**Challenges for the Sendai Framework for Disaster Risk Reduction 2015–2030 beyond the Fukushima Nuclear Accident**

Nagasaki University Organizing Team of for GP 2017

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**Six years after Fukushima Daiichi Nuclear Disaster**

On 11 March 2011, the Great East Japan Earthquake and Tsunami of 2011, a magnitude 9.0 earthquake occurred with a resulting 14-m or more tsunami. This disaster left nearly 19,500 people dead and more than 2,500 people missing[[2]](#footnote-2). On 13 March 2011, about 470,000[[3]](#footnote-3) people were evacuated. As of 13 April 2017,there are still 108,000 of them have no choice but to live at temporary locations[[4]](#footnote-4).

The Great East Japan Earthquake and Tsunami severely damaged the Fukushima Daiichi Nuclear Power Plant 1 owned and operated by the Tokyo Electric Power Company (TEPCO), resulting in a large release of radioactivity into the environment. It induced multi-hazard disasters on human livelihood and ecosystem in the affected area in the Fukushima Prefecture. Approximately 165,000[[5]](#footnote-5) people in the prefecture were evacuated in response to the radiological incident. Some elderly hospital patients died during their transportation. There were some 2,086 disaster-related deaths in Fukushima accounting for nearly 60 per cent of such 3,523 deaths[[6]](#footnote-6) in all prefectures affected by the Great East Japan Earthquake and Tsunami, which are defined deaths that were not caused directly by the earthquake and tsunami but were due to indirect causes such as deterioration of physical conditions as a result of evacuation. The number of those deaths was particularly high among people who evacuated from cities and towns within evacuation zones.

The population in the Fukushima prefecture decreased from 2,024,401 on 1 March 2011 to 1,899,486 on 1 November 2016. Still more than 84,000 evacuees stay at temporary locations, and are not able to decide whether to return or not to their home regions due to delay in recovery of economic and environmental livelihood, and lack of employment opportunities as well as fear of radiation risks to health. About 31,000 evacuees were less than 18 years old reflecting their vulnerability to radiation exposure.[[7]](#footnote-7)

**Table 1. Estimates of cost of damages by the Great East Japan Earthquake and Tsunami of 2011 (In trillion yen unless otherwise indicated)**

|  | Original estimates (June 2011) | Current estimates (March 2016) | Projected estimates  (December 2016) |
| --- | --- | --- | --- |
| (1) Damages caused by natural events i.e. earthquake and tsunami | 16.9 | 32 | 328 |
| (2) Total economic loss caused by 2011 Fukushima Daiichi Nuclear reactors’ disaster | $250-$500 billion US  /or 25-50 | N.A. | N.A. |
| (3) Assessment of damages caused by the Fukushima Daiichi Nuclear reactors’ disaster | N.A. | 13.3 | 22 |
| Total of (1) and (2):  Maximum total | 31.9 to 66.9 |  | N.A. |
| Total of (1) and (3) | N.A. | 45.3 | 55 |
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On June 24, 2011, the Cabinet Office of Japan estimated the economic damage caused by the Great East Japan Earthquake at JPY 16.9 trillion[[8]](#footnote-8) which is broken down as follows:

* Structures (Homes/housing sites, stores/offices, factories, machines, etc.) JPY 10.4 trillion
* Lifeline facilities (Water, gas, electricity, communications/broadcasting facilities)

JPY 1.3 trillion

* Infrastructure facilities (Rivers, roads, ports, sewers, airports, etc.) JPY 2.2 trillion
* Agriculture, forest, and fisheries-related facilities (Farmland/agricultural facilities, forests and fields, fisheries-related facilities, etc.) JPY 1.9 trillion
* Other (Educational facilities, healthcare/social welfare facilities, waste treatment facilities, other public facilities) JPY 1.1 trillion

These estimates relate to damages caused by natural events i.e. earthquake and tsunami of the Great East Japan Earthquake and Tsunami of 2011, but not to the Fukushima nuclear accident. The government estimates at present that the current Process for Reconstruction from 2011 to 2020 will require some 27.2 trillion dollars US net of the gross costs for recovery and reconstruction cost at 32 trillion dollars US[[9]](#footnote-9) inclusive of some 4.8 trillion dollars US defraying a portion of nuclear disaster recovery work to be borne by TEPCO.

