and many outreach programs were held at universities, large academic research projects, and academic societies.

Research institutes contributed to public programs based on the political concept. During these 10 years, the NIED has performed public services through basic research and development on disaster reduction as well as dissemination of research results for the benefit of society. Regarding the seismic hazard, two major projects proceeded utilizing the nationwide seismic network and the 3D Full-scale Earthquake Testing Facility (E-defense), both of which were constructed after the disastrous Kobe earthquake in 1995.
The DPRI serves as a national research center on natural disasters and their prevention and mitigation, authorized by the MEXT. Researchers working on natural disasters from various Japanese universities gather at DPRI, use its experimental and observatory facilities, and jointly work with DPRI researchers. Another role of the DPRI is to promptly provide diverse support at disaster sites in and outside Japan by offering advice regarding what to do, what aid is needed, how to secure and organize volunteers, and other relevant issues while working on pragmatic tasks with local personnel. In preparation for such tasks, our team is developing skills and expertise for managing potential challenges at disaster sites. Furthermore, several institutions and UN organizations related to disaster management are located in this area. This proximity enables the DPRI to serve as one of world's key centers for information on disaster risk management, in collaboration with these organizations.

The good qualities of human beings such as flexibility, kindness, generosity, strength, and joviality are the basis for building an attractive life, home, community, and society. To promote a prosperous society of the 21st century based on harmonious coexistence with nature, the DPRI will strive to disseminate useful disaster management information and expertise, which we believe are closely linked with the mindset of appreciating the importance and preciousness of life.

After:

The ERI speedily provided scientific information on the earthquake. The ERI succeeded in making the mechanism of the earthquake and tsunami easy to understand on the basis of precise analysis.

In addition to its domestic activities, the DPRI has established formal Memoranda of Understanding (MOUs) with 40 foreign research institutions (as of August, 2012) and organizes numerous joint projects and seminars to serve as an international center for research and education on natural disasters and their mitigation. The past decade has witnessed a notable increase in the intensity of natural disasters, such as the 2011 Tohoku Earthquake and Tsunami. To respond to the serious needs for the protection of the lives and assets of our people and society, the DPRI promises to continue to enhance its research efforts, using the knowledge and experience accumulated over the last several decades.

On the basis of NIDE's practical outputs in the past 10 years, they entered "The Third Five-year Plan" period in April, 2011 through negotiation with the Ministry of Education, Culture, Sports, Science, and Technology as well as the Ministries of Finance and of Internal Affairs and Communications. Synchronized with this turning point, we have changed the organization of our institute to create a more efficient system. The research sector was reorganized into three departments: Monitoring and Forecast, Experimental Research, and Social Systems; the management sector was simplified by spinning off the planning section. Further, the Outreach and International Research Promotion Center was newly established to strengthen public services and international activities, archive projects including a rental camera system for victims, etc.

In April, 2011, "The 4th Science and Technology Basic Plan" was also launched by the Council for Science and Technology Policy, Cabinet Office, Government of Japan. In this plan, the role of science and technology is highlighted to challenge important policy goals, one of which is "Realization of Rich and High-quality Life." Lessons from the Great East Japan Earthquake are summarized in the White Paper on Science and Technology, 2012. The public's trust in scientists declined because of the gap between expectation and reality. We thus urgently need promotion of integrated research of different fields such as seismology, geology, archeology, and history to sufficiently understand earthquakes and tsunamis. There was overconfidence in embankments and technology; some people did not evacuate because they lacked knowledge of the limitations of existing countermeasures and technologies. Scientific and technological risks and uncertainty involved have not been seriously considered with regard to the government's and experts' provision of information to the public. Therefore, most of the people lacked an adequate understanding of the situation.

Social engineering, social sciences, and humanities must be considered in implementing countermeasures. Anticipating massive earthquakes and tsunamis must take every possibility into account.

The IRIDeS has created a new academia of disaster mitigation that subsumes the lessons from the 2011 Tohoku Earthquake and Tsunami and the findings of world-leading research into our societies with the purpose of establishing social systems that respond promptly, sensibly, and effectively to natural disasters, withstanding adversities with resiliency, and passing and exploiting the lessons to the subsequent disaster management cycles. Enhancing cooperation with the local municipalities and governments in the affected areas and contributing to their recovery and reconstruction efforts, the IRIDeS conducts action-oriented research. They strive to create disaster-resilient societies that can overcome the complex and diverse processes of natural disasters, not only by mitigation strategies but also by preparing for and responding to them, and achieving recovery and renovation, thus engendering the culture of disaster-resiliency incorporated into our social systems.

The action-oriented research of the IRIDeS focuses on the following points:

1) Investigating the physics of global scale natural disasters such as mega-earthquakes, tsunamis, and extreme weather,
2) Reconstructing disaster response and mitigation technologies based on the lessons of the 2011 Tohoku earthquake and tsunami disaster,
3) Inventing "Affected Area Supportology" in the aftermath of natural disasters,
4) Enhancing disaster-resiliency and performance of multiple-fail-safe systems in regional and urban areas,
5) Establishing disaster medicine and medical service systems towards catastrophic natural disasters,
6) Designing disaster-resilient societies and developing the digital archive system to pass the lessons from the disasters.

The Inter-Graduate School Doctoral Degree Program on Science for Global Safety develops human resources through integrated education in the five-year doctoral program across university departments for students in humanities, sciences, and technologies. It develops leaders in the area of global safety who have a substantial knowledge of liberal arts, international adaptability, a high sense of ethics, and a clear vision, and are able to think and act appropriately on such bases. They are expected to contribute to the protection of human lives, societies, and industries from global disasters such as the Great East Japan Earthquake.

In this program, interdisciplinary cutting-edge education and research are conducted on the basis of practical disaster prevention studies in the (IRIDeS), with participation by the Graduate Schools of Science, Engineering, Environmental Studies, Arts and Letters, and others, so that this integrated program can combine knowledge from the natural sciences, social sciences, and liberal arts. This program strives to develop excellent human resources with core specialties, the ability to apply them in various areas, and other required abilities for leaders, through activities at recovery sites from the Great East Japan Earthquake and conducting world-class research.

Finally, we focus on the action of non-experts. For roughly the past decade, many technologies have enabled people to transmit information rapidly and simultaneously. Government offices transmit disaster information and action indicator messages through mass media and people expect unified information from responsible organizations. During the past several years, Internet technology has developed. The specific information path has diverged with interactive communication. Personal interactive information excluding mass media now enables direct personal interaction.

Fig. 3.1 Evacuation Drill for Tsunamis at an Elementary School

Good practices:

1) Scientific experts have increased in Japan. The speedy supply of scientific information about the mechanism of earthquakes and tsunamis has occurred. That information is open for access and quickly archived.
2) Disaster prevention education by Dr. Katada of the University of Gunma, which underpinned the "Kamaishi Miracle," became famous after the Great East Japan Disaster. Dr. Katada said that it was skills for life, not a miracle. Kamaishi is in the Sanriku Coastal Area, where disaster prevention education and countermeasures were relatively active. He emphasized the reality of tsunamis and the existence of preconditions in the hazard map to overcome the gap between well-informed action and carelessness regarding hazards. That orderly and repeated education caused success.

Problems:

The public's trust in scientists has declined because of the gap between expectations and reality. We urgently need integrated research in different fields to sufficiently understand earthquakes and tsunamis. Communities lack a sufficient number of interpreters and coordinators between experts and non-experts.

Future recommendations:

- The establishment of a domestic system for local hazard risk is the highest priority effort, comprising an observation system, a system for archiving and extracting data, expert training, and other elements. The establishment of an integrated knowledge system is the next priority.
- Education about disaster prevention for non-experts is very important. We learned from the Great East Japan Earthquake that it is effective to teach people the preconditions of hazard estimation. During the emergency, people themselves had to decide how to avoid hazards and protect property because of the inadequate information from outside their community.

HFA Priority for Action 4:
Reduce the underlying risk factors

HFA Core Indicator 4.1:
Disaster risk reduction is an integral objective of environment-related policies and plans, including for land use, natural resource management and adaptation to climate change

Post-tsunami Recovery Strategies in Sanriku Coastal Areas after the 1933 Tsunami

Keywords:
land use regulation, relocation to higher land, 1896 Sanriku Tsunami, 1933 Sanriku Tsunami, transition of housing location, urban recovery strategy

Context:
Land use mitigation is one of the most reliable strategies for avoiding future tsunami disaster. The Sanriku Coastal Area, one of the most tsunami-prone areas in Japan, located in the north part of the main island, was seriously damaged by catastrophic tsunamis in 1896, 1933, and 1960 before the 2011 Great East Japan Earthquake and Tsunami. The Japanese government prepared resettlement space on higher ground for the victims after the 1933 Great Sanriku Tsunami.

