Proposals for Disaster Countermeasures Based on the Experiences and Lessons Gained through the Kumamoto Earthquake in Japan

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Abstract: This paper aimed to make proposals for disaster prevention and reduction measures based on the experiences and lessons gained through the Kumamoto earthquake. This paper firstly introduced disaster countermeasures of affected local governments within Kumamoto Prefecture. Next, by narrowing the focus on measures concerning the intangible side of things, this paper discussed three points including (1) issues concerning the assumption of disaster countermeasures; (2) issues concerning the BCP (Business Continuity Plan) of both government and private corporations, the DCP (District Continuity Plan) concerning local communities, the CCP (Community Continuity Plan) concerning local communities, and (3) issues concerning disaster countermeasures besides the two issues mentioned above. Based on the discussion results, it was pointed out that the disaster countermeasures assuming complex continuous disasters should be considered.

Keywords: BCP (Business Continuity Plan), DCP (District Continuity Plan), CCP (Community Continuity Plan), advance reconstruction, complex continuous disasters.

1. Introduction

In recent years, various disasters have occurred around the world and some have been caused by climate change. In Japan also, since the Great East Japan earthquake in 2011, floods, sediment disasters and other disasters besides earthquakes have occurred. Throughout Japan, as such disasters have caused damages that surpassed previous expectations, there has been an increase in local governments that are examining local disaster management plans and revising them according to the actual circumstances of the area. Regarding the Kumamoto earthquake in April 2016, aftershocks were still continuing while this paper was being written, and there has caused a great impact on the local community and economy. In addition to the continuous aftershocks in Kumamoto Prefecture, there have been complex continuous disasters including floods and sediment disasters due

to the rainy season and torrential rain in summer as well as the eruption of Mt. Aso.

On the other hand, since the Great East Japan earthquake, the concept of “advance reconstruction” is spreading throughout Japan. This involves the promotion of city planning and actual community development in order to minimize damage with the assumption of a disaster. The above leads to the finding of vulnerable points in local areas in normal times and the minimizing of such points. In addition, advance reconstruction can be placed as part of reducing disasters and developing disaster management communities which are the main disaster management projects of local governments, and the main issues include preparing countermeasures for those vulnerable during disasters, reinforcement of earthquake/fire resistant structures of buildings, expansion of roads, installation of disaster management base facilities, and the grand design to create a national land that can resilient to disasters. Regarding Japan which has had frequent occurrences of various disasters in recent

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years, such disaster countermeasures with the reconstruction in mind for after disasters will be important for the future. Moreover, currently in Japan, the decreasing birthrate and aging population have been rapidly progressing, in addition to marginal villages which cannot maintain its community as well as disappearing villages which have no residents, the appearance of cities with the risk of disappearing have become a source for great concern.

With the occurrence of various disasters including the Kumamoto earthquake, it has become apparent that many of the problems pointed out in the previous disaster countermeasures were left unresolved. Therefore, this paper aims to make proposals for disaster prevention and reduction measures based on the experiences and lessons gained through the Kumamoto earthquake, by introducing disaster countermeasures of affected local governments within Kumamoto Prefecture (Section 2), and narrowing the focus on measures concerning the intangible side of things based on the information provided, as well as considering three points including (1) issues concerning the assumption of disaster countermeasures (Section 3); (2) issues concerning the BCP (Business Continuity Plan) of both government and private corporations, the DCP (District Continuity Plan) concerning local communities, the CCP (Community Continuity Plan) concerning local communities (Section 4), and (3) issues concerning disaster countermeasures besides the two issues mentioned above (Section 5).

2. Disaster Responses of Affected Local Governments within Kumamoto Prefecture

2.1 Disaster Situation

In Kumamoto Prefecture, the foreshock (Magnitude 6.5) occurred at 21:26 on April 14th 2016, and after the main shock (Magnitude 7.3) which occurred at 1:25 on the 16th, aftershocks over seismic intensity level 4 occurred 120 times in April, 8 times in May, 5 times in June, once in July, 3 times in August, and

twice in September. As of October 13th, aftershocks over seismic intensity level 1 occurred 4,087 times. In this way, the Kumamoto earthquake had continuous aftershocks over a long period and, there were many larger scale aftershocks especially in April.

In addition, from the evening of June 20th to the dawn of the 21st in 2016, various areas in Kyushu were hit with torrential rain, and the record for rainfall in June was broken in a single hour. In Kumamoto Prefecture, such torrential rain caused rivers to flood, and various areas within the Prefecture suffered from floods and sediment disaster. Additionally, at 1:46 on October 8th of the same year, there was an explosive eruption at the Nakadake 1st crater of Mt. Aso which resulted in the volcanic smoke reaching a height of 11,000 meters, and its ashes were found even outside of Kyushu. Because the explosive eruption of Mt. Aso occurred after an interval of 36 years, the relevance with the Kumamoto earthquake is still being investigated. In this way, Kumamoto Prefecture has not only had earthquake disasters, but has also had successive disasters such as the flood and sediment disaster caused by torrential rain during the rainy season in addition to the volcanic eruption.

Table 1 indicates human damages, and Table 2 indicates building damages. These tables show that both human and building damages in Kumamoto Prefecture are significantly higher than others, and it also shows that over 430 public buildings were also damaged, aside from over 186,500 houses being damaged. Additionally, as shown in Table 2, the number of damaged houses in Oita Prefecture was not low. Among the fatalities shown in Table 1, 153 were acknowledged as being related to the Kumamoto earthquake, and as 5 died during the torrential rain disaster during the rainy season in June, this was also acknowledged as being related to the Kumamoto earthquake.

