https://doi.org/10.20965/jdr.2012.p0517

Paper:

Government's Response to the Great East Japan Earthquake and Tsunami

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[Received April 4, 2012; accepted June 28, 2012]

This paper analyzes how the Japanese government has responded to the March 11, 2011, Great East Japan Earthquake and subsequent tsunamis that devastated cities and towns along the Pacific coast of northeastern Japan claiming many precious lives and causing extremely extensive destruction. The resilience of a society depends largely on how it identifies existing gaps, how it addresses them in the recovery process, and how it integrates solutions in the existing disaster management system as a result. From such a perspective, this paper examines the government's response to the disaster for approximately the first one year following it by taking stock of progress made versus the priorities of the Hyogo Framework for Action 2005-2015.

Keywords: Great East Japan Earthquake, Hyogo Framework for Action, tsunami, response, recovery

1. Introduction

More than one year has passed since March 11, 2011, when the Great East Japan Earthquake[2] and subsequent tsunamis struck numerous communities along the Pacific coast in the northeastern regions of Japan, resulting in a total inundated area of approximately 560 square km, either completely destroying or heavily damaging 374,000 buildings, and leaving 15,859 people dead and 3,021 missing as of May 29, 2012[3] [1]. It was the deadliest disaster in the postwar history of Japan. The government's cabinet office estimated economic damage from the disaster at approximately ¥16.9 trillion (nearly $210 billion) [2]. Although this damage estimate does not cover the consequences of the tsunami-crippled Fukushima Daiichi nuclear power plant accident, the impact of business disruption and the like, it was the largest of its kind in history. It has, accordingly, put 2005 Hurricane Katrina with its damage estimate of $125 billion in second place, and the 1995 Great Hanshin-Awaji (Kobe) Earthquake with its damage estimate of $100 billion in third place [3].

Japan experienced many catastrophic natural disasters prior to March 11, 2011, most notably the 1923 Great Kanto Earthquake that killed more than 100,00 people and devastated Tokyo and its surrounding regions, the 1959 Ise Wan Typhoon that killed 5,098 people and devastated Nagoya and its surrounding regions, and the 1995 Great Hanshin-Awaji (Kobe) Earthquake that killed 6,437 people and devastated Kobe and its surrounding regions. While Japan is certainly one of the most disaster-prone countries in the world, it may be correct to say that it is also one of the most resilient to natural disasters. This point has been raised by various disaster management experts, including Margareta Wahlström, the UN Secretary-General's special representative for disaster risk reduction, who stated that "Japan excels when it comes to public awareness of risks, evacuation drills and mobilizing the population in a way that few other countries can emulate. We are aware of examples of where school children seized the initiative and escaped the tsunami while also helping younger children to flee." She also stated that "there can be no doubt that the toll of 15,854 killed and 3,203 missing would have been much higher among the 600,000 or more people at immediate risk in affected areas if people had not responded to early warnings. Let us not forget this great achievement when discussing all the other things that could have been done better" [4].

Resilience in such a broad context is defined as "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" [5]. Resilience in such a context is naturally difficult to gain in a short period of time. Indeed, Japan's resilience has been gradually built upon the painful but precious experiences of numerous disasters in the past. The 1959 Ise Wan Typhoon, for instance, led to the enactment of the Disaster Countermeasures Basic Act, the most fundamental legislation of Japan's current disaster management system. The 1995 Great Hanshin-Awaji (Kobe) Earthquake likewise led to, among others, a new crisis management regime of government today, which may be explained by, for example, the creation of a new post of Minister of State for Disas-

1. The opinions expressed and arguments employed herein are those of the author and do not reflect any view or opinion of the FDMA.
2. The earthquake was named as "The 2011 off the Pacific coast of Tohoku Earthquake," but because of its vast damage the Government named the disaster "The Great East Japan Earthquake" by a cabinet decision of April 1.
3. These numbers have been changing even one year after the disaster as search for missing people has still been continuing.

ter Management and the transfer of disaster management functions from the National Land Agency to the cabinet office in 2001 when national government ministries and agencies were realigned.

The Great East Japan Earthquake and tsunamis posed a number of compound challenges to Japanese society for various reasons, including the following:

First, the Great East Japan Earthquake was not a single disaster but a succession of interrelated events encompassing earthquakes, tsunamis, nuclear power plant accidents, nationwide power shortages, and the disruption of supply chains. Together, they have made response and recovery far more complex and difficult to tackle than previous cases and thus posed unprecedented challenges to society as a whole.

Second, it revealed the "unexpectedness" of a natural event for which historical precedent and scientific knowledge were scarce, and thus society was not well prepared. Even experts, scientists, engineers, etc., in fact, repeatedly uttered the word "unexpected" after March 11. How to prepare for such an unexpected event thus became an important policy issue afterward.

Third, it demonstrated the limitations of modern science and technology against the strength of nature. The highly advanced tsunami early warning system that Japan had was effective to a great degree, but it was not sufficient, for instance, to help many people escape smoothly in time to avoid being caught up in what followed. The highly regarded breakwaters and seawalls could not head off tsunami waves although they reduced their impact to a certain extent.

Fourth, the municipal governments that had been expected to play a major role in rescue, relief and recovery were overwhelmed by daunting tasks under harsh conditions. The fact that many municipal government buildings were severely damaged and many local government officials became victims of the disaster hampered their response capacity, exacerbating the situation.

