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Dealing with Relief Supplies When Shelters Are at Risk of Becoming Isolated: Discussion of Current Japanese Practice

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ABSTRACT

Relief supplies stored at shelters may be the only available supplies if shelters become temporarily isolated and inaccessible from outside after a disaster. These supplies become absolutely essential and thus the types and quantities require careful consideration, especially in places that are at high risk of becoming isolated. This issue becomes even more important when vulnerable people are in the isolated shelters. It is a duty of society to take care of victims of disaster. On the other hand, when the number of evacuees in the isolated shelter is more than expected or when the isolation period is extended, a proper management plan is required. The plan should consider how the other shelters and/or municipalities can help when a municipality has lost its functionality after a disaster. It seems that collaboration between municipalities on a small scale operated well during the aftermath of the 2011 Great East Japan Earthquake; however, there is still a need to extend the scale to cover the entire country to increase the efficiency. This paper provides a discussion of the above issues based on current Japanese practice, which can be adapted to other countries as well.

Keywords: Relief supplies, shelter, human rights, humanitarian logistics

1. Introduction

When a shelter becomes temporarily isolated, evacuees have to rely on the goods stored at the shelter until aid can reach the shelter from outside. Thus, the goods stored at the shelter must be of sufficient quantity. On the other hand, as evacuees are different in characteristics, we should avoid storing uniform goods for a better response to the different needs of evacuees.

Unlike earthquakes, hurricanes or typhoons can sometimes be predicted in advance and thus arrangements such as safe shelter locations, relief supplies, and so on can be prepared well before the event. In this case, the designated shelters are less likely to become isolated after the disaster. However, disasters like downpours, landslides, earthquakes, and tsunamis happen suddenly, and the level of damage and exact location are rather difficult to predict in advance. Thus, the designated shelters may flood due to the disaster and/or become temporarily isolated due to damage to important infrastructures. At locations with a high risk of isolation, it is very important to prepare storage of some basic relief supplies at the shelters in adequate amounts, at least to secure victim survivability until aid from the outside can reach the shelter. In other words, the authors suggest preparing storage at all possible isolated shelters if the region is at risk of a disaster whose prediction in advance is difficult. However, we still need to investigate the types of supplies to be stored that are suitable for various types of victims including vulnerable people.

In August, 2012, the Japanese Cabinet announced a guideline for a good quality of life at shelters as several problems occurred during the 2011 Great East Japan Earthquake. The guideline divides the operation within the shelters into two phases: 1) immediate response and 2) after settling down. This paper aims to discuss the problems and logistics issues during the immediate response period when saving lives should be the utmost priority. However, during this phase, shelters may be damaged and become

temporarily inaccessible from the outside due to flooding as an example. It is necessary to prepare for this possibility. In countries prone to sudden disaster such as Japan, we should not expect all inhabitants to carry relief supplies at all times and should pay more attention to the possibility of shelters becoming isolated. This paper will discuss the types of relief supplies to be stored and the method of distribution, concerning priority and the Cabinet guideline.

This paper is organized as follows: the various characteristics of victims, the types and the quantity of goods to be stored, and the priority for distributing the goods to evacuees are discussed. Next, as operational efficiency can be improved through collaboration, issues regarding collaboration among municipalities and the rules to be considered for collaboration are explored. Finally, methods of efficiently supplying goods from outside are examined.

2. The storage of relief supplies

2.1 Who requires the aid?

Evacuees at a shelter are mainly local people in the region, although some evacuees might come from other regions. A clear understanding of the type of people in the region can help in deciding the appropriate types of goods to be stored at the shelters. Evacuees from other regions are possibly tourists and visitors, and it is rather difficult to predict the characteristics of these people. It is possible to predict the characteristics of local people from the population structure of the region. With knowledge of the characteristics, the preparation of relief supplies can be more efficient and respond better to the actual needs of evacuees. In particular, based on the Cabinet guideline, vulnerable people, who include elderly, infants, pregnant women, children, disabilities, those with allergies, and foreigners should be properly treated. Knowledge of the population of this group can help to prepare their necessities, and importantly all victims should be treated equally and with respect for their dignity.

