An Integrated Risk Analysis Framework for Emerging Disaster Risks: Toward a better risk management of flood disaster in urban communities

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1 Introduction

For many years in Japanese urban communities, it has prevailed that the various flood prevention measures implemented upon major Japanese floodplains would prevent almost all large-scale flood damage to homes and buildings, even in flood-prone areas until we had the Tokai Flood of September 2000 in Nagoya. This common belief in the public was founded on the huge amount of public investment spent for construction of disaster prevention structural facilities after the Ise Bay typhoon caused 5,000 casualties in 1959. However, as the inconceivable damage, beyond our imagination, from the Tokai Floods of 2000 showed, the risk of catastrophic flood disasters has not been eliminated and should have continued to be considered by society. We have learned that we are seriously at risk from events for which we are unprepared, not because we fail to remember what happened before, but because we will encounter newly emerging risks that differ completely from what we faced before.

This is called “systemic risk” in a modern post-industrial society where a single physical disaster can trigger a spread of secondary and tertiary effects on other social systems or organizations, resulting in the collapse of entire systems supporting our economy as well as our social welfare (OECD, 2003). In such cases, many people could suffer long-lasting damage to their health as well as their property and environmental assets, due to severe impairment to urban and industrial infrastructure functions—such as communication, transportation, public health and security, disposal of sewage and industrial waste (e.g., hazardous chemicals, heavy metals). In addition to such systemic disaster risks, we face other risk issues arising from the construction of large-scale structural facilities to prevent disasters. Firstly, flood control projects, where the priority has been on early completion with economic efficiency, have degraded in the long-run river environments by reducing biodiversity, shrinking the habitats of aquatic fauna and flora, degrading the water environment,
and changing the water-soil cycle. Secondly, rapid urbanization in the former
flood-plain has weakened disaster preparedness on the part of local residents
due to the decline of traditional local communities.

This paper is primarily concerned with the integrated risk analysis fram-
work for analyzing the vulnerability of modern urban communities to the
emerging disaster risks such as LPHC (low probability but high consequence)
or multiple disasters in specific urban communities that have been technolog-
ically and socially constructed in modern society. Much attention should be
directed toward community-based risk governance to cope with LPHC type
of emerging disasters, particularly, in participatory and precautionary ways.
The participation of local people in the planning, design, and implementa-
tion of flood-risk management measures could significantly reduce the scale
of possible damage from catastrophic events of LPHC types.

Specific characteristics of our new framework are: 1) hazard research
with interdisciplinary work for risk scenario formulation in terms of hazard
sciences and human-social sciences, 2) risk assessment of emerging disas-
ters under the high complexity and uncertainty involved in both human-socio-
economic and natural-environmental systems, 3) integrated risk management
under a wide range of value stakes among residents, local groups, NPOs and
public administrative institutions by exploring various ways of integration re-
garding risk reduction measures in terms of “structural versus non-structural”,
“regulatory versus non-regulatory”, “public versus market”, and “single ver-
sus multi-hazards”, respectively, and 4) disaster risk communication enhanced
by a community-based social platform which supports stakeholders sharing
previous disaster experiences of residents and hazard and risk information in
the concerned area. Public administrative information about disaster manage-
ment and the scientific knowledge of experts can also be provided through
the platform. The residents, NPOs, public administration, experts, and other
stakeholders can discuss mutual cooperation with nearby residents, and in the
case of a disaster, find an ideal way to provide relief via the social network
on the platform. Such a social system, which improves the level of disaster
prevention through risk communication, is called “risk governance”.

2 Integrated Risk Analysis Framework for Emerging Disaster Risks
2.1 Interdisciplinary concept of emerging disaster risks

It is not too much to say that many emerging natural disasters have been
technologically and socio-culturally induced, because they are deeply asso-
ciated with modern human settlement, production, transportation, and con-
sumption activities in a post-industrial society. In addition, these risks are
inevitably surprising and specific in their characteristics, typically of “low frequency but of catastrophic consequence” in terms of human life and health, economic loss, and associated environmental damage. Hence, such hazards are often comprehended as a possible danger as an event of “virtual-reality” in terms of the difference between the perceived possibility and reality, for example, the danger of encountering lightning or an airplane crash that are likely to occur no more than once in one’s lifetime (Renn, 1992).

