Recommendation

Disaster Risk Reduction and Promotion of International Research on Disaster Prevention and Mitigation – Recommendations for Implementation of the Sendai Framework for Disaster Reduction and Tokyo Statement

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Science Council of Japan

Subcommittee for the Tokyo Conference on International Study for Disaster Risk Reduction and Resilience

Subcommittee for IRDR, Committee for Civil Engineering and Architecture

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These recommendations compile and publish the results of deliberations of the Subcommittee for the Tokyo Conference on International Study for Disaster Risk Reduction and Resilience and Subcommittee for Integrated Research of Disaster Risks (IRDR) under the Committee for Civil Engineering and Architecture.

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Executive Summary

1. Background

The Science Council of Japan (SCJ) held the Tokyo Conference on International Study for Disaster Risk Reduction and Resilience (Tokyo Conference) in January 2015 on the basis of discussion of the Integrated Research of Disaster Risks (IRDR) subcommittee and the subcommittee for the Tokyo Conference. The results of the Tokyo Conference were delivered in the form of the "Tokyo Statement" and "Tokyo Action Agenda" to raise global awareness on the issue, and contributed to building a basis for further recognition of the importance of science and technology. This was eventually incorporated into the Sendai Framework for Disaster Risk Reduction 2015–2030 (Sendai Framework) and adopted at the Third World Conference on Disaster Risk Reduction (Sendai Conference) in March 2015. This paper is intended to summarize the discussions and recommendations that were made during the two conferences and to present items to be implemented, the implementing actors, and action plans through collaborative efforts by countries around the world in addition to actions to be taken by Japan, with the aim of contributing to disaster prevention and mitigation from the viewpoint of science and technology.

2. Current Status and Issues

The impact of natural hazards is showing an increasing trend in general and has been accelerated by human factors such as poverty, population growth, and urbanization. According to the Sendai Framework for Disaster Risk Reduction 2015–2030, global disasters in the past 10 years have claimed 0.7 million deaths, caused 1.4 million injuries, and resulted in 23 million people losing their homes. Over 1.5 billion people are estimated to have been affected by some form of natural disaster, and the resulting economic losses are estimated at over one trillion US dollars. The harm caused to children, women, and people in vulnerable conditions is particularly devastating.

Disaster damage is increasing in both developed and developing countries, which indicates that progress in science and technology and economic development have not necessarily contributed to a reduction in disaster risk. The question has been raised of why such damage and losses continue to increase despite the program made in the academic community with respect to understanding hazards and disasters and the development of practical methods to reduce disasters. To solve this global issue, it is essential to take practical actions to reduce the risks for disaster through interdisciplinary cooperation in which data and information is collected and

systematically integrated, beyond hazard types and research disciplines. Transdisciplinary cooperation is also needed, in which researchers and other stakeholders like politicians, administrators, private corporations, and civil organizations share data and information; exchange knowledge, experience and ideas; and discuss issues from different perspectives.

In Japan, a country that has achieved economic success despite frequent damage owing to natural disasters, science and technology have made substantial contributions to the implementation of disaster risk reduction policies. Scientific and technological knowledge in relevant fields has been accumulated, disaster statistics have been produced for policy decision making, and damage caused by mega disasters has been estimated by the Central Disaster Management Council. Furthermore, the Japanese experience with and knowledge about various types of disasters have been shared with other countries through international cooperation and interactions with foreign researchers. Despite the hard work by researchers toward a reduction in disaster risks, many problems are remain unresolved with regard to mega-earthquakes, tsunamis, unprecedented heavy rainfall and subsequent sediment-related disasters, abrupt volcanic eruptions, and other natural hazards that have intensified owing to climate change, as well as disasters resulting from development of human activities such as nuclear power plant accidents. It has become clear that scientists and engineers must continue working even more earnestly toward further progress, with the recognition that the progress made thus is insufficient to protect the country and the world from the awesome power of Nature.

From a global viewpoint, it is important to reduce disaster risks, build a resilient society, and strengthen social sustainability to ensure human security. Japan should continue its efforts in contributing to disaster prevention and mitigation worldwide by promoting further research and development based on lessons from devastating disasters of the past, including the 2011 earthquake disaster, while sharing the research outcomes with researchers in other countries through various international channels.

3. Contents of Recommendations

It is important to contribute to the prevention and mitigation of disasters worldwide though international cooperation, by sharing the efforts made and experience gained by Japan through its continued struggle with a severe natural environment. We summarize those actions to be taken by international societies and by Japan, through international coordination, including actions by individuals, often referred to as the last mile challenge.

(1) Promote and strengthen development of a system in which scientists and

practitioners in each country can assist with national platforms for disaster risk reduction in their own language, with international support through enhanced inter- and transdisciplinary cooperation.

1) **Monitoring (collection and use of basic disaster information such as data collection and archiving, production and use of disaster statistics, disaster risk monitoring)**
2) **Assessment of the socioeconomic impact of disaster risk and measures for its prevention and reduction**
3) **Improvement of disaster literacy**

(2) Coordinate ongoing scientific and technological research activities at national, regional, and global levels to establish a support system for disaster risk reduction through comprehensive, effective, and sustainable transdisciplinary cooperation.

