A better integrated management of disaster risks: Toward resilient society to emerging disaster risks in mega-cities, Eds., S. Ikeda, T. Fukuzono, and T. Sato, pp. 41–56.

Integration Framework of Flood Risk Management: What should be Integrated?

Kami Seo

1 Introduction

The concept of integrated risk management was not widely known until very recently in Japan. Both government and lay public take it that only the central government should be responsible for the risk management of natural hazard. The Japanese government has mainly relied on structural measures of risk reduction, which directly control the effects of natural events. Structural measures have taken because, first, those measures brings drastic risk reduction effects, at least for a while; second, they do not need communication and cooperation with other units including local governments, communities and lay public.

During the last decade, however, some situation changes have forced us to reconsider the system. One of those changes is financial difficulty in Japan. Long deflation and expected tax income reduction made repaying the national debt difficult, and the large expenditure for the public construction has been criticized from the cost-benefit (B/C) point of view. The second is the public awareness of environmental problems. Rivers are not only 'evils' that bring disaster; they also provide freshwater, fish, rich soils and all the amenities of the waterfront for humans, and habitat for all kinds of aqua life and birds. Large constructions disturb the ecosystem in the rivers, and they often decrease the amenity value of the river. Those non-marketable values are also a part of the construction costs of the structural measures, i.e. public awareness of the environmental values increases the social costs of the construction of a dam. The third is physical difficulty. City areas in Japan are densely utilized; therefore, getting extra land for construction is difficult, if it is not impossible. The fourth is public apathy to the risk. In Japan, we have often very heavy rains (as much as 50 mm in an hour and sometimes 100 mm in an hour). Since most of the cities in Japan are placed on the flood planes of rivers, Japan is a country with a high risk of flood disaster. Therefore, people are used to being aware of the risk from flooding and have personal and regional "experience" to cope with flooding. Unfortunately (or fortunately), with the frequency of flood decreaseing, these experience are being lost.

Such changes have provided the chance to reconsider the national policy of flood-risk mitigation. Integrated risk management aims for lower risks and lower non-marketable costs within a limited budget. Current risk mitigations are planned separately by kinds of hazard, by mitigation measures, and by organization. Consequently, if the total risk is reduced in the proper costs is not clear. Unclear risk-cost balance makes it difficult to reach national agreement as to what can be defined as a "sufficient level of safety" for our society.

Pursuing cost-effective risk management through optimal resource allocation to different types of measures is one of the key concepts of integrated risk management. Integrated risk management is basically the integration of different types of hazard mitigation measures, including both structural and non-structural, and pre-and post measures.

Change in resource allocation is necessarily accompanied by change in the responsible units of implementation. Large technological measures are usually introduced by the central government. Many other risk-reduction measures, however, are better provided by local governments, communities, and property owners. Moving to integrated risk management, therefore, is necessarily accompanied by a change in the share of the burden from the central government to local governments, and from the public sector to private sector.

Decentralization of those in charge allows flexibility in the integrated risk management system. Large-scale structural measures, provided by the central government, are necessarily distributed following the same criteria throughout the country. A nationwide system is equitable; however, it is not always efficient because both natural and social environments vary from region to region. Different social and cultural environments, as well as natural environments, require different methods of risk mitigation. Some can be more risk-averse than others, and some put a higher value on the natural environment of rivers. Risk management by local governments or communities is expected to be more sensitive to the local circumstances. Also, a decentralized decision system makes public involvement easier, which is expected to improve public ability of managing natural hazards.

2 Structural Measures in Japan—What is the Problem?

Japanese flood-risk management after the Meiji period has heavily relied on structural measures such as continuous banks and dams, which have successfully lowered the frequency of flood disasters. In general, however, relying on only a few measures is necessarily becoming more and more inefficient in terms of risk-cost effectiveness because the marginal cost of a measure for risk reduction increases with the progression of the coverage. Adding a meter

of bank on an existing one-meter bank is usually less expensive than adding one on two-meter bank. However, benefit is usually larger in the first raise than in the second one. Therefore, cost efficiency of risk mitigation measures necessarily diminishes (Fig. 1).