Before:
Fig. 4.1 illustrates the transition of housing location after the 1933 Tsunami in Hongo District, Iwate Prefecture[1]. Because of the relocation strategy, there is almost no building as of 1948, except in the higher elevations provided by the government. However, many buildings had been constructed in the vulnerable lowlands in the twentieth century.

After:
The 2011 Tsunami struck the district, washing away hundreds of buildings in the lowlands again (Fig. 4.2). In contrast, the houses on the higher resettlement area provided by the government after the 1933 Tsunami survived the destructive 2011 Tsunami.

Good practices:
The fact that the resettlement on higher ground provided by post-tsunami recovery planning and policy after the 1933 Tsunami was not damaged by the 2011 Tsunami demonstrates the importance of land use mitigation for tsunami disaster reduction. This successful experience in the tsunami-prone coastal area should be referenced in the future.

Problems:
Although the government developed the safer resettlement area for residents after the 1933 Tsunami, many people began living in the vulnerable lower lands or returned to the original tsunami-prone sites until 2011. Previous research[1] describes how several districts in Sanriku Coastal Area suffered from this hazardous situation because of the populace's lack of tsunami risk recognition, convenience, or inherited lands. The recovery planning and policy for the land use regulation was efficient in reducing tsunami risk in one sense, but it was not a mandatory strategy that required people to live only in the safe area.

Fig. 4.2 Building Damage in Hongo after the 2011 Tsunami (left) and Pre-tsunami (right)[2]

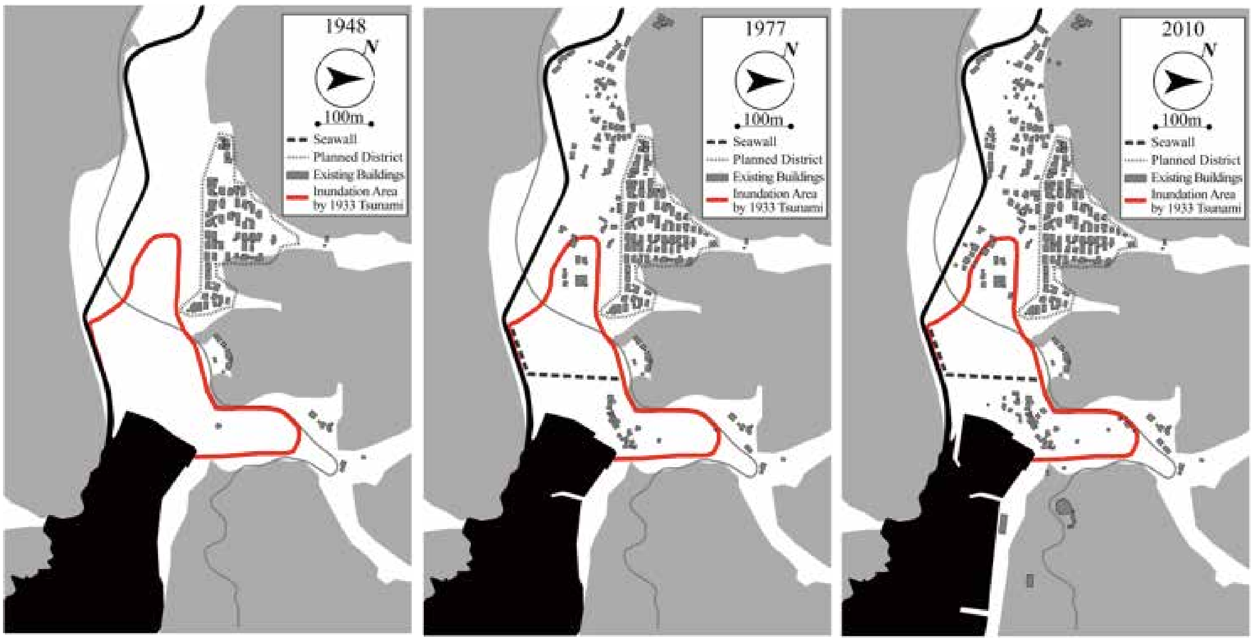

Fig. 4.1 Change of Housing Location in Hongo, Touni Village (1948–2010)[1]

[1] Murao, O., and Isoyama, S. (2012). Transition of Housing Location in Villages in Iwate Prefecture after the Sanriku Tsunamis in 1896 and 1933, *Joint Conference Proceedings of 9th International Conference on Urban Earthquake Engineering (9CUEE) and 4th Asia Conference on Earthquake Engineering (4ACEE)* (CD-ROM), 1877-1882, Tokyo, Japan.
[2] Geospatial Information Authority of Japan. Retrieved from http://saigai.gsi.go.jp/h23taiheiyo-ok/photo/photo_dj/index.html.

HFA Core Indicator 4.2:
Social development policies and plans are being implemented to reduce the vulnerability of populations most at risk

Measures for People Requiring Assistance during a Disaster

Keywords:
elderly people, Guidelines for Evacuation Support of People Requiring Assistance During a Disaster, evacuation, emergency network

Context:
It is vital for the elderly and disabled to be supported and assisted by neighbors in immediately evacuating from disastrous situations. The government and neighboring communities must strive to establish a framework for managing the various aspects of this issue.

Before:
To support such community activities, the Cabinet Office released the *Guidelines for Evacuation Support of People Requiring Assistance During a Disaster* in 2005 and *the Preparation of Measures for Supporting Persons Requiring Assistance During a Disaster*, which contains case studies from recent disasters, in 2007. They were also supposed to support municipal governments in producing overall plans. The 2005 *Guidelines* document consists of the following five activities.

1. **Improving the information communications system**
- Announcement of evacuation preparation information
- Establishment of a support unit for people requiring assistance
- Secure communications through various means such as the Internet and emergency call message service

2. **Sharing of information concerning people requiring assistance during a disaster**
- Collection and sharing of information on people requiring assistance in various ways
- Promotion of exceptional use of social-welfare-related personal information to prepare evacuation support systems

3. **Creating a tangible evacuation support plan for people requiring assistance during a disaster**
- Creation of an evacuation support plan for each individual requiring assistance
- Recognition of the importance of making communities resilient to disasters

4. **Assistance at evacuation centers**
- Establishment of an information desk for people requiring assistance at evacuation centers
- Establishment of welfare evacuation centers

5. **Collaboration among related organizations**
- Continuity of welfare services in disaster situations
- Wide-area support of health nurses
- Establishment of a committee on evacuation support for people requiring assistance at the municipal level

After:
Fig. 4.3 indicates the number of casualties, by age, due to the 2011Great East Japan Earthquake and Tsunami and the 1995 Great Kobe Earthquake. Both exhibit a similar tendency of the death toll by age in that the ratio of the older populace is higher than that of the younger. However, the ratio in the 2011 event is remarkably higher than that in the 1995 Earthquake. The deaths from the 1995 Earthquake were caused largely by building collapse, so a dwelling's structural type and age were significant. In contrast, the 2011 deaths were caused largely by the tsunami, so evacuation methods from the vulnerable area to safer places were critical. Thus, residents' age or health condition was an important factor affecting their fate. Following the guidelines, many districts had strived for strong community assistance for such people, but not all community plans worked well because of the size of affected areas and geographical conditions.

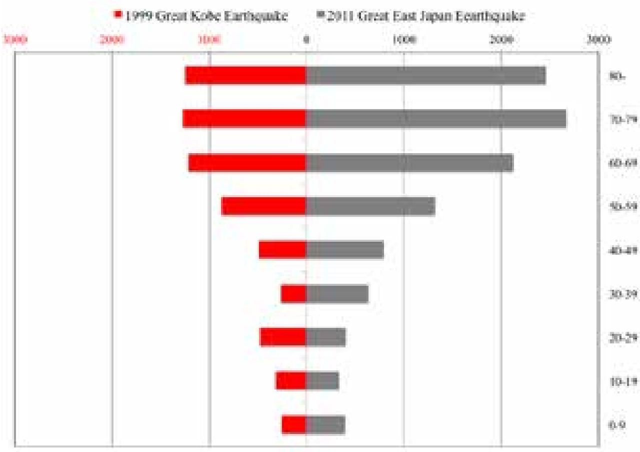

Fig. 4.3 Casualties, by Age, due to the 2011Great East Japan Earthquake and Tsunami and the 1995 Great Kobe Earthquake[3]

Good practices:
There were many elderly people needing assistance in shelters after the tsunami. Homehelpers in Japan dispatched supporters for them, and because of keeping accurate records of the elders' information, that plan worked well[4].