1) **International coordination and cooperation (support for national and regional activities, establishment of coordination between research and practice, promotion of cooperation between science and technology and the private sector, training of disaster risk reduction practitioners)**
2) **International assessment**
3) **International synthesis analysis**
4) **International advice**

To achieve the above recommendations, Japan proposes to provide assistance with strengthening the advisory function of the Science and Technology Advisory Group of the United Nations International Strategy for Disaster Reduction, in close cooperation with government ministries, the SCJ, Japan International Cooperation Agency (JICA), Japan Aerospace Exploration Agency (JAXA), and other relevant organizations, as well as support from the Asia Disaster Reduction Center (ADRC). A virtual research consortium should be founded that aims to reduce disaster risk, build a resilient society, and strengthen social sustainability by linking and integrating the research interests and capabilities of existing disaster research institutes. In coordination with government agencies, development aid organizations, academic societies, organizations for disaster risk reduction research, and local universities, such a consortium should serve to promote international joint research on planning and implementing assessment, integrated analysis, and recommendations to develop disaster risk reduction policies based on scientific evidence, as well as to advance the implementation of research outcomes in society. In addition, more face-to-face opportunities, such as summit meetings of disaster research institutes, should be organized to strengthen international information sharing. Japan should also strengthen coordination between relevant

government ministries to prepare reference resources for other countries, such as documents explaining policies and systems including the Disaster Countermeasure Basic Act and other relevant laws, thereby laying the groundwork for disaster risk reduction,.

1. Background

In fall 2012, the Science Council of Japan (SCJ) directed the Integrated Research of Disaster Risks (IRDR [2]) subcommittee, which functions as the IRDR national committee for Japan, to begin preparations for reaching a consensus on a new framework for disaster risk reduction using science and technology at the Third World Conference on Disaster Risk Reduction (the Sendai Conference [1]). Meanwhile, the subcommittee for the Tokyo Conference on International Study for Disaster Risk Reduction and Resilience (the Tokyo Conference subcommittee) was set up in April 2014, consisting of representatives in areas related to disaster risk reduction including researchers, engineers, administrators, and officers from organizations for development aid, Earth observation, and other relevant fields. After the subcommittee met a number of times to lay the groundwork, the Tokyo Conference on International Study for Disaster Risk Reduction and Resilience (Tokyo Conference [3]) was held in January 2015. The results of the Tokyo Conference were delivered in the form of the "Tokyo Statement" [4] and "Tokyo Action Agenda" [5], to raise global awareness on the issue and contribute to building a basis for further recognition of the importance of science and technology. These aims were eventually incorporated in the Sendai Framework for Disaster Risk Reduction 2015–2030 [6], adopted at the Sendai Conference. This paper is intended to summarize the discussions and proposals during the two conferences and to propose concrete actions that should be taken by countries around the world.

The SCJ has actively presented recommendations and reports related to disaster-related issues, particularly after the Great East Japan Earthquake Disaster of 2011. On 25 July 1989, the SCJ published a report entitled "The International Decade for Natural Disaster Reduction: Recommendations from Disaster Science Researchers," [7], with the same aims as in the present paper. The main emphasis of the report was on the enhancement of domestic research systems. On 30 May 2007, the SCJ submitted a report to the Ministry of Land, Infrastructure, Transport and Tourism entitled "Development of a Safe and Secure Society to Cope with Global Increase in Natural Disasters," [8] which presented basic concepts and comprehensive recommendations for the reduction of risks from future natural disasters and the importance of international assistance in disaster risk reduction. On 10 May 2012, the SCJ issued a joint statement, "Building Resilience to Disasters of Natural and Technological Origin" [9] together with the academic communities of G8 Summit member countries and other relevant nations, to call on leaders of countries attending the summit to take action for disaster risk reduction by incorporating disaster resilience strategies when planning national or

development assistance projects.

This paper, which is based on the international conferences held at Tokyo and Sendai, aims to contribute to disaster risk reduction from the viewpoint of science and technology by presenting issues, including concrete actions and implementing actors, to be addressed by each country in cooperation with other countries worldwide, as well as actions to be taken by Japan.

2. Expectations for Science and Technology in the Current Situation and the Challenges of Recent Disasters

(1) Current situation and challenges of recent disasters

On 11 March 2011, a magnitude 9.0 earthquake, the largest in the recorded history of Japan, struck the islands and caused unprecedented damage. A total of 18,466 people were dead or missing (including 3,000 casualties from secondary effects). About 400,000 buildings either partially or completely destroyed. Lifeline utilities were disrupted, with a nuclear meltdown at the Fukushima No. 1 nuclear power plant of Tokyo Electric Power Company [10]. According to the Sendai Framework for Disaster Risk Reduction 2015–2030, global disasters in the past 10 years have resulted in 0.7 million deaths, 1.4 million injuries, and 23 million homeless. Over 1.5 billion people are estimated to have been affected by some form of disaster, and economic losses are estimated at over one trillion US dollars. The resulting damage to children, women, and people in vulnerable situations has been particularly devastating [6].

The impact of natural hazards shows an increasing trend, in general, and this has been accelerated by human factors such as poverty, population growth, and urbanization. In addition, as the world becomes increasingly interconnected through economic activities, such as is typically seen with international supply chains in the manufacturing sector, the impact of an event even in a remote area immediately crosses international borders and can lead to a rapidly cascading consequences that unexpectedly affect a wide coverage area.

Damage from natural disasters has been increasing in both developed and developing countries, which indicates that the progress made in science and technology and economic development have not necessarily contributed to the reduction of disaster risk.

Japan is now facing many types of disasters including mega-earthquakes, tsunamis, abrupt volcanic eruptions, heavy rains that the country has never experienced and subsequent sediment-related disasters, and other natural hazards that have been intensified by climate change, as well as disasters resulting from development of human

activities such as nuclear power plant accidents. Despite the diligent efforts of researchers in the area of disaster risk reduction, many problems remain unsolved.

(2) Efforts and scopes of science and technology

Interdisciplinary and transdisciplinary cooperation efforts should be made. Data and information should be systematically collected and integrated through interdisciplinary cooperation by integrating research disciplines and hazard types. Disaster risk reduction should be practiced through transdisciplinary cooperation involving different groups of stakeholders, such as scientists, engineers, politicians, administrators, private corporations, and civil organizations who share data and information; exchange knowledge, experience, and ideas; and discuss issues from different perspectives.