2.2 Disaster Countermeasure Plans

Table 3 organizes the establishment status of plans

**Proposals for Disaster Countermeasures Based on the Experiences and Lessons
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Table 1 Human damage (March 14th 2017, buildings).

Prefecture	Dead	Severely injured	Slightly injured
Fukuoka	0	1	16
Saga	0	4	9
Kumamoto	208	1,123	1,552
Oita	3	11	22
Miyazaki	0	3	5
Total	211	1,142	1,604

Note: The cabinet office (2016) Survey on the damage situation regarding the Kumamoto earthquake.

Table 2 Status of damages towards buildings (March 14th 2017, buildings).

Prefecture	Residential damages			Non-residential damages		Fires (cases)
	Completely destroyed	Partially destroyed	Partially damaged	Public buildings	Others	
Yamaguchi	0	0	3	0	0	0
Fukuoka	0	4	251	0	0	0
Saga	0	0	1	0	2	0
Nagasaki	0	0	1	0	0	0
Kumamoto	8,673	33,433	144,402	439	10,590	15
Oita	9	222	8,070	0	62	0
Miyazaki	0	2	21	0	0	0
Total	8,682	33,660	152,749	439	10,654	15

Note: The cabinet office (2016) Survey on the damage situation regarding the Kumamoto earthquake.

Table 3 Establishment status of plans for disaster countermeasures of main affected local governments (December 14th, 2016).

Local governments	Establishment status of disaster management plans
Kumamoto Prefecture	Kumamoto Prefecture civil protection plan
	Kumamoto Prefecture flood management plan
	Kumamoto Prefecture disaster management plan for petroleum industrial complexes and other petroleum facilities
	Kumamoto Prefecture local disaster management plan (general disaster countermeasures edition, countermeasures against earthquake and tsunami edition)
Kumamoto City	Kumamoto City flood management plan
	Kumamoto City local disaster management plan (storm and flood countermeasures edition, countermeasures against earthquake and tsunami edition)
	Plan for individuals requiring support during disasters (Evacuation center installation and evacuation center operation manual)
Uki City	Uki City local disaster management plan (general disaster countermeasures edition, countermeasures against earthquake and tsunami edition)
Uto City	Uto City local disaster management plan (general disaster countermeasures edition, Uto City nuclear disaster countermeasures, and countermeasures against earthquake and tsunami edition)
	Uto City flood management plan
Yatsushiro City	Yatsushiro City local disaster management plan
Mashiki Town	Mashiki Town local disaster management plan
Mifune Town	Mifune Town local disaster management plan
Aso City	Aso City flood management plan
	Aso volcano disaster management plan
	Aso City local disaster management plan (general disaster countermeasures edition, countermeasures against earthquake and tsunami edition)
	Plan for individuals requiring support during disasters

Table 3 continued

Local governments	Establishment status of disaster management plans
Minami Aso Village	Minami Aso Village local disaster management plan (general disaster countermeasures edition, countermeasures against earthquake and tsunami edition)
Nishihara Village	Minami Aso Village flood management plan Nishihara Village local disaster management plan (countermeasures against earthquake and tsunami edition, storm and flood countermeasures edition)

Table 4 Preparation status of disaster countermeasure maps for the main affected local governments (December 14th, 2016).

Local governments	Preparation status of maps for disaster countermeasures
Kumamoto Prefecture	Kumamoto Prefecture integrated disaster information system Sediment disaster information hazard map Information concerning mountain disaster hazard areas
Kumamoto City	Hazard Maps (flood, high tide, earthquake, tsunami, liquefaction) Local hazard maps (created according to each neighborhood association by means of public participation)
Uki City	Hazard Maps (flood, waters, high tide, tsunami, sediment disaster)
Uto City	Hazard Maps (flood, high tide, sediment disaster)
Yatsushiro City	Hazard Maps (flood, high tide, sediment disaster)
Mashiki Town	Hazard Maps (flood, sediment disaster)
Mifune Town	Hazard Maps (flood, sediment disaster)
Aso City	Hazard Maps (flood, earthquake, sediment disaster, volcano disasters)
Minami Aso Village	Hazard Maps (flood, sediment disaster) Evacuation Center Maps
Nishihara Village	Hazard Maps (flood, sediment disaster)

for disaster countermeasures of the main affected local governments within Kumamoto Prefecture. Kumamoto Prefecture and each municipality have developed their local disaster management plans based on the Disaster Countermeasures Basic Act, and have also established plans for flood management measures (Kumamoto Prefecture, Kumamoto City, Uki City, Aso City and Minami Aso Village), and volcano disaster management measures (Aso City). In addition, Kumamoto City and Aso City have established plans for individuals requiring support during disasters, and Kumamoto City has also released its evacuation center installation and evacuation center operation manual. However, mainly assuming storm and flood instead of earthquake disaster, the local disaster management plans of most local governments in Kumamoto Prefecture were established.

2.3 Hazard Map

Table 4 summarizes the preparation status of

disaster countermeasure maps for the main affected local governments. Although the local governments have prepared hazard maps with flood and sediment disaster as its target, only Kumamoto City has prepared hazard maps with earthquakes in addition to these disasters as its target. In addition, by means of public participation, Kumamoto City also prepared local hazard maps according to each neighborhood association. On the other hand, Kumamoto Prefecture has developed a Kumamoto Integrated Disaster Information System, and information concerning mountain disaster hazard areas is also provided.

3. Issues Concerning Assumption for Disaster Countermeasures

3.1 Disaster Occurrences

Regarding disaster occurrences, the following four points are important, and countermeasures for complex continuous disaster which have been frequently occurring in recent years will be especially

important in the future.

