An Analysis of the Great East Japan Earthquake by Scientific Information Asymmetry Models

Yuko Hayashi, Yamaguchi University, Japan, yhayashi@alum.mit.edu

Abstract: This article presents analysis of how science for policy functioned in the Great East Japan Earthquake from the perspective of the scientific information asymmetry models. Scientific information is characterized by its complexity and high degree of professionalism and it is hard to understand for political actors or common people. Boundary functions like screening and signaling could help providing more credible information. Establishment of new organizations and posts for this earthquake appears to have resulted in preventing existing organizations from working as boundary functions. Control and concealing of scientific information, which seemingly included uncertain elements, amplified the anxiety of people. Several existing science related organizations contributed to providing credible scientific information that helped the formation of consensus among scientists. Finally, this paper will propose ideas on how to resolve scientific information asymmetry. Materials used for analysis are government papers and journals in the Great East Japan Earthquake.

Key-Words: *the Great East Japan Earthquake, science and technology, boundary functions, scientists, information asymmetry*

1. Introduction

1.1 Prefaces

The Great East Japan Earthquake hit Japan at 14:46 JST on Friday, 11th March 2011. The Japanese National Police Agency reported 15,805 deaths, 4,040 missing, and 5,927 injured across the Tohoku and Kanto area [1]. The Fukushima Daiichi Nuclear Power Plant was damaged by the Tsunami, the emergency electricity generators failed and the cooling systems of plants failed subsequently. Explosions caused by hydrogen gas lead to leak of radioactive materials into the air. It is a shame that this quake and tsunami caused such a grave crisis in Japan, a nation that used to advocate itself as a world leader in science and technology. Our technical and scientific knowledge should have been integrated to solve the problems in such emergency. In tackling the earthquake, the tsunami, and the nuclear accident, it became clear that scientific information which, in nature, is highly complex and divided into multiple degree of professionalism triggered many problems arising from such character. The role of science has been in focus in Japan in recent years, because emergency situation which calls for scientific approach such as new types of influenza, Shinmoe volcanic eruption, foot and mouth disease, and sarin gas attack in the subway train in Tokyo have greatly jeopardized people's lives. With such background, this article will analyze the reactions of the Japanese government and scientists to the Great East Japan Earthquake from the perspective of the scientific information asymmetry models.

1.2 Frameworks of Analysis and Preceding Studies

This paper will examine the relationship between the scientists – the specialists of science and political actors or society - the non-specialists of science. The problem of asymmetry of information between scientists and political actors, and between scientists and society exist at the same time. In the policymaking process, as it is difficult for non-specialist to make judgments based on the understanding of the difficult and complex results of analysis by specialists, boundary functions is required to bridge the non-specialists and the specialists. The boundary function helps signaling [2] of the scientists to appeal their integrity or productivity (to the

Received: 30 September 2011, Accepted: 2 November 2011
Available online 14 November 2011

public), and also helps the screening of the scientists by the non-experts to select high-quality professionals. Therefore it works to resolve information asymmetry. This paper will explore which organizations and institutions have a boundary function that help policy makers to craft good policies that achieve its objectives through dealing with complicated and difficult scientific information in the Great East Japan Earthquake case.

2. Case Studies

2.1 The establishment of new organizations after the earthquake

After the earthquake, how did science and technology related organization work?

The Great East Japan Earthquake occurred at 14:46 JST on Friday, 11th March 2011. The Emergency Disaster Response Office was established in Cabinet Secretariat at 14:50, and an emergency team was convened. The discussions started at 15:00. At 15:14, based on 2 of Article 28 of Disaster Countermeasure Basic Act, the Emergency Disaster Response Headquarters on Tohoku district - off the Pacific Ocean Earthquake was established and the Prime Minister was appointed as the Director of the office. Then, at 15:37 the first meeting of the Emergency Disaster Response Headquarters was held, and the "Basic Policy on disaster emergency measures" was announced.