To deal with these types of emerging dangers, the modern concept of “risk” has evolved from the conventional view of “risk” as “an expected value of the probability of a hazardous event occurring times the magnitude of the consequence of the hazard” to an ontological or sociological concept of “risk” that allows us to take into consideration a wide range of socio-cultural characteristics of disaster risks. From among such attempts to define an interdisciplinary concept of risk, we take one of the simplest ones:

“A potential for the realization of unwanted, adverse consequences to human life, health, property, or the environment.”

This simple concept originated from extended discussions to define an interdisciplinary concept of risk at the Society for Risk Analysis (SRA: a professional and academic association founded in 1982 with major memberships in the US, Europe, and Japan). According to this concept, when we specify “a potential” in the framework of risk analysis, it should be noted that something reflecting human values as to “adverse or unwanted” has been included in the stakes considered through assessment and management processes of the experts, assessors, managers, and other stakeholders concerned with each risk event. In response to this issue of “values”, either explicitly or implicitly inherent in any concept of risk, Kaplan and Garrick (1981) proposed the following expression of the risk concept as a risk triplet. The risk triplet consists of scenario $S$, likelihood $P$, and possible consequence $D$ in relation to three basic questions of risk analysis:

1) What is the nature of disaster events that can occur?
2) How likely is a particular event?
3) What are the consequences?

$$\text{Risk} = R\{\langle S_i, P_i, D_i \rangle \},$$

$S_i$: a set of scenarios concerning the nature of possible events
1) $S_i$: What will happen?
2) $P_i$: How often?
3) $D_i$: What consequences?

\[ \text{Risk} = R\{<S_i, P_i, D_i>, i=1,2,...> \]  

\[ R\{P_i \times D_i\} \]  

**Fig. 1.** The conceptual expression of “risk triplet” (Ikeda, 2000).

$P_i$: a set of likelihoods concerning event frequency, probability, or ambiguity

$D_i$: a set of consequences concerning potential damage to humans, animals, plants, and the environment.

The relationship between the conventional concept of risk $R\{<P_i, D_i>\}$ and the interdisciplinary one $R\{<S_i, P_i, D_i>\}$ is illustrated in Fig. 1 (Ikeda, 2000). In addition to the scientific knowledge regarding $P_i$ and $D_i$, scenario $S_i$ can incorporate questions and conditions related to ontological and socio-cultural factors concerning our anthropocentric activities in a complex and uncertain world. For example, in the case of risk analysis for flooding events, the scenarios will try to identify what are the most critical endpoints to be assessed in terms of the possible impacts on humans, communities, and the environment to enable better risk management. As generic endpoint indices, we may argue in favor of the number of human lives lost, the economic loss with respect to household and community assets, damage to landscapes and environmental assets, and so on, depending on our concerns with respect to the nature of hazards.
Once we have suitable endpoints to be assessed, we have to specify the particular nature of each hazard that could affect the endpoints in both terms of the likelihood and the degree of damage. We also have to explore possible external impacts, which might occur accidentally or spontaneously in areas beyond our market or social institutions, by posing the following questions:

- Are the impacts or damage within our management limit or outside of our control?
- On what scale will these impacts be felt and what is their degree of irreversibility?
- Are these impacts inter-regional or transboundary in character?
- Do these impacts pose a potential threat to human ethics or morality?

These are typical questions that must be answered to clarify scenarios $S_i$ in the problem formulation stage when we begin the scientific or objective evaluation of $P_i$ and $D_i$ because we may need other assessment schemes or tools tailored to the nature of each possible risk scenario. An important role of the risk analysis is to provide answers to these questions, either qualitatively or quantitatively, in relation to specifying the risk triplet $R = R\{S_i, P_i, D_i\}$ based on an analytical framework of risk analysis described in the following section.