Problems:
The Cabinet Office[4] noted problems in each response phase clarified by the event, as follows:
Before: lack of supporting systems, including acceptance of people and organizations, lack of dissemination of the procedures, shortage of helpers, shortage of previous drills.
Emergency response: no list of the elderly, not knowing how to use the lists, no guidelines, no information on evacuation for the elderly.
At the shelters after the emergency response: difficulty in continuing to live with other people, lack of shelters, limitation of response systems to the elderly, unsatisfactory health care, lack of information and materials, insufficient support by local governments because of damage, difficulties faced by infants and expectant mothers.

[3] The Cabinet Office (2011). Retrieved from http://www.bousai.go.jp/kaigirep/hakusho/h23/bousai2011/html/honbun/2b_sanko_siryo_06.htm.
[4] The Cabinet Office (2012). Retrieved from http://www.bousai.go.jp/taisaku/hisaisyagyousei/youengosya/h24_kentoukai.

HFA Core Indicator 4.3:
Economic and productive sectoral policies and plans have been implemented to reduce the vulnerability of economic activities

Business Continuity Planning after the 2011 Great East Japan Earthquake

Keywords:
Business Continuity Planning, Business Continuity and Resiliency Planning, post-disaster recovery

Context:
Business Continuity Planning (BCP), which is also called Business Continuity and Resiliency Planning (BCRP), "identifies an organization's exposure to internal and external threats and synthesizes hard and soft assets to provide effective prevention and recovery for the organization, while maintaining competitive advantage and value system integrity"[5]. The importance of an organization's having a form of continuity planning in preparation for disaster management had been discussed since Japan's 1995 Great Kobe Earthquake.

Before:
The Cabinet Office released *"Business Continuity Guideline – For Disaster Reduction and Improvement of Disaster Management for Business in Japan"*[6] in 2005. The document directed organizations in developing their post-disaster management plan, as shown in Fig. 4.4 and encouraged them to review it with a checklist. It was updated in 2009. Thus, the BCP concept had been widely disseminated among Japanese companies before the event on March 11, 2011.

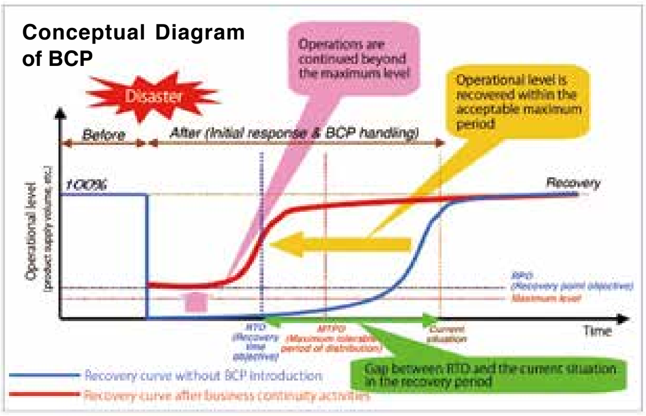

Fig. 4.4 BCP Concept[6]

After:
The 2011 Great East Japan Earthquake and Tsunami somewhat influenced the companies located in the damaged areas. Teikoku Data Bank conducted surveys on organizations' BCP status in April 2011 and February 2012. The report[7] revealed the BCP status of 10,713 organizations after the event, summarized as follows:
(1) The ratio of the companies whose business was interrupted by the event was 64.5% (6911 organizations), largely because of the difficulty faced in materials procurement (supply chain) affected by the damage to suppliers.
(2) Of the discontinued companies, 72.9% had resumed business within three months after the event. Another 6.5%, and notably the additional 9.2% in the four damaged prefectures (Iwate, Miyagi, Fukushima, and Ibaraki), had not resumed business as of February 2012.
(3) The most consistent conducted preparedness activity was establishing an emergency network (55.0%), followed by having multiple suppliers (38.0%) and multi-backup information systems (33.8%).
(4) As of February 2012, 10.4% of the total organizations had internal business continuity planning, and 50.8% had no plan, although they knew about BCP. Thus, the proportion of organizations with a BCP increased by 2.6% and that of the organizations that knew about BCP increased by 24.3% compared with the April 2011 status (Table 4.1).

Table 4.1 BCP Status[7]

	Done	Know but undone	Not know	Unknown
Apr. 2011	837 (7.8%)	3,150 (29.2%)	5,139 (47.7%)	1,643 (15.3%)
Feb. 2012	1,116 (10.4%)	5,446 (50.8%)	2,660 (24.8%)	1,491 (13.9%)

Good practices:
Natori Oil Plant[8] is an industrial waste company in Natori City, which collects and recycles waste oil to sell as clean recycled fuel. The company released its BCP in January 2011.
It reopened on March 18, 2011, after a one-week interruption by the event. They had refined waste oil and sold it to a trading partner until their two factories were seriously damaged by the Tsunami. Instead of self-refining, they outsourced the process to another company outside of the prefecture as they had prepared to do before the Tsunami. They could thus continue in business despite the difficult conditions immediately following the event. Their rapid recovery was also very supportive to the city because they devoted themselves to cleaning up the debris around the damaged coastal area. That is a successful case of having a BCP.

Problems:
First, although some companies had developed BCPs before the disaster, not all BCPs functioned well after the event because of lack of feasibility.
Second, it was more difficult for declining businesses or medium-sized and small companies to recover rapidly.
Third, a small business that had operated in a small surrounding area had difficulty surviving the destruction because of its limited client base, which had also been damaged in the disaster.
Finally, BCPs that addressed only the company's individual situation did not efficiently function because they had not accounted for supply chain continuity.

[5] Elliot, D., Swartz, E., and Herbane, B. (1999). "Just Waiting for the Next Big Bang: Business Continuity Planning in the UK Finance Sector," *Journal of Applied Management Studies,* Vol. 8, pp. 43-60.
[6] Cabinet Office (2005). "Business Continuity Guideline – For Disaster Reduction and Improvement of Disaster Management for Business in Japan." Retrieved from www.bosai.go.jp/kaigirep/chuoubou/20/pdf/shiryo51.pdf.
[7] Teikoku Databank Ltd. (2012). "Survey of Companies' Business Continuity Planning." Retrieved from http://www.tdb.co.jp/report/watching/press/pdf/p120308.pdf.
[8] Retrieved from www.opnatori.co.jp.

HFA Core Indicator 4.4:
Planning and management of human settlements incorporate disaster risk reduction elements, including enforcement of building codes

Promotion of the Earthquake-proof Retrofit of Buildings after the 1995 Great Kobe Earthquake

Keywords:
1995 Great Kobe Earthquake, building damage, earthquake-proof retrofit, seismic reinforcement

Context:
More than 100,000 buildings were severely damaged and roughly 150,000 were moderately damaged by the Hyogoken-Nanbu (Kobe) Earthquake on January 17, 1995. Most human casualties were caused by building collapse, and the building damage conditions depended on structural type and construction period (Fig. 4.5)[9]. Specifically, buildings constructed after the 1971 and 1981 amendments of the 1950 Building Standard Law were less damaged.
Consequently, that event indicated the importance of strengthening buildings to reduce future building collapse risk.

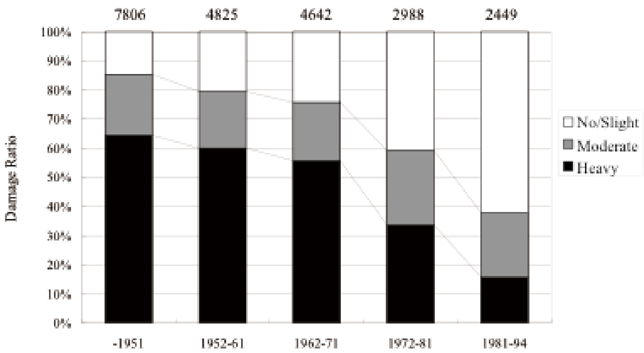

Fig. 4.5 Damage Ratio of Wood-frame Buildings by the 1995 Kobe Earthquake Classified by the Construction Period[9]

Before:
The Act on Promotion of Earthquake-proof Retrofit of Buildings was passed in 1995 after the Kobe Earthquake. It was amended in 2006 after the 2004 Niigata-ken Chuetsu Earthquake. The act serves to increase the ratio of earthquake-resistant buildings from 75% in 2005 to 90% by 2015. Fig. 4.6 shows the change in the number of earthquake-resistant buildings in a 2010 report released by Ministry of Land, Infrastructure, Transport, and Tourism[10]. Each local government had supported to strengthen buildings in the jurisdiction.