At 19:03, based on Article 15 and 16 of Act on Special Measures Concerning Nuclear Emergency Preparedness, the Prime Minister declared a nuclear emergency declaration on the Fukushima nuclear power plant disaster. The "Year 2011 Nuclear Emergency Response Headquarters Related to Fukushima Daiichi Nuclear Power Plant Disaster" was created with Prime Minister as the Chief, and Minister of Economy, Trade and Industries as the Deputy Chief. On March 12, a "Local Nuclear Emergency Response Headquarters Related to Fukushima Daiichi Nuclear Power Plant Disaster" was established in the disaster Management Center at Okuma Futaba-gun, Fukushima Prefecture. Thereafter, the government launched more than 20 new conferences and organizations in addition to disaster-related organization that had been already defined by law prior to the 3. 11 disaster (Chart1).

It was not clear what authorities, responsibilities and roles these newly established organizations and meetings (that were not designated by law) were given. Parliamentary deliberations pointed out that the decisions of each organization disappeared on the way and the chain of command and instruction was confusing.

In creating a new organization, it is important to clarify how the functions and powers are divided between them and the existing organizations. For example, the restoration work and the construction of temporary housing and debris were delayed until the blueprint of the restructuring plan was disclosed by the "Conference on the Reconstruction Plan" on June 25.

In addition to new organizations, six advisors to Cabinet Secretariat for the Great East Japan Earthquake were newly appointed by the end of March and the number of the advisors became fifteen in total. These advisors were part-time government officials and the selection of these advisors was apt to be through a personal connection, rather than screening and choosing diversity of specialty, research achievement, or high status as a scientist. For example, four out of six advisors to Cabinet Secretariat were mostly expert in nuclear power. Professor Kosako who resigned cabinet advisor on April 29 protesting the government for ignoring his advice on radiation limits, was an expert on radiation safety at the University of Tokyo. DPJ lower house member Seiki Karamoto recommended him as an advisor because he studied under Professor Kosako when he was an undergraduate at university. Prime Minister admitted at the National Assembly that he had not met Professor Kosako before his appointment or upon his resignation [5].