Pursuing further risk reduction by structural measures is being more and more difficult both in mega-city areas and in rural areas in Japan. In city areas, there are physical difficulties, as previously mentioned. Another factor that makes cities vulnerable to extreme natural events is low public awareness of risk. People always have difficulty remembering natural disasters if they are not frequent; for example, events that occur once in a hundred years (Huntington and MacDougall, 2002). People in the city areas are especially unprepared for natural hazards, because first, flood in mega-cities are less frequent thanks to the improved technology. Second, people in cities do not know the nature of their homelands because many of them come from the countryside, and their residential time in the city tends to be short. Consequently, losses due to floods often become larger. In the Tokai Flood in 2000, the area affected, including Nagoya, the third largest city in Japan, for example, the economic loss was as large as 730 billion yen (6.6 billion US dollars) (NIED, 2002). There is a dynamic relationship between flood reduction by structural measures and vulnerability of the city area; structural measures against floods lower the frequency of hazardous events, which attracts more people and accelerates development. Then the area requires a higher level of structural measures against floods. This spiral necessarily raises both the risk of floods and the cost of countermeasures (Seo and Sato, 2003).

In city areas, however, the cost-benefit balance of construction is better compared with in rural areas. After the Tokai flood disaster, a typical city flood disaster in 2000, for example, 61 billion yen (approximately 550 million US dollars) was used to improve structures around the Shonai river, but that cost is relatively moderate compared with expected loss in the future. In rural areas, on the other hand, physical restriction is not so tight; however, construction costs of large structures are much higher compared to the benefit, because of the small number of residents. After the earthquake in Niigata, rural area in Japan, in 2004, restoration costs of the infrastructure and public goods are estimated to be more than ten million yen (80 thousand US dollars) per person in small villages on the mountainsides. As hundreds of rural areas in Japan face a gradual population reduction, the situation looks as though it is going to get worse. These B/C inefficient undertakings will not continue to be accepted under the financial status of today's Japan.

