Report

on

Flood Disaster Risk Reduction against Large-Scale Inundations

Rebuilding Flood-Conscious Societies through Awareness-raising

December 2015

Council for Social Infrastructure Development

Contents

1. Introduction

Torrential rains in the Kanto-Tohoku region in September 2015 caused levee breaches on the Kinugawa River, the collapse and washout of residences, and long-lasting inundation of a large area. Moreover, delays in evacuation resulted in numerous stranded people, to a degree was not observed in flood disasters in recent years.

In Japan, before modern river improvements, river facilities had low capacity and society was resigned to dealing with frequent floods in the traditional way. For example, there is evidence of flood shelters built on high ground and rescue boats suspended under eaves.

After modernization, floods became less frequent and the society's attitude changed to "Any flood can be prevented by river facilities".

In the future, because of climate change, floods can often exceed the capacity of river facilities, as happened on the Kinugawa River. Therefore, governmental organizations, such as river administrators, and local stakeholders, should keep in mind that large-scale floods can exceed river facilities' limited capacity, and prepare the whole society for future inundations.

Thus, in October 2015, the Minister of Land, Infrastructure, Transport and Tourism equested the chair of the Council for Social Infrastructure Development to indicate how we should promote a policy of *Flood Disaster Risk Reduction against Large-Scale Inundations*. The council referred the question to the Sub-committee for River Management. The Sub-panel on Flood Disaster Risk Reduction against Large-Scale Inundation was established by the Sub-committee in November 2015. It presented the reports *Prompt Measures to be Implemented* and *Prompt Measures to be Discussed* in two panel meetings, and compiled this final report.

2. Challenges in response of Torrential Rains in the Kanto-Tohoku in September 2015

(1) Damage around the Kinugawa River

In the Kanto-Tohoku region, torrential rains fell in September 2015. Moist air flowed in from the south into a low-pressure system after Typhoon No.18 (Etau), bringing heavy rainfall from September 10th to 11th. Including 551 mm of rainfall at Ikari station in Nikko, Tochigi prefecture, record-breaking 24-hour rainfalls were observed at many sites.

Accordingly, in the Kinugawa River Basin, the heaviest-ever rainfalls (410 mm of watershed-average 24-hour rainfall) was observed (quick estimation), and the largest discharge was recorded at Hirakata and Kinugawa-Mitsukaido, Ibaraki Prefecture.

Floodwaters breached a levee at Misaka and overtopped at Wakamiyato to inundate approximately 40 km^2, equal to one-third of the area of the city of Joso. The outflow destroyed many houses near Misaka Levee.

In addition to the large inundation, a delay in evacuation advisories by the municipality and insufficient voluntary evacuation caused the stranding of numerous residents. Approximately 4,300 people had to be rescued.

Levee improvement had been progressing sequentially from downstream, but had not yet reached Misaka.

Flood fighting operations were carried out in many sections, but were not sufficient due to too many leakages, overtoppings and submergences and overly-complicated tasks, including evacuation guidance. It was impossible to carry out sandbag piling at all sites.

Some evacuation centers were unable to be used due to the flooding, so the municipality of Joso urgently requested that neighboring cities accept more than half of the evacuees.

Emergency drainage operations took place day and night using 51 drainage pump vehicles, but it took 10 days to ease the inundation of residential areas and public facilities.

(2) Features of the Flood

Based on the above-mentioned facts, the Kinugawa flood was characterized by:

- Long-lasting and wide-area inundation, including residential districts
- Destruction and washed-out of houses due to levee breaches
- Delayed evacuation advisories
- A large number of residents were stranded. This had not occurred in other recent flood disasters

- Insufficient flood fighting operations, such as sandbag piling.
- More than half of evacuees were sent to evacuation centers outside of the city

(3) Challenges to be addressed

This flooding occurred around the Kinugawa River, but such a disaster can happen along any major river nationwide. Furthermore, climate change will increase the frequency of floods exceeding the capacity of river facilities. Therefore, it is necessary to take prompt actions in response to the following issues:

- Considering the fact that houses were washed-out and many people stranded, it is necessary to urge residents to relocate from house collapse hazard zones, deep submerged zones and long-term inundation zones.