The Integrated Research of Disaster Risks (IRDR) was established as a result of a joint effort by the International Council for Science (ICSU), the International Social Science Council (ISSC), and the United Nations International Strategy for Disaster Reduction (UNISDR). The IRDR began operations in 2008, to reduce disaster risks by improving disaster preparedness and integration, and social implementation of scientific knowledge on the impact of natural and anthropogenic environmental hazards and disaster risk factors [2]. In addition, the International Union of Geodesy and Geophysics (IUGG), a scientific union under the ICSU, has begun the process of publishing disaster assessment reports, in cooperation with other relevant organizations [11].

(3) Actions by Japan

In Japan, a country that has achieved economic success despite frequent damage owing to natural disasters, science and technology have made numerous contributions to the implementation of disaster risk reduction policies. Scientific and technological knowledge in relevant fields has been accumulated, disaster statistics have been produced for policy decision making, and damage by mega disasters has been estimated by the Central Disaster Management Council. Furthermore, the Japanese experience and knowledge of various types of disasters have been shared with other countries through international cooperation and interactions with foreign researchers. However, the Great East Japan Earthquake Disaster served as a clear reminder that progress in science and technology in Japan was insufficient to offer adequate protection from the great power of Nature, and the country would have to continue working even more earnestly toward further progress.

In response to the Great East Japan Earthquake Disaster, government agencies and the science and technology sectors of Japan have been cooperating to review

fundamental issues at the national level, such as national land management and planning, development of energy strategies, and maintenance of economic sustainability. For the purposes of exchanging information and opinions, increasing necessary coordination among various disciplines and levels, and raising public awareness about disasters, the National Commission for Promotion of Disaster Prevention was established in September 2015 [12] in cooperation with the Central Disaster Management Council.

The SCJ has set up committees to address issues related to the Great East Japan Earthquake Disaster, disaster recovery support, academic research, and other topics, in addition to producing many other recommendations and reports. Interdisciplinary cooperation has also been initiated; for example, 30 different academic societies related to disaster risk reduction have begun to work cooperatively.

Japan must continue striving to reduce disaster risk on a global basis by earnestly promoting further research and development based on lessons from devastating disasters of the past, including the 2011 Japan earthquake disaster. This can be achieved by interacting with researchers of different countries and sharing the outcomes of research and interactions with experts in nations worldwide.

3. Process and Achievement of International Consensus

(1) Tokyo Conference

In the fall of 2012, the SCJ direct the IRDR subcommittee to prepare for reaching a consensus at the Sendai Conference on a new framework for disaster risk reduction using science and technology. The SCJ also set up the Tokyo Conference subcommittee to develop a basic concept for this new framework by calling for discussion internationally. It was decided to hold the Tokyo Conference prior to the Sendai Conference, with the intention to gather scientists and engineers in relevant fields from all over the world as well as representatives of principal international organizations.

The basic strategy for implementing disaster risk reduction proposed that each country should structure its disaster management system around its national platform for disaster risk reduction, and that UN agencies, international development organizations, and international scientific and technological initiatives should develop a support system for the national platforms. The strategy also stressed the importance of raising public awareness that each individual must play an important role in reducing disaster risks. Figure 1 shows a conceptual representation of this basic strategy. The strategy was presented for global discussion at a preparatory meeting for the Sendai Conference, held by the "Science and Technology Major Group" in October 2014 in Paris, and a basic consensus was achieved after some modifications and adjustments [3].