Sometimes, it is not clear if the *risk* is reduced by structural measures. In

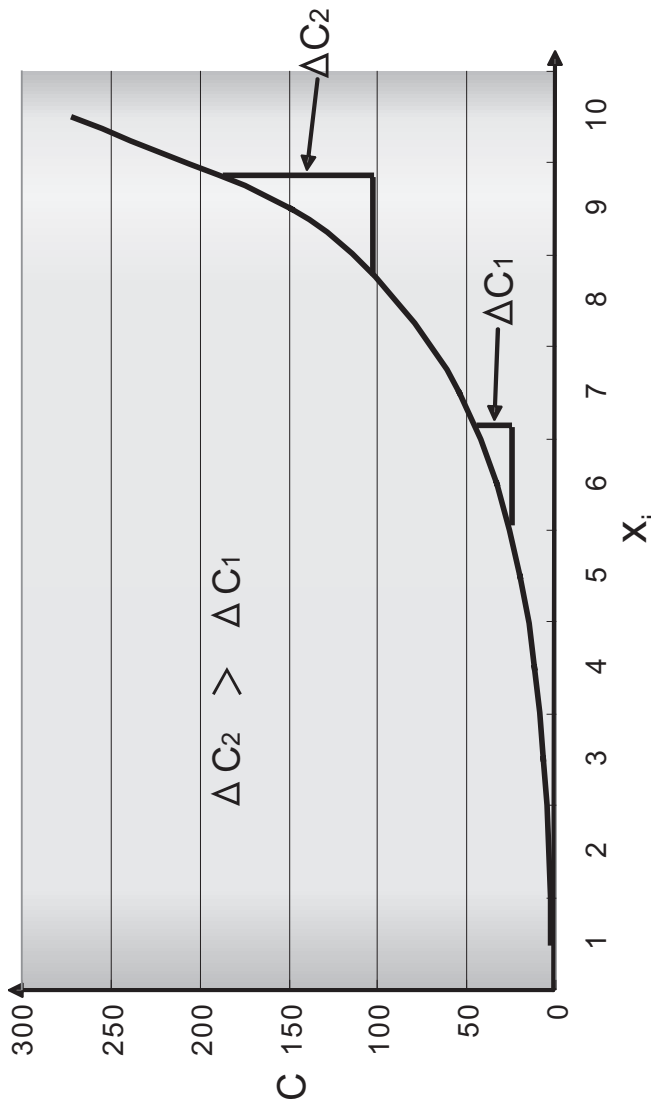

Fig. 1. General pattern of the measure improve (X_i) and its cost (C).
Under the same technology, the marginal cost of a certain measure usually increases with progression of the coverage, i.e., ΔC_2 in the figure is often more expensive than ΔC_1.

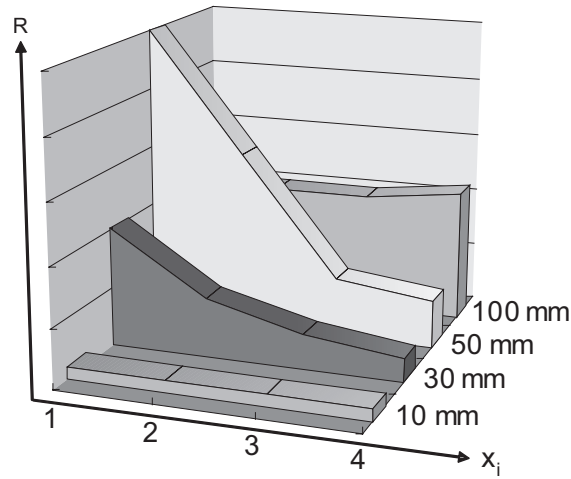

Fig. 2. Risk(R) with the progress of risk reduction measures (Xi).
The vertical axis represents risk of flood and the horizontal one represents the level of a measure: let us imagine the height of the bank. Relationship between the height of the bank and risk reduction effects is not linear as people intuitively expect. In case of frequent but not heavy rain (10mm/houre) even a small bank may not be necessary. In case of moderately heavy rain (30mm/houre) the low bank may be enough. In the rare case of heavy rain (50mm/houre), risk will be reduced by higher bank. Then what will happen in extreme case (100mm/houre)? This case is very rare, which may happen once in a hundred years. Thus the total risk of this case is not as large as the risk of 50mm/houre case, because of its low probability. However, the magnitude of hazard of each event is much larger. In this case, bank is often useless, or even worth; the reason is because, larger bank collapse gives larger damage than smaller bank collapse.

general, the lower *frequency* of floods does not mean a lower *risk* of flood. Continuous banks increase the quantity of river flow because water that used to flow out at the upper stream is retained by the river. In fact, the quantity of water in Tonegawa in Tokyo was 3.8 thousand square meters in 1900 and it became more than three times greater as 14 thousand in 1950 because of the 'Great Wall' like bank construction (Takahashi, 1971). Larger rivers cause more catastrophic flood disasters. Damage from flooding after the completion of the bank can be much greater than before the construction. In other words, a trade-off exists between the frequency and the size of hazards.

Large constructions are often decided upon by the government after a flood (Platt and Rubin, 1999). They are usually planned to help prevent further floods. However, if the decision is right or not, in terms of the cost-benefit balance, are not clear. For example, a town had a bank that resists 50 mm/hour

rain, but is attacked by a flood caused by 60 mm/hour rain. Suppose the loss of disaster was 100 million dollars. If the cost of bank improvement to resist 60 mm/hour rain is 30 million dollars, people will think that the construction is a good deal. However, the construction is useful only when they have just 50–60 mm/hour rain again within the life time of the structure. Up to 50 mm/hour rain, the constructio n is not necessary and if there is 100 mm/hour rain, the bank is not only useless but may enlarge the disaster. If the probability of 50–60 mm/hour rain is once in 200 years, and the life of the structure is 50 years, if the benefit is larger than the costs is not obvious. In general, one unit of structural measure reduces certain levels of flood disaster; however, it may not be necessary in most cases and/or it may be useless in the case of a really large natural event (Fig. 2). However, people tend to assume that *the risk* is automatically reduced by the construction.