After:
The 2011 Great East Japan Earthquake's building damage was not as great as that by the Tsunami or by the 1995 Great Kobe Earthquake because of the relationship between the structural natural period and seismic characteristics. However, slightly damaged buildings, including destruction of non-structural elements, were widely distributed.
Having strong misgivings about building damage due to the estimated destructive earthquake occurring in the Nankai Trough, the government amended the act again in 2013. The amended act requires the evaluation of seismic capacity of large-scale public facilities and publication of that information, among other actions.

Good practices:
Learning from previous disasters, the government passed and repeatedly amended the act. This cycle is vital for future disaster management. Setting a quantitative goal for the proportion of earthquake-resistant buildings in near future would also be effective.

Problems:
Some residents are not willing to strengthen vulnerable houses because of (1) uncertainty of the cost, (2) doubt about the building strength after the retrofit, and (3) the idea that it is inefficient to spend much money for reinforcing old buildings.

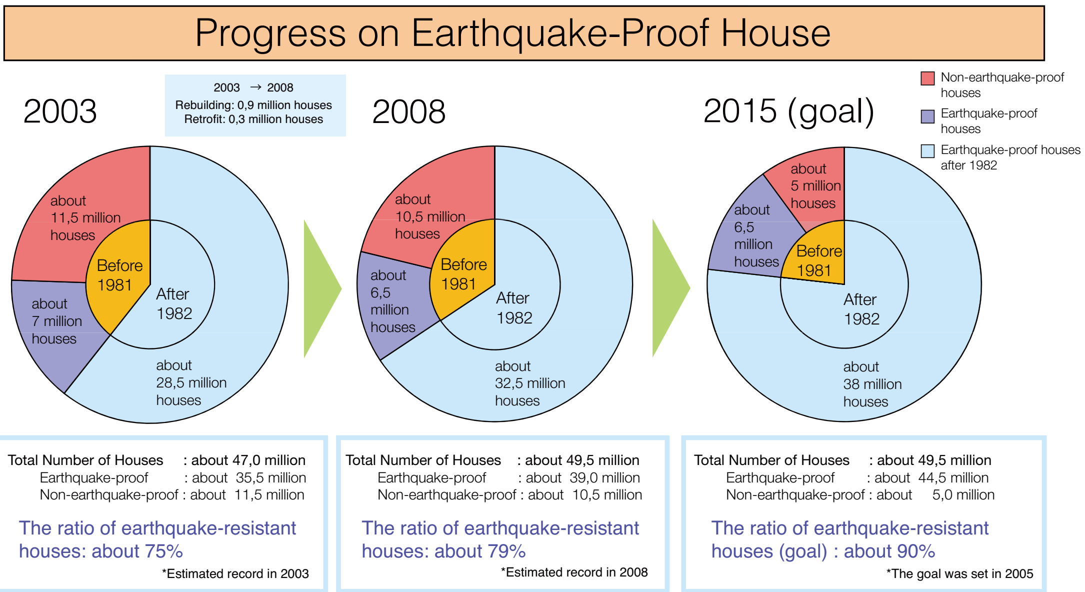

Fig. 4.6 Change in the Number of Earthquake-resistant Buildings (2003-2015)[10]

[9] Yamazaki, F., and Murao, O. (2000). "Vulnerability Functions for Japanese Buildings Based on Damage Data due to the 1995 Kobe Earthquake," *Implications of Recent Earthquakes on Seismic Risk,* Series of Innovation in Structures and Construction, Vol. 2, pp. 91-102, Imperial College Press.
[10] Ministry of Land, Infrastructure, Transport, and Tourism (2010). Retrieved on [date] from http://www.mlit.go.jp/common/000188412.pdf.

HFA Core Indicator 4.5:
Disaster risk reduction measures are integrated with post-disaster recovery and rehabilitation processes

Post-tsunami Recovery for Risk Reduction after the 2011 Great East Japan Earthquake and Tsunami

Keywords:
urban recovery strategy, land use regulation, relocation, concentration, avoiding, slowing, steering, blocking, compacted terraces and berms, reinforcement

Context:

Post-disaster recovery is a significant process for rebuilding a society with new, improved disaster reduction systems for the future. The Tohoku Region coastal areas had previously experienced several huge tsunamis and took measures to mitigate tsunamis' damage through the twentieth century. However the March 11, 2011, Tsunami struck them again and washed away the residential areas. Every district examined and designed its recovery plan according to its circumstances, and they are exploring strategies to build their new towns in the context of certain problems.

Before:

As described **HFA Core Indicator 4.1**, the government developed inland resettlements for the 1933 Sanriku Tsunami victims, but houses again increased in the lower elevations by the ocean, only to be washed away. The death toll including missing people was 21,000 as of March 26, 2013.

After:

The number of damaged municipalities by the Tsunami was 62, and 43 municipalities had released their post-tsunami recovery plans for future tsunami damage mitigation as of May 2012.

According to a survey for 208 damaged districts conducted by the Ministry of Land, Infrastructure, Transport, and Tourism[11], the post-tsunami recovery plans can be classified into five types and comprise four mitigation systems: (1) relocation as a land use mitigation system; (2) levee to block tsunamis; (3) compacted terraces and berms to avoid, slow, or steer tsunamis; and (4) tsunami mitigation design for facilities. The five classifications are as follows (Fig 4.7):

A. Relocation (127)
B. Concentration (6)
C. Compacted terraces and berms (19)
D. Relocation and compacted terraces and berms (18)
E. Reconstruction on the original site with facility reinforcement (38)

Good practices:

Every damaged district in Japan devised its recovery plan that reduces future tsunami risk based on previous experience. Public involvement has been recognized as an especially significant factor in devising recovery plans since the 1995 Great Kobe Earthquake.

Problems:

Now that the damaged municipalities have announced their recovery plans, each local government must implement it. However, they encounter several challenges in implementing actual projects, depending upon the regional situation, such as the following examples:

- Disagreements between governments and residents about the destruction of a beautiful piece of scenery by levee construction, or levees' adequate assurance of safety
- Shortage of available land for relocation
- Shortage of construction materials and workers for the extraordinarily large damaged area
- Construction costs

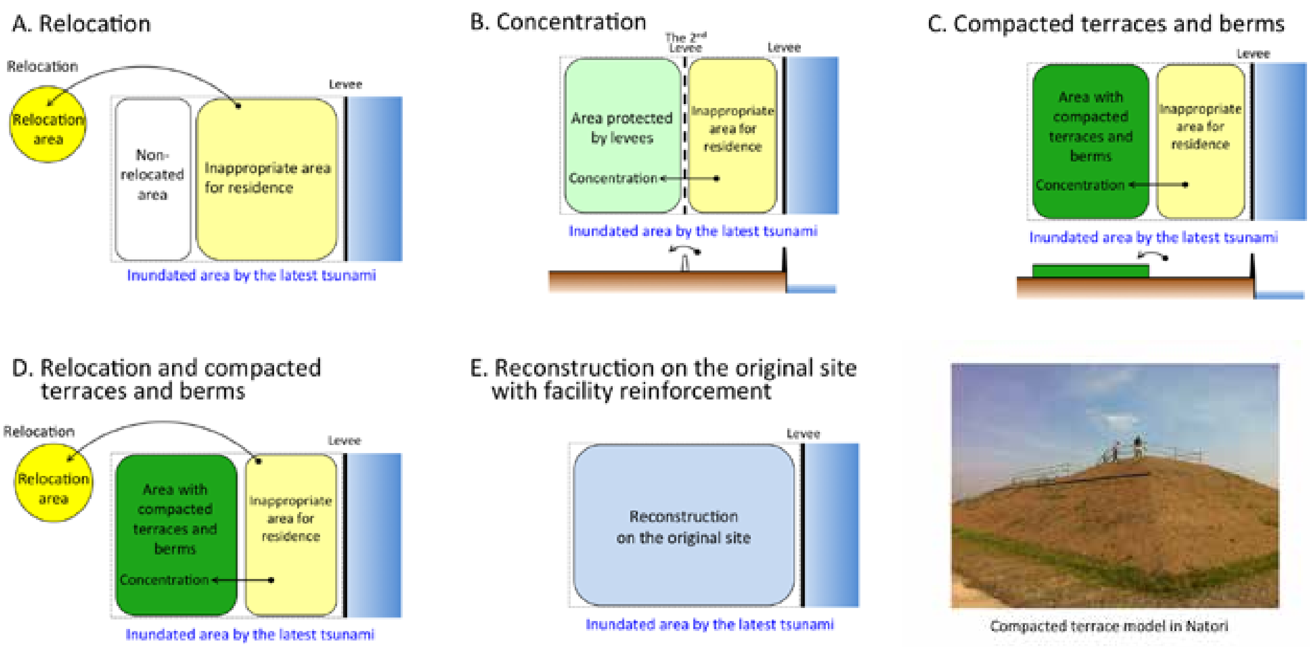

Fig. 4.7 Regional Urban Recovery Types Proposed after the 2011 Great East Japan Earthquake and Tsunami[3]

[11] Ministry of Land, Infrastructure, Transport, and Tourism (2012). Retrieved from http://www.mlit.go.jp/common/000209868.pdf (revised for this material by the author).