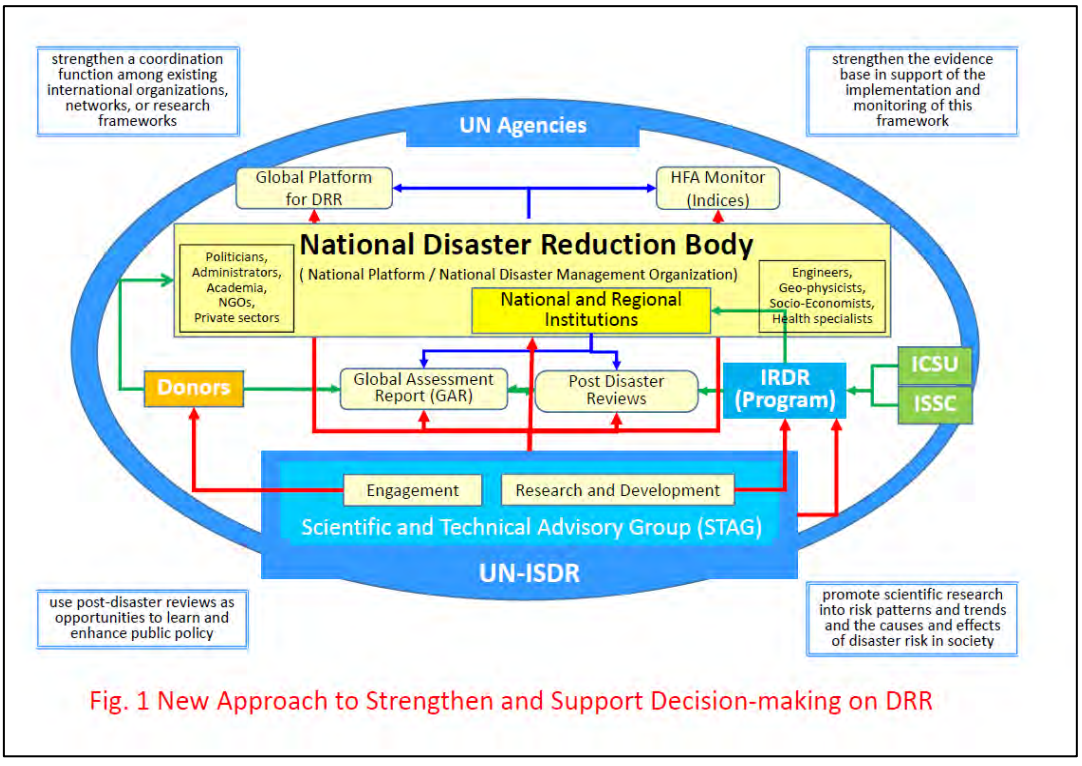

Fig. 1 New Approach to Strengthen and Support Decision-making on DRR

In January 2015, the Tokyo Conference was held, with 385 participants from 27 countries; the conference was also attended by His Imperial Highness the Crown Prince of Japan. During the conference, participants came to the understanding that to promote disaster risk reduction and sustainable development, it is crucial to strengthen the roles of national platforms and the general public, by providing them with scientific knowledge so as to more effectively implement evidence-based policies for disaster risk reduction. Based on this understanding, the Tokyo Conference adopted the "Tokyo Statement" [4], which clearly stated the need for enhanced collaboration among existing scientific disciplines related to disaster risk reduction, earth and environment, health, and earth observation. The "Tokyo Action Agenda" for concrete actions and proposals was also proposed during the conference [5].

(2) Sendai Conference

The Sendai Conference in March 2015 was attended by the leaders of 25 countries and delegations from 187 countries. Discussions and negotiations were held until the very last day of the conference. The Sendai Framework for Disaster Risk Reduction was adopted, aiming to achieve a "substantial reduction of disaster risk and loss of lives, livelihoods, health, and in the economic, physical, social, cultural, and environmental assets of persons, businesses, communities, and countries" over the next 15 years [6].

The ultimate goal of the Sendai Framework is as follows: "Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience." To achieve this goal, the Sendai Framework sets up seven global targets, as follows: 1) disaster mortality; 2) number of affected people; 3) economic losses; 4) damage to critical infrastructure; 5) number of countries with disaster risk reduction strategies; 6) international cooperation; and 7) availability of and access to multi-hazard early warning systems.

The Sendai Framework emphasizes the enhancement of national platforms and lists four priorities for action: 1) understanding disaster risk; 2) strengthening disaster risk governance to manage disaster risk; 3) investing in disaster risk reduction for resilience; and 4) enhancing disaster preparedness for effective response and to "build back better" in recovery, rehabilitation, and reconstruction.

The Sendai Cooperation Initiative for Disaster Risk Reduction, announced by Japanese Prime Minster Abe during the Sendai Conference [13], lists three basic

policies: 1) investment from a long-term perspective; 2) the concept of "build back better"; and 3) collaboration between central governments and various actors. To effectively implement these policies, the initiative also emphasizes three perspectives: 1) the human security approach; 2) cooperation based on the perspective of adaptation to the impacts of climate change; and 3) the application of Japan's knowledge and technology. Numerical goals are also set for the 4 years from 2015 to 2018 to help nations implement these perspectives, including providing a total of USD 4 billion and capacity building of 40,000 government officials and local leaders to play leading roles in disaster risk reduction efforts. Support will be provided in various forms such as material and nonmaterial assistance and global and regional cooperation.

The achievements of the Tokyo Conference can be found in both the Sendai Framework and Sendai Cooperation Initiative. The former emphasizes the enhancement of national platforms, and "understanding disaster risk" is at the top of the priority list. The latter emphasizes collaboration between central governments and various actors and use of Japan's knowledge and technology. More specifically, this includes the collection, analysis, management, and use of data; risk assessment of disasters, including complex disasters; use of geospatial information and observation; dissemination of disaster education; raising public awareness of disasters. Discussion at the Tokyo and Sendai conferences shared the same aims toward practical disaster risk reduction by strengthening cooperation between society and science and technology.

UN Secretary General Ban Ki-Moon expressed his hope at the opening ceremony [14] that the powerful outcomes of the Sendai Conference would give momentum to the adoption of the Sustainable Development Goals of the UN Summit in September 2015, the discussions at the 21st Session of the Conference of Parties to the United Nations Framework Convention on Climate Change (COP21) in November 2015, as well as to the conference in Addis Ababa in July 2015 where financing to achieve the goals proposed at these conferences was discussed.

4. Direction and Strategy of Actions by Society and Science and Technology

(1) Direction of actions

Decision makers, practitioners, and other stakeholders should be fully informed of the latest scientific knowledge on disasters and take evidence-based concrete actions to prevent or reduce disasters.

National platforms for disaster risk reduction should be strengthened to play a central role in incorporating science and technology in policy making.

To reduce disaster risks, it is necessary to appropriately implement science and technology for disaster risk reduction in society. For this purpose, interdisciplinary cooperation should be promoted in the fields of disaster science and technology and other fields related to, for example, environment, health and Earth observation. In addition, two fields of academia should be integrated, natural sciences studying disasters and social sciences and humanities studying politics, economics, society, human behaviors, and so on. Such efforts will help bridge the gap between society and science and technology. Transdisciplinary cooperation between society and science and technology is essential to reduce disaster risks, in which the two entities work closely together to identify problems and to craft and executing plans for this purpose.

Cooperation with local universities and other similar organizations is also important to increase disaster preparedness by means of science and technology. Through this process, national and local governments, communities, and individuals can make better choices for action and work toward the goal of building back better once a disaster occurs.

(2) Strategy of actions

Each country should enhance its national platform and reduce disaster risk based on scientific evidence for sustainable development. For this, it is essential to establish a system in which scientists and practitioners can cooperate in their own languages. The national platform should promote the collection, statistical analysis, management, and use of disaster data, as listed in the Sendai Framework priorities, so that these data can be used to implement evidence-based strategies for disaster risk reduction by platforms at from local to national levels. Adoption of disaster prevention strategy planning at each level should be promoted, forums organized for constant communication among stakeholders, and investment in disaster risk reduction encouraged for increased resilience to future disasters.