The above observations, although only a part of the entire picture, have already revealed that the Great East Japan Earthquake and tsunamis were certainly unprecedented in terms of the magnitude and nature of the event. Japanese society as a whole, i.e., government at all levels from national to community level, the private sector, academia and so forth, has been responding to such unprecedented challenges, the better to be prepared for future disasters. The Japanese government has, moreover, frequently underlined the significance of sharing "the experiences and lessons to be learned from this disaster with the international community" [6].

Against a such backdrop, this paper examines government activities for approximately the first one year by examining a broad range of information collected from various sources, mostly published government materials, reports of various institutions and the mass media. This information is analyzed according to the framework of the Hyogo Framework for Action 2005-2015, which is a common policy framework for disaster risk reduction worldwide. In so doing, specific objectives are two-fold: (i) to verify the usefulness of the framework of the HFA in evaluating the progress of a country and (ii) to apply such methodology to the case of the Great East Japan Earthquake, thereby analyzing the precious experiences and lessons to be learned. If this methodology is validated, the monitoring of progress is to continue in the coming years by applying the same methodology.

2. Hyogo Framework for Action 2005-2015

The Hyogo Framework for Action 2005-2015: Building the Resilience of National and Communities to Disasters, generally known as the HFA, has been performing as a set of policy guidelines for disaster risk reduction activities since its inception. The HFA was adopted by 168 countries at the World Conference on Disaster Reduction held in January 2005 in Kobe, Hyogo, Japan, and was endorsed by the UN General Assembly afterward [7]. The HFA aims at substantial reductions in disaster loss, in lives lost and in the loss of social, economic and environmental assets of communities and countries. To this end, it sets out the following five priorities for action:

1. Ensure that disaster risk reduction is a national and a 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; and
5. Strengthen disaster preparedness for effective response at all levels.

These priorities for action represent policy areas where governments should concentrate their efforts and resources, and thus can be used as benchmarks against which progress can be monitored or assessed. Progress of a country toward the goals of the HFA is usually reviewed on a periodical basis such as a mid-term review. It may also be relevant, however, to assess a country's progress at a given period in time or for a specific purpose [8]. As such, in the following pages, this paper examines Government's response to the Great East Japan Earthquake and tsunamis for approximately the first year by taking stock of progress made against each priority of the HFA.

3. Progress made Toward the Priorities of the HFA

3.1. Institutional Aspects

The HFA defines priority 1 as "ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation" that mainly concerns policy or institutional aspects of a country. It claims that

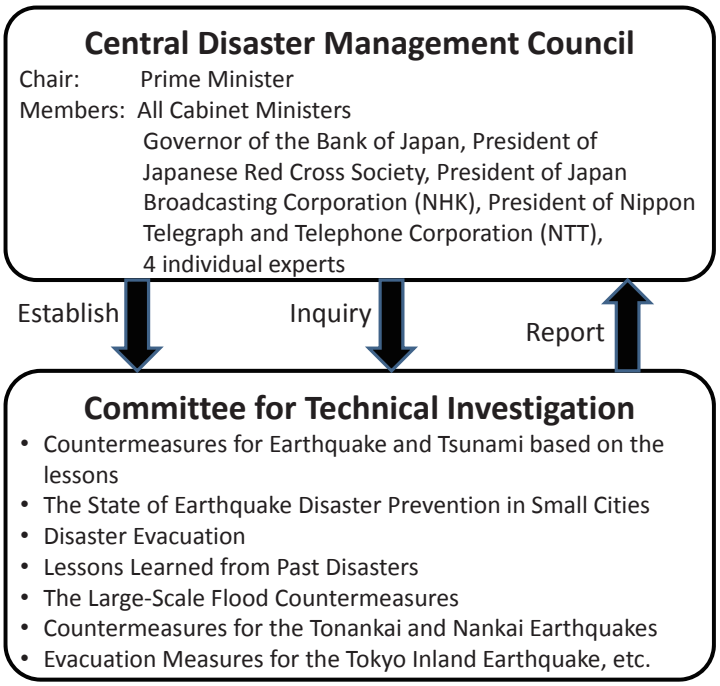

Fig. 1. Central Disaster Management Council structure.

countries that develop policy, legislative and institutional frameworks for disaster risk reduction and that are able to develop and track progress through specific and measureable indicators have a greater capacity to manage risks and to achieve widespread consensus for engagement in and compliance with disaster risk reduction measures across all sectors of society [7].

Within the Japanese government's disaster management system, the Central Disaster Management Council (CDMC) is positioned as the supreme institution, established according to Articles 11–13 of the Disaster Countermeasures Basic Act. It is a standing committee established at the cabinet office. It is chaired by the prime minister and composed of all state ministers, the heads of four designated public organizations[4] and four individual experts. The CDMC is responsible for promoting comprehensive disaster countermeasures, including the implementation of the Basic Disaster Management Plan (basic disaster plan), which is the most fundamental government plan encompassing government-wide activities and the deliberation of priority policy issues related to disaster management at the request of the prime minister or the Minister of State for Disaster Management[5]. As such, the CDMC has been examining pressing issues of the times by establishing committees for technical investigations, such as a committee on evacuation measures for the Tokyo Inland Earthquake, a committee on countermeasures against the Tonankai and Nankai Earthquakes[6], a committee on large-scale flood countermeasures, and so forth (**Fig. 1**).

