

## CHAPTER 4

# TRIPOD SCHEME FOR FLOOD DISASTER PREVENTION AND TECHNICAL TRANSFER

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### INTRODUCTION

In Asian monsoon region, rice production has been a key industry for two millennia. This region is blessed of fertile paddy on vast alluvial plain, which has been formulated through erosive/transport/depositional work of rivers around upthrust high mountains due to orogenic movements of the earth. Rice harvest was the main taxable property since the first step of the human history, and rice production process has made fundamental land use in this region. Catching up with the development of water transport and commodity economy, paddy field covered wide and flat alluvial plains expecting more and more harvest. Rice was brought away for tax or as currency.

That is the reason most of Asian historic cities have developed near broad paddy field and river mouth port. Also modern socio-economic activities in the past couple of hundred years have been conducted around rice producing/trading area where it is available to gather a large number of labors. Consequently major residential area is now spreading around low-lying area, where people are blessed with water resources, despite their vulnerability to water-related disasters. People have selected to live in flood-prone area taking risk of flooding damage.

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Water Communities

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Understanding this historic process, each Asian country has to manage water-related disasters, especially considering the fact that scale of flood is getting larger in recent years, and urbanization is accelerated even more. In the near future, mega flooding may cause catastrophic damage on a large part of population and economic activities. Therefore, central/local governments of Asian countries have to put high political priority on flood-risk reduction for its sustainability.

In the case of Japan, economic development in past hundred years has been achieved by local productive activities mainly in flood-prone area such as agriculture, manufacturing, and factory production. These economic activities suffered from flooding again and again; however, each time people recovered the damage quickly using adequate countermeasures, which have developed in the history accommodating topographic characters of flooding. Even administrative authority has changed in each region; the time-honored know-how is still alive and transferred to the next generation in local community to secure its social/economic sustainability.

This study traces social/legal framework of flood disaster management in Japanese history, scoping on responsible organization against flood. The purpose of this study is to clarify the principles in flood disaster prevention to achieve economic development and social sustainability in Asian monsoon region. This study shall be able to provide recommendations on flood disaster prevention not only for Japan but also for other Asian countries.

## HISTORIC BACKGROUND OF FLOOD DISASTER PREVENTION IN JAPAN

### *Ancient Age*

Until over 2,000 years ago, major livelihood in Japanese Jomon period was food collection, hunting, and fishing. People had high mobility from fishery coast to forestry, mountain, and could live selectively in food-abundant and flood-irrelevant area. After irrigative agriculture was introduced from Korean peninsula, in Yayoi period, people settled down near wetland in alluvial plains. In the area, people were able to cultivate sandy lands by elementary wooden equipment as paddy and to make up for agricultural uncertainty with fish and shells captured in the estuary. That was a dramatic improvement of food security (Table 1).

**Table 1.** Rice Production in Ancient Times in Japan.

		People's Livelihood	Countermeasure against Flooding
Jomon period	Over 2,000 years ago	Food collecting, hunting, and fishing	Emigration to low-risk land against flooding
Yayoi/Kofun period	Until 7th century	Elementary agriculture of irrigated rice	Cultivation in alluvial plains and shifting to alluvial fans with iron equipment to escape from flood risk
Asuka/Nara period	7th to 8th century	Earth works popularization such as embankment, reservoir, and diversion	Spreading of cultivation into disadvantaged land with earthwork techniques

*Note:* Commencement and settlement of early rice cultivation in Kyushu island is explained in a booklet "Ongagawa" (NPO Ongagawa-ryuiki-juumin-no-kai, 2006).

The capturing-and-cultivating life brought about prosperity and lead to growth of population. Although bloated community faced risk of flood, iron equipment was newly introduced in the 4th century. The magnum item enabled to develop uncultivated land and irrigation reservoirs. New frontier was spread in upper alluvial plains. Local ruling families gathered up iron resources and tried to develop uncultivated land, where stable rice harvest was expected year after year because of lower flooding risk. It was start of Kofun period.