  However, it is of concern that neither municipalities nor residents can make appropriate emergent judgments and take actions, due to insufficient knowledge and difficulty in understanding flood-risk information provided by river administrators and other official bodies.
- In this disaster, widespread evacuation beyond city boundaries was necessary. It was conducted with urgency due to the difficulty of evacuation within the city of Joso. Without sufficient preparations for such wide-area evacuation in the event of even larger-scale flooding or a higher number of evacuees, it will be difficult to operate emergency evacuations.
- The number of personnel engaged in flood fighting operations is further decreasing because of an aging workforce and locals who are too busy with their primary jobs. Firefighters, who are responsible for handling to multiple hazards, may not have specialized skills in flood fighting. Although flood fightings need to be improved in terms of both quantity and quality in areas such as evacuation guidance, it is difficult to provide wide area of services appropriately.
- Because flood risk information was not disseminated sufficiently, it was not utilized effectively, not only for evacuation behavior as mentioned above, but also in such areas as housing construction regulations and land use.
- The last flood breached a levee which had not yet been improved. However, it is difficult to eliminate all the risks at once because of concerns about maintaining up-and-downstream balance or budget constraints. The risks will remain for some time, and will increase both on improved and lower-priority river sections due to increasing climate change.

  For reducing the risk of large-scale flooding, conventional measures aiming at making floodwaters flow safely within channels are insufficient.

3. Basic Policy of Measures

In response to the Kinugawa flood disaster and future climate change, it is extremely difficult to take measures based only on conventional policies.

To deal with these issues, all stakeholders, including river administrators, municipalities, residents, and the private sector, should change their mindset from "Any flood can be prevented by river facilities.", to "Large-scale floods can exceed the limited capacity of river facilities.". All parties should always prepare for possible floods and inundations by re-building flood-conscience throughout our entire society.

In particular, society should set these targets:

- sharing flood risk information among public and private sectors, and local communities, forming a proactive plan for crisis management in such areas as evacuation or flood fighting, and building an institutional framework
- supporting facility operations for reducing the area and duration of inundations and ensuring non-structural measures such as evacuation, even in floods exceeding the capacity of facilities

It is necessary to strongly promote the policy by:

1) evaluating flood risks in river basins appropriately, to be conducted by river administrators and others
2) sharing the risk information throughout the whole society using hazard maps and other means
3) implementing more effective and efficient risk reduction measures in collaboration among the river administrators, municipalities, residents, enterprises, and other actors

- In addition, river administrators should design non-structural measures from the perspective of local communities, rather than that of the national government. For example, risk information provided on a community-by-community basis can encourage residents to think seriously about their own security. Well-planned hydrological observation and real-time river information can convey the urgency to take action during floods. Only this attitude will enable us to provide user-oriented and truly practical non-structural measures.
- Although river administrators have often treated non-structural measures as an additional service to structural ones, both structural and non-structural measures should be carried out as complementary functions to each other. Understanding that non-structural measures are essential to social infrastructure, river

administrators should cooperate with and support municipalities actively to develop their non-structural measures.

- In addition, river improvement and flood fighting are the twin-engines of flood management. Among non-structural measures, river administrators should cooperate with and reinforce flood fighting operations.

Moreover, river administrators should always be aware of the limitations of facilities' capacity. Adding to the conventional structural measures to make floodwaters flow safely within river courses, it is necessary to install new structural measures to activate non-structural measures for human and socio-economic damage reduction (hereinafter referred to as "structural measures for crisis management"), such as:

- a river improvement process aimed at reducing damage, taking into account the risk of floods that exceed the capacity of river facilities
- efforts to prolong the time before levees are breached after overtopping, or to shorten time needed for drainage after inundation

In aid of these measures, river administrators should change the river management policy to a river basin management policy which aims at reducing risk caused by an assumable maximum scale of flood

4. Prompt Measures to be implemented

To provide effective flood management during the next flooding season, the following measures should be implemented promptly under the current system:

(1) Appropriate Evacuation Advisories by Mayors

1) Executive Seminars for Decision-makers to Issue Evacuation Advisories

Convene seminars before every flooding season to remind mayors how to respond to flood risk information, such as through flood forecasting and hot-lines to river administrators.

2) Joint Inspection of High-risk Levees with Local Stakeholders

Conduct on-site inspections of high-risk levees (such as those in narrow channels, or those with recorded leakages: 20% of 13,000 km of levees managed by the MLIT). This should take place before every flooding season, jointly with municipalities, flood fighting teams, and communities, indicating simulations of levee breaches and sharing risk of inundations.

3) Publication of Time-series Simulations

Provide time-series inundation simulations for municipalities to decide areas for evacuation advisories. To promote better understanding, explain the contents and accuracy in plain language with a minimum of technical terms and provide easy access through web-search functions.

4) More Descriptive Flood Forecasting

Improve the descriptiveness of flood forecasting and improve communication tools to convey urgency to municipalities and residents.

5) Equipment for Information Sharing with Municipalities

Install water gauges and live cameras to judge danger and urgency in high-risk sections and install a river information system for municipalities to share information on upstream water levels and real-time images

6) Time-series Disaster Operation Plan and Operations Drills

Establish a time-series disaster operation plan and conduct implementation drills to issue evacuation advisories. Involvement of mayors and practical role-playing are important.