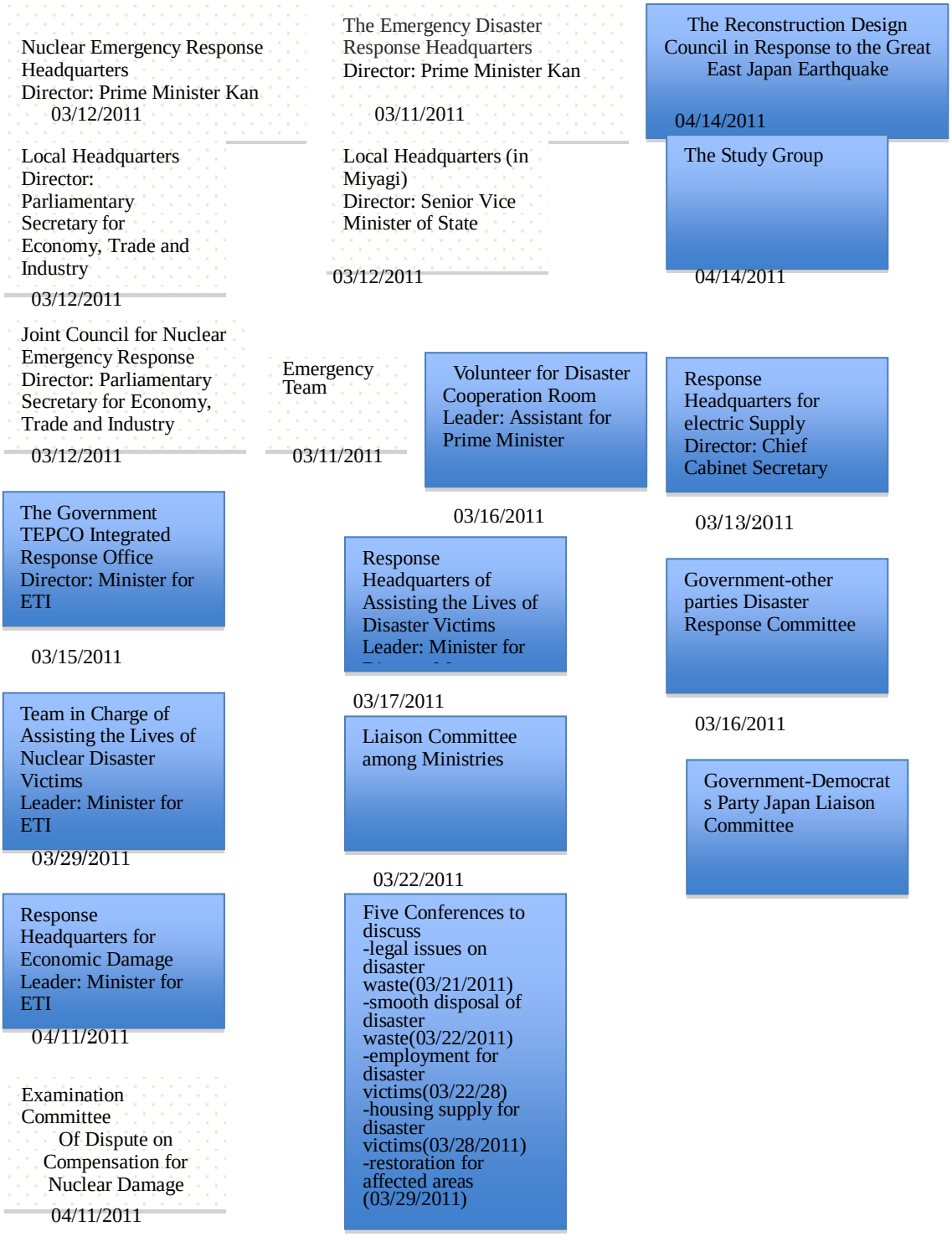

Chart1 Disaster-related Organizations established after March11 (As of May 8) [3, 4]

The power/responsibilities of the advisors were unclear. According to the Deputy Chief Cabinet Secretary Tetsuro Fukuyama and Prime Minister Naoto Kan, the role of the advisors was to provide second opinions [6]. Professor Kosako had a disagreement with the Nuclear Safety Commission in terms of allowing children maximum radiation exposure of 20 mSv per year. The government however adopted the opinions of the Nuclear Safety Commission. On other issues, there were times when the opinion of advisors, even they were the second opinions, stopped the restoration works [7].

The Prime minister appointed many advisors. It must have been difficult for him, a non-specialist of science, to make decisions based on affluent, and in many cases contradicting, advises from variety of scientific experts.

In science related advisory committees or councils, there is an idea of "Regulated scientific market (RSM)", which is about a place where they can discuss science for policy in a liberal climate and provide non-specialists of science a selective information that earned some degree of consensus. Here, non-specialists can have access to scientific information that is comparatively reliable. In contrast, there is a situation in policy decisions, where the various ideas and demands would be proposed to non-specialists. This situation is called the "Marketplace of Ideas". Here comes out a variety of ideas without restrictions, there is credence to each idea, and it is hard to determine which idea will help accomplish the purpose of the policymakers/non-specialists.

Some case study showed that "RSM" is more efficient than "Marketplace of Ideas" especially in issues related to science and technologies [8, 9]. In this case as the author illustrated above, since scientific knowledge is limited in political actors, the un-screened opinions from advisor apparently ended up in "Marketplace of Ideas", making it difficult for the policy makers to make decisions.

2.2 The existing science-related organizations

While quite a number of new organizations were established as described above, the already existing science related organization in Cabinet Office, whose role and rights were designated by law, were not fully utilized for Disaster Management, There are two existing science related organizations in Cabinet office today that works across ministries and offices. One is the "Sub Committees of the Central Disaster Prevention Council", and the other is the "Council for Science and Technology Policy and its Sub Committees".