3.1.1 Introducing the Concept of “Precautionary Principles”

Having disaster countermeasures based on precautionary principles from normal times are important, and advance reconstructions as well as reconstructions after disasters based on this are necessary. Regarding advance reconstructions in normal times, as it involves grasping local vulnerabilities and assuming the damage caused when disaster occurs as well as planning for reconstructions, it may be the greatest disaster countermeasure.

3.1.2 Implementing Disaster Impact Assessment and Disaster Risk Assessment Concerning Various Fields

In Japan, concerning prefectures and cities designated by government ordinance, the environmental impact assessment is always conducted before a new project is implemented. In order to apply such a system in disaster countermeasures, a disaster impact assessment, which assesses what kind of disaster will cause what kind of damage as well as the location of the disaster, will be necessary. In addition, as well as the disaster impact assessment, the risk assessment on what kind of disaster is likely to occur is also important.

3.1.3 Assuming Continuous Long Term Aftershocks

The past disaster countermeasures were not taken cases such as the Kumamoto earthquake where the aftershocks continued for a long period of time into consideration. Therefore, regarding disaster countermeasures which cover various fields, consideration of countermeasures for long-term continuous aftershocks is required. Thus, as it will be explained in detail in Section 5, efficient use of past disaster records and data for each area is necessary, and the participation of scientists from fields such as history, paleography and archaeology, in research on disaster science is anticipated.

3.1.4 Disaster Countermeasures based on the Assumption of Complex Disasters

Countermeasures must expect disasters to happen at

any time and location. Especially in Japan, the possibility of assuming that a meteorological disaster caused by the natural environment in addition to a general disaster will happen at the same time must be taken into consideration with characteristics of natural environment of each area. Additionally, the possibility of complex disaster countermeasures becoming a tradeoff, or in other words, the possibility of conflicts arising between each disaster countermeasure, must be taken into consideration.

3.2 *Complex Disasters*

Regarding countermeasures for complex disasters which are occurring more frequently worldwide in recent years, the following four points can be raised.

3.2.1 Assumption of Complex Disasters Happening Simultaneously or Successively

Although complex continuous disasters have been occurring, it has never been sufficiently considered in local disaster management plans. Therefore, concerning each area, being aware of what disasters are likely to occur as well as what kind of meteorological disasters are likely to happen at what time, and appropriately reflecting such information in local disaster management plans is necessary.

3.2.2 Necessity for Considering the Time Scale of Complex Disaster Occurrences

For example, the Kumamoto earthquake had floods, sediment disasters and volcano disasters, and the Niigata Chuetsu earthquake (2004) had sediment disaster as well snow disasters before the earthquake occurred. Such continuous occurrences of complex disaster as shown in these examples may cause reconstructions to delay. Therefore, regarding local disaster management plans, if the occurrence of complex disasters is assumed, the times scale of each disaster occurrence must be considered.

3.2.3 Relevance between Complex Disasters

There are cases where the relevance between complex disasters are clear and cases where they are not. For example, as the relevance between an

earthquake and tsunami is obvious, countermeasures for tsunamis must be conducted especially in coastal areas in the case of an earthquake. However, because the relevance between earthquake and volcano disasters is still unclear, countermeasures based on the latest scientific findings in the related field must be considered.

3.2.4 Complex Disaster Impact on the Reconstruction

When complex disasters occur as mentioned above, the impact on reconstructions in the affected areas is greater than that of a single disaster. Therefore, by grasping specific disaster risks according to the area, the consideration of the possibility of complex disasters occurring is necessary. In areas with a higher risk of having complex disasters, the assumed damage results should be reflected in the development of local disaster management plans, advance reconstructions, awareness raising and knowledge dissemination on disaster reduction, disaster management education, development of disaster management leaders and every drill. In addition, in such areas, the current situation of not only the local natural environment but also the condition of community and economic environment (population decline and population aging) must be considered.

3.3 *Review of Assumptions for Disaster Countermeasures*

The following three points are necessary for the review of disaster countermeasure assumptions, and the difference in roles must be considered on a national and local government level.

3.3.1 Review of Disaster Assumption

Instead of establishing plans or legal systems, disaster assumptions must be reviewed whenever necessary according to changes in the natural environment and community and economic environment as well as the latest academic findings.

3.3.2 Review of Disaster Countermeasure Assumption on a National Level

As well as reviewing the Large-scale Earthquake

Countermeasures Act and expanding the target to the Great Nankai Trough Earthquake, the propriety of the law itself was discussed. Additionally, concerning the disaster management plan, based on the lessons learned from the torrential rainfall in Kanto and Tohoku (2015), locations where there is a possibility for water to reach the second floor were indicated in the hazard maps, and points to urge early evacuation of residents were changed. In this way, the review of disaster countermeasure assumptions on a national level are especially important, as it greatly affects the disaster countermeasures of local governments.

3.3.3 Review of Disaster Countermeasure Assumption on a Local Government Level

As stated in Section 2.2, as the local disaster management plan (storm and flood countermeasures edition, and countermeasures against earthquake and tsunami edition) of Kumamoto City was developed based on the storm and flood disaster edition and the earthquake and tsunami edition is mainly composed by referring to it. Therefore, this made the issues such as evacuation centers not having enough stockpile to accommodate the evacuees arouse at the time of the Kumamoto earthquake were raised. Therefore, countermeasures concerning earthquake and tsunami must be mentioned thoroughly in local disaster management plans.

3.4 *Utilization and Application of Information Technology*

As part of the disaster countermeasures, considering the development status of information technology in Japan, the following three points are considered necessary.

