The Successful Experience in Disaster Risk Management in Japan: Focus on Earthquake Disaster

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Introduction

In recent years, the argument that damage caused by natural disasters cannot be prevented but only mitigated has become popular among scientists and engineers engaged in research on natural disasters. This argument implies the following two factors that have been noted from the characteristics of recent natural disasters.

First, people assume that there are technological and engineering limits to fully preventing natural disasters and therefore damages caused by them might be unavoidable up to a certain level.

Second, recent natural disasters have proved that damage caused by disasters vary greatly according to social and institutional factors rather than physical and engineering ones. They strongly depend on preparedness, relief and rescue arrangements, and quick recovery and reconstruction measures. Thus, currently, the concept of disaster management rather than disaster prevention is widely accepted and its importance is gradually being recognized. A typical example is the Hanshin-Awaji Earthquake in Kobe, which occurred on 17 January 1995.

After the earthquake, a heated argument about overall crisis management including natural disasters took place among politicians, scientists, and the general public in Japan. In fact, the Japanese central government as well as the local governments that were directly affected by the earthquake obviously failed in taking appropriate response actions immediately after the quake.

Then Prime Minister Murayama did not receive a prompt report of the full extent of the quake, and, therefore, did not realize the extent and severity of the damage until about noon that day, that is, more than six hours after the earthquake had occurred. Hyogo Prefectural Governor Kaibara did not make a request for the Self Defense Agency (SDA) to dispatch a rescue team to the affected area until 10:00 a.m., that is, four hours after the occurrence of the quake, while the SDA just waited for the request by the Governor without taking any action on its own initiative.

As shown by this example, many instances of miscommunication created a situation that allowed the disaster to remain out of control. Needless to say, quick responses, or crisis management must be an essential part of disaster management.

This paper aims at discussing the disaster management measures in Japan, which is partially successful, but not all, by focusing on earthquakes in line with one of the risk components.

How can earthquakes be defined as a risk?

Before discussing the practical earthquake disaster measures in Japan, the concept of risk in terms of earthquake disasters has to be examined. In particular, the discussion focuses on usefulness of the risk concept as a target indicator for measures against disasters.

A theoretical discussion on risk concept itself was actively conducted during the 1950s among members of the American Risk and Insurance Association (ARIA).

According to Prof. Morimiya,(1) the definition of risk can be roughly classified into the following three groups:

(a) Chance of loss,
(b) Uncertainty of loss, and
(c) Variance or deviation of loss.

The loss in this classification implies not only direct and primary but also indirect and secondly damage.

The term chance in definition (a) has the same meaning as probability. The chance of loss thus implies two probabilities. One is the probability of occurrence of an event that causes a loss. It is identical with the probability of earthquake occurrence itself. The other is the probability of loss generation under the condition that the event has happened. Then the chance of loss can be calculated as a product by multiplying these two probabilities.

From the viewpoint of risk management, since the probability of earthquake occurrence cannot be controlled, the probability of loss generation might depend on social vulnerability, including structural and nonstructural frame.

In general, the frequency of small earthquake occurrence is high, while that of large earthquake occurrence that causes severe damage is quite low. Accordingly, when proper earthquake measures are taken, almost no damage might be caused by small earthquakes, and thus, the risk, which is the chance of loss, becomes equal to the probability of large earthquakes which seldom happen.

This definition, however, does not take into account the volume of loss itself. Therefore, whatever severe damage is anticipated, the risk itself is recognized to be very small, since it may rarely happen. To cover up this fault, Shah and Davidson, Stanford University, proposes the Earthquake Disaster Risk Index (EDRI), which is defined as a linear combination of probability of hazard, vulnerability of structures, volume of exposure, and emergency response and recovery capability. (2)

With regard to definition (b), there is a discussion about subjective and objective uncertainties, the details of which are omitted in this paper.

The relationship between a probability and an uncertainty can be illustrated in figure 1. As seen in the figure, uncertainty is highest when the probability of an event occurrence is 0.5.

- Figure 1 -

Useful discussion about earthquake prediction, which is currently being undertaken for the anticipated Tokai Earthquake in Japan, can be drawn from the application of this definition. That is, the risk of earthquake loss becomes highest when no information about it is available. When earthquake prediction is successfully made in such a way that an earthquake of a given magnitude can be anticipated within a week or so in a certain region, uncertainty will be reduced.

In fact, if this kind of warning is announced by an authority, the whole population within a region can take preparatory actions for the earthquake so that railways might halt operations, traffic might lower its driving speed, industries might stop operations, schools would be closed, and so on. In this way, earthquake loss might be drastically reduced.