HFA Core Indicator 4.6:
Procedures are in place to assess the disaster risk impacts of major development projects, especially infrastructure

Comprehensive Post-tsunami Recovery after the 2011 Great East Japan Earthquake and Tsunami

Keywords:
post-tsunami recovery projects, tsunami simulation

Context:
To support local governments to arrange proper regional plans for tsunami disaster reduction, the Japanese government published the "*Tsunami Disaster Estimation Manual*" and "*Guideline to Strengthen Tsunami Disaster Management in Local Disaster Prevention Plans*" in 1997, followed by the "*Tsunami and Tidal Wave Hazard Map Making Manual* (2004)" and "*Guideline for Management of Tsunami Evacuation Buildings* (2005)."

Before:
Considering these guidelines, local governments in the damaged areas had developed their disaster management systems according to regional conditions. However, the 2011 Earthquake off the Pacific coast of Tōhoku was greater than expected, and some management systems failed to work well.

After:
Each municipality performed two types of tsunami simulations, depending on the occurrence risk to devise recovery plans for resettlement. The Japanese government[12] prepared several projects (Fig. 4.8) to support their plan development and implementation.

Good practices:
Problems:
HFA Core Indicator 4.6 good practices and problems are those previously described for HFA Core Indicators 4.1 and 4.2.

Future recommendations:
- Relocation to higher land from the waterfront area as a post-tsunami recovery strategy should be performed by national/local government purchase of the lowlands to avoid future private usage of vulnerable waterfront space.
- More thorough business operation analysis should be performed to devise BCPs including the network required for maintaining the supply chain.
- Reinforcement of buildings is essential to reducing the risk of collapse. Setting quantitative goals and education figure strongly in promoting this effort.
- Pre-disaster recovery planning worked well in Kobe's Mano District after the 1995 Great Kobe Earthquake as well as in Tokyo after the 1923 Great Kanto Earthquake. Pre-disaster recovery planning is an important process for reaching agreement among the local government and residents on a future vision of the district. Sharing the future vision prior to a disaster may avoid emotional conflicts at the stages of developing or implementing the post-disaster recovery plan.
- Prediction of available resources as well as disaster damage is necessary for implementing reconstruction activities. Reconstruction activity estimation should be considered at the national, local, and community levels corresponding to predicted damage levels.

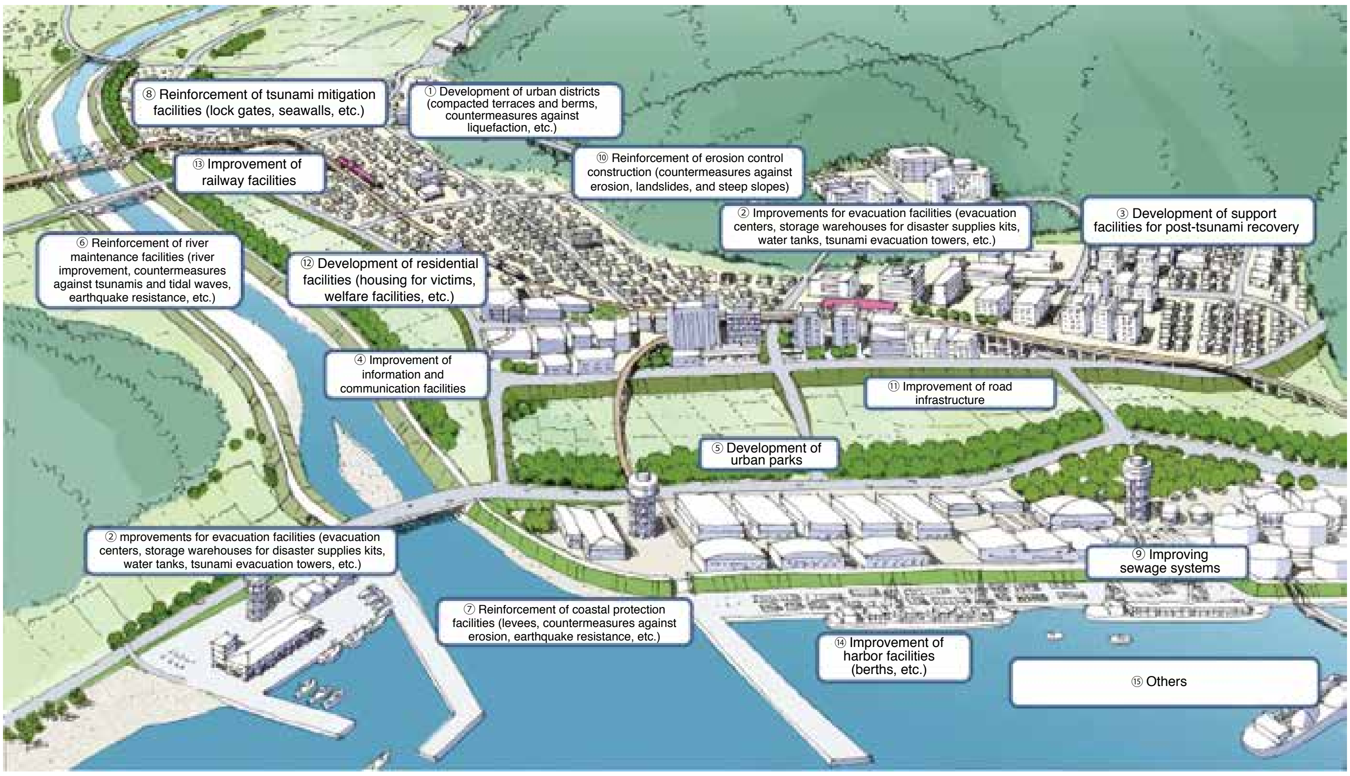

Fig. 4.8 Urban Recovery Projects at a Glance after the 2011 Great East Japan Earthquake and Tsunami[12]

[12] Ministry of Land, Infrastructure, Transport, and Tourism (2013). Retrieved from http://www.mlit.go.jp/report/fukkou-index.html.

HFA Priority for Action 5: Strengthen disaster preparedness for effective response at all levels

HFA Core Indicator 5.1:
Strong policy, technical and institutional capacities and mechanisms for disaster risk management, with a disaster risk reduction perspective, are in place.

Measures and Agenda for Large-scale Disasters in Japan: from the Perspective of Personal Information and Disaster Prevention Education

Keywords:
Disaster Countermeasures Basic Act, Personal Information Protection Law, local knowledge

Context:
Because of the several disasters such as typhoons, earthquakes, tsunamis, and heavy snowfall in Japan, the country has suffered a great loss of people's lives and assets and a massive economic loss. On the basis of these experiences and lessons learned, disaster-related acts, policies, and legal frameworks have been developed and enacted to prepare for and respond to disasters.

Before:
The 1961 Disaster Countermeasures Basic Act was enacted on the basis of the experiences of the 1959 Typhoon Isewan. Before that, the national and local government roles and responsibilities had not been stated clearly. The Act regulated the roles and authorities of each level of government for disaster risk reduction, response, and recovery to secure the victims' welfare and social order by protecting citizens' lives and assets from disasters. Municipalities have the responsibility of establishing a disaster response office; however, to respond to a massive disaster (causing damages beyond the capacity of prefectures and municipalities), the national government is required to establish a disaster response office to provide the necessary assistance.

After the 1995 Great Kobe Earthquake, major revisions to the Act included 1) easing the conditions of establishing the disaster response office and strengthening the disaster response office's authority; 2) mayors' issuing a request for the deployment of the Japan Self-Defense Force (JSDF) to the governor and reporting the disaster situation to the Director-General of the Defense Agency; 3) traffic control; and 4) training of the local voluntary organizations for disaster risk reduction, including measures for the elderly and persons with disabilities.

After:
The experiences from the 2011 Great East Japan Earthquake and Tsunami revealed that the existing act was insufficient for response to such an unexpected disaster. The April 2005 Personal Information Protection Law hampered the confirmation of people's safety, making it difficult to obtain the information and pre-determine whether people would require extra support lives. The leaders of community-based organizations and the chairpersons of neighborhood associations addressed such issues. As a result of such problems, the number of casualties of the elderly and persons with disabilities reached was double that of ordinary persons.