The Great East Japan Earthquake and Tsunami severely damaged the Fukushima Daiichi Nuclear Power Plant 1 owned and operated by the Tokyo Electric Power Company (TEPCO), resulting in a large release of radioactivity into the environment. Due to the complexity of compensation issues involved in man-made radiation incident inducing multi-hazards on human livelihood and ecosystem in the affected area, TEPCO in consultation with the government entities has mooted a separate cost assessment of damages caused by the Fukushima Daiichi Nuclear reactors’ disaster that stands at 13.3 trillion yen, but seems to rise to a level of 22 trillion yen as discussed in Box 1. It would be significant to note that the cost of damage caused by a single man-made hazard may eventually either equate to the total cost of damages or surpass individual costs of sectoral damages caused by the natural hazards.

To sum up, in the intermediate phase, the primary concerns are with sheltering, relocation, control of the radioactively contaminated environment, and foods or drinking water intake controls. In the late response and early recovery phases, long term management and monitoring are necessary to lay the foundation for the long recovery process. In this context, continued public health tracking is the *sine qua non* of the long-term health of exposed populations.

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| **Box 1 Estimates of the total economic loss caused by 2011 Fukushima Daiichi Nuclear reactors’ disaster**  The precise value of the abandoned cities, towns, agricultural lands, businesses, homes and property located within the roughly 310 sq miles (800 sq km) of the exclusion zones has not been established. Estimates of the total economic loss range from $250-$500 billion US[[10]](#footnote-10).  More precisely, based on the information from TEPCO[[11]](#footnote-11) and the Board of Audit of Japan[[12]](#footnote-12), Mycle Schneider et al.[[13]](#footnote-13), estimated in their World Nuclear Industry Status Report 2016 that the total cost of damages caused by the Fukushima nuclear power disaster was 13.3 trillion yen (US$ 133 billion), based on the following items:  (1) Decommissioning and contaminated water treatment costs of 2 trillion yen (US$ 20 billion.  (2) Compensation costs of about 7.1 trillion yen (US$ 71 billion).  (3) Decontamination costs of 3.6 trillion yen (US$ 36 billion): decontamination cost at about 2.5 trillion yen (US$ 25 billion) and the interim storage facilities cost at about 1.1 trillion yen (US$ 11 billion).  Furthermore, TEPCO submitted to the Government in its “New Second Comprehensive Special Business Plan”[[14]](#footnote-14) an up-dated 22 trillion yen (US$220billion) estimates of cost that reflect delay in removal of melt-downed debris and lifting of evacuation orders in the contaminated zones. The break-down of the amount is as follows:  (1) Decommissioning and contaminated water treatment costs of 8 trillion yen (US$80 billion).  (2) Compensation costs of about 8 trillion yen (US$80 billion).  (3) Decontamination costs of 6 trillion yen (US$ 60 billion) including the interim storage facilities cost.  The estimate of the total cost of damages caused by the Fukushima disaster is significantly high, compared with the rest of cost of damages caused by natural events i.e. earthquake and tsunami of the Great East Japan Earthquake and Tsunami of 2011 which is originally estimated at 16.9 trillion yen. |

**Challenges for the Sendai Framework for Disaster Risk Reduction**

The 2011 Fukushima nuclear power plant disaster reminds us that even contemporary systems are vulnerable to natural hazards, e.g. earthquakes and tsunami, and are subject to interdependent complexity between natural and human factors. According to international researchers of the United Nations University Institute for the Advanced Study of Sustainability, “[The] consensus within the DRR community is that technological hazards such as nuclear accidents must be addressed through a multi-hazard approach, considering sequences of risks that can trigger such hazards and their impacts on the surrounding communities and environment.[[15]](#footnote-15)” They also considered it necessary to “open up the safety culture in the nuclear industry so that it accommodates the concerns of the surrounding communities”[[16]](#footnote-16).