This definition implies that losses are suffered due to uncertainties rather than probabilities. Because, if the occurrence of events which cause losses is certain or perfectly predictable, actions must be taken beforehand to avoid them.

In case of earthquake losses, however, there is again some questions as to this definition whether the predictable loss is a risk or not, and that unavoidable loss due to lack of proper preventive measures cannot be regarded as a risk. Questions also arise regarding ignorance of the size of loss in this definition. Definition (c) is proposed in many ways. In this paper, the definition by Robert Mehr and Bob Hedges will be examined. [3] They say that risk is a possibility in cases where a loss exceeds the one normally anticipated.

Figure 2 shows this definition by taking the probability of earthquake occurrence in a horizontal axis.

- Figure. 2 -

In this definition, risk depends on the normally anticipated losses. In other words, the higher the losses are anticipated, the lower the risk becomes. This argument can be met with an insurance contract, because the risk is normally reduced by insurance benefits that are determined based on the beneficiary's anticipation.

However, in case of public disaster management policy by governments, this definition may not be applicable. As shown in figure 3, governmental measures have the effect of shifting down the curve of loss occurrence.

- Figure. 3 -

According to this definition, the original risk of (x) has theoretically been reduced to the new risk of (y) by the measures. The difference between tow risks at the same level of anticipated loss clearly implies the effect of risk management program by governments. The next step for the government, however, must be to replace the original anticipate loss (a) with a new one (b) because it must have already been achieved for the same risk of (x). Thus, the risk itself is kept as it was and therefore cannot be the target indicator of earthquake measures, but reduction of anticipated loss is. In other words, the efforts of governments to disaster are normally made to reduce an anticipated loss at the same level of risk.

Thus, Morimiya[(1)] proposes a new definition, i.e., that a risk is the extent of variance between an unwished state and the current normal one, which is observed as a potential gap. When it is applied to disasters, the variance is identical to the estimated damage to the present properties of society, resulting from earthquakes.

In figure 3, the volume of anticipated loss (b) that is reduced by earthquake measures is the index of a risk, which may vary with the magnitude of earthquakes, i.e., the risk of a large earthquake is high, and that of small earthquakes is low regardless of their probability of occurrence.

Risk management for earthquake disaster in Japan

Since Japan is one of the most earthquake-prone countries in the world, the governments, private sectors and citizens have taken intensive measures against earthquakes, to mitigate the damage caused by them, in particular, in terms of the technological and engineering fields.

However, very few efforts have been made so far to reduce earthquake damage from the viewpoint of risk management except for an earthquake insurance system, which has not enjoyed popularity due to the limited indemnity per contract for a high premium.

Table 1-(a) indicates the percentage of households that insure their homes and properties against earthquakes. As shown in the table, its average ratio was about 7 per cent until the Hanshin-Awaji Earthquake occurred on 17 January 1995. The ratio jumped to 9 per cent just after the quake and to 11.6 per cent in 1996 as the limit of indemnity per contract was increased from 10 million yen to 50 million yen for buildings and from 5 million yen to 10 million yen for contents (Note: 13.3% in 1997, unofficial figure).

It is also noted that earthquake insurance contract ratios vary among regions that are classified into four groups on the basis of potentiality of earthquake occurrence (See Table 1-(b)).

In class 4, which comprises the most earthquake-prone regions including Tokyo, the contract ratio is a record 20.1 per cent, while in class 1, lowest potential regions of earthquake occurrence, only 7.6 per cent of the households carry earthquake insurance.

As such, the earthquake insurance system does not seem to be recognized as an effective earthquake risk management policy among the Japanese people.

Table 1-(a) Ratio of Earthquake Insurance Contact by Year

Year. Month	Ration	Average insured amount
1996.3	11.6%	5,614 yen
1995.3	9.0%	5,007
1994.3	7.0%	4,462
1993.3	7.0%	4,233
1992.3	7.1%	4,026
1991.3	7.3%	3.812

Table 1-(b) Ratio of Earthquake Insurance Contact by Risk Class

Class	Percent	Area
1st.(Lowest)	7.6	Hokkaido, Kagoshima, Hiroshima,etc.
2nd.	7.7	Niigata, Miyagi, Nagasaki, etc.
3rd.	11.2	Osaka, Hyogo, Kyoto, Aichi, etc.
4th (Highest)	20.1	Tokyo, Kanagawa, Shizuoka
Total	11.6	

(As of March l996)

With regard to the risk management measures by the government, most of local governments have been conducting periodical surveys on potential danger on earthquake disaster of their region.

For example, the Tokyo Metropolitan Government conducts two types of surveys periodically every five years. One is a survey on damage estimation in Tokyo in an event of the anticipated Second Kanto Earthquake, and the other is vulnerability assessment by district in Tokyo.