2.2 Typical risk scenarios of emerging flooding disasters in Japan

Figure 2 displays the salient issues and factors for generating risk scenarios that take into account the historical and cultural backgrounds in the context of hazards, river environments, and communities as discussed in details by other chapter (Sato). In this way, we can elaborate upon, for example, typical risk scenarios that require an integrated perspective in selecting adequate combinations of risk reduction measures:

Risk scenario 1: Increased flood-damage potential due to urban development and agglomeration

The accelerated economic growth and innovation in all social infrastructure sectors during the period from the 1960s through the 1980s brought about a rapid increase in the population of Japan’s metropolitan areas. During this time, local rice paddies that once acted as a flood-protection belt were developed into residential and industrial districts. Such areas were vulnerable to
Fig. 2. Issues and factors in making “risk scenarios” for flood-disaster risk analysis (Sato, 2002b).

Floods and frequently suffered damage as medium-sized and small rivers overflowed and inner flooding occurred. This problem leads to the rapid construction of rainwater drainage canals and flood-control facilities for such rivers. Flood damage in urban areas has declined, as indicated by a decrease in the total inundated area, with the construction of flood-control facilities. No decrease can be seen, however, in property damage due to floods over this 40-year period (Zhai and Sato, 2002).

Risk scenario 2: Increased systemic risk due to cascaded facilities or organizations

A number of small-scale problems in urban areas might lead to a series of large-scale hazards, increasing the systemic risk in a cascading manner, under specific conditions. In the Tokai floods, the inner drainage system failed to function properly for the first time during extraordinary precipitation—at a rate of 93 mm/hour, which exceeded the 100-year probability—that was nearly twice the capacity of the rainwater drainage canals in those areas. The overflow of medium-sized and small rivers continued until dikes, which were under the management of the local government failed at the Shin River. The
area inundated by water was only 15% of the total inundation area, but accounted for 56% of the total property damage. A dreadful catastrophe would have occurred if the dikes holding back the largest river, which were under the management of the central government, had consequently failed (Sato, 2002a).

Risk scenario 3: Decline in preparedness of local communities to fight disasters

Urbanization has meant an increase in the number of new residents who are unfamiliar with the vulnerability of the local land to flooding. When danger from flooding is evitable, the government evacuates residents via a public warning system. This approach ensures an appropriate level of safety, but also reduces disaster-prevention awareness among the populace. It has become increasingly difficult for people themselves to prepare for an out-of-the-ordinary risk and to decide how to best protect their lives and property at the time of a disaster. In short, the trend is to "leave disaster prevention to authorities or other organizations", and residents wait for information from the authorities before acting when a disaster occurs (Sato et al., 2001). As a result, the ability of local communities to minimize losses from a disaster has been weakened. At the same time, a new movement has appeared in the form of disaster-prevention volunteers and non-profit and non-governmental organizations that provide assistance during disasters and deal with community safety of their own volition.

Risk scenario 4: Possible outbreak of LPHC type flood disasters

Continual development of man-made embankments along rivers has changed runoff characteristics and significantly increased the magnitude of flood discharge. Furthermore, embankment height has also significantly increased. As compared to 100 years ago, former excessive flood peak discharge now flows down river channels. This has enlarged the magnitude of flooding by potential failure of embankments, although, the probability of this occurrence is extremely low. In the 2004 severe flood disaster in Niigata Prefecture, the volume of floodwater that overflowed river channels, because of the failure of embankments of the Ikarashi and Kariyata Rivers, was assumed to be 40 to 50 times larger than the volume of flood water that overflowed the embankments. The large height difference between the top of the embankment and the ground made the destructive power of the flood-water strong. Once embankment failure had occurred in an urban area, tremendous damage would follow (Sato et al., 2006).
Risk scenario 5: Environmental devastation and coastal erosions by interrupting soil-cycle

Artificial river channels have been increasingly constructed by flood control work for over 100 years since the introduction of former river law (1897), owing to strong public requirements for flood prevention. Fewer considerations were given to other functions of rivers than flood control. The river environment and wildlife habitat have been adversely affected as a result of public works. Prevention of downstream sediment transport, owing to the construction of dams for flood control and collection of large quantities of gravel in the high economic growth period, has caused riverbed degradation since the early 1960s. This degradation has necessitated further reinforcement of river structures, repairment of intake-weirs, and more restoration work of beach erosion as well (Sato, 2002b).