The ISDR secretariat considers that the 2011 triple disaster of earthquake, tsunami and nuclear power plant disaster in East Japan, accelerated an ongoing global shift to a multi-hazard approach to disasters, in which risks are not viewed in isolation but as interlocking parts of a whole.[[17]](#footnote-17)

The ISDR secretariat emphasizes that a multi-hazard approach to disaster risk management underpins the Sendai Framework, the 15-year international blueprint for reducing disaster risk adopted in March 2015 at the Third UN World Conference on Disaster Risk Reduction (WCDRR) in the Japanese city of Sendai, a community that has rebuilt in the wake of the 2011 earthquake and tsunami[[18]](#footnote-18). Although nuclear accidents and similar hazards were not on the official agenda of the Conference[[19]](#footnote-19), fortunately, one of the working sessions organized by multi-stakeholders addressed a nuclear emergency issue as part of discussions of Natural hazard triggered technological (Natech) accidents with a presentation by the Government of Japan on its experience with the Fukushima nuclear power plant disaster[[20]](#footnote-20).

The Sendai Framework includes technological hazards in its scope, thus marking a long-awaited start to the process of sharing lessons from Fukushima.

**Sendai framework’s definition of hazard**

Hazard is defined in the Hyogo Framework for Action as: “A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards)”.

The present Framework not only reconfirms this definition, but also will apply, in its paragraph 15, to the risk of small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters caused by natural or man-made hazards, as well as related environmental, technological and biological hazards and risks. It aims to guide the multi-hazard management of disaster risk in development at all levels as well as within and across all sectors with a view to substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.

Furthermore, in follow-up to this definition, Member States agreed, in November 2016, to define technological hazards as hazards originating from technological or industrial conditions, dangerous procedures, infrastructure failures or specific human activities. Examples include industrial pollution, nuclear radiation, toxic wastes, dam failures, transport accidents, factory explosions, fires and chemical spills. Technological hazards also may arise directly as a result of the impacts of a natural hazard event[[21]](#footnote-21). (Emphasis is placed by the authors)

The Sendai Framework for Disaster Risk Reduction Sendai contains agreed guidelines such as Priorities for action (Box2) including Science-policy interface(Box3), and Seven global targets as well as Implementation Guiding Principles, Role of stakeholders, International cooperation and global partnership such as Means of implementation and

Follow-up actions, etc. In the light of the clear cut agreement to include nuclear radiation in the scope of, there should be conscious and systematic efforts to apply and implement the substantive elements of the Framework in relevant areas for nuclear radiation hazard.

**Box 2 Priorities for action**20. Taking into account the experience gained through the implementation of the Hyogo Framework for Action, and in pursuance of the expected outcome and goal, there is a need for focused action within and across sectors by States at local, national, regional and global levels in the following four priority areas:

Priority 1: Understanding disaster risk.

Priority 2: Strengthening disaster risk governance to manage disaster risk.

Priority 3: Investing in disaster risk reduction for resilience.

Priority 4: Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction.

**Seven global targets of the Sendai Framework**

The seven global targets are agreed in para.18:

(a) Substantially reduce global ｄｉｓａｓｔｅｒ mortality by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020–2030 compared to the period 2005–2015;

(b) Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 in the decade 2020–2030 compared to the period 2005–2015;

(c) Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030;

(d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;

(e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;

(f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the present Framework by 2030;

(*g*) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.

**Box 3 Science and policy interface**

The Sendai Framework puts unprecedented emphasis on the role of science in understanding and delivering risk reduction. It builds on its predecessor, the Hyogo Framework for Action 2005−2015: Building the Resilience of Nations and Communities to Disasters, and reflects shifts in scientific thinking over the last 20 years, with a powerful implication that disasters are not natural events against which human societies are powerless, but are the result of the interaction between hazards (natural and human-made), exposure levels, and pre-existing vulnerability.