Another issue was the citizens' lack of awareness of tsunamis. The areas affected by the 2011 Tsunami included regions with no previous tsunami experience, and a number of citizens there had no proper knowledge and believed that a tsunami poses no danger. They held such beliefs from their knowledge of the 1961 Chile Earthquake and were convinced that their residential areas were safe as they had no such earlier incidents.

On the basis of the lessons learned from the 2011 Tsunami, the Act was again revised, and local governments gained the authority to develop a list of affected people, specifically through information gathered by municipalities, and the information on the elderly and persons with disabilities, in particular, can now be submitted to relevant offices, with the individuals' consent. In addition, the dissemination of the lessons learned and disaster education will strengthen the capacity for local disaster risk reduction.

Good practices:
Quick response is required after a disaster, whereas enactment of a law is, by its nature, a post-process. Therefore, now is the time to revise the fundamental act for disaster measures on the basis of the experiences of the 2011 Tōhoku Earthquake and Tsunami and the 1995 Hyogoken-Nanbu Earthquake.

In an attempt to determine the essential knowledge, for example, the education committee of Shizuoka Prefecture has established the Fundamental Education Policy of Disaster Presentation of Shizuoka Prefecture (2012 revision) to prepare for a Tokai Earthquake. The policy addresses several guidelines with two main purposes of education for disaster prevention. Beginning in preschool, the first purpose is to develop knowledge and understanding, interest, motivation and attitudes, thinking and judgment, and skills (social contribution, etc.). At each stage of maturation, the second purpose comprises developing the abilities of self-preservation (kindergarten to lower grades of elementary school), actively applying knowledge (mid-high grade of elementary school), contributing to local society's safety, understanding and responding to the situation (middle school), and rebuilding a safe society (college/university student, working people).

Problems:
Preventing municipal access to private information is the largest barrier constraining local networks. When the chairman of the municipality, who is a local community leader, is not concurrently a member of the public welfare committee, it is difficult to understand the issues of a community's vulnerable people such as senior citizens.

Furthermore, a dilemma exists in that the idea of being in a "safe place," handed down from olden times, continues in the community with no validity. This phenomenon is understandable for the short-term to mid-term stage of recent history; people might have difficulty understanding the reality of a once-in-a-thousand-years event. This mindset has become clear from the precedent that migrants to higher places have returned to the coast repeatedly in the Sannriku region.

HFA Core Indicator 5.2:
Disaster preparedness plans and contingency plans are in place at all administrative levels, and regular training drills and rehearsals are held to test and develop disaster response programmes.

Three Coastal Districts in Iwaki City, Fukushima Prefecture: Differences Resulting from the Local Residents Organization Disaster Response Activities

Keywords:
neighborhood association, regional activities, disaster prevention

Context:
Overview of three coastal districts in Iwaki City:
Iwaki City, Fukushima Prefecture, is located approximately 50 km south of the Fukushima Daiichi nuclear power plant. There are about 33 million people in less than 500 districts. Coastal areas in this city were also damaged by the tsunami caused by the 2011 Earthquake, resulting in the deaths of fewer than 300 people. The population of the coastal areas discussed here is roughly 5,000: over 2,000 in districts A and C, and less than 1,000 in B. Fig. 5.1 and Table 5.1, respectively, present each district's location and population.

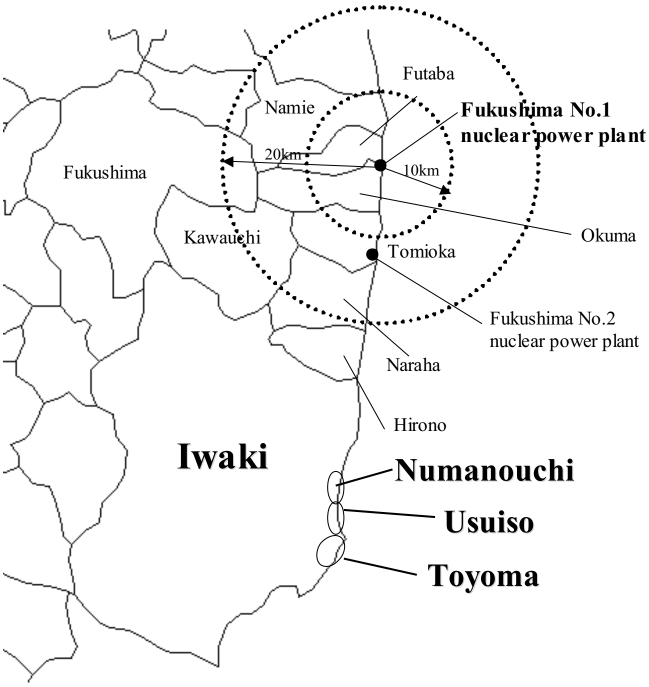

Fig. 5.1 Map of Iwaki City Area

Table 5.1 Overview of each district

		poplation	households	damage
Iwaki City		343,008	133,270	・death 310, missing 37 ・completely destroyed 7,640 houses
District	A	2,200	660	・death 85 ・completely destroyed 420
	B	760	260	・death 130 ・completely destroyed 230
	C	1,600	700	・completely destroyed 47

Table 5.2 reports disaster-related activity evaluations before and after the earthquake. The next section explains the details of this evaluation.

Table 5.2 Activity Evaluation before and after the Earthquake

District	Before		After		Future
	Activities	Preparation of disaster	call for evacuation	management or search	
A	○	○	○	○	○
B	△	△	△	△	△
C	○	◎	○	◎	○

Before:
(1) Pre-disaster activities of each district
A： ○ There was an activity at each district level (Gyosei-ku), block associations (Chonai-kai), and neighborhood associations (Tonari-gumi). This district has many festivals and activities organized by each block association.
B： △ Activities in the latter were mainly in the district and neighborhood associations. The only event was the Children's Day Festival, which is held once a year in May.
C : ○ The district is divided into small towns (Buraku), composed of neighborhood associations and a district with many festivals.
(2) Preparation for disaster in each district
The "Iwaki Regional Disaster Prevention Plan" (Iwaki Conference on Disaster Reduction, revised 2010) had been enacted before the earthquake. However, efforts to ensure its effectiveness were left to the districts because this is only a "guideline." Disaster preparedness in each district is as follows.
A : ○ Although planning occurred in the district, block associations had insufficient time to effectively support it.
B： △ This district was the only well-known refuge for residents.
C： ◎ District officers have created primarily a hazard map that was well known to residents.

After:
(1)Communication of each area of the disaster immediately afterward: call for tsunami evacuation
A： ○ The mayor personally performed the call for evacuation. Residents escaped to the shelter while helping each other.
B： △ There was no particular communication plan as a district; it had only a refuge by neighborhood association unit.
C： ○ The mayor personally performed the call for evacuation and opened the shelter (community center). Then the officers gathered without a specific call to them because there was a tacit understanding that everyone should "Go to the community center, if there is a disaster."
(2)Communication of each area of the disaster afterward: shelter management or missing person search.
A：○ Under the mayor's direction, district officers kept in touch with other districts and the system engineer

(SE) volunteered to help make a missing persons list.
B： △ It was difficult for the district to support communications immediately.
C： ◎ After performing their roles (foods, communication, health, collecting information, etc.), officers of districts took action to manage shelters and seek missing persons.

(3) Future response plans: activities for disaster prevention and mitigation, from the efforts of the emergency drill on August 31, 2013.

Iwaki City has presented for each district the "2013 Comprehensive Disaster Training in Iwaki City." The document provides an outline that includes an overview of training, time schedule, and publicity materials in each district. The districts had to revise it according to the actual situation for shelters and response methods.

A： ○ The emergency drill was supported at the block association level. The mayor conducted it, with three district conductors and the heads of the neighborhood associations. Under each conductor, the association head called for evacuation and guided residents to shelter. After the head confirmed the number of people displaced in the primary evacuation site, he reported it to each conductor.
B： △ The district asked two neighborhood associations to collaborate via a circular notice. The others were difficult to implement for the disaster drill.
C： ○ The district conducted the drill at the neighborhood association level. Thirty association heads had residents evacuate to the primary place of refuge, and reported the number of evacuated people to the district officers. After moving evacuees to the secondary shelter according to the officers' instructions, officers reported the results to the mayor.

Good practices:

Daily regional activities enhance disaster prevention awareness and lead to involvement in creating the hazard map, which enables better post-disaster support by organizations. Furthermore, autonomous organizations formed by local residents (A, C) can utilize various functions to prevent disasters.

Problems:

Even if there is partial solidarity, such as a blood–territorial relationship, if the community is not active and the self-government organization function is weak, the community's disaster response capabilities before and after the earthquake are also weak (B).