The CDMC met for the first time after the March 11, 2011, disaster on April 27 when the recovery phase started[7]. It eventually decided to set up a new investigation committee named the Committee for Technical Investigation on Countermeasures against Earthquake and Tsunami Based on Lessons Learned from the 2011 Earthquake off the Pacific Coast of Tohoku (the investigation committee). The specific mandates of the investigation committee were to analyze the mechanism of the earthquake and subsequent tsunamis and the extent of damage caused as well as to explore future earthquake and tsunami countermeasures as soon as possible. The investigation committee also planned to reassess its projections for how much damage could be caused in the near future by a huge tsunami triggered by the three simultaneous ocean-trench earthquakes called the Tokai, Tonankai, and Nankai earthquakes. The results of the technical investigation were envisaged to be used by both central and local governments to draw up specific countermeasures.

After five months of intensive discussion, the investigation committee compiled and submitted a final report, Report of the Committee for Technical Investigation on Countermeasures against Earthquakes and Tsunamis based on Lessons Learned from the 2011 off the Pacific coast of Tohoku Earthquake (the CDMC report), to the

4. Governor of the Bank of Japan, President of the Japanese Red Cross Society, President of NHK (Japan Broadcasting Corporation) and President of NTT (Nippon Telegraph and Telephone Corporation).
5. On the other hand, government's emergency response (search & rescue, relief, emergency supplies, etc.) is handled by other organizations, such as the Extreme/Major Disaster Management Headquarters, as described later.
6. Tonankai and Nankai earthquakes, estimated to occur in the near future, are feared to cause massive tsunami in the Pacific Coast of Central and Southern regions of Japan.
7. Government established the Reconstruction Design Council on April 11, 2011 when a recovery phase was officially launched.

prime minister in September, 2011. The CDMC report suggests that the methodology of the past is no longer applicable and thus needs to be overhauled in such a way that is based on the research and analysis of tsunami traces left in geological layers and other scientific information. Past tsunami countermeasures were drawn up based on the largest tsunami among confirmed cases in the past, but the government should draw up plans in anticipation of the largest possible tsunami and continue updating them based on scientific findings. The report also argues that existing structures such as seawalls and breakwaters should be used to protect communities from frequently occurring tsunamis. Countermeasures against less frequent massive tsunamis, however, should focus on the evacuation of residents, not solely on protection measures. Tsunami countermeasures therefore require the establishment of comprehensive evacuation plans in anticipation of massive tsunamis; this approach represents a shift from past emphasis on dikes and other structural protection measures. The report also stressed that disaster prevention education and training should be re-evaluated and city planning should take into account evacuation routes to enable massive evacuation in enough time for as many evacuees as possible to reach higher ground [9].

Based on the CDMC's recommendations, the basic disaster plan was revised in December 2011 to enhance earthquake and tsunami countermeasures, in particular incorporating a new section dedicated to tsunami disaster countermeasures. It was revealed that the basic disaster plan itself did not pay enough attention to tsunamis before the Great East Japan Earthquake and tsunamis because the description of countermeasures against tsunamis appeared only as part of earthquake disaster countermeasures. Likewise, a survey conducted in 684 coastal municipalities nationwide revealed that only 59% of the municipalities surveyed had prescribed tsunami countermeasures as part of their local disaster management plans [10]. It is therefore expected that a revision of the basic disaster plan will eventually prompt local governments to revise their own local disaster management plans accordingly.

The CDMC has made substantive progress, as described so far, demonstrating its vital role in the Japanese disaster management system. More important development in line with HFA priority 1 is the establishment of the new Committee for Policy Planning on Disaster Management in October 2011. Unlike other investigation committees established by the CDMC, this new committee has been given a higher status than in previous cases, i.e., it is comprised of state ministers including the Chief Cabinet Secretary and Minister of State for Disaster Management, in addition to representative of prefectures and experts, as members. This new committee compiled an interim report in March 2012 that summarizes lessons from the disaster and issues outstanding in an integrated manner, as in the following [11]:

- There should be no unexpected disaster even if it cannot be predicted perfectly: pessimistic assumptions, rather than optimistic ones, are required;
- It is not always possible to respond to a disaster in the immediate aftermath with sufficient information, so it is necessary to be prepared to respond to it even without sufficient information;
- Government, local communities, the people and enterprises need to work together to combine both structural (hard) and nonstructural (soft) measures of various kinds to minimize damage caused by a disaster;
- Since damage caused by a disaster spreads extensively, a system is necessary that enables evacuation from and support to local disaster-affected communities across wide regions;
- Society seems to learn many lessons from the 1995 Hanshin-Awaji (Kobe) Earthquake, but these lessons were limited to those of an earthquake and thus had nothing to do with tsunamis, so what society is going to learn from the Great East Japan Earthquake and tsunamis should not be limited to those of a tsunami *per se*;
- Measures against a disaster should pay due attention to and be based on local and historical aspects;
- Efforts have to be made to transfer lessons learned and issues identified to future generations through disaster education and other possible means.

Based on a broad range of proposals presented in the interim report, the CDMC decided on policy guidelines to improve and strengthen disaster measures on March 29, 2012, approximately one year after the disaster. The guidelines, covering the range of actions to be taken by the end of Fiscal 2012, i.e., the end of March 2013, include the following [12]:

- Measures should be developed by mid-2012 to enable prompt, smooth evacuation;
- Measures should be developed by mid-2012 to prepare for a large-scale inter-plate earthquake originating in the Nankai trough;
- Measures should be developed by mid-2012 to prepare for an inland earthquake predicted to occur in the capital (Tokyo) region;
- The Disaster Countermeasures Basic Act should be amended to incorporate such high priority measures.