3.4.1 Countermeasures Taking into Consideration the Advanced Information Network Society in Japan

Strengthening the nationwide information infrastructure is important, and the improvements of an information environment (electricity, internet, information terminals, etc.) that can be used even during disasters are anticipated [1]. In addition, when

the land information network is not available after the earthquake, the satellite communication network must be improved in order to be available for use in such situations.

3.4.2 Strengthening the Government's Means of Information Communication

It must be assumed that many will try to access the government website when disasters occur. If government information communication means are stopped, this may not only obstruct disaster countermeasures but daily tasks as well. There were cases concerning the Kumamoto earthquake where several local government websites crashed due to access concentration. Additionally, some local governments operated their websites in emergency mode after the disaster, and information obtainment from the website was made difficult. Therefore, by strengthening the means of information communication of local governments from normal times and sharing data with related local governments, developing a system where unaffected local governments can take over the role concerning information communications during disasters is expected.

3.4.3 Effective Utilization and Application of Social Media

During the Great East Japan Earthquake, not only was social media used as a means of information communication and obtainment [2], but also a collaboration system with mass media centered upon TV was created. In times of disasters, such collaborations between social media and mass media are important. Taking into consideration real time in the affected local governments, information communication using Twitter is anticipated.

In addition, in order to have the public play their role as social sensors by providing disaster information as knowledge gained through life experiences, social media can be an effective method. However, in order to prevent false information from circulating, having a supervision and regulation

system is essential. Also, demands of relief supplies from individuals or evacuation centers using social media must be regulated in order to prevent confusion in the distribution system.

3.5 Responding to Disaster Victims and Supporters

Regarding disaster victims and supporters, the following two points must be especially considered in the future.

3.5.1 Consideration for the Health Conditions of Disaster Victims and Supporters

As part of disaster countermeasures, not only injuries but the mental state of individuals must also be taken into consideration. Among the disaster victims, particularly children, elderly people and handicapped people, experiencing disasters or living in evacuation centers for a long period of time can have a great negative impact. In addition, concerning supporters coming from other areas, seeing the damaged state of the affected areas can be a big shock, and this may affect their mental and physical state. In short, under the unusual circumstances of the affected areas, the impact long-term reconstructions can have on disaster victims in addition to the supporters must be thoroughly considered.

3.5.2 Consideration towards Japanese Tourists, Foreigners and Handicapped People

Sufficient consideration towards Japanese tourists, foreigners (both long-term residents and tourists), and handicapped persons and patients who have become disaster victims is required. Therefore, disaster countermeasure with an inclusive design with various people as its target must be developed. In view of the Tokyo Olympics and Paralympics (2020), countermeasures for foreign tourists, which are expected to increase, will be especially important. Although each local government has developed plans for individuals requiring support during disasters with handicapped people as its target, having a constant supportive system in the community is also important.

4. Issues Concerning the BCP of Government and Private Enterprises, DCP of Local Communities and the CCP of Local Communities

4.1 BCP Concerning Governments

The government BCP is especially important, and disaster countermeasures for the following eight points must be conducted.

4.1.1 Government BCP

In past disaster examples, because disaster emergency response and the reconstruction progress were fast in cases where the government buildings of affected local governments were safe, earthquake resistant government buildings must be promoted as soon as possible. In addition, in times of disasters, it is important for each local government to immediately receive support from public and private sectors outside of the affected areas. Thus, it is necessary to unify the various systems including applications for residents throughout Japan so as that temporary staffs from other local governments can take over some tasks in the affected areas.

4.1.2 Expediting Reconstructions by Means of Government ICT (Information and Communication Technology)-BCP

Because government data (both digital and paper) accumulated thus far will be damaged if local government buildings are damaged, the backup system for government data must be fully equipped before the occurrence of disaster as stated in Section 3.4. In addition, because the implementation of an accurate and fast survey of the damage condition is needed, satellite and aerial photographs should be utilized more effectively. Furthermore, the applying and issuing process for disaster certificates should be computerized by utilizing the modern Cloud computing technology. There is a need for the speedy promotion of ICT-BCP by means of the cooperation with not only the government but with other entities (residents, corporation, universities and research

institutions, etc.) within the local community from before disasters occur.

4.1.3 Improvements of Designated Evacuation Centers

Because many of the designated evacuation centers were unavailable during the Kumamoto earthquake, the promotion of earthquake resistance of designated evacuation centers should be prioritized. Designated evacuation centers must be equipped with emergency stockpile including food and water from normal times. Additionally, revising the sending method of relief supplies from non-affected areas as well as having nearby local governments in non-affected areas to take over the receiving and sorting work for relief supplies can be a way to improve the distribution system for relief supplies, as described in Section 3.4.

4.1.4 Ensuring the Safety of Evacuation Centers

Ensuring safe evacuation centers are necessary for both public and private facilities. It is important to choose evacuation centers, with the assumption that it will become a mid-to-long term residing place, and prepare the necessary facilities and supplies. The increase of the aging population must also be considered in the future and evacuation centers will need to be equipped with the universal design. In addition, if those with handicaps become disaster victims, it will be difficult for such individuals to stay mid-to-long term in standard evacuation centers. Therefore, the preparation of welfare evacuation centers is needed for such individuals. Fig. 1 shows the welfare evacuation center in Mashiki Town, Kumamoto Prefecture, and securing such special facilities must be taken into consideration.

4.1.5 Evacuation Drill and Evacuation Center Drill

Along with the need for evacuation center drills as well as evacuation drills, the preparation of evacuation center manuals for each local government is also necessary. However, if it is difficult for each local government to create manual, manuals of advanced local governments such as Tokyo Metropolis and Kawasaki City can be applied. By actually using these

Fig. 1 Welfare evacuation center for handicapped people in Mashiki Town, Kumamoto Prefecture (August 2016).

manuals in evacuation center drills, the drills will be more adequate and realistic. Because there is a possibility that evacuation center operation during disasters will be overseen by staffs that are not in charge of disaster management, all staffs must be familiarized with the manual.