The damage estimation survey measures to what extent the loss of buildings and lives in a given area could be attributable to the Second Kanto Earthquake.(4) On the other hand, vulnerability assessment measures how vulnerable each district in Tokyo is, from overall points of view without specifying any particular earthquake .(5)

The survey of vulnerability assessment does not examine the damage itself but the relative degree of magnitude of possible/probable damage which may vary according to district. In the case of Tokyo, vulnerability assessment is represented here by five ranks in the smallest administrative units (figure 4).

- Figure.4 -

The results of damage estimation naturally reveal that regions subject to extensive damage also rate high in the vulnerability assessment, while, on the other hand, regions with little damage are safe and vulnerability assessment is low. Obviously, they are in direct proportion to each other.

In general, the relationship between damage estimate and vulnerability assessment can be formulated as follows.

$$L(i, j) = \int_k \int_t P(k, t) \cdot D(i, j, k)\, dt\, dk$$

$$V(i) = \frac{\int L(i, j)\, dj}{\int_i \int_j L(i, j)\, dj\, di}$$

$P(k, t) =$	Probability of occurrence of the earthquake k. during the period of t
$D(i, j, k) =$	The extent of damage (or loss) in aspect j caused by the earthquake k in district Aspect j includes human loss and property loss
$L(i, j) =$	Total damage (or loss) of aspect j in district i
$V(i) =$	Vulnerability to earthquake in district i during the period of t

As seen in this formula, a damage estimation study covers those cases of damage occurring under certain conditions, while a vulnerability assessment study examines the possibility/probability of damage. If this were to be described literally, it would have the meaning of "the mean value of various suppositions of damage under varying circumstances."

These two studies are being conducted with different aims. The purpose of damage estimation is to formulate emergency measures during the response phase, while a vulnerability assessment contributes to preventive measures among the pre-disaster phase from the viewpoint of urban planning.

Now, how can the results of these two surveys be utilized in an assessment of risk management for earthquake disaster mitigation? The damage estimate obviously indicates Morimiya's definition of a risk, although it is not used for purposes of reducing direct damage but for preparing for relief activities during the response phase.

As mentioned earlier, quick response is vital to control the extent of damage by rescuing the injured at an early stage thereby resulting in reduction in the overall death toll. In this sense, the damage estimate survey should definitely be considered as a component of risk assessment.

As to the measurement in the vulnerability assessment survey, no definition of a risk discussed so far has matched it, since it reflects neither probability nor volume of loss. Nevertheless, the vulnerability assessment survey is useful for identifying districts where high priority should be given to intensive urban planning and therefore provides an effective guideline for risk management. In this regard, more detailed discussion about risk definition is urgently required, in a practical sense.

The strengthening community capability to disasters is another aspect that every local government makes its effort expecting as an important risk management measure. It is really true that the best resources for rescue and relief after a disaster are the affected peoples themselves (Eisnar). In every disaster, it is generally observed that public relief assistance cannot start just after the disaster but delays for a couple of hours or more, and sometimes does not reach to the affected area due to over relief demand. The affected people, therefore, must help themselves until the public assistance reach to them.

Based on this recognition, Japan Disaster Countermeasure Basic Act provides people's responsibility for self-aid to natural disasters. Thus Japanese

Government has been encouraging to form Self-Defense Community Organization to Natural Disasters. As a result, 93,000 organizations have been formed and 55 per cent of households of the nation join this organization as of year 2000. The capability of the respective organizations, however, is still unknown, though local governments provide certain amount of subsidy for them to buy rescue and relief equipment for their capacity building. If we can measure their capability of risk reduction in a quantitative way, it should be definitely important component of risk concept.

Concluding remarks

The idea of disaster risk management implies to reduce the risk of damage caused by disasters. In this sense, the concept of risk works as a target or objective indicator, by which the effect of disaster measures should be evaluated. However, such risk indicator has not been clearly defined yet, or at least is not shared as a common operational term for disaster management by related bodies such as politicians, administrators, enterprises, and citizens.

To meet this requirement, it seems to me that the definition of risk needs to satisfy the following conditions:

a. The body who run a risk and therefore take measures to avoid it, should be clarified,
b. The event that causes a risk should happen with probability or uncertainty to the body,
c. To serve as an objective indicator for the body to achieve,
d. The period and spatial boundary applicable should be clarified,
e. To be defined with clear dimension of scale.

Even though the concept of risk is vague, an idea of risk management is quite attractive. It is because it implies an expectation for subjective and positive efforts of human beings, which is an opposite attitude of passive resistance to unavoidable destiny. The progress of the idea is strongly expected.

References

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