The government eventually submitted a bill to the Diet (Japanese Parliament) to amend the Disaster Countermeasures Basic Act in May 2012. The bill proposes various new measures aiming, among others, to strengthen the response capacity of government, particularly at regional and local levels, to improve measures to disaster victims and to strengthen community resilience through raising awareness, the transfer of disaster lessons to future generations and enhanced disaster education. After intensive deliberations at relevant sessions, the bill was finally approved by the Diet in mid-June 2012.

3.2. Risk Assessment and Early Warning

Priority 2 of the HFA is defined as "identify, assess and monitor disaster risks and enhance early warning" as the starting point for reducing disaster risk and for promoting a disaster resilience culture [5]. Knowledge of hazards should be enhanced and physical, social, economic and environmental vulnerabilities to disasters be evaluated and monitored continuously.

3.2.1. Risk Assessment

Risk assessment has been practiced at different levels of government. At the national level, the Headquarters for Earthquake Research Promotion (HERP), which was established by the Special Measures Law on Earthquake Disaster Prevention enacted in July 1995. The establishment of the HERP was based on bitter experiences from the 1995 Great Hanshin-Awaji (Kobe) Earthquake and promoted research into earthquakes with the goal of strengthening disaster management measures, particularly for reducing damage and casualties from earthquakes. The HERP, originally attached to the prime minister's office, is currently assigned to the Minister of Education, Culture, Sports, Science and Technology. The HERP makes three types of evaluation: (i) regular monthly status of earthquake activities and evaluation of largescale earthquakes if its JMA intensity is 6 or larger; (ii) longterm evaluation of the location, scale and possibility of occurrence of both inland and plate boundary earthquakes, and (iii) estimation of ground motion in evaluated earthquakes [13].

Prior to March 11, 2011, the Earthquake Research Committee of the HERP estimated as part of its longterm evaluation program that a large inter-plate earthquake, i.e., the Miyagi-ken-Oki earthquake, would occur off Miyagi Prefecture at magnitude ranging from M7.5 to M8.0 within 30 years with a 99% probability. It is clear by now, however, that the Great East Japan Earthquake was much larger than those predicted with a much wider source region extending over multiple fault segments. As a result, the scale of the earthquakes, ensuing tsunamis and consequent damage far exceeded predisaster predictions.

The HERP thus reviewed long-term evaluation method in light of experiences in the Great East Japan Earthquake. The HERP had not evaluated earthquakes of the Tohoku earthquake type because "there was no historical data for such an earthquake to occur in the Japan trench in conjunction with six regions." After review, the HERP was thus directed toward improving the evaluation method by introducing the following steps: (i) reevaluation of past earthquakes and tsunamis by the investigation of tsunami deposits and submarine active faults; (ii) understanding and reevaluation of seismic activity and crustal movement in the sea; (iii) consideration of interacting between the regions; (iv) the addition of evaluation methods for tsunami height, etc.

Further to afore-mentioned progress two developments are to be noted by the end of March 2012.

The first development is the revised estimate of a powerful inland earthquake expected to occur in the Tokyo metropolitan area by the team of experts set up by MEXT. It has been reported that "a powerful inland earthquake expected to occur in the Tokyo metropolitan area is likely to register 7 on the 7-point Japanese intensity scale over the largest area if it hits near the Tokyo-Chiba border" and "such an earthquake will measure at least upper-6 in most of the 23 wards of central Tokyo, regardless of where the epicenter is located" [14]. It had been believed previously that it would register not more than a lower-6 in western Tokyo wards.

The second development is the revised estimate of a plate boundary earthquake by the CDMC's investigation committee, assuming magnitude 9, expected to occur along the Nankai trough located in the seabed off central to eastern Japan and comprises three possible source regions of Tokai, Tonankai and Nankai. Estimated areas to be hit by tsunami, tsunami heights and arrival times far exceed previous assumptions. According to the new estimate, there would be huge tsunamis in areas from the Kanto region centering on Tokyo to the Kyushu region in southwestern Japan in the event of a massive earthquake in the trough, for instance, a tsunami more than 34 meters high might hit Kuroiso town in Kochi Prefecture within a few minutes after the earthquake, which is almost 4 times higher and much faster than previously expected [15]. These estimates are based on lessons learned from the Great East Japan Earthquake that society needs to be prepared for a maximum level disaster. Hence, national and local governments have prompted conducting a thorough review of damage projections as well as disaster prevention measures.

3.2.2. Earthquake Early Warning

In order to continuously monitor seismic activity, the Japan Meteorological Agency (JMA) and other organizations[8] have installed seismometers at 4,300 locations nationwide that are used to estimate the location of the epicenter and magnitude of an earthquake as well as for tsunami warnings, and seismic intensity meters that measure the intensity of ground motion in numerous spots nationwide.

The JMA has, moreover, been operating an earthquake early warning (EEW) system since October 2007. As soon as an earthquake occurs in or around Japan, the JMA analyzes P waves at seismometers placed close to the hypocenter. If an earthquake of intensity 5 or more is forecast, EEW information is then issued in two steps. Within about two minutes, it issues information on seismic intensity of 3 or greater. Within about five minutes, it issues earthquake information indicating the epicenter and magnitude of the earthquake and the seismic intensity in areas where strong shaking was observed [16]. EEW information is transmitted to the public through multiple channels, including the J-ALERT national early warn-

8. Include the National Research Institute for Earth Science and Disaster Prevention (NIED) and the Earthquake Research Institute (ERI) of the University of Tokyo.

ing system developed by the Fire and Disaster Management Agency (FDMA) of the Ministry of Internal Affairs and Communications, which transmits high-priority emergency information such as emergency earthquake information, tsunami information or even missile launch information to the public instantly through satellites.