4.1.6 Utilization of Personal Identity Numbers Nicknamed as “My Number”

As the purposes of using personal identity numbers, the confirmation of identification and qualifications of supporters (medical staffs, volunteers, etc.), the confirmation and management of places where evacuees are staying and their destinations, and the management of evacuation centers can be considered. For example, in Sanjo City of Niigata Prefecture, because the area has many flood disasters, an evacuation drill using the personal identity number was held in June 2016. Concerning the introduction of the personal identity numbers, various authentication methods using cards, smartphones and bio-information must be considered.

4.1.7 Cooperation and Role Division between Local Governments inside and outside the Affected Areas

A wide area cooperation system between local governments must be established during normal times in preparation for disasters. Concerning past examples of disasters, although disaster countermeasures were

conducted by local governments in the affected area, the dividing of roles between such local governments and supporting local governments nearby must be considered. Due to the spread of Cloud computing in modern society, appropriate role division arranged between the affected and supporting local governments will make the acceleration of the reconstruction work possible.

4.1.8 Establishing a Wide Area Cooperation System

If the area affected by a disaster is wide area, wide area evacuation is also necessary. For example, assuming a volcano disaster, the committee of disaster management for Mt. Fuji was established in 2014 by means of the wide area cooperation of Tokyo Metropolis, Kanagawa Prefecture, Yamanashi Prefecture, Shizuoka Prefecture, vicinity municipalities, the cabinet office, the Ministry of Internal Affairs and Communications, and the Ministry of Land, Infrastructure and Transport. The Mt. Fuji volcano wide area evacuation plan was also discussed at this committee, and joint disaster reduction drills with the government, Kanagawa Prefecture, Yamanashi Prefecture and Shizuoka Prefecture are being held since 2014. In addition, concerning the Kansai area including Shiga Prefecture, Kyoto Prefecture, Osaka Prefecture, Hyogo Prefecture, Nara Prefecture, Wakayama Prefecture, Tottori

Prefecture, Tokushima Prefecture, Kyoto City, Osaka City, Sakai City and Kobe City, the Kansai Wide Area Union was established in 2010 in order to solve administrative issues extending over a wide area which each individual local government cannot deal with. Regarding disaster countermeasures, the Kansai Wide Area Union has promoted the disaster prevention and reduction plan in Kansai as well as providing support concerning the Great East Japan earthquake by means of the counterpart method. As the decrease of the birth rate and increase of the aging population progress in Japan, unassisted implementation of disaster countermeasures during disasters becomes difficult for small-scale local governments, thus having such a wide area cooperation system in preparation for disasters is important.

Disaster reduction drills by means of wide area cooperation are conducted in areas close to nuclear power plants. For example, in November 2016, the Japanese government and Hokkaido Prefecture conducted a nuclear disaster reduction drill assuming an accident at the Hokkaido Electric Power Tomari Nuclear Power Plant (Tomari Village). As with the Great East Japan earthquake, the drill was conducted with the assumption of a complex disaster which included an earthquake, tsunami and an accident at the nuclear power plant, and an evacuation drill for residents living close to the nuclear power plant as well as evacuation guidance for foreigners were conducted. In addition, drills with the harsh weather conditions of Hokkaido Prefecture taken into consideration, which include evacuation in blizzards and removing of snow, are scheduled to be conducted. Additionally, Ehime Prefecture with the participation by Oita Prefecture, Yamaguchi Prefecture and the Japanese government, conducted a nuclear disaster reduction drill assuming a disaster at the Shikoku Electric Power Ikata Nuclear Power Plant on the Sadamisaki Peninsula of Ikata Town, Ehime Prefecture. This drill involved the evacuation of

residents living around the nuclear power plant to Oita Prefecture by boarding private ferries and patrol boats of Ehime Prefecture. Such evacuation drills by means of wide area cooperation should be conducted worldwide based on the assumption of disasters that could occur according to local natural conditions.

4.2 Local DCP and Local Community CCP

Disaster countermeasures should be implemented in the order of self-help, mutual-help and lastly public help. Because the disaster countermeasures are primarily for the residents and community, the following five points must be considered when implementing the disaster countermeasures.

4.2.1 Cultivating Awareness towards Disaster Countermeasures

Although the theory of disaster countermeasures based on the lessons learned from past disasters already existed, because it was not put into practice, awareness of not only the government but also society as a whole in addition to individuals must be cultivated. For example, with disaster countermeasures for Kumamoto Prefecture, the previous main targets were typhoons, torrential rain and volcano disasters. Although earthquakes had happened before, because its risk was not fully recognized, this became a problem at the time of the Kumamoto earthquake.

4.2.2 Self-help

As the most basic method of self-help, the implementation of earthquake-proofing examinations and retrofit of house, and furniture overturning prevention by each household, as well as the sufficient preparation of necessary supplies by residents and community are important.

4.2.3 Mutual-help

Right after the Kumamoto earthquake, mutual-help was provided through relief and rescue operations. However, if voluntary disaster management organizations in the community are in name only, they may not function during disasters. Therefore, there is a

need to train disaster management leaders in each community before disasters occur in order to increase the chance of the voluntary disaster management organizations actually functioning during disasters.