The "Central Disaster Prevention Council" headed by the Prime Minister is the Prime Minister's advisory body. All ministers, including the Prime Minister; representatives of designated public institutions including NHK, NTT, and the Japanese Red Cross; and two academics constitute its members. They create and implement disaster plans, discuss and evaluate important issues on disaster management. Article 11-2 of the Disaster Measures Basic Law say that at times of emergency, the Central Disaster Management Council is responsible for making plans for the measures and promoting its implementation. Article 4-11 says that the Prime Minister must consult the "Central Disaster Management Council" to outline temporary emergency measures or announce "disaster emergency proclamation". However, the first meeting of the "Central Disaster Management Council" for the March 11th earthquake was on April 27th that was a month and a half after the disaster.

At this first meeting, the Council decided upon the establishment of "Expert Committee on Lessons Learned From the Experience of the Tohoku District Pacific Ocean Coastal Line Earthquake Disaster." This Expert Committee consists of scientists and social science specialists. They are responsible for analyzing the mechanism of how earthquake and tsunami are formed, to review the current earthquake intensity estimation and damage estimation techniques in creating the outline of Earthquake measurement.

The Expert Committee gathers once or twice a month to summarize their report by fall. Middle and Long-term technical assistance was recommended but the technical assistance at the time of emergency was, regretfully, not

provided.

Council for Science and Technology Policy (CSTP) was established in the Cabinet Office as one of the councils on important policies. Its aim is to plan and execute overall coordination of a comprehensive and basic science and technology policy under the leadership of Prime Minister and Minister for Science and Technology Policy, from the national perspective [10]. CSTP was established in the Cabinet Office in accordance to the reorganization of the central government in January 2001. The members consists of the Prime Minister as a chair person; the chief Cabinet secretary; Minister for Science and Technology Policy; the Minister of Finance; the Minister of Economy, Trade and Industry, the Minister of Education, Culture, Sports, Science and Technology; the Minister of Internal Affairs and Communications; three experts from natural science; two experts from social science; two from industry; and the President of the Science Council of Japan. Besides the plenary session of CSTP which is held once a month, the Ministers, senior vice Ministers, Parliamentary Secretary of Science and Technology Policy and experts of CSTP meet together once a week in order to exchange views on science and technology policy.

On March 31, 20 days after the earthquake, expert members of CSTP delivered a message titled "Countermeasure for Tohoku district - Pacific Ocean Coastline Earthquake." On April 1 they announced "Logistics support using ITS technology in the affected area." In May, they announced to allocate 1.2 billion yen to the project of "Establishment of a Base for the Environmental Impacts of Radioactive Materials." Since April 21, discussions on a countermeasure for the Great East Japan Earthquake are being held among the Ministers, senior vice Ministers, Parliamentary Secretary of Science and Technology Policy and experts of CSTP on a weekly level.

Article 26 of Act for Establishment of the Cabinet Office states that, "CSTP will assess and investigate basic policy in order to promote a comprehensive and systematic development of science and technology in response to the consultation of the Prime Minister. "" CSTP will assess and investigates budget, personnel and other resources concerning the promotion of science and technology as well as important matters on promoting science and technology." CSTP is also entitled to express their opinions on the above stated matters to the Minister of Science and Technology Policy.

However, the government did not consult CSTP in the time of 3.11 emergency and no activities were observed during this period. Although expert committees of scientists have a number of specialists, most of the advice (second opinions) given to the Prime Minister was primarily given by the advisors for the Cabinet. Since the Central Disaster Management Council and the CSTP are scientific organization close to the decision-making body that possesses the ability of “screening” it is highly recommended that these boundary functions be actively used for policy making.

Science Council of Japan (SCJ)

SCJ was established in January 1949 under the notion that science is the foundation of a civilized nation, subject to the Science Council of Japan Law, under the jurisdiction of the Prime Minister. SCJ functions as a "special authority" which fulfill its duties independently from the government, aims to introduce science into public administration, industry, and people’s life. It discusses important issues of science, materialize the ideas, and promote communication between science researchers/projects to improve its efficiency. The government bares its expenses.