2.3 Conceptual risk analysis framework for natural disasters

As far as the generic issues of risk analysis posed in the risk triplet are concerned, our scheme of a risk-analysis framework can follow the classic one developed in the US by the National Research Council (NRC, 1983), which was primarily intended for the regulation of hazardous chemicals to protect human health and prevent environmental degradation. Although each step of a risk analysis may vary depending on the particular sources of the hazards, including both natural and man-made disasters, this has been widely accepted as a generic framework for regulating various types of risk problems. The framework consists of the three processes as shown in the upper part of Fig. 3:

1) Research processes (or problem formulation) to examine potential risk events, performed in laboratories, field studies, and communities, and in the case of disaster events, mostly based on scientific disciplines such as seismology, hydrology, climatology, environmental science, civil engineering, and so on.

2) Risk assessment, which provides an objective and integrated judgment in terms of scientific evaluations regarding hazard identification, pathways, and exposure assessment, and exposure-damage response assessment as an integrated form of risk characterization.

3) Risk management, a subjective decision-making process to select regulatory measures from among alternative regulatory options in conjunction with the outputs of scientific risk assessment and other socio-economic and cultural conditions.
One of the most important features of the NRC framework is the clear conceptual and functional separation between risk assessment and risk management. Although each process has its own tasks of risk characterization and management decision, respectively, both must deal with scientific uncertainty and complex stakes that are involved not only in its own process but also in the other process. The explicit representation of risk scenarios can provide an intermediate step or catalyst at the interface between these two types of processes to enable better assessment and regulatory decisions under high scientific uncertainty and complex stakes among researchers, assessors, managers, and stakeholders. However, we have seen many controversial cases of risk management which lost public acceptability or credibility primarily due to the lack of coordination regarding how to handle the uncertainty and complex stake issues between risk assessment and management processes. Typical examples were, in Japan, “Minamata disease” of organic mercury or “Itai-itai disease” of cadmium exposed through the complex food chain in the water environment. Hence, the critical role of risk communication and stakeholder
participation in risk analysis has been widely recognized as a necessary fourth process in the risk analysis framework (NRC, 1996), as shown in the lower part of Fig. 3.

2.4 A new scheme of risk analysis framework for emerging disasters

In response to the NRC risk analysis framework, several models of disaster risk analysis framework have been developed to deal with the uncertain and complex nature of natural hazards, and these explore the relationships between hazards and damages in terms of either risk or vulnerability. For example, Wisner et al. (2004) advocated the pressure and release model (PAR model) as a means to understand risk in more realistic terms of vulnerability in the field of disaster sciences based on the disaster risk model of Alexander (1993)

\[ \text{Risk} = \text{Hazard} \times \text{Vulnerability}. \]  

(2)

In the PAR model, vulnerability is defined as “the degree to which someone’s life, properties and other assets are put at risk by events in nature and in society”, which can be measured in terms of potential damage.

In reference to the conventional expression of disaster risk provided by Smith (2001),

\[ \text{Risk} = \text{Hazard}(\text{Probability}) \times \text{Loss}(\text{Damage})/\text{Preparedness}(\text{Resilience}), \]  

(3)

Wisner’s definition of “risk” as “hazard times vulnerability” can be interpreted as a unit measure of the possible damages \( D \) under an exposure probability \( P \) to the hazardous event in our risk triplet expression \( R\{\langle S_i, P_i, D_i \rangle \} \) (1), where risk scenario \( S \) is implicitly taken into consideration as a degree of vulnerability in (2), or the preparedness in Smith’s definition of disaster risk in (3). It should be noted here that our notation of “resilience” has just an inverse meaning of “vulnerability” to disasters. Rather, it has a more practical sense of enhancing “societal preparedness” to respond the emerging disaster risks.