4.2.4 Evacuation Centers

It is important to take into consideration diversity and family structures concerning location and role division. However, regarding those vulnerable during disasters including patients and elderly people, considering the health condition of such ones, a temporary transfer to unaffected areas will be considered. In addition, because evacuation center operation with the incorporation of women's opinions is important during disasters, the active participation of women in community organization activities should be promoted. The reasons for this are that, in past disaster examples, in addition to the importance of the roles of women in order to continue daily activities in the evacuation centers, there were many cases where supplies for women were put off when obtaining relief supplies.

Additionally, regarding evacuation centers, whether relationships in the community which is a unit of everyday life can continue is important. In order to prevent and control various crimes, countermeasures by not only the government, police and fire departments, but also residents as well as the community based on such human relationships are important. In addition, although many in recent years consider their pets as parts of their family, because there are few evacuation centers that allow pets, many were prevented from staying in the evacuation centers. There are also cases where pets left without their owners are wandering around the affected areas. Therefore, there is a need to consider having evacuation centers which allow pets.

4.2.5 Life after the Disaster in the Affected Areas

As shown in Section 2.1, disaster related deaths concerning the Kumamoto earthquake have increased, and the number of deaths of elderly people is especially high. Therefore, instead of relying on

correspondence by the government and medical institutions, a protective system with the cooperation of various entities in the local community must be established. Additionally, because there are crimes directed at damaged buildings, an alert system by not only the government, police and fire departments, but also the disaster victims themselves as well as the community must be established.

4.3 *Government BCP, Local DCP and Local Community CCP*

Concerning the government BCP, the community DCP, and the local community CCP, because the following three points are all important, disaster countermeasures with the cooperation of various entities in the local community are necessary.

4.3.1 Receiving Volunteers

In times of a disaster, self-contained volunteers who can prepare their own necessities are essential so as not to burden the affected area. In addition, as there may be a mismatch of supply and demand between the volunteers and disaster victims, it is necessary to grasp the needs of the victims and have people responsible for the adjustments in order for volunteers to be sent to areas needing help [1].

4.3.2 Establishing a Logistic Support System

It is best to establish a wide area cooperation system between local governments during normal times, and be able to establish a logistic support base close to the affected area right after a disaster. For example, Tono City of Iwate Prefecture became the logistic support base for affected coastal areas after the Great East Japan earthquake, and both officials and local people cooperated together in the logistic support activities. In the basic regulations for disaster management established in 2014, logistic support activities were incorporated based on the experiences and lessons gained through the Great East Japan earthquake. As the background for this, with the purpose of the early development promotion of Sanriku earthquake disaster logistic support base

facilities in 2007, Tono City established a promotion council with nine municipalities of the Iwate Coastal areas. In 2008, this council proposed the logistic support base facility development to the government and conducted various disaster reduction drills. Concerning the support for the affected coastal areas in the Great East Japan earthquake, the logistic support system by means of wide area cooperation as mentioned above functioned effectively with Tono City as its base. Therefore, as shown in the example of municipalities in Iwate Prefecture, the wide area cooperation system should be established early in other areas.

4.3.3 Roles of Information Volunteers and GIS (Geographic Information Systems) Volunteers

In cases where information in the affected areas is hard to obtain, supporters with the role of communicating information to the disaster victims from outside the affected areas using ICT are necessary. Additionally, supporters to provide support in the affected areas by providing free information systems for the reconstruction are also necessary. According to Yamamoto, K. [3, 4], such supporters are called information volunteers, and these new-type volunteers using ICT are becoming widespread. Because GIS is effective during disasters, volunteers using this are called GIS volunteers.

4.4 BCP of Private Enterprises

For private enterprises, as business continuity and countermeasures for employees are important, the following two points must be considered when conducting disaster countermeasures.

4.4.1 Preparing the BCP Concerning Private Enterprises

Based on the lessons learned from the Great East Japan earthquake, preparing BCP with the relationship between related enterprises taken into consideration is important. Even in the case of Kumamoto earthquake, many companies and factories had to shut down. In order to reconstruct businesses of each enterprise as

soon as possible, the sustainment of BCM (Business Continuity Management) concerning each enterprise, office and factory, is necessary. In addition, regarding sightseeing areas, as disasters greatly impact the local economy, BCP of tourist enterprises are important in order to start inviting tourists again as soon as possible [5].

4.4.2 Countermeasures for Those Who Have Difficulty Going Home

Taking into consideration the traffic conditions (using public transportation or cars) of locations, private enterprises must conduct countermeasures for those having difficulty going home. Especially with enterprises located in the suburbs, because most workers commute by car, it is particularly important to prepare supplies in order for people to temporarily stay within the buildings after the disaster.

5. Other Issues Concerning Disaster Countermeasures

Aside from (1) issues concerning disaster countermeasure assumption (Section 3) and (2) issues concerning BCP of government and private enterprises, DCP of local communities, and CCP in local communities (Section 4), the following points (disaster preparedness in normal times, recovery and reconstruction measures, and research on disaster science) are raised.

5.1 Disaster Preparedness in Normal Times

5.1.1 Enhancing the Intangible Side of Disaster Countermeasures Concerning Advance Reconstructions

Although countermeasures concerning the tangible side of things were focused on in past advance reconstruction works, based on the experiences and lessons gained through past disasters, there is a need to focus more on the intangible side of things such as plans, systems and structures in the future. Also, promotion of awareness raising and knowledge dissemination on disaster reduction in the community and workplaces as well as disaster management

education in schools should be included in intangible countermeasures.