It is absolutely essential for the dignity of people and victims to be respected so that they keep their will and energy to live. Also, there are guidelines on how to properly deal with victims of natural disasters, and refugees or victims of political conflicts such as the Guiding Principles on Internal Displacement by UNOCHA[1)] and IASC Operational Guidelines on the Protection of the Persons In Situations of Natural Disasters.[2)] These standards are only a guideline and not an obligation; however, we can apply these standards for the preparation of relief goods.

2.2 What is required?

When considering the types of goods to be prepared at shelters, we should assume that victims evacuate to shelters without any preparation as a result of a sudden event. The types of relief supplies to be stored at shelters must be decided with careful consideration. Several types of goods are suggested in the Cabinet guideline[3)]; however, it is not possible for all shelters to prepare all these goods. Despite space and budget constraints, municipalities at risk of isolation should prepare the goods adequately, at least to sustain the lives of victims while waiting for aid from outside. Preparing goods necessary for daily life such as toilets and napkins should not be neglected, although this may require a reduction in the space for food for sanitation reasons. Blankets are also necessary to maintain body temperature. Also, on March 14, 2011, the goods first provided by Aichi Prefecture were 34,880 blankets, which were at the request of the government. Therefore, the authors suggest preparing food and water as the minimum requirement, blankets, and daily goods and equipment for sanitation.

When looking through the list of goods provided by municipalities during the 2011 Great East Japan Earthquake,[4, 5, 6,7)] the relief goods prepared by the municipalities are rather similar all over the country, and they mainly include food, water, and blankets. Obviously, these items are basic goods necessary for victims. Regarding these basic items, food should be ready-to-eat meals that are easy to consume. Tins that require a can opener should be avoided. Three liters of drinking water is a minimum requirement in a day.[8)] Two blankets are necessary to maintain body temperature. Infants and the elderly may need diapers and some adult females require sanitary napkins as well. We also suggest some other items to be considered as basic relief supplies. Some goods are necessary to respect the dignity of victims, for example, room partitions and disposable toilets. Room partitions are rather important especially to the elderly and nursing mothers since they need a little privacy when changing diapers or feeding babies. Toilets should be considered as important as food. Generally, evacuees need to use the toilet approximately within two hours of their arrival at a shelter.[9)]

2.3 How much in terms of quantity?

Some shelters risk being isolated due to damage to critical infrastructures. Under such circumstances, victims will need to live in the shelters until aid from outside can reach the shelter and must rely only on the prepared goods at shelters. Therefore, the necessary quantity of relief supplies is decided according to the isolation period of the shelter. However, the exact period of isolation is rather difficult to predict as it depends on multiple factors.

In previous experience, the recovery of roads after the 2011 Great East Japan Earthquake was achieved very quickly. The process started with, as the first step, the repair of the main line with relatively less damage. On the fourth day, as the second step, the works extended to recover the sub-lines in order to reach the coastal roads that were severely damaged by the tsunami. Finally, as the last step, the coastal line was repaired in seven days after the disaster.[10)] From this experience, a recovery plan of infrastructure after a disaster can be used to estimate the isolation period of shelters. The plan for the predicted Nankai Earthquake[11)] hints at the preparation of relief supplies for at least three days at shelters. Obviously, the duration required for recovery is different in each region. In addition, we should not rely only on road transport but

should also consider other options for supplying goods such as by coastal transport. For example, Chiba Prefecture prepared a port operation plan during emergency.[12] Thus, both recovery plans for roads and ports can be used to estimate requirements concerning the quantities of relief supplies.

2.4 Where should relief supplies be stored?

Relief supplies may be stored at designated storage spaces or directly at shelters. The current practice in Japan is to store supplies at the municipalities' storage spaces. However, the latter method can cope better with the risk of shelter isolation. If all supplies are stored at the central storage, when an unpredicted disaster happens, victims at isolated shelters will need to wait until the supplies are delivered. In the authors' opinion, storing the supplies directly at shelters is strongly recommended.