When constitutional governance started in the 7th century, civil engineers diffused well-developed earthwork techniques to all over the country. Storage reservoir, embankment, and diversion channel were installed. Throughout Asuka/Nara period, paddy field expanded to every ground where it was cultivable and water-available.

### *Middle Age*

About 400 years from the 9th century was the age of manor (Table 2). Noble families and powerful temples/shrines in Heian period wanted to take exclusive possession of land and harvest. Even in poor drainage land, new manors were established competitively. Farmers in the manor had to be plagued by yearly flooding and were ordered to secure rice harvest by each farmland owner.

After establishment of warrior's rule in the 13th century, during Kamakura/Muromachi period, material land ownership was gripped by

**Table 2.** Rice Production in Medieval Times in Japan.

		People's Livelihood	Countermeasure against Flooding
Heian/Ka makura period	9th to 13th century	Manorialization funded by aristocratic lords	Competitive cultivation in flood- prone area, accepting suffer of flooding/draught – beginning of self-help
Muromachi period	14th to 15th century	Self-defense of farmland by land owners	Self-motivated flood fighting in each farm land – beginning of flood fighting
Sengoku period	16th century	Governance of warring lords to secure harvest	Flood control and channel improvement with river engineering – beginning of river management

*Note:* For understanding of rice field development, it is recommended to study in a social scientific book "Nippon-no-kome" (Tomiyama, 1993).

armed estate stewards. In emerging commodity economy, they started asset management and promoted rice production. At the same time, in each community, the stewards improved self-motivated defensive system against all kind of invaders, including flood. Most of the communities were formed on a fatalistic unit of flood-submerging land separated by mountain ridges and levees. That was the beginning of flood fighting.

The 16th century in Japan was the age of civil war. Warring lords were aggressive in protecting farm land because rice production was the source of feudal power. To maximize rice production in the territory, they surveyed and planned to protect farming community against flooding by river training and channel improvement. This systematic river work was the beginning of river management.

#### *Early Modern Age (Edo Period)*

After the civil war, almost 300 years in the 17th to 19th century, Japan was governed by Edo feudal government. During the Edo period, Japan was divided into about 300 domains, and each lord managed his domain with own governance (Table 3).

On these domains, transport development had a great impact. When waterway network was completed in the first half of Edo period, all domains were covered by a united commodity economy, in which any trade accounts were adjusted by rice. Lords in Japan began to put a mortgage on rice

**Table 3.** Rice Production in Edo Period in Japan.

		People's Livelihood	Countermeasure against Flooding
Edo period	17th to 19th century	Self-management of rice farming villages under local domain taxation	Flood fighting of farmland community and river management by domain administrators

*Note:* Farmers flood fighting efforts are described in "Suigai" (Miyamura, 1985) with a lot of examples.

product in coming years. They had to be very keen to maximize tax revenue of rice.

As a matter of course, domain taxation was based on rice production. The retainers in taxation section collected rice from hundreds of village. In each village, leader group had to gather all harvest and paid it in a lump. Domain retainers and village leaders made all sort of efforts to expand paddy field. As a result of their hard work, by the end of Edo period, land use of Japan islands were well sophisticated for rice production. Small-scale reservoirs were constructed everywhere in the river basin. Poorly drained wet land, including shallow estuary area, was reclaimed. Paddy field expanded to almost all space of cultivatable lands and all volume of usable water resources in Japanese islands had been supplied for paddy. It is obvious that newly developed farmland was vulnerable for flood or draught. In the case of flood disaster, its risk reduction had high priority for both domain retainers and village leaders. However, the purpose of tax collector and tax payer was different from each other.

On the village side, the leaders considered to sustain their village with the highest priority. They controlled all parts of flood fighting to reduce substantial flood damage, during, after, and before flooding. During the flood, the leader commanded flood fighting actions such as temporary embanking and evacuation support. After getting damages, he recovered destroyed facilities or requested financial/technical aid to domain office if necessary. And before next flood, he patrolled around the river and shot troubles on levees. All activities were developed through the accumulation of experience at the site and conducted in cooperation with voluntary initiatives of villagers.