SCJ is an institution representing about 84 million scientists in Japan from all fields including cultural and social sciences, life sciences, and science and engineering. It has 2,000 members and 210 linkage members that fulfill SCJ’s work. SCJ's roles are: policy recommendations to governments, international activities, building a network for scientists, and encouraging public awareness of the role of science. Its organization consists of the General Assembly, executives (chairman and three vice chairman), executive committee, three committees, four functional committees that serves for selected objectives (permanent), 30 academic field

committees (permanent), thematic committees (temporary), the district council and the secretariat.

According to SCJ Law Article 4-3, government is free to consult with SCJ on important subjects that need professional investigations by scientists. On March 18, right after the earthquake, SCJ held an emergency session and set up a task force on the Great East Japan Earthquake chaired by the president of SCJ. Since then, six proposals have been announced over the emergency, aggregating the opinions of many scientists. SCJ also created a detailed report on Fukushima Daiichi Nuclear Power accident and sent out the information to academies abroad. It also contributed to the dissemination of the ICRP (International Commission on Radiological Protection) standard for protective measures of radiation that is globally recognized as the standard of radiation protection, in order to manage strategies of protection from radiation damage arising from the nuclear power plant accident. In June, it announced two proposals; "For the reconstruction from the Great East Japan Earthquake - goals and seven principles of reconstruction" and "Toward the selection of energy policy for Japan's future - the six scenarios related to a power source ".

Some of the recommendations proposed by SCJ were accepted and put into actions by the government. However, SCJ points out "Almost no information regarding the accident was provided to the SCJ, and it was not possible for the SCJ to independently gather information, other than that which could be obtained through newspapers, television and other media sources." [11] Besides drafting proposals, SCJ, as a group of scientists, made every effort to collect information and analyze them. In course of this effort, SCJ requested disclosure of the data to the Nuclear Safety Commission, which is a government agency to check the safety of nuclear power, but the Commission did not respond. Because the situation of Fukushima nuclear power plant accident changes on a daily basis, it is very difficult to grasp the exact condition of the reactor, if not impossible. SCJ also said that since the data on the amount of fuel rods at a given time in the reactor in the spent fuel pool, the extent of damage caused, the total radioactivity of contaminated water released into the ocean was not provided to them, the best they could do was guess roughly. On April 8th, SCJ established two committees. One is for "The grand design for the reconstruction of affected areas" which will study the affected areas, deliberate measures to create a new model for the 21st Century on disaster reduction, environment, industries, land use, urban structure, and community organizations.

Another is "Alternative energy policy committee" which examines all available resources for energy. On March 18th, SCJ held an emergency meeting open to public at the SCJ Auditorium in order to stimulate communication and exchange information.

On September 1st, SCJ held an emergency seminar titled "Fearing radiation correctly," with focus to the impact of low-dose radiation exposure on health and international standards of the International Commission on Radiological Protection (ICRP). The purpose of this seminar was to distruibute correct information to the public, relieve people's concern and improve the nation's literacy on radio activities through the discussion of first-class scientists.

The recommendations and proposals issued by SCJ were quoted 18 times in the question and answer of Diet deliberations, which indicates the deep trust the National Assembly has for SCJ.

Japan Science and Technology Agency (JST)

JST is an independent administrative institution established to promote science and technology which will create new values that lead to the future in order to advance the national welfare and prosperity.

On March 23rd, facing the large earthquakes, JST offered free access to scientific and technical literature related to earthquakes in the database "JDreamII" in order to help the dissemination of science and technology information.

JST supported researchers by providing urgent funding programs to continue their work without interruption.

In J-RAPID Program (Urgent International Collaborative

Research with USA), JST, collaborating with National Science Foundation of the USA, supported immediate research needs arising from the Great East Japan Earthquake. Fourteen projects have been funded as of July 19th, 2011.

Implementation Support Program was launched and fund of 5-10 million yen was provided per a project that could implement the result of research to the restoration and development of the affected areas by year 2011.

Research Seeds Quest Program (RESQ) focuses on the researches mainly in the Tohoku region that were forced to be suspended by the earthquake, providing emergency measures and support measures.

In Japan –U.S. Strategic Science and Technology Cooperation Project, a joint team of researchers from both countries carried out emergency relief operations including activities utilizing a robot for underwater exploration or rescue work in the affected areas.