HFA Core Indicator 5.3:
Financial reserves and contingency mechanisms are in place to support effective response and recovery when required

Preparedness for Low-frequency and High-impact Disasters from a Medical Perspective

Context

After the 1995 Great Kobe Earthquake, Japan has made changes and progress in its disaster management mechanism, especially in the medical assistance field. However, the 2011 Great East Japan Earthquake and Tsunami raised the issue of the need for further consideration and progress in both short- and long-term medical services provision in a disaster situation, including public health issues.

Keywords:

disaster response preparedness, medical assistance, public health

Before:

Japan's disaster response mechanism has been regulated by the 1961 Disaster Countermeasures Basic Act, which responded to the experiences of the Typhoon Isewan in 1959. The Act specifies that municipalities and/or prefectures are responsible for developing a regional disaster risk reduction plan, along with the Basic Disaster Prevention Plan, and to respond to disasters. However, the Act was developed without the expectation of a large-scale disaster such as the 2011 Tsunami, with damages and impacts beyond the management capacity of prefectures and municipalities.

On the basis of the experiences of the 1995 Great Kobe Earthquake, many initiatives have been taken, including the establishment and maintenance of disaster base hospitals, development of the Disaster Medical Assistance Team (DMAT), and establishment of a wide-area medical transportation system and Emergency Medical Information System (EMIS). At the time of the Chuetsu-Oki Earthquake in 2007, whose damages occurred within a restricted area, the disaster medical response was implemented immediately after the event and provided effective assistance by transporting the seriously injured to a disaster base hospital. In addition, since 2008, a disaster medical response system has been established in each prefecture and municipality, 603 disaster base hospitals have been constructed, 1000 DMATs have been formed, and 6000 DMAT members have been trained.

During:

Because of the 2011 Tsunami, more than 16,000 lost their lives, and more than 2700 were missing. The cause of more than 90% of the deaths was drowning, which was completely different from the case of the Hanshin-Awaji Earthquake, wherein the major cause was crushing by building collapse.

Ishinomaki City was severely affected by the Tsunami. In the City, several hospitals located along the coast areas were forced to evacuate. Only the Ishinomaki Red Cross Hospital, which had just moved inland prior to the 2011

Tsunami, could remain functioning and played a central role in disaster medicine at the frontline as a disaster base hospital.

In most affected areas, wide-area medical transportation was required for dialysis and other treatments. One characteristic of such a massive disaster is creating a wider than usual variety of medical needs, not only at hospitals but also at evacuation centers and homes.

After:

- On the basis of the 2011 Tsunami, the existing law was modified to enable prefectures to provide the necessary support to municipalities for their own initiatives.
- DMAT was empowered to provide short-term, middle-term, and long-term medical assistance.
- The Disaster Countermeasure Basic Act was modified and specified that municipalities must create a list of people requiring special and additional assistance during emergencies.
- A manual for public health in emergency situations has been discussed and coordinated in a series of meetings organized by relevant organizations, agencies, and groups to unify the medical information in disaster situations.
- Efforts to enhance public health, medicine, and social welfare in emergency situations have been undertaken at different levels, including the establishment of specialized medical teams to respond to radiation disasters; developing psychosocial care teams, such as the psychological first aid promoted by WHO; and initiating a lecture series for disaster medical coordinators to train them to respond effectively to large-scale disasters.

Good practices:

Practices developed after the Hanshin Awaji Earthquake

- Several medical teams including DMAT hastened to provide medical services at evacuation centers in the affected sites and provided assistance for hospital evacuations.
- Initiatives adapted after the Hanshin Awaji Earthquake were implemented at the time of the 2011 Tsunami, including the operation of disaster base hospitals, psychosocial support teams, networks for dialysis, EMIS, and a wide-area medical transportation system.

Disaster medical coordinator

- Under the leadership of the prefecture and municipality level coordinators, collaboration and cooperation between public and private sectors including the JSDF and DMAT were strengthened. The coordinators played an important role in many efforts, including autopsying victims, requesting accommodation for injured people, and disaster medical team deployment after the sub-acute phase.

University hospital

- The university hospitals located in three affected prefectures played crucial roles as disaster base hospitals in providing support to the local hospitals, receiving the patients, assisting wide-area medical transportation for dialysis, and collaborating with prefecture-level disaster medical coordinators.
- They provided and provisioned the required medical personnel such as doctors, nurses, and pharmacists to the hospitals and medical facilities in the affected areas

Activities at evacuation centers

- On the basis of the experiences and the lessons learned from the 1995 Great Kobe Earthquake, there was a concern about the increasing number of patients suffering from post-traumatic stress disorder (PTSD), depression, and alcoholism. However, with active intervention by psychosocial teams, the occurrence of these symptoms was minimized.

Relocation of hospitals to higher grounds and hills

- The Ishinomaki Red Cross Hospital, which had just moved to higher ground prior to the 2011 Tsunami, played a central role as a disaster base hospital.

Problems:

Preparedness and measures against massive tsunamis

- Earthquakes had been the main focus of existing measures. In the 2011 Tsunami, many needs emerged that had not been seen during the 1995 Great Kobe Earthquake and were thus unidentified for the required response.
- There were insufficient preparations and countermeasures for handling the interruption of regional public health systems and other serious damage.
- It was extremely difficult to obtain information on the situation and needs of expectant mothers, infants, elderly persons, persons with disabilities, and foreigners who require extra support and assistance. The medical records of chronic patients were lost in some hospitals.
- Hospital damages included not only the buildings and equipment, but also human resources and medical personnel, requiring hospital evacuation.

Disaster public health

- When a large-scale disaster occurs, the functions of the municipal-level disaster countermeasures offices and the prefecture and municipality public health centers cease. The current policy and law do not clearly state how the national and prefectural governments can assist these offices in the medical response in such situations, nor do they provide planning tools or guidelines.
- After the 1995 Great Kobe Earthquake, the calculation of "disasters=DMAT=external injuries" was widely acknowledged, and there was no concept of "disaster public health risk management." Even the Disaster Relief Act did not target activities related to public health, sanitation, nutrition, and welfare. Therefore, the adoption of public health measures for welfare and nutrition, relief activities for persons requiring extra support, and infection control were delayed.
- The absence of a comprehensive/holistic control and coordination mechanism delayed the establishment of the relief system. The interruption of communication and information sharing and the severe damages in the extensive affected areas hampered medical relief activities at evacuation centers.

Preparation of receiving support

- The affected hospitals were not sufficiently prepared for receiving and managing assistance from external organizations effectively, although they were familiar with providing medical assistance. There was no clear guideline describing the mechanism of receiving support, such as how the affected hospitals can request assistance for a wide area.

Relief supply

- The emergency supplies stockpile was insufficient as it had been prepared under the assumption that the lifeline could be secured from private power generation and well-water use facilities.
- It was impossible to respond to the affected areas' requests immediately because of insufficient manpower and equipment.

HFA Core Indicator 5.4:
Procedures are in place to exchange relevant information during hazard events and disasters, and to undertake post-event reviews

Prospect of Future Information Exchange Methods in the Event of a Disaster by Taking Advantage of SNS.

Keywords:
mass media, social network service (SNS), Twitter, risk communication

Context:
In the past two decades, there were two greatest earthquakes, in 1995 and 2011. During this period, the methods of delivering and sharing disaster information to the public have changed considerably. In 1995, the most widely used form of communication was newspapers and TV, whereas in 2011, Internet social network service (SNS) such as Facebook and Twitter were used. SNS have figured prominently as an instant info-sharing cybertool, despite the presence of ethical and privacy issues for individual account holders. As a future goal, methods to respect and protect SNS account users should be implemented, while maximizing the instant info-sharing potential of SNS.

Before:
When the 1995 Great Kobe Earthquake occurred, TV and newspapers were the main source of sharing information. Immediately after the disaster, these media conveyed the damage situation. It remained difficult to obtain information regarding damage conditions in the early stages. Over time, the information contents changed to the victim's perspective such as sharing information about shelter locations, their conditions, and confirming people's whereabouts. With time, the relevance of information contents changed for victims' long-term living environment in evacuation facility such as life lines, preventing second disasters, medical services, and school re-opening. The origin of the information was mainly the government, and mass media delivered it to the public. However, there was a lot of incorrect information or rumors around. The mass media also had ethical issues; for example, the roar of broadcasting company helicopters reporting on damage conditions, such as destroyed buildings or roads, caused search-and-rescue crews difficulty in hearing the voices of victims who were underground or in collapsed buildings. Moreover, those mass media concentrated on areas of massive or shocking events. Thus, it is difficult to say that they provided sufficient information about rescuing outcomes and emergency treatments. Community radio and news programs for people with disabilities and foreigners have earned positive reviews. At that time, the Internet had just begun to spread widely, and it was considered the first full-scale media attention devoted to a disaster. One of online communication network, Nifty Serve, has launched an earthquake information hub and provided diverse information on administration, shelter, and volunteer activities. However, much of the information had previously been announced by the government, and in other

cases, concerns existed about the information's reliability because of its origin.