To prevent disasters from increasing owing to intensified hazards and social vulnerability to disasters, science and technology should focus on identifying the causes

of social vulnerability to disasters and studying methods to eliminate the fundamental causes of such vulnerability. First, disaster risks existing in local communities and the coping methods used should be fully understood through extensive investigation; quantitative evaluation of disaster risk should then be conducted. Furthermore, the social capacity to prevent the creation of new risks at the planning stage of development projects should be strengthened by learning the knowledge and skills needed to forecast and visualize new disaster risks and their impacts on societies. In addition, engineering research should be promoted for to improve design and construction methods as well as building materials. Coping with the risks of complex disasters, in which multiple disasters occur at once, requires the integrated perspectives of humanities and natural and social sciences, considering regional or local characteristics and situations, and development of comprehensive simulation methods. Such methods can be developed for forecasting and providing early warning information, as well as preparing hazard maps with reference to geospatial information. These measures can encourage people to take actions toward the prevention and mitigation of disasters. For this purpose, it is critical to enhance the capacity to conduct quantitative risk assessment for many types of disaster, by the effective use of interdisciplinary knowledge from humanities and the social and natural sciences. The engineering approach to disaster risk reduction should be also strengthened to develop technological methods that can more effectively reduce disaster risks.

With the recognition that the implementation of science and technology in society should be the frontier of disaster risk reduction, concrete actions should be taken to reduce disaster risk, with collective efforts made by politicians, administrators, private corporations, and civil organizations.

In coordination with various social entities and the educational sector, prototypes should be devised for system and capacity development to implement scientific knowledge in society. Furthermore, community-based disaster risk reduction and disaster education should be promoted, and the effectiveness of methods to improve disaster literacy should be examined.

Disaster risk reduction and Earth observation communities should continually cooperate and improve their capacity to monitor existing risks and the social impacts of risks, prevent increased vulnerability to disasters, and reduce disaster damage. In doing so, it is essential to provide assistance for national platforms collecting disaster-related data and producing statistics, as well as to equip disaster monitoring and early warning system at local and global scales. In particular, Earth observation, information communications technology (ICT), and data integration and analysis technology should

be used to conduct real-time data sharing and integration of interdisciplinary data and provide information that leads to societal action toward disaster prevention and mitigation.

Disaster science, Earth environmental and observation sciences, and health sciences should cooperate to study and implement improvement in the resilience to disasters. Future Earth has been promoted as an area of Earth environmental science that pursues improvement in the sustainability of the Earth environment through interdisciplinary cooperation among natural and social sciences and humanities and transdisciplinary cooperation with societal activities [15]. Although there are some differences in the time scale and urgency of policy implementation between disaster science and Earth environmental sciences, interdisciplinary knowledge of both areas of study is essential to ensuring sustainable development, contributing to discussions on climate change impact assessment and adaptation measures, and reduction in disaster and environmental risks. The management of physical and psychological health is of primary importance in building a society that is resilient to disasters throughout the entire process, from rescue efforts immediately following a disaster to post-event restoration and rehabilitation.

Toward a sustainable environment and society, the international community such as UN agencies, international development organizations, and international scientific and technological initiatives, should lead existing programs and initiatives to create research networks for accelerating evidence-based disaster risk reduction and to implement research outcomes in actual efforts and programs. In particular, nations and regions should be able to share disaster risk information and data that are comprehensive and highly reliable. These should also be provided assistance with preparing various measures according to social conditions, to thereby make evidence-based decisions that are proper and timely. Moreover, systematic disaster education should be provided to societies. Disaster and environmental risks should be reduced through mutual collaboration among the sciences of disasters, Earth environment and health, and sustainable development should be established by building societies more resilient to disasters, to ensure human security.

Best practices of evidence-based disaster risk reduction should be shared among stakeholders.

5. Recommendations for Disaster Risk Reduction and Promotion of International Research on Disaster Prevention and Mitigation

On the basis of the situation and challenges of recent disasters, the consensus and achievements of the Tokyo and Sendai conferences, and the direction and strategies of actions by society and science and technology, we present actions that Japan should take toward disaster prevention and mitigation. These actions, including those by individuals who are often referred to as "the last mile challenge", should be realized through international cooperation toward disaster prevention and mitigation by each country proactively setting up opportunities for discussion, such as international conferences, emphasizing two important items: (1) support of national platforms for disaster prevention; and (2) coordination of international research activities.

Regarding the first point of emphasis, the actions are organized as follows: 1) monitoring; 2) assessment of the socioeconomic impact of disaster risk and measures for its prevention and reduction; and 3) improving disaster literacy. With respect to the second emphasis, actions include: 1) international coordination and cooperation; 2) international assessment; 3) international synthesis analysis; and 4) international advice. For each action category, we propose:

a) Actions to be taken in global collective efforts.

b) Implementing actors and detailed descriptions of the proposed actions.

Japan is still struggling by trial and error after the tremendous devastation of the East Japan Earthquake Disaster. However, the country is tirelessly inching its way toward complete recovery while accumulating invaluable experience. Japan's efforts and experience should be shared with other countries, to achieve disaster risk reduction through international cooperation. Therefore, we also propose:

c) Actions that Japan should take through promotion of science and technology diplomacy and the application of domestic projects to foreign countries.

(1) Promote and strengthen the development of a system in which scientists and practitioners in each country can assist with the national platform for disaster risk reduction in their own language, with international support through enhanced inter and transdisciplinary cooperation.