EEW information is also used by various public institutions such as Japan Railway (JR). In the wake of the Great East Japan Earthquake, the JMA issued an earthquake emergency alert 8.6 seconds after the seismic wave was detected. Shinkansen (bullet) trains running at as fast as 250 km/hour at the time of the earthquake came to a halt without any accidents due to the JR's Urgent Earthquake Detection and Alarm System (UrEDAS)[9], which successfully halted power to Shinkansen trains after the detection of early tremors and applied emergency brakes to trains before major tremors reached them.

3.2.3. Tsunami Early Warning

The JMA has, furthermore, been operating a tsunami warning system and upgrading it. Specifically, the JMA succeeded in reducing the time required to issue a tsunami warning by about three minutes based on experience in the 1993 Hokkaido Nansei-oki Earthquake. In 1999, the JMA introduced the tsunami warning system (quantitative tsunami prediction system) employing tsunami simulation technology to increase the accuracy of prediction. After these changes, the JMA became able to deliver tsunami warnings to the public more quickly and accurately.

On March 11, 2011, the JMA started issuing tsunami warnings three minutes after the earthquake. Evidence shows that the warning prompted many people to start evacuation in time and, as a result, saved lives. It has also become evident, however, that the magnitude of the earthquake was underestimated and thus predicted tsunami heights were also underestimated in the initial stage. Tsunami heights that were smaller than actual tsunami heights, such as 6 meters in Miyagi and 3 meters in Iwate and Fukushima, were announced on TV and through other means. These tsunami heights were revised upwards more than 10 meters in Miyagi and Fukushima, but such revised warnings did not reach many people, mostly due to power outages or communication failures, delaying evacuation [10].

There were also some technical issues related to the earthquake and tsunami observation systems, i.e., given the current level of technology, it is extremely difficult to accurately determine the size of an earthquake within three minutes of its occurrence if it is greater than magnitude 8. The CDMC report states nevertheless that "the very first warning is the piece of information that serves as the trigger for evacuation action, and it is therefore essential that the content to be conveyed as tsunami warnings be examined from the point of view of the warning's recipients." In parallel with the CDMC's review process, the JMA also reexamined its tsunami warning system and reached the conclusion that the information that the JMA delivers should not underrepresent the magnitude of tsunamis, especially in the initial stage. To this end, in the future, the JMA will deliver initial warnings without specifying estimated tsunami heights. It plans instead to use such wording as "huge" or "high" to prompt people's evacuation, to be followed by more detailed secondary warnings, about 15 minutes after the earthquake, carrying magnitude and tsunami height estimates. Tsunami height forecasts will also be simplified from the current eight levels of classification to five categories to make them simpler and easier for the public to understand. The JMA will, moreover, make more use of every possible means of communication to deliver tsunami warnings and evacuation advisories and orders, such as mobile phones and one-segment broadcasting in addition to ordinary channels such as local disaster management radio communication systems, J-ALERT, TV, or radio. The JMA plans to put the new tsunami warning system in place before the end of 2012.

9. Pronunciation of "UrEDAS" in Japanese actually means "start shaking."

3.2.4. Hazard Mapping

Municipalities are responsible for developing their own tsunami hazard maps based on inundation risk assessment by prefectural governments. Developed hazard maps are posted in public areas and distributed to individual households. This was done in tsunami-hit communities, but a survey conducted after the March 11 disaster revealed that people's recognition level of such tsunami hazard maps was much lower than generally expected. There were, moreover, many cases in which inundation areas indicated on hazard maps were much lower than those in actual tsunami inundation areas [17]. The CDMC report described it in such a way that "while the estimated inundation area was used for preparing disaster prevention materials including hazard maps, it cannot be denied that the fact that the tsunami inundation area and tsunami height were far greater than estimated levels led to the proliferation of damage. It is possible that hazard maps, prepared based on predisaster assumptions led to a false sense of security among people and that tsunamis exceeding these assumptions led to the expansion of damage" [9].

If so, it is ironic, because hazard and risk maps are regarded as a most effective tool for raising people's awareness about immediate risk based on which community-based disaster prevention measures are often practiced. The HFA stresses the importance of "developing, periodically updating and widely disseminating risk maps and related information to decision-makers, the general public and communities at risk in an appropriate manner" [7]. While waiting for opportunities to renew hazard or risk maps based on revised risk assessments coming from the national government or prefectures, many municipalities have already started working on worst case scenarios.

3.3. Knowledge, Innovation and Education

Priority 3 of HFA Priority 3 advocates "use knowledge, innovation and education to build a culture of safety and

resilience at all levels, insisting that disasters can be substantially reduced if people are well informed and motivated towards a culture of disaster prevention and resilience, which in turn requires the collection, compilation and dissemination of relevant knowledge and information on hazards, vulnerabilities and capacities" [7].

3.3.1. Local Knowledge (*tsunami tendenko*)

Local knowledge applies to tsunami-hit coastal areas in the same way since they had been hit by tsunamis recurrently in the past, including the 1896 Meiji Sanriku, 1933 Showa Sanriku and 1960 Chile tsunamis. Based on such experiences in the past, the "tsunami tendenko" concept as local knowledge was originated in this region. The term literally means that individuals should escape to safe places as fast as possible without concern for others in times of tsunami. It signifies mutual trust among family members that if individual family members try to evacuate on their own, some of them may be able to survive.