The SCJ and the JST, as described above, could use signaling to promote boundary function in helping non-science specialists because they had a volume of information on the scientific experts in segmented specialized fields and, over the course of years, have cultivated mutual trust with government sector and the domestic and international society and therefore the messages they sent out were accepted as good and reliable information. Several experts discussed and built consensus of scientific information, so RSM was formed as a boundary function. However, in cases where raw data was not available, such as in the nuclear power plant accident, the scientists were unable to reduce the degree of uncertainty in their scientific investigation result.

2.3 The relationship between science and society

Through our experience in this earthquake, difficulty of distributing scientific information, which is complex and including much uncertainty, at domestic or international level. Especially in the issue of the leakage of radiation, so many rumors spread regarding the extent of the leakage of radiation spread or the degree of harms affecting human health.

Because of the poor reliability of data, in many cases, the government made wrong announcements or had to delay the unveiling of information. For example, Deputy Director-General Koichiro Nakamura of NISA committee pointed out the worst case, the possibility of a meltdown, in the afternoon of March 12. But then, his position was replaced by another person who denied the possibility of the melt down. Specialists and the media at later pointed out the possibility of a meltdown also overseas and this formulated a sense of mistrust among Japanese people that the government might be hiding important information from them. On May 15th, the government finally admitted the meltdown of reactor unit1 and on May 24th, reactor unit 2 and unit 3. [12]

On April 17th, the government upgraded the International Nuclear Event Scale (INES), the safety significance of reported nuclear and radiological incidents and accidents, from level 5 to level 7. Some pointed out the possibility of the government concealing some information that affected this upgrade. NISA announced that total amount of Cesium-131 and Cesium-137, or radioactive iodine, released into the atmosphere had reached 370,000 tera Becquerel estimated from the state of the reactor. On April 12th, Nuclear Safety Commission (NSC) of Japan announced the total release of iodine and cesium into the atmosphere was 630,000 (iodine equivalent) tera Becquerel as estimated based on the amount of radiation which was measured around the neighborhood. The government explained that they announced level 5 since the numbers announced by NISA and NSC did not match, but after the both digit numbers matched they officially raised the level to 7.

While the government of Japan set evacuation zone as within 20 km and zones for planned preparation for evacuation as 20 km to 30 km, foreign embassies including the United States and the British set 80 km as the evacuation zone. Although American and British governments commented that the Japanese evacuation zone setting seemed to be reasonable, they explained that they adopted 80 kilometers as evacuation area to ensure the safety of their citizens living away from their homeland. However, here

again, the difference in numbers caused confusion among the people of Japan. Another problem was that the evacuation area was designated as a concentric circle, and this caused some experts to object for not considering the direction of wind and the hot spot.

Some scientists and legislatures protested that no data were provided by SPEEDI (System for Prediction of Environmental Emergency Dose Information). SPEEDI is a system designed to quickly predict the influence of radio activities on surrounding environment based on the weather conditions, geography, and emitting source when an emergency situation occurs such as the release of radioactive material from a nuclear power plant.

Japan Atomic Energy Research Institute started to develop SPEEDI in 1985 at the cost of 160 billion yen over 20 years. Although SPEEDI's information had been calculated by the Nuclear Safety Commission and were distributed to disaster-related organizations every hour from 16:00 on March 11th, the government disclosed the information of SPEEDI to public for the first time on March 23rd, 12 days after the earthquake, followed by the second information release which took place in April 11th [13].

As of September 2011, due to the failures of the contingency/emergency planning support system in Fukushima and Miyagi, no information from measurements of the radiation emission source in nuclear facilities is provided, therefore updating of information stopped [14]. Delay of the publication of data lead to wider radiation exposure to humans [15], and wider damage or contamination to the agricultural products [16]. According to special advisor to the prime minister, the reason for government's withholding the data was 1. the sources of information were not clear thus these data were largely based on assumptions and 2. the government feared panic.