Based on these concepts and measures of disaster risk, we can reach an integrated framework for disaster risk analysis which consists of the following four steps corresponding to the four parts of the previous NRC Framework (Fig. 3):

1) Hazard research (scenario formulation)—collection and analysis of data related to hazards in terms of their possible origins, pathways, and past
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and present mitigation actions taken; based on this research process, risk scenarios can be developed.

2) Disaster risk assessment—preparation of a list of potential hazards along with their likely exposure or vulnerability, followed by risk characterization in terms of “risk curves” by both occurrence probability and damage outcome.

3) Disaster risk management—development of mitigation measures and procedures primarily based on the output from the risk characterization, taking into account uncertainty and other socio-human dimensions.

4) Disaster risk communication—creation of a platform to enable stakeholder participation in all processes of the risk-analysis cycle to help stakeholders understand the rationale behind risk assessment results and management options so that they can make better informed choices in uncertain and complex situations.

As a core part of our risk analysis framework, the process of disaster-risk assessment is schematically illustrated in the lower part of Fig. 4, which consists of the following three components and one integrative part of “risk characterization”, given the possible risk scenarios in relation to the resilience or vulnerability in human/socio-economic dimensions and the potential sources of hazards in natural-environmental dimensions:

1) Identification of potential hazards of external forces either in natural-environmental dimensions or human-socio-economic dimensions. The likelihood of the strength of causal links between hazards and the endpoints (such as human casualties, damage to property, or impact on critical infrastructure) is also a critical issue to be taken into considered;

2) Assessment of the exposure to the hazardous events in relation to the resilience or vulnerability of human-dimensional systems, such as population, houses, assets, landscapes, etc.; and

3) Exposure-damage response such as the risk functions or curves between the degree of the exposure and damages based on possible mitigation measures;

4) Risk characterization will evaluate all issues of uncertainty and complexity involved in the preceding three steps, and will judge them in some integrated ways under a given acceptable or tolerable level of risk, which presumably should be considered as historically acceptable or being implicitly rooted in the concerned society with regard for safety from natural disasters.
3 Risk Management Strategies for Better Governance to Emerging Disasters

To figure out the salient issues in disaster-risk management strategies for better governance, we can classify the nature of risks into four categories by dividing them according to two perpendicular axes, with one axis indicating the degree of uncertainty of our knowledge (a scientific evaluation axis related to a causal structure) and the other axis indicating the degree of social stakes among the stakeholders involved in the risk events (a socio-economic or cultural and ethical evaluation axis associated with a disutility structure) (Ikeda, 2000).

Area 1: This is an area where scientific knowledge about risks is fairly certain and it is little stake among stakeholders for evaluating the results of the scientific assessment using objective indices or standards. Here, we can easily implement regulatory measures to reduce risks based on objective risk assess-
Degree of decision stakes

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<td><strong>Issue: Design &amp; Operation</strong></td>
<td><strong>Issue: Diagnosis &amp; Inference</strong></td>
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<td><strong>Approach: Risk-based</strong></td>
<td><strong>Approach: Precaution-based</strong></td>
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<td><strong>Applied Sciences &amp; Engineering</strong></td>
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<td><strong>Issue: Stakes &amp; Disclosure</strong></td>
<td><strong>Issue: Values and Ethics</strong></td>
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<td><strong>Approach: Consensus-based</strong></td>
<td><strong>Approach: Deliberative Integration-based</strong></td>
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<td><strong>Decision and Policy Sciences</strong></td>
<td><strong>Meta-Assessment Procedures (Inter-/cross-disciplines)</strong></td>
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Fig. 5. Risk management issues and approaches in the uncertain and complex world (Ikeda, 1996).