Important recommendations of the Sendai Framework to the scientific community and its partners include improving the scientific and public understanding of risk and optimizing the use of science for decision-making.

Paragraph 24 of the Sendai Framework

(h) To promote and improve dialogue and cooperation among scientific and technological communities, other relevant stakeholders and policymakers in order to facilitate a science-policy interface for effective decision-making in disaster risk management;

**Bangkok Principles for the implementation of the health aspects**  
**of the Sendai Framework for Disaster Risk Reduction 2015-2030**

The implementation of the health aspects of the Sendai Framework is a typical example of the application of a multi-hazard approach to disaster.

The International Conference on the Implementation of the Health Aspect of the Sendai Framework for Disaster Risk Reduction 2015-2030, held on 10-11 March 2016, in Bangkok, Thailand, recommended a series of measures that could assist countries in implementing the health aspects of the Sendai Framework for Disaster Risk Reduction (see Box 4 for the summary of the recommendations).

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| **Box 4 Bangkok Principles for the implementation of the health aspects**  **of the Sendai Framework for Disaster Risk Reduction 2015-2030**  Principle 1. Promote systematic integration of health into national and sub-national disaster risk reduction policies and plans and the inclusion of emergency and disaster risk management programmes in national and sub-national health strategies;  Action to: Increase the participation of health sector representatives in multi-sectoral emergency and disaster risk management committees and platforms at all levels; and Strengthen the integration of biological hazards, including epidemics, pandemics, and diseases at the human-animal-ecosystem interface, into all-hazards multi-sectoral disaster risk management.  Principle 3. Stimulate people-centered public and private investment in emergency and disaster risk reduction, including in health facilities and infrastructure;  Action to Promote investment in research and development and enhance innovation and the use of modern technologies and modelling for managing disaster risks including for biological hazards.  Principle 5. Incorporate disaster-related mortality, morbidity and disability data into multi-hazards early warning system, health core indicators and national risk assessments;  Action to Include biological hazards and zoonotic diseases as well as chemical and radiation hazards in disaster risk assessment and multi-hazard early warning systems; and Include health-related disaster losses (illness, injury, psychosocial effects, as well as damage, and disruption of health facilities and services) and other relevant disaggregated data by sex, age and disability in disaster loss databases.  Source: http://www.who.int/hac/events/2016/Bangkok\_Principles.pdf |

**Conclusions**

**The ISDR is actively following up the agreed Framework in Sendai, mainly in the context of the formulation of the Words into Action in response to paragraph 48 (c) of the Framework as well as periodic reviews on progress, in particular for the Global Platform for Disaster Risk Reduction.**

**Based on the previous Words into action guide for implementation of the Hyogo Framework for Action, the ISDR secretariat is developing a number of targeted Sendai Framework implementation guides. That includes Words into Action Guide on Man-made/Technological Hazards containing practical implementation guide on Nuclear/Radiological hazards together with other technological hazards such as Chemical/Industrial accidents; Marine Incidents; Transport Accidents. It is intended to provide practical considerations for addressing man-made/technological hazards in disaster risk reduction.**

**The 2017 Global Platform for Disaster Risk Reduction will be held in Cancun, Mexico on 22-26 May. In the light of the progress made at Sendai, the scope of discussion at Cancun will be broad enough to address radiation hazards. As pointed out by UNU-IAS’s report, “Nuclear emergency preparedness remains a highly specialized and closed field.”[[22]](#footnote-22) In order to ensure science-policy interface between radiation experts and the DRR community, the ISDR Science and Technology Conference in January 2016 benefitted from the expertise offered by international leading radiological medicine specialists from Nagasaki University and discussed the necessity of a Global Research Platform on Nuclear Disaster Risk Reduction and Recovery for Scientific and Technical Partnership, like the International Recovery Platform (IRP, launched by the Second WCDRR at Kobe). This would contribute to opening up interface between radiation disaster experts and the DRR community and their engagement with local communities to provide them with better risk communication on imminent and potential risks.**