3 Integration of Different Types of Measures

3.1 Hard and soft, pre and post

Our society has relied on structural measures to prevent flood. The purpose of integrated risk management, however, is not flood prevention but reducing human and/or financial loss through flooding. Preventing floods can be one of the ways, but in itself it is not the main purpose. We may accept flooding once in a while if the loss is low enough.

As is often discussed, risks of natural hazards are at the intersection of extreme natural events and the human system (Burton *et al.*, 1993). Therefore, in order to reduce flood losses, preventing flooding is not the only way. The pathway from the natural event to the endpoint—loss of flood—is not simple, and measures to reduce risks are varied. We analyzed the structure of the pathway of flood hazard in mega-cities in Japan by drawing a flood causal model (Fig. 3), originally constructed by Hoheneser *et al.* in (1982). In Japan, with population growth, high-risk areas in cities become densely populated (at the upper left of Fig. 3). At the same time, suburbs of the cities are developed from agricultural lands to residential areas and that lower the penetration of lands. Since Japanese mega-cities are placed on flood plains of large rivers and their suburbs are at the upper streams of the river basin, a change in the land coverage of suburbs often presents extra loads to rivers. Then unusual natural events are more likely to cause river overflowing. Also, cities are increasingly flooded, without river overflow, by internal water. This is because the capacity of drainage becomes less sufficient since penetration of the lands rapidly becomes smaller than expected, and concentrated land use impedes magnification of drainage capacity. Finally, flooding causes human death and

property loss (at the right of Fig. 3). In order to reduce risks, one of the causal chains above needs to be interrupted.

- Prevention

Flood prevention by hard measures is one of the most utilized ways in Japan. Preventing flooding is a direct way to reduce risks. The problems of relying too much on preventative measures have already been discussed.

- Information and Education

Integrated risk management focuses more on non-structural measures at the lower reaches of the causal flow, improving social vulnerability and reducing human and financial losses in the case of flooding. Those measures include emergency alarm systems, hazard maps and web education systems, land use regulations, and insurance.

An emergency alarm system is the last system to save lives in the case of flooding. It is simple and has a relatively long history. However, the timing of the alarm and evacuation is not always easy. Obviously it should not be too late, but if it is too early, it will not be taken seriously. Also, too early evacuation always attracts looters to the region.

In order to reduce human losses in the case of flooding, education about hazard is important. In cities, many people have no experience of floods, and they do not know the fear of flooding. Sometimes people die by remaining in basements during flooding. Another group of people who are use to flooding, often take quick action: moving goods from the first floor to the second and going to higher places with some water, snacks and money. Thus, risk education and emergency alarm systems are expected to effectively reduce human losses even if those systems do not reduce flooding themselves.

- Land use regulation

Change in land use is also one of the traditional non-structural measures that drastically reduce human and property losses. As is often mentioned that "water remembers the way". Water reaches lower places by always taking the same paths. Therefore, if society pays more attention to the land use of those places, flooding will not be followed by losses.

- Post-event planning

Post-event planning is an important topic of integrated risk management. Today, property losses through flooding is expanding and this can be covered by insurance. In many cases in Japan, constructing structural measures is much more expensive than the expected risk reduction. In other words, prevention needs more social resources than restoration after the event. In those cases, risk transfer through insurance is more appropriate than pre-event risk reduction.