On April 29, a professor at University of Tokyo, Toshiso Kosako resigned from the position of advisor to the government in protest of the government's policy to allow use of the elementary school grounds with limit of the amount of radiation to 20 mSv per year [17]. Kosako criticized the government in terms that their counter measures for nuclear reactor accident did not follow laws, guidelines, nor the manuals, and all these factors resulted in delay of recoveries. Kosako also claimed that the decision-making process was not clear and that the government did not publish the results of SPEEDI. Fukushima governor Yuhei Sato expressed his annoyance for the government saying", we should have instructions from the government on the basis of professional knowledge" [18].

The government was also criticized for controlling and hiding information in fear of panic and harmful rumors arising from the scientifically illiterate people. Every time the government used the word "safe"(and repeatedly so) in their announcements concerning the radiation, people increased their anxiety that the government might be hiding some information. One of the reasons for anxiety was that the Chief Cabinet Secretary who announced the safe declaration separately/without support from NISA and NSC was a not a scientific expert.

While information from the government was far from sufficient, various information and data on influence of radiation on the human body, or on radiation level in the surrounding areas were posted to the Internet without any restrictions. There were many posts by the scientific experts. Seeing this, the president of the Meteorological Society posted a document on the Society's website warning that if the members of the Society provide any information related to disaster measures, that contain uncertainty, this would only confuse people. This in effect was the president's control over the data posted by members of the Society. This warning was criticized on the internet as suspicions of a controlling of information [19].

Generally, when scientific experts regulate scientific information, it helps decreasing uncertainty of the information that circulates in the society. However, in this case, control of information highlighted its negative aspects and was criticized in internet or other media as counter to the trend of

the world.

In response to the warning, some scientists at the University of Tokyo created a web site which posted measured radiation amount with elaborated scientific explanation including how the measuring was done and instruments used for measuring in order to certify the posted data.

Since variety of “scientists” appeared in the media and delivered variety of opinions, it caused confusion to the public [20]. Some internet sites labeled the scientists as "scholars that take sides with the power" if they commented that the radiation level is safe.

Confusion was caused through concealing and controlling of uncertain scientific information although some organization made effort to diminish uncertainty from scientific data by certifying them with their scientific knowledge.

Therefore, in case of making policy decisions that calls for scientific expertise, it will be important to clarify what the basic scientific data can tell, and what decisions come from political judgment based on that data.

Trying to control information on the Internet does more harm than good, so it is desirable that well-known reliable organizations play key roles in delivering elaborated information.

3. Conclusions and implications

The analysis from the boundary functions point of view suggested following implications.

- At present some advisors to Cabinet Secretariat are appointed in the field of science and technology. However, rather than having the advisors who provide personal views or second opinions, considering the nature of scientific information which is highly specialized and complex, it is more appropriate and desirable to appoint science advisors who have explain to the prime minister or to the (political) decision makers, scientific consensus obtained from free discussions by multiple scientists. Moreover the advisors need some councils formed by scientists to help creating qualified consensus.
- In crisis management, to ensure the reliability of scientific organizations, statutory organizations or existing organizations are more suitable rather than new organizations or new personnel. Scientific information should be analyzed by a professional group of those organizations, and it is desirable that they help political decision-making.
- The SCJ, the JST, and some Universities that contributed to restoration from 3.11 disaster have built a relationship of trust with the government and society through their everyday works and rich stock of scientists from variety of fields. Such highly esteemed organizations capable of analyzing scientific data are suitable for providing scientific data to the public. These agencies also have ability of forming consensus among scientists (based on those data) to serve for government decision-makings. The mechanism to provide some raw scientific data to reliable scientific organizations above is needed even if they are independent from the government.
- Since the forecast of earthquakes, measurement of the effects of radiation, and other scientific data contains many uncertainties, there is divergence of opinion on judgment even among scientific specialists. As a result, in face of the 3.11 disaster, it became difficult to accurately explain the situation to the public. To reduce these difficulties and uncertainties, it is important to inform without mixing up political decision making and science data. In announcing political decisions based on scientific data, it is highly recommended that scientists accompany to the announcement venue and answer to questions that need scientific explanations.

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