**Annex: Web-links related to nuclear DRR reference materials**

**IAEA Safety Standards Series**

**http://www-pub.iaea.org/books/IAEABooks/Series/33/Safety-Standards-Series**

**IAEA Resources in Emergency Preparedness and Response**

**https://www.iaea.org/newscenter/focus/fukushima/emergency-preparedness**

**IAEA: Annex 3. List of items to be reported to IAEA**

**https://www.iaea.org/OurWork/SV/Invo/annex3/annex3\_e.pdf#search=%27nuclear+materials+reference%27**

**IAEA Nuclear Security Series No. 6 Technical Guidance Reference Manual**

**http://www-pub.iaea.org/MTCD/publications/PDF/pub1309\_web.pdf#search=%27nuclear+materials+reference%27**

**IAEA Fukushima Report 2015**

**http://www-pub.iaea.org/books/IAEABooks/10962/The-Fukushima-Daiichi-Accident**

**UNSCEAR The Fukushima-Daiichi nuclear power plant accident**

**http://www.unscear.org/unscear/en/fukushima.html**

**WHO Radiation Emergency**

**http://www.who.int/ionizing\_radiation/a\_e/en/**

**United States Nuclear Regulatory Commission**

**https://www.nrc.gov/materials/sp-nucmaterials.html**

**The European Commission’s Science and Knowledge Service**

**https://ec.europa.eu/jrc/en/research-topic/reference-materials-nuclear-safeguards-safety-and-security**

**IRSN Enhancing Nuclear Safety in France**

**http://www.irsn.fr/EN/Fields\_activity/emergency\_management/Pages/emergency-management.aspx**

**BSF Accident Management Analysis: Consequences for Germany**

**http://www.bfs.de/EN/topics/ns/accidents/fukushima/accident-management/accident-management\_node.html**

**UK Radiation Protection Services**

**https://www.phe-protectionservices.org.uk**

**UK PHE CRCR Radiation Emergency Response and Arrangements**

**https://www.gov.uk/government/publications/radiation-emergency-response-arrangements-public-health-readiness/phe-crce-radiation-emergency-response-arrangem**

**SCK-CEN Academy Preparedness and Response for Nuclear and Radiological Emergency**

**http://academy.sckcen.be/en/Customised\_trainings/Calendar/Preparedness-and-response-for-nuclear-and-radiological-emergencies-20150316-20150320-170ce5c0e83fe411**

**Swedish Radiation Safety Authority**

**http://www.stralsakerhetsmyndigheten.se/In-English/Enactments/Regulations/**

**Nuclear Safety Institute of the Russian Academy of Sciences**

**http://en.ibrae.ac.ru/contents/21/**

**Nikiforov Russian Center of Emergency and Radiation Medicine**

**http://www.mci-forum.com/nikiforov-russian-center-of-emergency-and-radiation-medicine-emercom-of-russia-past-present-future/**

**Korea Institute of Radiological & Medical Sciences**

**http://www.kirams.re.kr/eng/nremc/preparedness02.jsp**

**RPA Radiation Protection**

**https://www.epa.gov/radiation/radiological-emergency-response**

**Emergency Preparedness and Disaster Relief of PAHO**

**http://www.paho.org/disasters/newsletter/index.php?option=com\_content&view=article&id=454&Itemid=86&lang=en**

**REMC in Japan**

**http://www.nirs.qst.go.jp/ENG/core/rem/remceng/index.html**

**Nuclear Safety Research Association in Japan**

**http://www.nsra.or.jp/index-e.html**

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End

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   Graphic 25: Trend of the Number of Evacuees in the Great East Japan Earthquake (Compared to the Great Hanshin-Awaji Earthquake) <http://www.mlit.go.jp/hakusyo/mlit/h22/hakusho/h23/index.html> [↑](#footnote-ref-3)
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