On domain side, to reduce flood damage is to minimize total loss of rice harvest. Therefore, river engineering in the previous period was succeeded and brushed up by professional retainers. They implemented river improvement under basin-wide planning and budgetary/technical

limitation. For example, retarding pond was adopted frequently to reduce flow discharge in the downstream because the method was manageable with their budget and techniques.

However, the officials could not put higher priority on all paddy field protection than military/social objectives, such as castle defense and merchant town preservation. Moreover, in some severe flooding, the retainers had to make decision for intentional riverbank breach to retard flood water to protect selected higher-productivity paddy. They considered how to maximize rice harvest in the river basin every year, paying less attention for each village.

These activities of hundreds years formulated a flood disaster prevention system, which included tense relationship between a river manager and village leaders (Fig. 1). Throughout Edo period, both sides continued technical transfer on flood disaster prevention with each objective in each hereditary education system. The education method was based on on-the-job training. All people in every generation had to tackle against flooding events frequently in their workable years of live. Using these chances, younger generation learned from elders and stored local know-how to fight against undesired water.

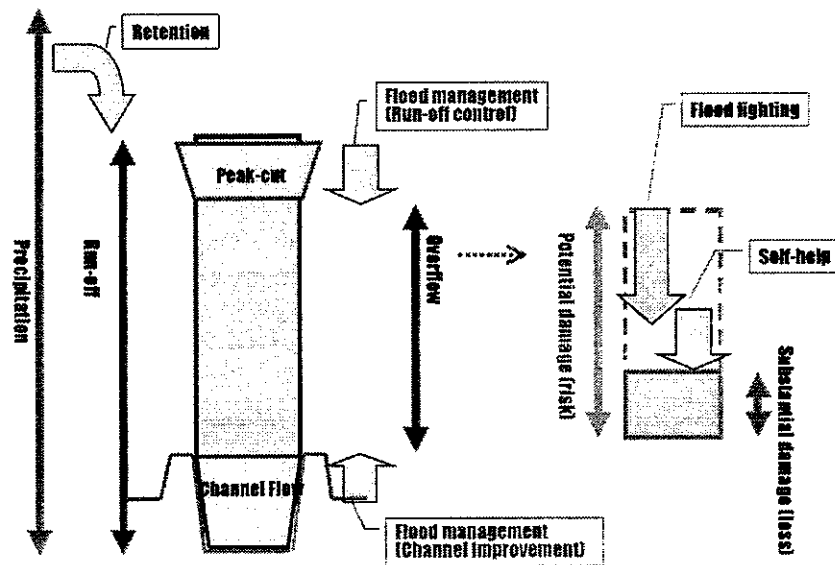


Fig. 1. Reduction of Overflow and Damage.

### Modern Age (Meiji Period to Present)

Modernization in Meiji period in the end of the 19th century brought a wide range of changes. Traditional flood disaster prevention also affected in both the village side and the domain side; however, person in charge did not lose his noble responsibility and technical contribution. In the rural area, although several villages are united into a new municipality to make up simpler local governance, village leaders conserved their position in the village they lived. Therefore, flood fighting organization had dynamic reforms, under the new local administration of the new government; a mayor of broad-scale municipality had to manage all villages in his governorate. However, he had no legal duty to compile rice harvest for tax payment or to manage flood fighting. Then village leaders, who were one of the land-owning farmers, had to protect their land and harvest against flooding by themselves. For this reason, village leaders established a farmer's voluntary team to protect rice production.

The main mission of the voluntary team was to prevent disaster prevention and to secure irrigation water. It covered all kinds of water arrangement for rice production. Actually the team succeeded all the time-honored technical know-how for sustainable land use in alluvial plain. Later the voluntary team was separated into two types due to its primary task required by topographic conditions of paddy field; one is the team for flood fighting and another for irrigation management. And some organizations for fire service started to take a role for flood fighting. Today in many municipalities in Japan, flood fighting is conducted as a municipal public service offered by fire service organization. And community-based flood fighting teams are fulfilling its function as a local squad in multi-hazard risk reduction in the municipality.