7) Human Resource Development in River Management

Train officials of the MLIT and prefectures who must communicate with municipalities and residents. They should improve their explanatory capacity regarding rainfall situation, flooding mechanisms and the meaning of risk information.

(2) Voluntary Evacuation by Local Stakeholders

1) Announcement for Residents of High Flood Risk Areas

Continue public awareness-raising in high flood risk areas through the Internet and local public relations. To promote better understanding, explain the contents in plain language with a minimum of technical terms and provide easy access through web-search functions.

2) Publication of Time-series Simulation

Publish time-series inundation simulations for each levee breach point on websites. To promote better understanding, explain the contents in plain language with a minimum of technical terms and provide easy access by web-search functions.

3) Roadside Indicators of Probable Inundation Depth

Publish probable worst-case inundation depths stipulated in the revised Flood Risk Management Act, and promote roadside indicators of probable maximum inundation depth.

4) Publication of Information on House Collapse Hazard Zones

Publish information on house collapse hazard zones where houses may be destroyed and washed away in a probable worst-case flood. To promote better understanding, hold briefing sessions in cooperation with municipalities.

5) Information Delivery through Smartphones

For those with smartphones, establish:

- an active delivery system of flood forecasts and other information
- an information sharing system for such resources as accurate hazard maps and real-time flood risk before the next flooding season, providing one-stop services and easy access through search functions.

6) Human Resource Development in River Management

Train officials of the MLIT and prefectures who must communicate with municipalities and residents. They should improve their explanatory capacity

regarding rainfall situation, flooding mechanisms and the meaning of risk information.

(3) Accurate Flood Fighting Operations

1) Survey of Height Continuity of Levees

To contribute to effective flood fighting operations, survey levees to confirm height continuity, identify overtopping risks and share this information with flood fighting teams.

2) Joint Inspection with Flood Fighting Teams

Conduct on-site inspections of high risk levees regularly, jointly with municipalities, flood fighting teams, communities, and others. Conduct levee breach simulations, share risk information on each site and confirm priority actions for flood fighting operations.

(4) Effective Structural Measures for Crisis Management to Reduce Disaster Risks

Continue necessary river improvements steadily:

Additionally, in order to reduce flood damage in high-risk but lower capacity river sections due to up-and-downstream balance, promote reinforced levee structures which can prolong the time before levees are breached after overtopping when flooding exceeds the capacity. In implementing these measures, regional non-structural measures to boost the effects of improvements and consensus-building among residents are important.

5. Urgent Measures to be discussed

The measures under the conventional framework mentioned in Section 4 are not enough to solve all the problems, so it is necessary to change the institutional framework. We should quickly discuss other measures shown below, to realize them within 2 or 3 years, and actively promote technical research and development in order to implement them.

(1) Smoother and Swifter Evacuations

1) Improving Hazard Maps to Directly Assist in Evacuations

Conventional hazard maps show inundation depth and evacuation centers, but are not linked to evacuation behavior. The new hazard maps can directly assist in priority evacuation actions by indicating displacement areas such as house collapse hazard zones and deep, longer-term inundation zones. Publish these information and display them in the streets.

2) Provisioning Data on Probable Inundation Areas

Disclose data on probable inundation areas through multiple means to allow delivery by various stakeholders.

3) Disclosing Information on Land-side Water Inundations

To encourage appropriate evacuation behavior, disclose information on land-side water inundations on hazard maps through inundation simulations, considering water from both rivers and inner-city waterways.

4) Support by River Administrators for Evacuation Planning

So far, river administrators have delivered disaster information such as flood level forecasting, while municipalities have planned evacuation operations. Because they work separately, disaster information is insufficient for evacuation, and evacuation plans do not utilize all the disaster information.

It is necessary to establish a committee through which municipalities and river administrators can work out collaborative evacuation plans, taking wide-area evacuation into consideration, in order to decide:

- the contents of information, such as water levels, and the timing of announcements
- what areas to put under evacuation advisory, and the timing of advisories
- the location of evacuation centers and evacuation routes

This committee can work not only on evacuation planning, but also rule setting for flood fighting, water drainage, and other risk reduction measures.

5) Liaisons to Support Mayors in Decision-making

Foster and dispatch liaisons with the MLIT and build the capacity of municipalities to support the mayors' decisions, such as those related to evacuation advisories. A training and certification system is recommended.

6) Improvement of Flood Warning and Flood Forecasting

Currently, meteorological observatories announce flood warnings, and river administrators and meteorological observatories jointly issue flood forecasts. This system confuses residents. Therefore, the relevant agencies should clarify their roles in flood warning and flood forecasting, and develop a collaborative system to notify municipalities and residents of rising flood risks.