The important management issue is how to ensure that risk information is objective in maintaining the accountability of regulatory decisions, selected from among possible options, to reduce risks to a level lower than acceptable levels. Hence, the appropriate management strategy is to take a risk-based regulatory approach under the existing legislative frameworks and institutional settings.

**Area 2:** This is an area where scientific knowledge about risk events is fairly certain, but there is disarray among stakeholders regarding their evaluation of the risk-assessment outcomes. In this area, a consensus-building approach to risk management is required as the principal management strategy. The critical issue is to ensure that the risk assessment procedure is reliable and transparent, not only by having stakeholders involved at all levels of regulatory decision-making, but also by making democratic institutional arrangements to ensure their involvement.

**Area 3:** This is an area where the scientific knowledge is uncertain, but stakeholders feel that they have less at stake in evaluating the risk assessment results, even in an uncertain and ambiguous context. Some risk events corresponding to natural or environmental hazards, such as earthquakes or volcano eruptions, would be located in this area. Here, the risk assessment must take the form of a diagnosis, prediction, or scenario in terms of qualitative or subjective measures under a high level of uncertainty. The main management strategy is
how to promote “sound science of diagnosis and presumption” despite a high level of uncertainty in our scientific knowledge. Hence, it would be desirable to allocate a significant share of resources not only to surveillance systems for detecting early warning signs but also to developing “precaution-based risk communication” for sharing risk information and data among experts and the public.

**Area 4:** This is an area where the scientific knowledge is uncertain and significant conflict is likely among stakeholders evaluating the diagnosis or presumptions in relation to an acceptable or tolerable level of risk. Since several existing approaches based on scientific and objective indices or standards are almost impossible to employ, it is necessary to develop a meta-science of deliberative integration approach to evaluate both scientific and socio-cultural factors associated with human dimensions of risk problems that include anthropological, ethical, and value judgments. At the same time, as in Area 3, we need to enhance “risk communication” platform for the stakeholders to foster their integrated perspectives of risk governance in relation to both human and natural dimensional issues.

In Areas 1 and 2, we can scientifically evaluate possible events qualitatively or quantitatively with a reasonable degree of certainty, such as the probability of precipitation being greater than 100 mm per day or the odds ratio of excess economic damage caused by floods based on measured inundation depth. The important management issues then become 1) how to ensure risk scenarios and the related indices or risk measures are properly chosen, monitored, and regulated, and 2) how to achieve reliable decision-making or consensus-building through the participation of stakeholders in these processes. Most disaster risk management, except that concerning surprising or catastrophic events, falls into these domains provided we have fairly good scientific monitoring data to allow objective assessment.

However, since most emerging risks correspond to surprising or catastrophic hazards, which inevitably are associated with high scientific uncertainty or ignorance, they generally fall into Area 3 or 4. Whether the main management issues are located in either Area 3 or 4 depends on the context of socio-cultural stakes among the interested groups or actors, whose risk perceptions will have different roots depending on their ontological or anthropological perspectives, which lie outside of conventional science paradigms. Here, we need a “societal risk governance” approach that is centered around the precautionary framework primarily supported by discursive-type risk com-
munication among stakeholders (Renn and Klinke, 2001). We use “risk governance” to represent a new integrated type of risk management strategies in which interdependence or intercommunication among stakeholders is essential for them to pursue collective decisions and attain policy goals, particularly through socio-political-cultural networks both vertically and horizontally. It is also assisted by a variety of networks enhanced by social networking systems among volunteer groups and other stakeholders, which we call e-community, a virtual type of community implemented in the internet web by utilizing a variety of information technologies of web-log and web-GIS systems together with mobile technologies as described in other chapter (Nagasaka, 2006).