3. An example of basic relief supplies

The authors proposed an example list of basic relief items for 1,000 people for three days, as shown in Table 1. The space requirement was calculated using the population structure from the current Population Census of Japan in 2010 and daily dietary requirements per person. The quantity of each item was approximated from the average proportion of the population. As a result, the storage requirement per 1,000 people is approximately 34.16 m^3, which weighs 6,660 kg for the first day; however, this depends on the exact type of goods. The storage requirement for the second day can be reduced to 6.28 m^3 and the weight decreases to 3,560 kg, since blankets, nursing bottles, and room partitions are to be distributed only on the first day. Finally, the total space requirement for the storage of three days' supplies is 46.27 m^3 (34.16 m^3 + 6.28 m^3 × two days) and 13,780 kg (6,660 kg + 3,560 kg × two days). Considering Nagoya City's standard space requirement of 2 m^2 per person at a shelter,[13] we would thus require 2,000 m^2 for 1,000 persons. The height of a room is generally about 2 m, so 23.14 (46.27/2) m^2 is required when considering only the volume requirement. On the other hand, when considering the weight constraint, based on the Japanese Building Standards Act, the load-bearing capacity of a floor is 3600 N/m^2 (approximate 367 kg); thus, 38 m^2 is required as a horizontal space (13,780 kg / 367 kg = 38 m^2) for the storage of the proposed relief goods for 1,000 persons.

Goods	Users	Per package		National-wide average (2010 National Census)									Onagawa town (October 2010)			
				Population Structure			Space and Weight Requirement						Population Structure		Space Requirement	
							First day				From 2nd day				First day	
		Quantity	m3	Number in every 1000 persons	Quanity per person	Quantity per 1000 persons	Case	m3	%	kg	m3	kg	Number in every 1000 persons	Quantity per 1000 persons	Case	m3
Every one																
Blanket	Babies			8	1	8	0.8	0.11	0.003	12	0.11		6	6	0.6	0.08
	Everyone else	10	0.13	992	2	1984	198.4	26.17	0.766	2976	unnecessary		994	1988	198.8	26.22
Water500ml	Babies			8	3	24	1	0.01	0.000	12	0.01	12	6	18	0.75	0.01
	Everyone else	24	0.01	992	6	5952	248	3.42	0.100	2976	3.42	2976	994	5964	248.5	3.43
Biscuits	Everyone except babies	150	0.05	992	3	2976	19.8	0.94	0.028	298	0.94	298	994	2982	19.88	0.94
Powdered Milk	Babies	12	0.02	8	130g	1040	0.2	0.003		1	0.003	1	6	780	0.08	0.001
Nursing bottle	Babies	40	0.15	8	1	8	0.2	0.03	0.001	1	unnecessary	1	6	6	0.15	0.02
Heat pad	Babies	50	0.01	8	2	16	0.3	0.003		1	0.003	1	6	12	0.24	0.002
People in need																
Napkins	Female adult	50	0.15	58	6	348	7.0	1.02	0.030	30	1.02	30	9	54	1.08	0.16
Diapers	Babies	336	0.17	37	7	259	0.8	0.13	0.004	10	0.13	10	21	147	0.44	0.07
	Elderly	104	0.17	2	7	14	0.1	0.02	0.001	1	0.02	1	4	28	0.27	0.05
Toilet bags	Male adults	100	0.01	468	1	468	4.7	0.04	0.001	23	0.04	23	477	477	4.77	0.04
	Female adults	100	0.01	494	7	3458	34.6	0.32	0.009	173	0.32	173	497	3479	34.79	0.32
Toilet papers	Male adults	12	0.01	468	122	19.0	1.6	0.02	0.001	3	0.02	3	477	19.4	1.62	0.02
	Female adults	12	0.01	494	1099	181.0	15.1	0.21	0.006	27	0.21	27	497	182.1	15.17	0.21
Bags for toilet bags	Male adults	2	0.001	468	116	4.0	2.0	0.003		0	0.003	0	477	4.1	2.06	0.003
	Female adults	2	0.001	494	116	29.8	14.9	0.02	0.001	3	0.02	3	497	30.0	15.00	0.02
Equipments																
Portable toilets		1	0.044			4	4	0.17	0.005	3	unnecessary	110		4	4	0.17
Room Partitions		1	0.137	11	1	11	11	1.51	0.044	110	unnecessary	3673	11	11	11	1.51
							Total	**34.15**	**1.00**	**6660**	**6.28**				**Total**	**33.28**