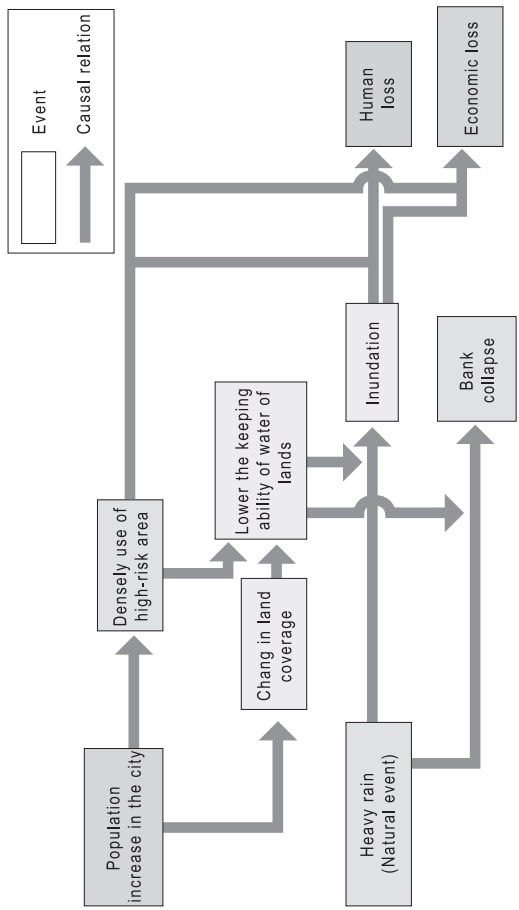

Fig. 3. Causal relationship between natural/social events and loss of the events.

Risk mitigation measures are varied, including structural and non-structural, technological and social, prevention and restoration. Integrated risk management is the optimal allocation of human and monetary resources among different kinds of measures. If measure A is more cost effective than measure B, re-allocating more resources from B to A is efficient, which means reducing more risks within the budget.

3.2 Integrated management of multi-hazards

Discussed above is the efficiency of the integration of different types of mitigation measures against a single hazardous event. Theoretically, the same discussion is possible among mitigation measures of different kinds of hazardous events, such as floods, earthquakes, and criminality. Currently, different types of hazards are managed differently, mainly for historical and institutional reasons. As both target level of risks and the budget of risk management is set by each hazard, marginal risk reduction cost can be higher in one kind of hazard than another. In those cases, monetary resource re-allocation across different kinds of hazards is efficient.

Also, integration of different types of hazard management is efficient because it can often curtail redundancy. For example, the infrastructure of an information system can be used for plural hazards—or the system should be constructed to be adaptable to multi-hazards. We found one unsuccessful case in the Tokai flood—some shelters and emergency storage were submerged (Seo and Sato, 2002). Those shelters are provision against disasters, but it is easily imagined that an earthquake was mainly assumed, because those shelters were constructed soon after the catastrophe of the Hanshin earthquake. Shelters were constructed in low places. If they had been constructed by the budget of flood-risk prevention, they would have been on high ground, but could have been more vulnerable against earthquake. The idea of multi-hazard will be helpful to construct a facility that is tolerable against both hazards.

As will be discussed, communities are expected to play an important role in integrated risk management. The idea of multi-hazard management will be important especially in community level risk management, because human resources are limited in communities. Recently in Japan, with crime on the increase, the role of the community in the prevention of crime is expected. Systematization of the community, not only against crime but also against multi-hazard, makes it less vulnerable.

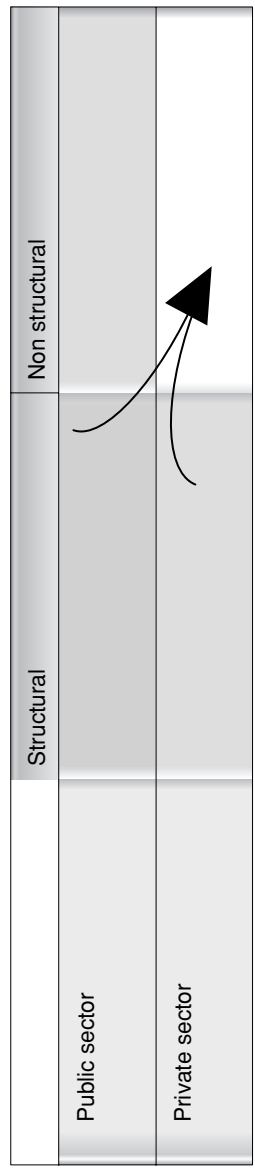

Fig. 4. The type of measure and the responsible units of implementation.
Change form the hard to the soft in the risk reduction measures often means the change from the public sector to the private sector in the management units.