In reality, however, mixed results have been reported in the case of the Great East Japan Earthquake and tsunamis. The CDMC report explains that "a considerable number of residents failed to evacuate immediately after shaking stopped, but it would be inappropriate to attribute this entirely to a low awareness of tsunami disasters. Other reasons for not evacuating immediately include people who were outside at the time of the quake returning home or checking on the safety of family members." Although the reasons for not evacuating immediately are still under scrutiny, the CDMC report further states that "this will require that routine checks be made by families and communities about evacuation procedures in the advent of a tsunami, and that thoroughness be sought in awareness of evacuating to higher ground as fast as possible in the event of a tsunami, regardless of the circumstances, in the "*tsunami tendenko*" spirit" [9].

3.3.2. Disaster Education – a Case of Mixed Success and Failure

The HFA underscores the importance of "education and training" specifically by promoting the implementation of local risk assessment and disaster preparedness programs in schools [5].

In Kamaishi city in Iwate Prefecture, one of the hardest hit cities, there were examples of school students validated the effectiveness of pre-disaster education and exercise. Concretely, Kamaishi East Junior High School students had been given education and training by a university professor before March 11, 2011. On March 11, most students sensed that this was no ordinary earthquake and immediately took actions necessary to evacuate. At Unosumai Elementary School, close to the junior high school, elementary school students saw junior high school students evacuating and then decided to follow. Accordingly, all the students ran to the designated evacuation site but when they arrived, they sensed danger and raced to higher ground. When the group of students finally reached the second evacuation site, they could hear screams of "The tsunami has breached the levee." Then, everybody ran to the third evacuation site, located higher up. In the end, all Unosumai Elementary School and Kamaishi East Junior High School students – some 570 in all – found refuge and survived [10].

While this very successful story has become known as the "miracle" of Kamaishi among disaster management experts, there were also many tragic stories reported. The importance of disaster education against earthquakes and tsunamis was, in any case, once again recognized. Based on such experiences, the CDMC report suggests that enhanced disaster education must be implemented throughout Japan, and should include specific conditions of communities where students live, local risks with regard to earthquakes and tsunamis, the state of historical tsunami damage, and lessons that have been learned from tsunamis of the past.

3.4. Reducing Underlying Risk Factors

Priority 4 of the HFA states that disaster risks related to changing social, economic, environmental conditions and land use and the impact of hazards associated with geological events, weather, water, climate variability and climate change, should be addressed in sector development planning and programs as well as in post-disaster situation [7].

3.4.1. Relocation to Higher Ground

Many of the tsunami-hit areas were located on coastal plains surrounded by steep slopes that had repeatedly suffered tsunami damage in the past as described before. Among communities that had been relocated to higher ground, many of them returned as times went by to the low-lying land. Also in many communities ravaged by tsunamis in the past, old inscriptions on stone monuments warned of the dangers of tsunamis.

The Reconstruction Design Council in Response to the Great East Japan Earthquake was established by a cabinet decision on April 11, 2011, precisely one month after the disaster. This council was given a mandate to produce a vision as a basis for policy guidelines for reconstructing areas affected by the Great East Japan Earthquake. After nearly two months of intensive deliberation, the council compiled a report, entitled "Toward Reconstruction: Hope Beyond Disaster," on June 25, 2011. In the report, the council presented a renewed concept of "disaster reduction" that a large-scale natural disaster cannot be completely contained, but rather that damage from such a natural disaster should be minimized, which calls for a move away from exclusive reliance on waterside defensive structures. The report also argues that, "in principle, the aim should be to relocate to higher ground, given issues of procuring suitable land and commercial needs, such as those of the fisheries industry, it will still also be unavoidable to utilize low-lying areas. In these cases, given the possibility of damage in the event of large-scale tsunamis, it will be important to implement integrated land use and building regulations that stipulate that only

industrial functions that are absolutely required to be located in such areas are reestablished there" [18].

Relocation of settlements to higher ground has been discussed in many communities, but they are faced with the difficulty of securing sufficient, suitable land given the fact that many such settlements are surrounded by the sea in front and steep mountains in back. Although the government has established a mechanism to provide grants and subsidies for relocation projects, it is a very difficult task for communities to reach a consensus.

3.4.2. Protection by Infrastructures

Despite its strong intensity, registering the maximal level of 6 to 7 on the JMA scale in many places in the northeastern Japan, the March 11 earthquake caused less-than-expected collapsed buildings, thanks to the earthquake-resistant construction of new buildings and seismic retrofitting of older structures based on experience in the past, especially from the 1995 Great Hanshin-Awaji (Kobe) Earthquake. This fact has reminded us once again of the importance of retrofitting of old buildings, especially those that do not meet current building codes, which could collapse in the event of a large-scale earthquake.