Table 1 List of Basic Goods and the Space Requirement Using Average Population

In fact, space for storage is not too large for the preparation. Note that these values should be adjusted so that they suit the local requirements. In areas where there is a higher number of elderly people, a greater quantity of items for the elderly should be prepared. During the aftermath of the 2011 Great East Japan Earthquake, a reporter visited Onagawa Town, Miyagi Prefecture, which has a relatively high number of elderly people (approximately 33.7% of the population) and found a large quantity of useless baby diapers and powdered milk.[14] This problem might be a consequence of applying the average population structure without considering the local characteristics.

When applying the population structure of Onagawa Town, the requirement of relief supplies per 1,000 people becomes as shown on the right-hand side in Table 1. Compared with the nationwide average population structure, the quantities of adult diapers increase while the quantities of powdered milk and baby napkins decrease. Although the number of required partitions is same, the purpose of usage is more for the elderly. Four partitions are required for the elderly in Onagawa Town but two in the nationwide average.

4. Preparing to deal with insufficient supplies

Not all municipalities are able to prepare sufficient storage to meet the different needs of people due to the constraints of space and/or budget. For this reason, relief supplies should be ranked by priority. The priority of goods is clearly different according to the needs of each local community. Also, this matter is rather sensitive and should be discussed thoroughly in the community. For example, reducing the space for food and instead increasing the space for disposable heat pads, which can be used for warming water to make milk from baby formula, might be advantageous. Despite constraints on either budget or space, the needs of vulnerable people are not negligible.

In general, the space requirement for each person determines the capacity of a shelter. The storage requirement of relief supplies can be calculated in the same way. However, when a large-scale earthquake occurs, people evacuate to shelters much more than their capacity allows. If a shelter and its neighborhood become isolated due to damage to lifelines, it will be difficult to live at home due to lack of food and water, forcing victims to seek help at shelters. The prepared supplies may become inadequate. In this circumstance, we need to clarify rules for the distribution of supplies to people who stay at home or at temporary shelters such as temples.[15,16] Based on the January 2014 government disaster prevention plan, relief supplies must be given to victims outside shelters as well (such as victims confined at home). However, in the case of a large area being isolated, the method of providing aid to these people still remains to be determined.

While waiting for aid from outside, the goods in storage might become insufficient. Priority in distributing the goods should be considered and it is difficult to treat everyone equally under such circumstances. Considering the Cabinet guideline, perhaps the first priority should be given to infants, pregnant women, children, those with disabilities, and those with allergies. Later, the remaining supplies are to be given to those with lower priority. However, this is a sensitive topic, and the types of goods and their quantities in the storage require the agreement of the people. According to the Cabinet guideline, the government emphasized the involvement of several people and different gender perspectives to improve the operation. However, a method of supplying goods from outside should be prepared in order to avoid an uncomfortable situation.

5. Supplying goods to isolated shelters

5.1 Collaboration among municipalities

After all discussions have been concluded, the types of goods and their quantities are decided and prepared at a shelter as well as the priority of distributing goods to victims. There is still a possibility that the prepared supplies become inadequate due to several uncertainties, such as an excessive number of evacuees or a longer staying period. We thus need to prepare a plan to quickly supply goods from outside to the affected shelters. The basic relief supplies to be given at the first time are generally the most important, with the reminder that a more rapid distribution of supplies can help save more lives as well as easing victims' stress. A delivery of 30 minutes faster will become more crucial than in usual circumstances. Thus, there is a need to find a more efficient way to deliver the supplies.