4 Integration of Different Levels of Risk Management

4.1 The role of Government

Resource re-allocation with integrated risk management necessarily requires changes in the unit of risk management from central government to the local governments, communities, and individuals and from the public sector to the private sector (Fig. 4). The expected role of the government in integrated risk management is different from that in flood prevention by the structural measures. In the latter, the role of government is basically assessing the risk of flooding, and constructing banks and/or dams. The process requires careful observation of natural events, a high level of technology, and a large enough budget but not cooperation with other units. In integrated risk management, the role of government is more varied and complex. The government has to plan how to participate with the local governments and communities. It is also required to plan how to share the responsibility with the private sector. If the government's share or responsibility is too large, the incentive for private sectors to improve their own safety will be discouraged. If the share is too small, however, the poor and the weak may be left in danger.

4.1.1 Information and communication

The importance of the role of government in risk information and education cannot be over-emphasized. The government should appropriately inform people so that they can take rational action. The history of open-information policy is short in Japan. Until recently, many landowners were negative about opening risk information such as distributing hazard maps because risk information may lower the value of their properties. Also, both the government and public shared the same idea that the government could guarantee zero risk; open information was inconsistent with the illusion.

Today, the policy of open-information is widely accepted. Japanese people can get risk-related information through various media if they want it. For instance, we developed a Web system, the Participatory Flood Risk Communication Support System, for education, information and helping risk communication as introduced later in this book.

The argument whether information should be open goes on. However, we have little experience about *how to* open it. Lay people may not pay enough attention to the risk information in daily life; they may feel it is ridiculous to prepare for a hazardous event which may come within two hundred years. If, however, the way of opening information is too sensational, people may overestimate the risk and take unnecessary action, which often causes different types of risks. Studying effective ways of release information and education—implementation science—may be one of the new roles of the government un-

der the integrated risk management.

4.1.2 Informed choice

To reduce risks, the government must make the difficult decision between regulation and informed choice. In general, regulation is easier and a more risk-averse way. Land use regulations against flood, including retarding basins and building regulations, are direct ways for a society to circumvent flood-risk exposure. Keeping a retarding basin in a city area is sometimes costly, but often less expensive than the cost of constructing structural measures.

Regulation, however, is rigid compared with informed choice, and thus is not always supported by the public. Informed choice is often better in terms of cost-benefit efficiency if the public appropriately perceives the risk. It is especially efficient when the value system of the risk-takers and that of policy-makers is different. When the public and policy-makers are sharing the same value system, the public will take appropriate action, even without regulation, only if they are informed. In this case, regulation is not necessary. When the public and policy-makers have different value systems, regulations always lower the risk-takers' satisfaction: if the regulation does not exist, people can take different actions, which increases their benefit, according to their own cost-benefit evaluation. "Satisfaction" of risk-taking people is naturally subjective which can be evaluated only by the risk-taking people themselves.

Effective risk management through informed choice, however, is not always realistic, because many people do not fully understand their own risk of natural hazards. As mentioned, risk perception is not easy for many people, although their lives are inundated with risk information. Informed choice requires education and communication system at the same time, because it is effective only when a certain degree of rationality of the public can be expected.

4.1.3 Insurance

A substantial role by the government is often expected in the restoration after a disaster. Some people in Japan even insist that the government should restore private property as well that was destroyed by the disaster. In fact, after the earthquake in Tottory in the 2000, the local government restored privately owned houses through taxes. The policy benefited the sufferers, but private loss is better being restored by the owners for the same reasons as informed choice is superior to regulation as discussed above. Inflow of governmental money discourages personal efforts of preparation against hazards, and may cause "moral hazards", which increases the total risk of the region as a result. Loss from natural hazards is often large and certainly is difficult to restore privately. However, although the loss is large, the *risk* is not because the

frequency is not large. Thus, risk transfer through an insurance system is preferable.