5.1.2 Development and Inheritance of Disaster Management Culture

In order not to forget the experiences and lessons gained through past disasters, the development and inheritance of disaster management culture is important. For example, in Gamagori City of Aichi Prefecture, the experience of the Mikawa earthquake in 1945 is being passed down to children through picture-story shows made by citizen organizations. Also, in Hirogawa Town of Wakayama Prefecture, there is a story based on the Nankai earthquake and tsunami in 1854 called “The fire of rice sheaves”. This story was on every textbook in Japan before the World War II, and it was a significant tool to teach the next generation about the importance of being cautious of tsunamis after an earthquake and evacuating as soon as possible. The story has recently been drawing attention again, and it has spread not only in Japan but also to countries including Indonesia. In connection with this story, November 5th, which is when the Nankai earthquake and tsunami occurred, was set as the “International Tsunami Day” of the UN (the United Nations) common memorial days from 2015.

5.1.3 Promotion Concerning the Utilization and Application Method of ICT

In order to prevent those with inadequate information to become vulnerable during disasters, the promotion of the utilization and application of ICT by means of the government and NPO (Non Profit Organization) as well as the establishment of a support and cooperation system among residents from normal times are necessary.

5.1.4 Utilization and Application of Hazard Maps

Because hazard maps have not been effectively utilized in Japan until now, information concerning hazard maps must be widely provided. Additionally, hazard maps should be utilized and applied in school education for children.

5.1.5 Scientific Literacy Improvement of the Public

Concerning the Kumamoto earthquake, the reading method for the seismic movement prediction maps was raised as an issue. More specifically, in the case of active fault earthquake, because possibility for it to occur in the next thirty years is shown in small numerical values, people who mistakenly thought that the number of earthquakes were low became common. From this example, as part of the disaster countermeasures, the improvement of the scientific literacy of the public is desired.

5.2 *Recovery and Reconstruction Measures*

5.2.1 Reconstruction Work Taking into Consideration Correspondence for the Natural Conditions in the Affected Area

Risks are assumed to increase due to the weather in the affected areas. Therefore, in order to prevent secondary disasters, the reconstruction work must be conducted taking into consideration the natural conditions in the affected areas.

5.2.2 Appropriate Development of Temporary Houses

In order to continue everyday activities in the temporary houses and prevent isolation and solitary deaths of single ones, as much as possible, living together as a community is important. With elderly people as the main target, buses that go from the temporary houses to public facilities, medical facilities and commercial facilities should be provided. Depending on the natural and social conditions, if the building of temporary houses is difficult, the provision of public housing and considering the use of private houses as temporary housing are necessary. In addition, it is necessary to consider the age structure of disaster victims and develop temporary houses for elderly people.

5.2.3 Sending Local Government Staffs from Unaffected Areas to the Affected Areas

The sending of local government staffs will result in not only the affected local governments receiving

support but also the staffs obtaining know-how on disaster countermeasures through OJT (On-the-Job Training). However, it is best to also have staffs who have worked in the local governments of the disaster affected area and are familiar with the tasks related to recovery and reconstruction.

5.2.4 Establishing a System to Support Supporters

It is difficult for disaster victims and supporters of the local governments in the affected areas to fulfill important roles by themselves over a long period of time. Therefore, in order for supporters to play their role in an efficient and effective way, the establishment of a system that can support such ones is necessary.

5.2.5 Making of Dialect Collections for Supporters from Different Areas

In past disaster examples, there were cases where medical staffs from outside the affected areas were not able to understand the dialect of especially elderly people, and this hindered the medical treatment. Therefore, there is a need for local people or those in nearby areas to create a dialect collection and to distribute this to supporters coming from outside the affected area.

5.3 *Research on Disaster Science*

5.3.1 Collection and Storage of Various Public and Private Data Related to Disasters

Because the various public and private data related to disasters are not stored in one place, by collecting and storing the information, it should be archived and shared among public and private sectors. Such archived past disaster data can be reflected in future disaster countermeasures.

5.3.2 Promotion of Research on Disaster Science by Means of the Cooperation of Various Academic Fields

Although research on disaster science has been promoted mainly in the science and engineering field, because the damage that is caused varies, this research in humanities and social sciences should be promoted. In addition, the further promotion of research on disaster science by means of the cooperation of various

academic fields is important. For example, academic fields such as historical science, paleography and archaeology have contributed to research on disaster science. In previously affected areas, as experiences and lessons gained through disasters are passed down through records and documents, oral tradition and monuments, it is important to apply the research results concerning these in disaster countermeasures [6, 7].

For example, Fig. 2 shows the Namiwake shrine in Wakabayashi Ward of Sendai City, Fig. 3 shows the stone monument stating “Do not build houses below this point” located on Omoe Peninsula of Miyako City, Iwate Prefecture, and Fig. 4 shows the famous “Oriishi” on Karakuwa peninsula of Kesennuma City, Miyagi Prefecture. The name of the Namiwake shrine in Fig. 2 comes from when giant tsunami of Sanriku earthquake (869) was divided at this point. Although the linear distance of this shrine from the shore was approximately 5.5 km, the giant tsunami in the Great East Japan earthquake also reached this point. Therefore, this shrine was built in order to teach future generations the damage caused by great earthquakes and giant tsunamis, and the appropriateness of this message was evident by means of the Great East Japan earthquake. Regarding the words engraved in the stone monument as shown in Fig. 3, it shows how the giant tsunami reached this point of the mountain in both the Meiji Sanriku earthquake (1896) and the Showa Sanriku Great earthquake (1933), and the whole village was wiped out. This message on the stone monument is famous as a warning from our ancestors to the future descendants, and it was widely reported on in both inside and outside Japan. In addition, stone monuments of the same type were placed in many places along the Sanriku coast, and the misery of the impact the great tsunami had on this area is evident. The Oriishi as shown in Fig. 4 was named after 2 m of the tip was broken by the Meiji Sanriku Giant Tsunami. Because the Oriishi survived the giant tsunami of the Great East Japan earthquake, it has become the symbol for reconstruction.