The goods required during an emergency often need a longer process time until their arrival. In Japan, most municipalities prepare similar basic goods for the survival period and it may be possible to share these throughout the country. In a small-scale disaster, the affected shelter may receive supplies from unaffected nearby shelters. But, in the case of a large-scale disaster, it may be difficult for the affected municipality to move goods from the unaffected shelters to the affected shelters. It may be easier to buy goods from suppliers. However, it is often difficult for suppliers to provide goods quickly due to a too-sudden huge demand. Also, some emergency goods, such as toilet bags, are not usually used in daily life and it is unusual for retailers to have a stock ready and they thus need another way to procure the goods. For example, the affected municipalities may receive supplies from other municipalities. This means that municipalities should collaborate and share their supplies. This method is different from the current practice in which an individual municipality makes its own agreement with other municipalities. The proposed stock-sharing method aims to involve all municipalities and share all their storages together. The goods stored at unaffected municipalities can be gathered and transported to the affected area when a disaster occurs. Using this sharing method, the goods to be put into storage at shelters can be reduced.[17]

If the collaboration is successful, we can increase victims' survivability and the sharing system can reduce

waste of goods with a shelf life as the goods stored at unaffected municipalities will be actually used.

5.2 Donating and receiving rules

A single relationship between two municipalities might be not very efficient in the case of a large-scale disaster. Gathering donor municipalities together into a group and providing the goods together can help to reduce redundancy and distribute the supplies more evenly throughout the affected region. However, if there is no rule, when there are numerous affected municipalities, most donated goods may be provided to only a few recipients. For example, Sendai City was the only affected member in a network of 21 large cities in Japan[18] during the 2011 Great East Japan Earthquake. Sendai City received a more-than-necessary amount of relief supplies from the other 20 cities in the network. The city had to redistribute many goods to other municipalities that were hit by the earthquake as well. Generally speaking, bigger cities are preparing more supplies compared with other smaller municipalities and thus the amount of donation will be larger.[19] In addition, when multiple donors provide goods to the same recipient, the delivery times are very likely to be different according to the donor and this can cause waste of time and labor. A rule for receiving and giving aid among municipalities can help reduce these problems. For example, the arrival time of goods should be decided by the recipients themselves and the recipients should also prepare space and labor ready for the arrival of the goods.

5.3 Sharing information

A smooth flow of information plays a critical role in the overall operation. Sharing information on goods in the storage, including goods types, storage location, and their quantities, can improve the efficiency. A centralized database of the stored goods at all municipalities in the country can help management of the storages. The goods' names and codes should be standardized. In addition, shelter information, not only addresses and capacities but also aviation addresses, should be included in the database for the case of transportation by helicopter.

When supplying goods to isolated shelters, one should be aware that the environment before and after a disaster can be totally different. For example, if a region is heavily flooded, the goods need to be transported by helicopter; a normal address cannot be used in such case. In March 2011, the pilots needed to use a televised image to identify the locations of shelters.[20] In Japan, we suggest gathering the locations of shelters in the aviation formats of UTM, N-code, and latitudes and longitudes instead of normal addresses. There should also be a standard for all municipalities as the system may differ from region to region. For example, Chubu and Kansai Aviation Associations use different systems. Thus, the shelter locations should be prepared so as to be ready to work in every system.

It is also necessary to always keep the information up to date. Not only correcting any changes but also regular updating of the database for all municipalities can increase the efficiency. According to the Cabinet guideline, sharing information among municipalities is possible.

5.4 Goods packages

A standard package of goods, including package size and quantity per package, can shorten the time required for transporting and distributing goods. As an example shown in Table 1, approximately eight nursing bottles are required for every 1,000 people. In the current Japanese market, storing a whole package, which contains 40 bottles, is not recommended since the space should be used for other important items. A similar consideration should be applied to the storage of powdered milk and sanitary napkins as well. In the case of Nagoya City, the biggest shelter has a capacity of 3,681 people, while shelters in rural areas, which are generally community centers, have a capacity of approximately 50 people.[21] A rural shelter, which has a lower capacity, will store too many nursing bottles if storing the package as a whole. It is recommend to consider the capacity of each shelter when preparing goods and, if necessary, divide packages and store items in appropriate quantities.