1) Monitoring

I. Disaster data collection and archiving

a) Each country should collect and archive disaster and land use data and information on social and economic activities, to support and strengthen the development of systems and staffing needed for identifying areas of

vulnerability prior to disasters through the combined use of ground and satellite observations and simulation models.

b) To achieve these goals, various organizations should build closer ties for international research and development initiatives, to create systems for data integration and analysis and provide assistance for each country to strengthen data collection and archiving. This involves activities by UN agencies and the Group on Earth Observation (GEO), forensic investigation of disasters by the IRDR and IUGG, Post-Disaster Needs Assessment (PDNA) by international development agencies and UN agencies, and data integration and analysis led by the Committee on Data for Science and Technology (CODATA), ICSU-World Data System (ICSU-WDS), and data centers of each country.

c) Japan should provide scientific and technological assistance for countries to improve the disaster data collection and archiving capacity of their national platforms through numerous opportunities for international cooperation and joint research projects. Japan should also help countries to strengthen their capacity for collecting additional data and information that cannot be obtained at on-site locations, such as satellite observation and numerical models. Furthermore, Japan promotes the international use of disaster data by effectively using data integration and analysis functions.

II. Production and use of disaster statistics

a) Each country should produce disaster statistics that are highly reliable, and assist with the development of systems and staffing structures, to use these statistics for the development of policies for disaster risk reduction.

b) To achieve these goals, each country should strengthen its ties between the areas of disaster statistics and science and technology, and assist its effective coordination with international organizations such as the UN or other development agencies.

c) During the Third UN World Conference on Disaster Risk Reduction, the United Nations Development Programme (UNDP) and Tohoku University set up the Global Center for Disaster Statistics at the International Research Institute of Disaster Science of Tohoku University. Japan. This Center, with the cooperation of relevant government ministries, SCJ, and other government agencies, academic societies and organizations for disaster research, should assist countries in improving the quality of disaster statistics, promote the use of the statistics for making disaster risk reduction policies, and continuing the efforts

of such activities. Japan will also promote the global sharing of disaster information by means of the Global Unique Disaster Identifier Number (GLIDE) managed by the Asian Disaster Reduction Center.

III. Disaster risk monitoring and forecasting

a) Each country should assist with the development of systems and staffing that can monitor and forecast changes in disaster risk, using ground and satellite observations and numerical model simulation, and that can use the data and information for policy making. Each country should also assist with strengthening research and research promotion systems, including laws, administrative guidelines and organizations, to detect problems leading to new social vulnerabilities to disasters. The outcomes of these efforts should be translated into understandable information that can stimulate independent action by the public to prevent and mitigate disasters.

b) To achieve these goals, international scientific and technological research initiatives such as those by UN agencies, GEO, IRDR, IUGG, and Future Earth should support monitoring activities, development of early warning systems, and production of hazard maps in cooperation with national governments and domestic research communities. Each country should support the establishment of systems to domestically share the collected information.

c) Japan should increase its involvement in international disaster charters using satellites and disaster-related activities by GEO. In addition, it should promote participation in international development assistance, establish disaster prevention and mitigation in Future Earth, and increase regional disaster-related projects of the Science and Technology Research Partnership for Sustainable Development (SATREPS), enhancing the wide-area disaster monitoring system of Sentinel Asia and other projects. Through such projects, Japan should develop a system to effectively carry out data integration and analysis. All these should help each country to realize sustainable risk monitoring.

2) Assessment of the socioeconomic impact of disaster risk and measures for its prevention and reduction

a) Each country should provide support to develop its capacity to assess risks from disasters that may harm economic growth, public health, and social equality. In particular, research and research systems should be supported and

strengthened to help assess disaster risks and prevent an increase in vulnerability; these are related to development and economic activities as well as the laws and systems that control them, such as land-use planning, technological development, infrastructure and housing development, and corporate activities. Each country should be informed about proper investment in disaster risk reduction and its effect, to encourage their efforts in disaster risk assessment. Engineering research should also be promoted in such a way that the results of impact assessment can have a direct influence on the improvement of design and construction methods as well as building materials.

b) To achieve these goals, international scientific and technological research initiatives, such as UN agencies, international development agencies, GEO, IRDR, IUGG, and Future Earth, should engage in disaster risk assessment together with national governments and domestic research communities. They should also evaluate the impacts of investment in disaster risk reduction on economic growth and the safety of the general public, and provide assistance to establish a system for sharing such information domestically.

c) Japan should effectively coordinate international development assistance and scientific projects such as Future Earth and SATREPS, evaluate the effects of investment in disaster risk reduction, provide assistance for countries to improve their capacity for disaster risk assessment, and contribute to increasing disaster preparedness and the capacity to build back better.

3) Improving disaster literacy

a) Each country, particularly each developing country, should improve understanding about the importance of disaster risk reduction and develop the capacity to make evidence-based decisions at individual, community, and governmental levels. This requires developing the capacity to produce, collect, and use reliable information. The development of such capacity should be encouraged by promoting education and other awareness-raising activities, to improve disaster literacy.

b) To achieve these goals, the international community should provide assistance to improve school and social educational systems and scientific and technological capacities for individuals, local communities, and governments through proper organizations and by various means such as the use of tools and systems.

c) Japan should assist countries in comprehensive capacity building through

various types of programs, advising, and cooperation including technological cooperation projects by governments and grass-root groups, and projects led by Future Earth, IRDR, and SATREPS. These programs should be conducted by effectively coordinated planning and by modularizing capacity-building programs through close cooperation among different organizations. Japan should also develop a virtual research collaboration system of relevant government agencies, universities, academic societies, and organizations for disaster research. This system will offer practical content for political decision makers, practitioners, and local communities to improve disaster management capacities, upgrade social systems, and enhance scientific and technological capabilities. Such content should be developed through international collaboration and be provided for public use. Japan should also host foreign students, particularly from developing countries, to promote the transfer of these technologies.