Most of the insurances are usually provided by the private sector in Japan. However, the government is expected to play a roll in insurance related to natural hazards, because the loss from natural hazards is often huge, which can bankrupt companies. If there is risk of bankruptcy of an insurance company, people will hesitate to buy insurance. Therefore, governmental assurance is worth considering for this system. There is another merit in the cooperation of the public sector and the private sector in improving insurance systems. The government can participate in the designing process of the insurance. Carefully designed insurance can encourage public awareness and preparation for hazards. For example, if the premium is risk-based, insurance provide incentives to insured people to lower their own risks because personal efforts will be rewarded with lower premiums. Living in a safer area and other private risk mitigation can be justified by insurance systems.

In the United States, the federal government runs an insurance system, National Flood Insurance Program (NFIP), which is planned to give incentive to private efforts for safety. The Community Rating System (CRS) of NFIP encourages people and communities to protect their own places from floods through a risk-based premium system (FEMA, 2005). Under CRS, if a community improves the regional safety, the insurance premium is lowered. Therefore, communities and people have incentives to lower the risks. In fact, however, a risk-based insurance system is technically not easy because a fair assessment of risks from natural hazards throughout a country requires a significant amount of both human and monetary resources. Also, risk may be too different among people to reflect correctly on the premium (Adams, 2000). This sort of system can be regarded as for the public good, which is not necessarily appropriate to be provided only by the private sector.

As discussed above, integrated risk management sometimes requires efficient cooperation between the public sector and the private sector.

4.1.4 Post event restoration

Planning of risk-related resource allocation often focuses more on the prevention of disaster than on restoration. People find restoration planning before the event to be relatively hard to accept because it means that the risk is not zero. Actually, however, risks of natural hazards cannot be zero, so restoration planning before events is quite important.

Post-event planning is not only a fail-safe system for hazards that cannot be physically avoided by prevention measures. Sometimes restoration after the event is much less expensive than risk prevention. In other words, saving

resources for restoration after the event is often more efficient than allocating resources for prevention. Public agreement may be more difficult to get for the policy, not implementing possible prevention measures and saving resources. However, an appropriate balance between measures taken before and after events ultimately lowers risks within the limited budget.

Prevention and restoration by the government sometimes have different meanings for property owners in the target region. Pre-event measures, which lower risks, directly raise the value of privately owned property. On the other hand, restoration is usually designed not to restore privately owned property through government expenditure, because otherwise, taxpayers' agreement is hard to get. The government typically restores only public property, such as roads and public schools that benefit the private sector only indirectly. Therefore, a change in resource allocation from prevention to restoration partly means a change in the allocation of burdens from public to private, and therefore, property owners have incentives to impede this change and tend to overemphasize the importance of pre-event measures.

The restoration of private property through public expenditure seems unfair to taxpayers, as mentioned above. Private property should be restored by the owner rather than by taxes because only the owner benefits from the restoration. However, the restoration of privately owned property is not necessarily unfavorable for taxpayers, if the marginal cost of curtailing risk through restoration, including the restoration of private property, is still less expensive than prevention, which is charged to the public account. Again, the problem of the government restoring private property is the moral hazard. Knowledge that the government will pay for restoration after a disaster discourages owners' personal efforts to lower the risks. Also, if the government compensates a private loss, no one will buy insurance, which disturbs the risk-reduction function of a risk-based insurance system.

The integration of pre- and post-event risk management is the difficult part of integrated risk management. As governmental policy affects public choice, as discussed above, a simple cost-benefit-based design is not effective. The expected role of the government is preventing moral hazards and giving incentives for self-defense. At the same time, the government should help people who cannot surmount risks through their own efforts.

4.2 Role of residents and community

Public involvement is one of the most important but difficult topics in integrated risk management. When moving from governmental management to integrated risk management, public agreement and cooperation is necessary. The reason is because systems such as informed choice and insurance are ef-

fective only when a certain degree of rationality of the public can be expected, as discussed.

However, individual ability to process information varied substantially and their value system is quite different depending on the experience, region they live, age, and income. Some people have experienced flooding and know well about that hazard, but others do not. Some obtain information through the Internet freely and others do not. Therefore, reaching an agreement, even among lay people, is difficult. Those differences among people are one of the sources of uncertainty, because the probability of loss in the case of an emargency depends on the action of individual people.