Another problem can occur with goods to be shared among multiple users. For example, powdered milk in tins is rather difficult to use and share. Items in small bags for single usage are more convenient. Furthermore, goods that are used for the same purpose should be packed together into a set. Through this method, the quantity can be easily confirmed and distributed to victims. For example, instead of preparing powdered milk and other related items separately, a baby set that contains powdered milk, a nursing bottle, and a disposable heat pad is preferable.

If the package tag also follows the same standard, it will be possible to use the unit-load system,[22] which may reduce the workload of the recipient and also make it easier for donors share trucks to transport the goods together.

5.5 Method of transportation

If shelters are not isolated, it is possible to use the current delivery practice to access the shelters by truck. However, this will become impossible when shelters become isolated,[23] or when it is unclear whether the road condition is sufficient to access the shelters. Other transport modes, such as, helicopter, boat, and primitive modes like trolley, might be a good option. For example, in Japan during March 2011, a helicopter was used to deliver supplies to Ajishima, which is an isolated island on the Oga Peninsula.[20]

In 1959, Aichi Prefecture was struck by the Isewan Typhoon, which caused many regions to be isolated for a long period of time. At that time, it was difficult to transport relief goods by truck. Some goods were delivered by helicopter to the isolated areas. The goods were dropped to people waiting on the roofs of flooded houses. On March 23rd, 2011, the Ministry of Transport relaxed the aviation law and allowed the dropping of the relief goods from the air, a means previously restricted. However, dropping

goods from the air requires very careful investigation, in terms of not only the dropping method but also the quantity of goods and the packaging considering the dropping condition. If this preparation is successful, the time required for loading and unloading the goods in and out the helicopter can be reduced.

In 1959, goods were also delivered by boat as the region was heavily flooded. There was huge demand for boats and some of them were transported from faraway such as Yokohama City, which is more than 150 km from Aichi Prefecture.[24] A database related to transport modes such as boat and other primitive modes (i.e., trolley) should be organized. Yokkaichi City, Japan, is storing some trolleys as shown in Figure 1. The Japanese Ground Self-Defense Force also uses trolleys for transporting weapons or certain goods such as food and water in fields where trucks cannot be used.

Figure 1. Tolleys can be used as a delivery mode during emergency.

6. Preparing for the loss of bureaucratic function

During the aftermath of the 2011 earthquake, the bureaucratic process stopped at some affected municipalities. It is necessary to plan in advance the acting municipality instead of the affected municipality in this situation. When a municipality losses such function, the process of supplying goods should be handled by the upper administration level (i.e., prefecture). However, in the case of a large-scale disaster, the affected prefecture may not be able to take responsibility; hence, the neighboring prefecture may act instead. Next, the acting prefecture should also prepare a method of supplying goods to isolated shelters considering the network of municipalities, the locations receiving the goods, and other details for a more efficient operation. Also, the operation should be decided considering the efficiency of the operation, not focusing solely on the governing boundary of the municipality.

Next, during the aftermath of a disaster, the workload on municipality staff will increase massively. Preparing clear responsibility for the workload in advance can reduce waste of time. Staff should provide necessary information or a guideline on the operation: for example, planning for the case where a region becomes isolated regarding estimated quantity of supplies considering the victims inside and outside shelters. This method can ease the operation by the acting municipality. Then, the acting municipality decides on the relief goods to be supplied and the quantities. Later, the actual operation of distribution of relief goods should be given to specialists such as logistics sectors, fire brigades, etc.

7. First delivery after isolation

The first delivery lot from the outside should be viewed in a different way from the goods to be stored at the shelter. The goods to be put into storage are focused on maintaining the victims' survivability, while the goods to be supplied from outside should focus more on how to recover the victims' health. During the two or three days after a disaster, all basic goods will be consumed and these goods are a minimum requirement to survive. However, the health of most victims may be at its worse. Stress and lack of sleep can compromise the immune system. We need to supply high-nutrition goods and those that can relieve fatigue and to supply supplements to help recover the victims' health; however, consultancy with medical doctors is necessary for finding the appropriate set of goods for this purpose.