On March 11, 2011, some coastal protection facilities, breakwaters, seawalls, water gates, etc., worked well as expected, but others did not meet people's expectations. A famous watergate in Fudai village in Iwate Prefecture, for instance, which is 15.5 meters high and 200 meters wide, protected villagers safely from the tsunami. Famous breakwaters at the mouth of Kamaishi bay in Kamaishi city, Iwate Prefecture, were destroyed by tsunamis, but are estimated to have reduced the power of the tsunami by almost 40% and delayed its arrival six minutes according to simulation [19]. The famous seawalls in the Taro district of Miyako city, Iwate prefecture, which had been built for many years to nearly 10 meters high and more than 2.4 km long were topped by tsunamis, devastating those communities inside the seawalls. On the Sendai coastal plain, tsunamis reached 5.5 kilometers inland at a maximum, but the Sendai Tobu Expressway 23 located 2-4 kilometers inland and 5-6 meters high acted as a secondary barrier, preventing tsunami waves from penetrating further inland and reducing the size of the inundation area. It also served as a temporary evacuation site [9].

Mixed results regarding coastal protection infrastructures have been reported, and it is evident that such infrastructures alone cannot protect people against large-scale tsunamis. The CDMC report argues that coastal protection facilities are effective against tsunamis when tsunami heights are within the scope of their design, but the massive tsunamis and colossal damage during this disaster exposed the limitations of disaster prevention measures that rely too much on coastal protection facilities. As a result, the CDMC put forward the idea of two levels of tsunami – one is the largest-possible tsunamis that require comprehensive disaster management measure focusing on the evacuation of local residents as the main pillar, and the other is tsunami that occur more frequently than the aforementioned largest-possible tsunami, for which coastal protection facilities to prevent tsunamis from penetrating inland still has a major role to play.

3.5. Strengthening Disaster Preparedness for Effective Response at All Levels

Priority 5 of the HFA states that at the time of a disaster, impact and loss can be substantially reduced if authorities, individuals and communities in hazard-prone areas are well prepared and ready to act and are equipped with the knowledge and capacity for effective disaster management [7].

At the national level, the Japanese disaster response framework is characterized by the collaboration of many government ministries and agencies. The Cabinet Information Collection Center monitors and collects disaster information continuously. In a large-scale disaster, an emergency team composed of designated director-generallevel officials of ministries and agencies gather immediately at the Cabinet Crisis Management Center situated in the Prime Minister's Office Building to analyze the status of the disaster and assess the level of casualties and damage.

When the level of disaster damage is estimated to be very high, the government establishes a major disaster management headquarters, which is headed by the Minister of State for Disaster Management, according to articles 2428 of the Disaster Countermeasures Basic Act. Likewise, in a case in which the level is estimated to be extremely high, the government establishes an extreme disaster management headquarters headed by the prime minister. Since the enactment of the Act in 1961, however, a number of headquarters have been established in response to large-scale disasters, including the 1995 Great Hanshin-Awaji (Kobe) Earthquake, but all of them had been given the status of major disaster management headquarters. Extreme disaster management headquarters thus remained a last resort before March 11, 2011 [16].

On March 11, after the earthquake with a record magnitude of 9.0 occurred at 14:46, an emergency team gathered at the Prime Minister's Office Building at 14:50 to carry out a situation analysis. By that time, the JMA already had provided earthquake information on magnitude, hypocenter, and seismic intensity at various spots and issued tsunami warnings – estimated tsunami heights and arrival times – to Iwate, Miyagi, Fukushima, and other prefectures. It was already certain that the earthquake was one of the largest ever in Japan and that a massive tsunami was likely to hit coastal areas. The government then decided to establish an extreme disaster management headquarters for the first time in its history in order for the government as a whole to exert every possible effort in emergency disaster response, including the rescue of victims, and to do its utmost in early recovery of livelihoods and economic activities (**Fig. 2**) [20]. Since then, the extreme disaster management headquarters convened 19 times as of September 11 and, throughout this process,

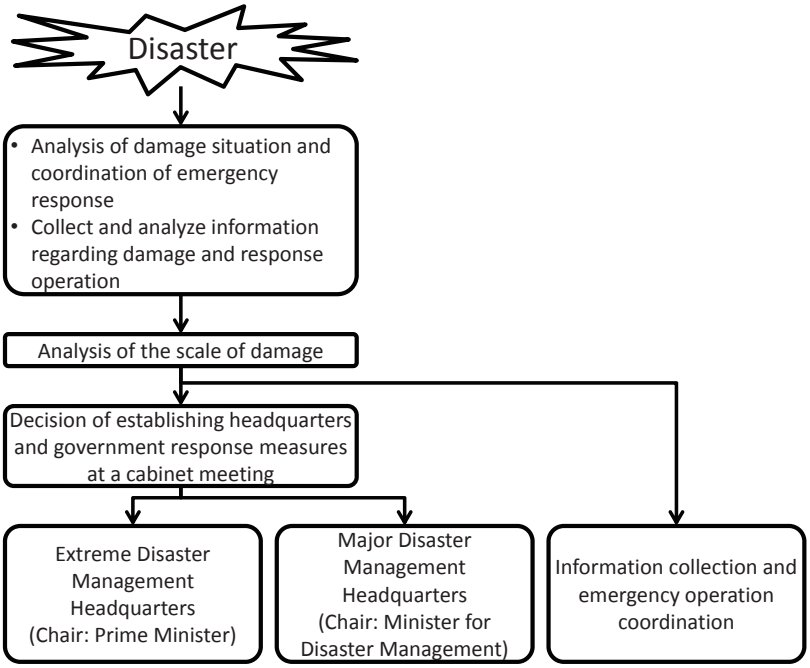

Fig. 2. Flow of government emergency response.

was instrumental in coordinating overall government response operations.