Agreement between policy-makers and lay people is more difficult because many people do not understand about budget constraints. Another difficulty is related to public agreement to share responsibility. Unlike structural measures or regulations, people have to be responsible for their own choices. Public involvement can lower risks, but sometimes people will find the costs imposed on them. In other words, public involvement is necessarily accompanied by costs, charged directly to the public. Therefore, the idea is not always readily accepted.

Traditionally, however, the risk of a natural hazard was managed by each community to a certain level. Individuals used to take expected action as members of the community. The weak in the community, such as the elderly and handicapped were taken care of by other members. The case study of the Tokai flood show that the collapse of the community makes a region significantly more vulnerable (Seo and Sato, 2002). The community should be appropriately positioned in integrated management.

Expected effects of risk communication are the reconstruction of the community and construction of a good relationship between the government and the community. Rapidly spread Internet provides convenient ways for risk communication. Our project developed a prototype of an e-community platform on the Internet for risk governance by a community, and collecting empirical data on risk communication through the platform using the experiment in Shimada City, as discussed in Chapter 5 (Nagasaka).

5 Direction—Concluding Remarks

Today, governments are expected to provide high levels of safety and social welfare under budget constraints. Thus, a simple strategy of relying on only a few measures provided by the central government is not satisfactory because both environments and human value systems (cultures) vary from region to region. Integrated risk management is, literally, rational integration

of different types of measures: technological and social, structural and non-structural, and preventive and restorative.

Different types of measures require different levels of risk managers. Integrated risk management requires the involvement of local communities and cooperation between the public and private sectors. It is necessarily accompanied by a change in the role of the government. In addition to providing technological measures, the government is expected to support regional decision-making. Effective information systems, community involvement and alternative ways of allocating resources will be more important in risk management in Japan.

Public involvement is one of the key concepts of integrated risk management. To achieve the optimum balance of risk and cost, involved people are required to share certain expenditures; otherwise, the demand on public goods becomes too large. A system should be designed to bring out the ability of the public to help itself. At the same time, it must provide a high level of safety to those who are not capable of helping themselves.

References

Adams, J., "A Richter Scale for Risk?" (2000): in Julian Morris eds., *Rethinking Risk and the Precautionary Principle*, Butterworth Heinemann, Oxford, UK.

Burton, I., R. W. Kates, and F. G. White (1993): "Hazard, Response and Choice", in *The environment as hazard*, Guilford Press, NY, NY.

FEMA (2005): http://www.fema.gov/nfip/crs.shtm (accessed in Aug. 2005).

Hohenemser, C., R. E. Kasperson, and R. W. Kates (1982): "Causal Structure: A framework for policy formulation", in C. Hohenemser and J. X. Kasperson eds., *Risk in the Technological Society*, Boulder, CO, Westvies Press.

Huntington, S. and K. MacDougall (2002): "Flood Risk", in George Fleming eds., *Flood Risk Management*, Thomas Telford Ltd., London, UK.

NIED (2002): "Report on Urban Flood Disasters and Landslides on September 2000 in the Tokai Regions, Japan", in Natural Disaster Research Report No. 38.

Platt, H. R. and C. B. Rubin (1999) "Stemming the Losses: the Quest for Hazard Mitigation", in H. R. Platt eds., *Disasters and Democracy: The Politics of Extreme Natural Events*, Island Press, Washington, D.C., 69–107.

Seo, K. and T. Sato (2002): "Tokai Disaster as an Urban Flood hazard: a survey report", in "Report on Urban Flood Disasters and Landslides on September 2000 in the Tokai Regions, Japan", in Natural Disaster Research Report No. 38, 163–176.

Seo, K. and T. Sato (2003): Environmentally friendly flood risk management, *Environmental Economics and Policy Studies (Japanese)*, **8**, 94–204.

Takahashi, Y. (1971): Changing country and food Iwanami, Tokyo, Japan.