Even though a shelter is in isolation, if communication is still possible, it is necessary to communicate with the outside about the status of supplies and the requirements. The requisite information is, for example, the number of victims by type and their health condition. Importantly, attention should be paid not only to the people at the shelters but also to people at temporary shelters and people confined at home. This information can help in deciding suitable goods and the quantity to be supplied. However, communication is often impossible due to power outage. The quantity of these goods may be decided considering the population structure.

The requirements of these goods will not be the same as the basic goods for survival, since victims may require more nutrition. We should know these requirements in advance for efficient delivery. As an example, a coffee franchise company has a concept of an emergency pack. The distribution center will deliver the emergency pack that contains the necessary items to a chain store when there is a communication problem between the store and the center. During the Great East Japan Earthquake in 2011, these emergency packs were delivered to certain chain stores.[25] This concept can be applied to the delivery of relief supplies to isolated shelters as well. It is recommended to prepare for the worst case of communication outage. In this case, relief goods and medical kits in a quantity sufficient for a day should be prepared in advance. The goods are adjustable according to the situation. For example, more toilet items should be prepared if water outage continues. If using the relief goods list shown in Table 1 plus medical sets, the space requirement per 1,000 persons is

approximately 0.5 m^3.

After deciding the type and quantity of goods, the mode of transport should be considered. It is not always possible to immediately supply a large amount of goods after a shelter becomes accessible. Often, the repaired road during the early period is yet to gain its full capacity, causing a limited driving speed and available lanes. It is necessary to consider a transport mode that can work under such circumstances. Using trucks as in a normal delivery might be difficult due to narrow roads or other constraints. Light trucks,[26] motorcycles, bicycle, or trolleys may be more suitable. During a disaster, a large number of these vehicles will be necessary and they should thus be prepared in advance as it may be difficult to find a sufficient number in a short time. During the 2011 earthquake, there was also preparation for transport during emergency. Shizuoka City prepared off-road bikes that can run on very narrow roads (about 1 m in width). These off-road bikes worked to gather information during the disaster.[27] Another example is a medical wholesaler, anticipating road obstacles caused by disaster debris, who prepared a hundred 50cc. motorcycles at its logistics center.[28] Using these motorcycles, the wholesaler could deliver medical goods to hospitals inaccessible by normal truck. Although the purpose of usage may be different, this idea can be applied to the delivery of relief goods under conditions of damaged infrastructure as well.

However, these transport modes have very limited capacity despite making increasingly numerous round trips. They cannot be used for the delivery of large quantities and the main deliveries still rely on trucks. The combined usage of trucks and primitive modes can be applied by using such primitive delivery modes only when it is necessary to access difficult-to-access shelters. Sometimes, when a normal truck cannot pass, goods can be transferred to a small vehicle such as a motorcycle. Goods packaging should also be considered for efficient transfer. Inaccessible locations may differ every day and the goods transfer method should thus be very well managed. Therefore, the involvement of a logistician is recommended.

Often, in past disasters, although the goods arrived at the primary or the secondary stockyard, they could not reach shelters due to lack of sufficient preparation of transport when there is degradation of infrastructure. Securing emergency transport modes is absolutely essential for successful delivery until the goods reach the users. Also, in an emergency situation, the requirements of goods and transport mode may change day by day. The involvement of experts is preferable for proper management.

Dealing with waste from shelters is not a negligible problem. If shelters are in a water outage situation, a large amount of disposable toilet waste can be expected. An estimate of this type of waste for 1,000 people over a duration of three days is more than 2,500 kg.[29] Likewise, empty water bottles can occupy more than 10 m^3. Vehicles previously used for supplying goods can be used for collecting waste as well. Considering the health issue, human and animal waste should be collected as soon as possible.