Fig. 2 Namiwake shrine in Wakabaku, Sendai City, Miyagi Prefecture (October 2011).

Fig. 3 Stone Monument Stating 'Do not build houses below this point' in Miyako City, Iwate Prefecture (September 2011).

Fig. 4 The famous "Oriishi" in Oogama Hanzo of the east coast of Karakuwa peninsula, Kesennuma City, Miyagi Prefecture (July 2016).

5.3.3 Information Transmission Regarding Disaster Countermeasures to Other Countries

By communicating information concerning disaster countermeasures of Japan to other countries (especially developing countries), it is anticipated that it can be utilized in disaster countermeasures of countries that experience many severe disasters. Additionally, by collecting information regarding disaster countermeasures of other countries in Japan and applying them in future disaster countermeasures, the national land will be further strengthened.

6. Conclusions

Because disasters are easily caused by geographical, topological and methodological conditions in Japan, this country has been called a “Disaster Nation”, and disaster countermeasures have always been an important issue in every region. Especially when the Great East Japan earthquake occurred in March 2011, the giant tsunami was combined with the nuclear power plant disaster within Fukushima Prefecture, and the reconstruction of the great damage caused is still ongoing to this day. In addition, because the nuclear power plant disaster resulted in the financial damage caused by misinformation, and farming industry as well as tourism industry in Fukushima Prefecture and its neighboring areas also suffered great damage.

Under such circumstances, Mt. Ontake in both Gifu and Nagano Prefectures had a phreatic eruption at volcanic level 1 in September 2014 which resulted in deaths of 58 hikers, and this was the worst volcano disaster in Japan since the World War II. As a few other volcanos are also active, the risks of volcano disasters must be considered. In August of the same year, sediment disaster was caused by regional torrential rain mainly in Hiroshima City, and this resulted in large-scale human damage. Additionally, the Kumamoto earthquake occurred in April 2016, and this resulted in complex successive disasters including flood and sediment disaster which were caused by the torrential rain due to the rainy season as well as the

successive occurrence of the volcanic eruption. In addition to the above, great damage was caused by typhoons in both Iwate and Hokkaido Prefectures in September of the same year, and not only did the farming industry suffer great damage, but it also resulted in human damage. As the regions affected by the typhoon are also heavy snowfall zones, damage by snowfall during winter is also a point of concern. Additionally, the Tottori Chubu earthquake occurred in October of the same year, and the white walled dozos which is a famous tourist spot in Kurayoshi City suffered great damage as a result. The disasters mentioned above are disasters that occurred recently in Japan, and there are many other disasters in other countries which are too numerous to mention. While this paper was written, a large-scale earthquake occurred in other countries such as New Zealand, Indonesia and Chile.

With the disasters mentioned above starting with the Kumamoto earthquake as a turning point, it is important to find issues in disaster countermeasures and improve them. In addition, concerning the issue of decreasing birth rate and aging population in Japan, this must be considered anew for disaster countermeasures. Based on such backgrounds, this paper focused especially on the intangible side of the countermeasures, organized the information into three points, including (1) issues concerning the assumption of disaster countermeasures, (2) issues concerning BCP of government and private enterprises, DCP of local communities and CCP of local communities, and (3) issues concerning disaster countermeasures aside from the two points mentioned above, and made proposals for disaster countermeasures based on the experiences and lessons gained through the Kumamoto earthquake.

As future research subjects, based on the discussion results of this paper, the disaster countermeasures assuming a complex disaster, as pointed out in Sections 3.1 and 3.2, will be considered. Concerning Japan, because various disasters have occurred more

frequently in recent years, although it is important to have disaster countermeasures which consider the possibility of complex continuous disasters, each countermeasure differs greatly according to the characteristics of each disaster. Therefore, sufficient consideration about the possibility of conflicts arising between individual disaster countermeasures must be made.

References

- [1] Yamamoto, K. 2011. "Great East Japan Earthquake Proposal: Construction of Local Information Databases as Information Infrastructure." *Planning Administration* 34 (3): 11.
- [2] Yamamoto, K. 2012. "Effective Use of Information Systems for Reconstructions." In *Proposals for the Reconstruction Work of the Great East Japan Earthquake*, edited by Kaji, H., Izumi, J., and Yamamoto, K. Tokyo: Gihodoshuppan.
- [3] Yamamoto, K. 2013. "Volunteer Activities." In *Reconstruction Starts from Human Development-A Special Lectures by 15 University Faculty Volunteers*, edited by the Iwate Higher Education Consortium. Morioka, Iwate: The Iwate Higher Education Consortium.
- [4] Yamamoto, K. 2013. "Volunteer Activities in Time of Disaster in Japan's Highly Information-Oriented Society." *Journal of Earth Science and Engineering* 3 (3):190-202.
- [5] Yamamoto, K. 2012. "Sustainable Regional Revitalization Using Natural Environmental Assets for the Reconstruction of the Great East Japan Earthquake." *Planning and Public Management* 35 (2): 17-20.
- [6] Yamamoto, K. 2012. "Using Information Systems for Recovery and Reconstruction after the Great East Japan Earthquake." *Joint Conference Proceedings 9th International Conference on Urban Earthquake Engineering/4th Asia Conference on Earthquake Engineering*, 1841-7.
- [7] Yamamoto, K. 2012. "GIS as an Information Infrastructure for Recovery and Reconstruction after the Great East Japan Earthquake." *Journal of Earth Science and Engineering* 2 (8): 461-71.