(2) **Coordinate ongoing scientific and technological research activities at national, regional, and global levels to establish a support system for disaster risk reduction through comprehensive, effective, and sustainable transdisciplinary cooperation.**

1) International coordination and cooperation

I. Support for national and regional activities

a) Regional or bilateral cooperation frameworks should be used to provide assistance for the implementation of legal, institutional, and technological systems for disaster risk reduction and the promotion of socioeconomic infrastructure development, to increase disaster preparedness and resilience. Regional cooperation should be further strengthened to be better prepared for before a disaster, and so that necessary actions can be taken rapidly and appropriately for emergency response, restoration, and recovery once a disaster occurs.

b) To achieve these goals, regional platforms (RP) should be encouraged to be more active. For example, regional platforms should be held biennially in coordination with regional development banks and international and UN agencies in the region. Administrative and scientific and technological communities of each country, local offices of international scientific research initiatives such as IRDR, IUGG, and Future Earth, and private corporations should be invited to these biennial opportunities, and each country should be provided with assistance in producing disaster reports and progress reports on

the Sendai Framework. Best practices collected from each country should be translated into international common languages, to be shared among countries and organizations.

c) Japan should be aggressive with respect to providing assistance to government ministries, the SCJ, and other government agencies, academic societies, organizations for disaster research, and private corporations. In the Asia and Oceania region, Japan should play an active role in applying novel practices conducted through multinational and bilateral cooperation with third countries.

II. Establishment of collaboration between research and practice

a) Collaboration between practice and science and technology in disaster risk reduction should be further promoted at national, regional, and global levels. More support should be provided for UNISDR, which has had an important role in the global promotion of disaster risk reduction and the coordination of relevant international organizations. More efforts should be encouraged for the establishment of wider regional systems for disaster risk reduction. Closer ties should be built with the research areas of environment, health, and Earth observation, and collective efforts should be planned and executed in cooperation with IRDR, IUGG, Future Earth, Urban Health and Wellbeing (an ICSU program), GEO, and the World Federation of Engineering Organization (WFEO).

b) To achieve these goals, each program should include interdisciplinary projects and subtasks and develop a progress monitoring system with international mapping. With the recognition that the implementation of science and technology in society is the frontier of disaster risk reduction, the science and technology community should build trust with disaster management administrators and establish a system in which practice by disaster management administrators contributes to progress in science and technology. This requires reforming research and education systems as well as systems for research assessment, organization, and education. In the Future Earth program, a Knowledge–Action Network (KAN) on disaster risk reduction should be established to perform transdisciplinary research in cooperation with society and science and technology.

c) Through a competitive framework that is equitable and fair, Japan should develop a data integration and analysis system as a common foundation for the areas of disaster risk reduction, environment, health, and Earth observation;

promote internationally collaborative research that is both inter- and transdisciplinary; and build revolutionary research facilities that can put forward technological measures that are even more effective in disaster risk reduction.

III. Promotion of cooperation between science and technology and the private sector

a) The participation of various stakeholders should be encouraged to promote coordination between research and practice. A system should be developed to quickly provide the public with information that is consistent in content and based on reliable scientific evidence. More knowledge of science and technology should be made publicly available and used in practice by strengthening ties between the science and technology community and private corporations to provide facilities, products, and insurance related to disaster risk reduction.

b) To achieve these goals, the two advisory groups of UNISDR, the Science and Technology Advisory Group (STAG) and the Private Sector Advisory Group (PSAG), should strengthen their ties.

c) Japan should boost dialogue on disaster risk reduction cooperation, which the government has been promoting with other countries. It should also accelerate the enhancement of disaster risk reduction measures based on science and technology through information exchange regarding seeds and needs and planning and implementation of joint projects in cooperation with relevant government ministries, the SCJ, other government agencies, and the Japan Bosai Platform (JBP).

IV. Training disaster risk reduction practitioners

a) Assistance should be provided to train disaster risk reduction practitioners who can lead the efforts to reduce disaster risk and to build back better after a disaster.

b) The science and technology community and disaster risk reduction practitioners should cooperate to develop and execute workshop and training programs for increasing personnel who can produce, collect, and effectively use information based on scientific evidence.

c) Through workshops and training, Japan should engage in the transfer of knowledge and technologies in various fields including disaster risk assessment; disaster observation; prediction, forecasting and warning; disaster risk reduction policy planning; disaster response; post-event activities for

building back better; community-based disaster prevention; and disaster education, among others.

2) International assessment

a) A mechanism for reliable international assessment should be developed, in which the status of scientific and technological knowledge on disaster risk, resilience, and progress toward a safe and secure society will be regularly and objectively assessed from a scientific and technological viewpoint in terms of applicability to disaster risk reduction policy.

b) To achieve these goals, international scientific and technological research activities such as those of IRDR, IUGG, and Future Earth should be promoted with a focus on the global targets of the Sendai Framework and Sustainable Development Goals (SDGs). Collaboration with the Global Assessment Report (GAR) effort led by UNISDR should also be strengthened, through which the GAR production method should be restructured, and a system to conduct a scientific review of the method should be established. For example, assessment should be carried out regularly (e.g., biennially) at national and regional levels, and terminology, assessment criteria, and data quality management should be standardized.

c) Japan should play a leading role in risk and resilience assessment across Asia and the world in coordination of relevant government ministries, the SCJ, other government agencies, academic societies, organizations for disaster risk reduction research, and private corporations.