(2) Accurate Flood Fighting Operations

1) Involvement to Flood Fighting Operations

Enhance the support of river administrators for flood fighting teams, which have limited personnel and budgets, in order to improve operational capacity for such functions as sandbag piling, river monitoring, and evacuation guidance. Invite volunteer disaster defense teams and private companies to use the support system.

2) Enhancement of Flood Fighting Operations

To make flood fighting operations more efficient and effective, prioritize actions, review strategic areas, improve materials and equipment and disseminate these improvements.

(3) Land use Innovation in Accord with Flood Risk

1) Roadside Indication of Probable Inundation Depth outside of Residential Zones

Expand roadside indicators in areas outside of residential zones for developers and land owners to easily learn of flood risks.

2) Provision of Data on Probable Inundation Areas

Disclose data on probable inundation areas through a variety of means, to allow various stakeholders to deliver them.

3) Real Estate Business with an Awareness of Flood Risk

Encourage real estate business with an awareness of flood risk, holding briefing sessions for real estate agencies regarding the reviewed probable inundation areas in accordance with the revised Flood risk Management Act.

4) Promotion of Preventive Measures at Emergency Centers

Provide city halls and disaster center hospitals, which play roles as emergency operation centers in the possible event of disasters, with information on flood risk, and encourage these facilities to implement preventive measures against flooding.

(4) Integration of Structural Measures for Crisis Management and Systematic Non-structural Measures

1) Mechanism to Integrate Structural and Non-structural Measures

Conventionally, structural measures for disaster prevention and non-structural measures for damage reduction have been promoted separately. We must institute structural measures for crisis-management, integrate structural and non-structural measures and set targets to minimize damage caused by probable maximum floods.

2) River Planning Taking Risk Reduction into Consideration

Review conventional river improvement plans, which focus on design flood discharge flowing safely,

- add provision for disaster risk reduction even after inundation to disaster prevention
- formulate structural measures for crisis-management so as to reduce disaster risks in river basin while floods exceeding the capacity of facilities

3) Crisis-management Operations at Existing Dams

Develop crisis-management operations at existing dams to prevent downstream inundation and reflect this in the operational rules of each dam.

(5) Technical Research and Development

1) River information System to Convey Urgency

Develop a new river information system to convey urgency by displaying not only observed water levels but also real-time estimates of when levees near residences will crest.

2) Real-time Calculation System to Simulate Inundation

Develop a new calculation system to simulate flooding by rivers and inner-city waterways to ensure smooth evacuations and appropriate flood fightings, and to improve accuracy of flood forecasting.

3) Flood Forecasting System for Small and Medium Scale Rivers

Develop technology to improve the accuracy of flood forecasting and a program for small and medium scale rivers with short runoff times.

4) Research on Levee Structure to Reduce Flood Damage

Investigate, research, and develop levee structures for more durability and swifter drainage capacity.

5) Accuracy improvement of Measurement of Inflow into Reservoirs

Improve the accuracy of measurement of inflow into reservoirs to enable crisis-management dam operation and proactive release operations for flood control considering water-use capacity.

6) Economic Analysis of Flood Risk

Estimate the economic impact of floods and evaluate flood risks appropriately.

6. Conclusion

The torrential rains in Kanto-Tohoku in September 2015 caused levee breaches on the Kinugawa River, bringing serious damage. The scale of flooding exceeded the capacity of facilities. Such flooding can potentially occur anywhere nationwide and is happening more frequently due to climate change.

Many residents affected by the flooding commented that they had never experienced a flood. Because of climate change, however, we should realize that we cannot rely on past experience, and that large-scale floods can exceed the capacity of river facilities. We should raise social awareness to induce stakeholders to take voluntary action during emergencies. In recognition of this, the council sub-panel discussed seriously for two months the policies necessary to rebuild flood-conscienceless throughout our entire society. The policies are summarized in this report.

This report proposes a wide range of concrete structural and non-structural measures for disaster risk reduction, and requests that the MLIT implement them promptly and develop them pro-actively. In promoting the measures contained in this report, municipalities and flood fighting authorities play a more important role than before, so the MLIT should support them more strongly, including financially. In addition, the MLIT should empower regional bureaus, especially river offices and branch offices that are in direct contact with municipalities and the public.

At the *Second United Nations Special Thematic Session on Water and Disaster* in November 2015, His Imperial Highness the Crown Prince made a keynote speech, saying that "People's motivation to reduce water-related disaster has been realized through technology and institutional systems. This trend does not change even in the present age". With our strong motivation to reduce the risk of water-related disasters, the measures and technologies based on this report are expected to be enforced as soon as possible and verified continuously in order to realize better policies.