8. Dealing with pets

Evacuees often come with pets. It is rather common for victims to bring their pets to shelters as well. In New York, the city allows people to bring pets to evacuation centers and provides separate spaces for pets and humans.[30] Disasters in the region can mostly be predicted in advance and the city thus had enough time to prepare for evacuation and it was possible to deal with pets before the hurricane arrived. However, the timing and location of many disasters in Japan cannot be predicted correctly. In past disasters, many pets were left without good care after the disasters. Two years after the Great East Japan Earthquake, the Japanese government issued a guideline for dealing with pets at shelters.[31] In the guideline, pets are received at shelters that have enough space to divide pets from humans. If the shelters receive pets, they should also prepare some basic supplies for pets at the shelters. Similar to humans, the number of evacuated pets also needs to be estimated.

However, uncommon pets other than dogs and cats need more consideration. In the aftermath of the 1995 Kobe Earthquake, it was reported more than 30 dogs and cats and other animals, such as crocodiles, snakes, and crows, were found at shelters.[32] In tropical regions, there are also problems between animals and humans during a disaster.[33] During the 2011 flood in Thailand, there was a report of a serious crocodile attack. Also, 15 poisonous snakes escaped from a cage.[34] Japan needs to prepare to deal with these possibilities as well. A concrete guideline on how to deal with uncommon pets should also be discussed publicly.

Conclusion

One of the most important issues related to relief supplies is how to distribute goods to victims at the very beginning of evacuation after a disaster. The government has a responsibility to prepare the storage of basic relief supplies, as protected by human rights. Furthermore, victims are diverse in characteristics such as there being vulnerable groups including those with disabilities, the elderly, children, pregnant women, and so on. They require more various types of goods and the government should thus be notified that all victims are not the same and should consider preparing the storage of basic relief supplies to cover the needs of people with different characteristics. In this paper, we propose the preparation of at least some stored items necessary for survival ready at all shelters during the early period after a disaster. This method can cope better with unpredictable disasters (in terms of timing and location), which often occur in Japan. We should also pay more attention to the possibility of shelters becoming isolated. From this point of view, municipalities should consider what kind of goods should be stored and how they should be stored. In the current situation, it seems that

many municipalities neglect this issue and do not prepare a sufficient quantity of goods at shelters. Preparing some storage of goods ready at all shelters and sharing them among the municipalities are both important and need to be done together for better efficiency.

Sometimes, the prepared quantity may not be adequate due to numbers of evacuees exceeding the previous expectation or a longer period of isolation. As a countermeasure, we suggest sharing the stock of relief supplies among municipalities because this method can reduce cost and waste due to the disposal of unused goods because their use-by date has expired. Pooling relief goods among municipalities is very efficient as unused goods from other municipalities can be given to the municipalities in need. This method would not require too much additional cost to all municipalities. The estimated benefits of sharing storage can be discussed with the general public.

The rules for operation should be decided in advance and, in particular, we must prepare for the possibility of loss of bureaucratic function.

The goods to be stored at shelters can be classified into three types: (1) goods to be distributed to everyone; (2) goods distributed to people in need; and (3) items to maintain quality of life at shelters. When preparing these goods, it is necessary to consider the population structure to avoid excess or shortage of goods.

We also need to prepare successful logistics to supply goods to victims through the following method: (1) necessary information about the goods and shelters between donors and recipients must be shared; (2) since normal logistics may not be operable under possible degradation of infrastructure, rules, standards, and methods for the logistics operations should be prepared in advance; and (3) some primitive modes as an emergency delivery mode should be prepared.

Furthermore, the first delivery from outside after isolation should be considered very carefully. As victims may be exhausted due to limited consumption of food and water, some goods recommended by medical doctors should be given. In order to deliver goods to shelters after reopening of damaged roads, a plan for goods and their delivery method must be prepared.

The logistics of delivering goods to isolated shelters and for the first delivery after isolation are very different from those to an unaffected area. The work condition is rather dangerous. Involving experts in the operation is recommended to ensure a successful and efficient operation.

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