3) International synthesis analysis

a) Comprehensive knowledge on the status of science and technology related to the identification of disaster risks, assessment of the socioeconomic impact of disasters, and approaches to substantial reduction of human and economic losses should be presented in a clear, easy-to-understand manner, for the worldwide application of disaster risk reduction policies. Collaboration should be reinforced not only among areas of disaster risk reduction but also with other closely related areas, such as those concerning climate change measures and the achievement of sustainable development goals.

b) To achieve these goals, integrated analysis reports should be produced periodically (i.e., mid-term and final reports during the period of the Sendai Framework) by coordinating international scientific and technological research

initiatives such as IRDR, IUGG, and Future Earth. An international working group for this purpose should be set up under STAG and a support system should be established in which countries, UN agencies, and development aid organizations are expected to provide assistance with this effort.

c) Japan should play a central role in organizing and operating an international working group for the analysis reports, with UNISDR at the heart of the effort, by arranging for cooperation from Japanese organizations such as relevant government ministries, the SCJ, other government agencies, academic societies, and organizations for disaster risk reduction research as well as from international counterparts, such as UN agencies and development aid organizations like UNESCO, WMO, WHO, UN University, ICSU, ISSC, and WFEO.

4) International advice

a) The science and technology community should improve its function of delivering scientific advice to countries and regions throughout the world in collaboration with UN organizations and other international aid agencies, so as to implement effective assessment at national and regional scales as well as integrated analysis, coordination, and collaboration based on such assessment. The national platform of each country should be encouraged to periodically publish disaster reports that contain disaster records, statistics, analysis of the current status, records of disaster-related activities, and progress in disaster policy making. Researchers of each country should actively engage in these efforts and provide advice that matches the needs of practitioners.

b) To achieve these goals, STAG should be reorganized in consideration of geographical distribution. The new organization should comprise high-level scientific advisers from each country; representatives of UN agencies that are closely related to the promotion of science and technology within national disaster risk reduction such as UNESCO, the World Meteorological Organization (WMO), and WHO; members the international science and technology community such as IRDR, IUGG, and Future Earth; organizations of higher learning such as UN University; and those involved in earth observation, development aid, and other relevant fields as well as private corporations. UNISDR should be assigned the responsibility to perform its secretariat function. In addition, the national committee of IRDR in each country should enhance its participation in various national efforts that have

been developed under the initiative of UNISDR to promote concrete actions toward disaster risk reduction. Through this effort, scientists of each country should be provided with more opportunities to interact with a wide range of stakeholders, including all levels of governments, while discussing disaster risk reduction in their own languages. Cooperation with local universities and other organizations should be encouraged to spread efforts in disaster risk reduction to local areas, which is expected to be a driving force in accelerating implementation of disaster risk reduction policies in each country.

c) Japan should provide assistance in strengthening STAG to build a greater global influence and capacity for policy implementation, to enhance its function of delivering scientific recommendations worldwide in close coordination with government ministries, the SCJ, Japan International Cooperation Agency (JICA), Japan Aerospace Exploration Agency (JAXA), and other government agencies, with support from the Asia Disaster Reduction Center (ADRC). A virtual research consortium should be founded aiming to reduce disaster risk, build a disaster-resilient society, and strengthen social sustainability, by linking and integrating the research interests and capabilities of existing disaster research institutes. In coordination with government agencies, development aid organizations, academic societies, organizations for disaster risk reduction research, and local universities, such a consortium should serve to promote international joint research for planning and implementing assessment, integrated analysis, and providing recommendations that are effective in developing disaster risk reduction policies based on scientific evidence, as well as to advancing the implementation of research outcomes in society. Additionally, more face-to-face opportunities such as summit meetings among disaster research institutes should be organized to strengthen international information sharing. Japan should also strengthen coordination between relevant government ministries to prepare reference resources for other countries that help to lay the groundwork for disaster risk reduction, such as documents explaining policies and systems including the Disaster Countermeasures Basic Act and other relevant laws.

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Appendix 1: Abbreviations

ADRC	Asian Disaster Reduction Center
CODATA	Committee on Data for Science and Technology
COP21	The 21st Session of the Conference of the Parties
GAR	Global Assessment Report on Disaster Risk Reduction
GEO	Group of Earth Observation
GLIDE	Global Unique Disaster Identifier number
ICSU	International Council for Science
ICSU-WDS	International Council for Science – World Data System
ICT	Information and Communication Technology
IRDR	Integrated Research on Disaster Risk
ISSC	International Social Science Council
IUGG	International Union of Geodesy and Geophysics

JAXA	Japan Aerospace Exploration Agency
JBP	Japan Bosai Platform
JICA	Japan International Cooperation Agency
KAN	Knowledge–Action Network
PDNA	Post-Disaster Needs Assessment
PSAG	Private Sector Advisory Group
RP	Regional Platform
SATREPS	Science and Technology Research Partnership for Sustainable Development
SDGs	Sustainable Development Goals
STAG	Science and Technology Advisory Group
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNISDR	United Nations International Strategy for Disaster Reduction
WFEO	World Federation of Engineering Organization
WHO	World Health Organization
WMO	World Meteorological Organization

Appendix 2: Process of discussion and approval

November 22, 2014 First meeting for Tokyo Conference Committee
Officers were elected, the schedule was discussed
Contents and targeted outcome of the conference were discussed
Management of the conference was discussed

December 24, 2014 First meeting of IRDR National Committee
Officers were elected; the schedule was discussed

December 24, 2014 Second meeting for Tokyo Conference Committee
Management of the conference was discussed
Contents and targeted outcome of the conference and international negotiations were discussed

April 2, 2015 First joint meeting of Tokyo conference and IRDR National Committees
Reports of the Tokyo conference, Third UN World Conference on Disaster Risk Reduction
It was agreed that both committees jointly prepare the present recommendations

May 22, 2015 Second joint meeting

Structure of the recommendations was discussed

June 5, 2015 Third joint meeting

Draft of the recommendations was discussed

September 23, 2015 Fourth joint meeting

The present recommendations were approved

December 4, 2015 The International Committee (16th)

The present recommendations were approved

December 11 to 20, 2015 The Committee for Civil Engineering and Architecture (Third, through e-mails)

The present recommendations were approved

February 26, 2016 Executive Board Meeting (225 th)

The present recommendations were approved