4 A Pilot Study of Risk Governance to Emerging Flood Disasters in Urban Communities

4.1 A NIED project

Japan’s National Research Institute for Earth Science and Disaster Prevention (NIED) has launched a five-year research project (2001–2005) with the aim of making modern societies resilient not only to a traditional natural disaster but also to emerging disasters such as LPHC (low probability but high consequence) or multi-disasters that have technologically and socially induced in modern society. The project put specific emphasis on the following policy issues which recent Japanese disaster management had began to look for:

1) Shifting the management strategy from disaster prevention with zero risk to disaster reduction with an acceptable level risk that the residents or local communities may take.

2) Integrating a variety of risk reduction options in terms of hardware versus software, precautionary versus recovery, or regulation versus market/volunteers for making better governance to emerging disaster risks.

3) Facilitating both residents and stakeholders (local regulatory authorities, communities, NGOs) participation in planning, designing, implementation, and monitoring processes.

In order to cope with such policy issues, we have been developing such a social platform of assisting disaster risk communication, called Participatory Flood Risk Communication Support System (Pafrics), that can facilitate community-based participation in planning, designing, implementation, and recovery processes. The Pafrics has been constructed by taking a number
of research outcomes concerning local people’s risk perception and disaster prevention activities through a series of questionnaire surveys conducted by NIED (Sato et al., 2003).

Figure 6 shows our risk analysis procedure for dealing with emerging flood risks exposed to communities of highly urbanized areas. Although this new procedure of risk analysis follows the generic framework of disaster-risk analysis, as illustrated in Fig. 3, it has specific emphasis on the utilization of a social platform of a risk communication system in its management process as a social experiment of risk communication in local communities. The whole procedure consists of four major steps in which each task of the NIED project is allocated as written on the right-hand side in Fig. 6. In the first step, alternative risk scenarios are created as the problem formulation taking into consideration the human-dimensional and natural-environmental factors and the social issues displayed in Fig. 4. In the second and third steps, the risk is assessed either qualitatively or quantitatively, paying careful attention to the uncertainty involved in each process of hazard assessment, exposure assessment, and exposure-damage response, by focusing on a combination of hard and soft measures to reduce the flood risk. In the fourth step, a new type of flood-risk communication support system, Pafrics, which involves resident participation, is developed and tested.

During period of the project development, socio-economic and psychological studies regarding the social vulnerability to emerging disasters, are being carried out to develop methods for raising disaster-prevention awareness in flood-prone areas or for creating a mechanism of informed choice by having stakeholders’ participation in the collective decision-making of choosing alternative prevention measures including the study of risk finance or insurance institution. The seven research topics of the NIED project appearing in Fig. 6 are:

1) Structural and simulation analysis of disaster-risk occurrence, propagation, and associated damage based on risk analysis.

2) Risk-based assessment of disaster-prevention measures within the conventional scientific framework of probabilistic approach to natural disasters.

3) Integrated risk characterization including both human and environmental dimensions with specific emphasis on economical, cultural, and psychological considerations.
4) Exposure and vulnerability assessment together with community-based preparations for disasters mitigation in terms of precaution-based or deliberative integration-based management.

5) Development of a participatory flood risk communication support system (Pafrics) to help users to obtain a deeper understanding of the nature of flood risk and management options for their collective informed choice among stakeholders. (http://www.pafrics.org).

6) Risk finance and institution for flood disaster funds for the LPHC type of catastrophic disasters as one of the critical options.

7) Community-based integrated framework of multi-disaster risk governance based on the e-community enhanced by information technology.

Although each task is discussed in details in other chapters of this book, it should be stressed here that, while a construction of a social platform of risk communication support system (Pafrics) operates as a warp for the NIED project, the concept of integration in various measures of risk reduction works as a weft of all tasks in the NIED project. Here are listed such ways of integration, depending on the nature of a pertinent risk in terms of the degree of uncertainty in our knowledge and the degree of social stakes among stakeholders as illustrated in Fig. 5.

i) Integration of hard (structural control facilities) and soft (institutions and information) measures for shifting the concept from “disaster prevention with zero risk” to “disaster reduction with an acceptable or tolerable level of disaster risk”:

Under the present conditions, much attention should be directed towards soft measures consisting of institutional arrangements such as land-use regulation, risk finance schemes for disaster insurance, dissemination of early alarms or risk information through hazard maps or media, and provision of economic incentives for public participation in emergency preparation or drills.

ii) Integration of risk-based and precaution-based measures or actions throughout the disaster risk management cycle:

It is always desirable to take balancing perspectives between scientific uncertainties and complex processes of cause and effect relationship such as long-term economic efficiency, political flexibility, sustainable development of communities, and preservation of the natural environment at each stage of normal, emergency, and recovery processes.
Problem formulation
Risk Scenario

Assess & characterizing risk (risk curve)

Create countermeasure Options (hard + soft)

Evaluate measures based on Participatory Platforms of Parfics

Social Experiments of participatory risk communication by Parfics

Uncertainty Analysis

Risk-based assessment of disaster-prevention measures

Integrated risk characterization including human-and environmental dimensions

Exposure assessment and community-based preparations for disasters mitigation

Development of Participatory flood risk communication support system (Parfics)

Risk governance platform and institution of catastrophic disasters

Structural & simulation analysis of disaster-risk occurrence, propagation, and associated damage

7 community-based Integrated framework of disaster risk governance

Fig. 6. Integration procedures for the NIED project.
iii) Integration of regulation, market, and community-based volunteer activities in planning, design, and monitoring activities by promoting the participation of local residents:

Since both the government and local communities are limited in terms of their budgets and human resources, it will be necessary to return to such basics of disaster prevention culture based on an “informed choice of risk”. Here, individuals take on the responsibility of protecting their lives and property given the adequate provision of risk information either by governmental sectors or by the mutual support of the local community and relief provided by the social network of citizen volunteers.

iv) Integration of single risk management program toward multiple sources of disasters in local community:

There are various types of socially constructed disasters such as traffic accidents, fires, criminal activities, or terrorism and so on at the level of local communities. However, the social structure of most communities is rapidly becoming one of an aging society with less knowledge of ways to deal with these multi-disaster issues. In this situation, it is urgently requested that the local communities adopt positive attitudes in favor of activating the mutual support in their neighborhood and relief provided by the social network of citizen volunteers fostered through e-community platform.

5 Concluding Remarks

To have a better societal governance of the emerging disaster risks triggered by phenomena such as rapid urban agglomeration and complex processes of infrastructure development in our post-industrial society, we have developed an integrated risk analysis framework for finding ways of making modern urban society resilient to such disasters. Much of our attention has been directed towards community-based risk governance to enhance our preparedness for disaster risks by integrating a variety of risk-reduction options in terms of hardware versus software, precaution versus recovery, or regulation versus market. For making better governance to emerging disaster risk, it is critical to improve the mutual cooperability among residents and stakeholders (regulatory authorities, community, volunteer groups, NGOs) in planning, designing, implementation, and recovery processes of disaster governance.

We have described four ways of integrating risk-reduction measures, emphasizing the soft measures of implementing institutional arrangements such as land-use regulation, risk finance schemes to provide disaster insurance, dissemination of early alarms or risk information through hazard maps or media, provision of economic incentives to encourage public participation in emer-
gency preparation, and so on. Our focus is partly based on the fact that, as concern grows regarding the emerging disaster risks of increased potential for catastrophic disasters in our mega-cities, we face an urgent need for an integrated approach to the systemic risk in which human-environmental factors will be critical to the societal governance of emerging disaster risks.

Finally, we should point out that alluvial lowlands—where Japan’s mega-cities are located and which are especially vulnerable to flood disasters—are essentially new lands formed within the last 10,000 years. This means that these urban areas are eventually vulnerable to earthquakes and other natural or man-made disasters. When discussing the means of reducing disaster-related damage in Japan’s mega-cities, a comprehensive and integrated approach to multi-hazards must be taken as opposed to treating earthquakes, floods, and fires separately. This is among the next tasks we will explore.

References