The disaster response to the Great East Japan Earthquake and subsequent tsunamis was unprecedented in terms of scope and scale. There were many issues to be examined carefully to improve the disaster management system. To this end, the Cabinet Office established a study group on emergency response during the Great East Japan Earthquake. The study group has been reviewing various response measures during the disaster and exploring ways to further strengthen such measures in future disasters. The study group compiled an interim report in late November 2011 that covers a broad range of issues relevant to government response activities, as follows:

- Prompt, accurate information collection and sharing, which concerns, among other things, a proactive information collection framework, ways to shorten "no-information" periods, how to consider priorities among various information sources, the seismic resistance of the communication infrastructure and systems

- Establishment of emergency logistics that concerns the use of various transportation modes, such as railways, ships, and aircrafts, and fuel storage bases and the resilience of supply chains

- Directing and coordinating emergency responses, which concerns simulation, preparedness, standards for deciding the appropriate level of a response, the effectiveness of disaster management measures and effective coordination of a multilayer response system

- Establishment of wide-area support systems that concern a mutual support system extending across large areas, the standardization of disaster response operations, a wide-area support system incorporating not only municipal governments but also private entities and volunteers and disaster drills under the assumption of wide-area disasters

- Appropriate information provision to the public by addressing such issues as promoting evacuation methods, preventing confusion and information provision overseas

The study group is continuing its activities in parallel with an ongoing examination by the CDMC's Committee for Policy Planning on Disaster Management, described before in this paper. Some of these issues have already been incorporated in the revision of the Disaster Countermeasures Basic Act or in other measures, but many still remain unsolved, waiting for solutions.

4. Conclusions

This paper has provided an overview of the Japanese government's activities in response to the Great East Japan Earthquake and tsunamis by analyzing progress made to date and by examining them against the priorities of the HFA. **Table 1** summarizes major progress in such priorities as discussed so far in this paper. Overall, there has been significant progress made to date, that is, various government bodies such as the CDMC, the HERP, the JMA and government ministries and agencies, have reexamined their approaches to natural disasters in an integrated manner. This is a very positive sign of govern-

Table 1. Progress made by government against HFA priority areas.

HFA priority	Major progress
1. Institutional aspects	- The CDMC conducted a thorough review of government activities. Its new committee, given a higher position than usual, is still discussing solutions. A bill was submitted to the Diet to amend the Disaster Countermeasures Basic Act.
2. Risk assessment and early warning	- Various government ministries and agencies, such as the Cabinet Office, MEXT, and JMA, have revised previous assessments and upgraded measures.
3. Knowledge, innovation and education	- The importance of local knowledge and disaster education was verified, but they need to be further enhanced. MEXT is discussing new measures in disaster education.
4. Reduction of underlying risk factors	- Relocation of settlements to higher ground has been envisioned but faces difficulties. Meantime, the combination of structural and nonstructural measures is deemed necessary.
5. Disaster preparedness for effective response at all levels	- A committee established by the Cabinet Office reviewed government response for first several months. Such a response is now being discussed by the CDMC committee.

ment attempts so far. Although Government ministries and agencies have already come up with new policy measures, many are still in the process of integrating them in the existing disaster management system or of creating new systems. It will therefore take some time for them to be completed and become operational, given the mere scale of the enormous demands and needs.

Major challenges to society, as listed in the Introduction, namely, unprecedented challenges, the unexpectedness of the event and the limitations on modern technology have been well addressed in such a process. The government's reflection on and reexamination of past policies have been based on the concept that there should be no unexpected disaster, even if it cannot be perfectly predicted. The bill to amend the Disaster Countermeasures Basic Act, moreover, includes measures to strengthen the response capacity of the government, particularly at regional and local levels. Revised evaluations of earthquake risk, in contrast, such as the Tokyo inland earthquake and the Tokai, Tonankai and Nankai earthquakes, have created a situation in which local governments and communities are difficult to tackle on their own, since existing measures, both structural and nonstructural, are based on much lower estimates of the magnitude of earthquakes and tsunamis. One of the pressing issues now is therefore how to make new policies and measures, which have been developed based on precious lessons learned from the Great East Japan Earthquake and tsunami, operational at local and community levels.

Last, the framework of the HFA has been effective in examining government activities as exemplified in this paper, although there are several shortfalls in applying HFA priorities. One such shortfall is the fact that the HFA does not pay much attention to recovery process. It is understandable in view of the fact that the HFA is basically targeted at disaster risk reduction objectives. Still, a more comprehensive approach is desirable if it is to be more comprehensive as a form of policy guidelines. The current HFA will terminate in 2015, so the United Nations and governments worldwide already have started discussions about post HFA. In the same way as with the 1995 UN World Conference on Disaster Reduction in Hyogo-Kobe gave birth to the current HFA, the Japanese government has already expressed the hope that Japan will host the next World Conference on Disaster Reduction in 2015, where a new policy framework to replace the current HFA will be discussed and hopefully agreed on. Sendai, one of the cities hit hardest by the earthquake and tsunamis, already has expressed the wish to host the conference, whose venue will be decided at the UN General Assembly in the near future.

At the Ceremony to Commemorate the First Anniversary of the Great East Japan Earthquake on March 11, 2012, Japanese Prime Minister pledged to "pass on to future generations the lessons of the disaster" and "never forget the spirit of mutual assistance and appreciation that links us all" [21]. As such, Japan is expected to take the lead in discussions leading up to the 2015 conference and beyond based on its experience in the Great East Japan Earthquake and tsunamis. Toward such goals, it is extremely relevant to continue monitoring the progress to be made in the coming years and to share such results with international society.

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