After:

Using a wide range of mass media, including the Internet (SNS), for exchanging disaster information during the 2011 Earthquake and Tsunami was novel. The huge tsunami, with more than 10 m waves, followed a magnitude 9.0 earthquake and reached an elevation of 40.1 m, catastrophically damaging the Japanese Pacific coastal area. TV and radio announced warning information such as aftershocks and the second and third waves of the Tsunami. After the Fukushima nuclear power plant accident, they also announced evacuation information by removal order and the radiation diffusion of contamination areas. Media also reported in detail on the rescue activities by the Japan Self-Defense Forces (JSDF) and experts from abroad. It informed the public about the damage from liquefaction to the coastal areas in Chiba Prefecture, and train and bus schedules for commuters in the central Tokyo area. NHK and certain commercial television stations provided real-time disaster-related information via their websites to people who could not watch TV due to power outage[1] and so on. According to the result of a survey of 100 companies in the Kanto area, the percentage of the purpose of SNS usage including Facebook and Twitter in April 2011 (immediately following the disaster) increased: the percentage for communicating with family and friends before the disaster and for receiving early information after the disaster rose from 32% to 49%, for supplying media report but with lack of information by TV and newspaper rose from 20% to 33%, for informing to large numbers of people rose from 22% to 29%. Receiving domestic and international information from mass media ranked fourth (22%), and confirming family members' and friends' whereabouts and safety occupied 21% of SNS usage. Public information could be obtained via SNS[2], but they can also transfer private information. In addition to affecting a wide area, the Great East Japan Earthquake and large-scale Tsunami caused the Fukushima nuclear plant accident and subsequent secondary disasters. Therefore, it is increasingly thought that a Nankai Trough Earthquake has a high probability of occurrence, and discussion has begun addressing it as a real and practical matter. Regarding the effects of a large-scale earthquake in a big city, the 2011 disaster triggered broad perspective discussions on TV forums about disaster prevention and relief among individual, academic, industrial, and government experts. In 2011, smartphones also played an important role. Despite a phone charging problem due to power outage or communication towers being broken, many people sent real-time messages/news of affected areas using SNS through smartphones.

Good practices:

By tying up with NHK, certain commercial television stations and internet sites provided Nico-Nico movie news and Ustream for people with disabilities and those unable to watch TV because of the power outage. Yahoo Japan and Google Japan launched a real-time disaster-related information site and a people's whereabouts information site, respectively.

Moreover, people using SNS exchanged considerable information. For example, fuel for cars or house heating systems was not delivered to the affected areas, including lightly affected areas, because of a malfunction of the logistics system. Twitter users frequently shared information via Twitter about the available gas stations. Twitter messages also shared information on when aid and medical supplies were not delivered on time, requesting the rescue supplies, and people's emotions, such as anxiety for the aftershocks and fears about cold temperatures. Information on volunteer activities and people's whereabouts was also shared via SNS. SNS played an especially important role for foreigners who did not understand Japanese, sharing real-time information in their native language.

Problems:

In virtual online space such as SNS, the first uploader's opinion on the information occasionally has more powerful influence, for better or worse. The point is that a vast amount of information is spread to public with no verification, which could cause chaos.

Future recommendations:

5-1.

It is important to establish legislation for responding to large-scale disasters and re-establishing the network among residents in the municipalities and lower levels.

One goal is to develop an information-sharing system by reviewing how personal information may be excessively protected, and by creating a database with detail, a management strategy, and the system's application under the regulation, through cooperation among residents, local governments, and the national government.

The other goal is to share and hand down local knowledge, including disaster information. To accomplish sharing and handing down requires encouraging citizens to perform daily activities positively for their local community and embedding activities that increase safety awareness and disaster relief (local knowledge), which can reduce community vulnerability to disaster.

5-2.

As the countermeasures required of local municipalities (counties and cities) are only to present an outline, voluntary, autonomous communication (such as hazard mapping) at the community level is very important for the plan to be effective. Specifically, a disaster prevention and mitigation system in accordance with the historical path dependency of each district is required. Examples include spatial hierarchy such as district － block association － neighborhood association (A) and district － neighborhood association (B, C); various forms of governing such as top-down decision-making (A) and combination of bottom-up decision-making and roles by officers (B, C).

Community development and enhancement of the activities of resident organizations is one key to achieving these goals.

[1] The Cabinet Office (2011). Retrieved from http://www.bousai.go.jp/kaigirep/hakusho/h23/bousai2011/html/honbun/2b_sanko_siryo_06.htm.
[2] The Cabinet Office (2012). Retrieved from http://www.bousai.go.jp/taisaku/hisaisyagyousei/youengosya/h24_kentoukai.

5-3.

The experiences of the 2011 Great East Japan Earthquake and Tsunami identified various issues and challenges. The following are the recommendations and suggestions considered most important on the basis of disaster medical response experiences.

1. Enhancing the capacity of disaster base hospitals
2. Strengthening the Disaster Medical Assistance Team (DMAT)
3. Enhancing the Emergency Medical Information System (EMIS)
4. Expanding a wide-area medical transportation plan including hospital evacuation
5. Training for disaster medical and public health coordinators
6. Capacity development of medical personnel for disaster response

5-4.

Figures 5.2 and 5.3 depict Twitter account classification by the keywords “Great East Japan Earthquake” for August 30th and “Tsunami” for September 4th, 2013, respectively. The total number of accounts for “Great East Japan Earthquake” was 1,165 and that for “Tsunami” was 797. Uploading messages and providing information regarding the earthquake by individual occupied 52% of the total accounts, suggesting a project by individuals or communities occupying 19% by the keyword “Great East Japan Earthquake.” The keyword “Tsunami” occupied 46% of uploads from individual accounts and 20% from municipalities managing the account. This phenomenon can be interpreted as demonstrating the power of individuals sharing information via SNS and proving SNS to be the most effective method for sharing/exchanging information, anytime and anyplace. As another point, personal information such as bank account, tax, or health information that are stored by municipalities must be digitized and backup data kept in a secure place, safe from natural disasters. In the big data era, legal restrictions must be created as a filter ensuring the high quality and quantity of data, analysis methodology, and method of interpretation. Early ethical education for sharing information via SNS is also required. Risk-related communication using traditional multimedia, SNS, and WebGIS techniques can figure more importantly as next-generation communication methods.

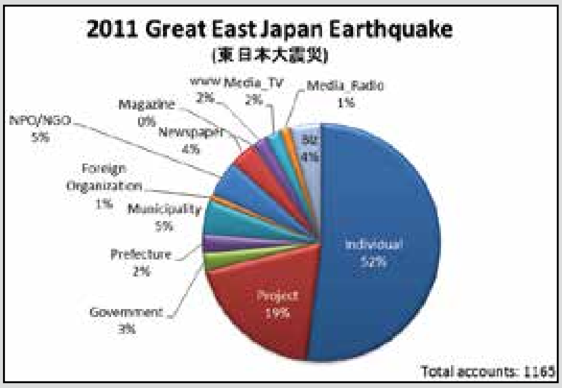

Fig. 5.2 Classification of Twitter Accounts by Keyword “Great East Japan Earthquake”

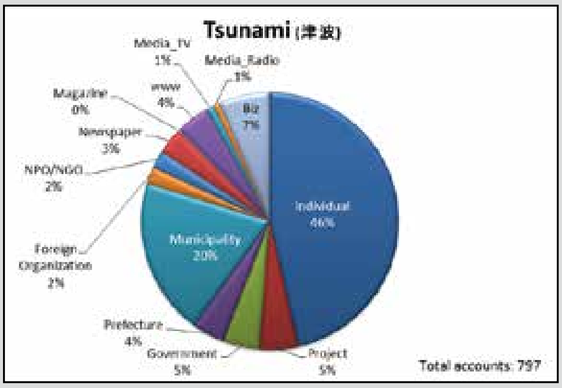

Fig. 5.3 Classification of Twitter Accounts by Keyword “Tsunami”

*Since the keyword was searched in Japanese, it is possible that results in English differ.

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Hyogo Framework for Action 2005-2015:
Building the Resilience of Nations and Communities to Disasters
HFA IRIDeS Review Preliminary Report Focusing on 2011 Great East Japan Earthquake

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