Under rapid transformation to the modern governance, qualitative alteration on flood disaster prevention proceeded in all villages in Japan. Some revolutionary changes were caused with tax reform. As one of their first actions, the new Japanese government switched taxpayer from village leaders to land owners and shifted to land price taxation in cash.

These tax payers had simple request to the government to implement river management and reduce flooding damage by river management, as domain officials tried to do before. Prefecture governors made all efforts; however, prefecture revenue was so limited in the first years of Meiji period. The prefecture governor and landowners made severe discussions and made a lot of petitions to the central government to disburse national budget on flood disaster prevention.

Through sincere discussions around the Diet, the petitions were approved by the central government. The government of Japan had recognized flood damage on agriculture, and industry has un-repairable impact on the gross national product, and therefore, adequate flood disaster prevention must be implemented as necessary investment for national economic growth. Then, the central/prefectural governors appointed well-known engineers as a river administrator in the government organization, to carry on river basin management. They started soon to draw up a long-term river improvement plan, which adopts continuous levee system to separate flood way from utilized land, not only paddy fields, but also residential area and newly risen manufacturing.

By installing the newest river engineering into the long-term river plan, river administrators have been implementing river management to raise security level against flooding. As a result, flooding events in Japan have decreased even in flood-prone area (Fig. 2).

Reflecting topographic and historic situations mentioned earlier, efforts on flood disaster prevention have been conducted in the present people's livelihood and local administration in Japan. These activities can be broken down into three sections by responsible organizations, and these are working

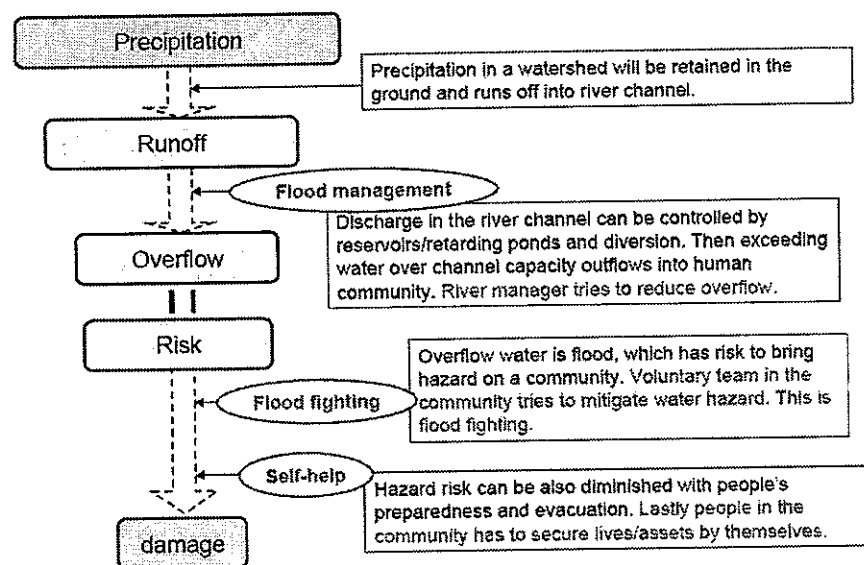


Fig. 2. Three Function of Flood-Risk Reduction.

Table 4. Impact of Meiji Modernization in Japan.

	Edo Period	Present
Self-help	Villagers	Residents
Flood fighting	Village leaders	Community-based organization (food fighting team)
Flood management	Domain engineer	Government organization (public service with river engineering)

Note: Actual flood fighting activities in Japan is profiled in yearly databook "Suibo 2009" (Zenkoku-suibokanridantal-rengokai, 2009).

independently and collaboratively, like a tripod (Table 4). When these three legs stand firmly, "zero-fatality" target can be achieved.

- Self-help of people living in the flood-prone area,
- Flood fighting of voluntary team to sustain own community, and
- River management by river administrator under a basin-wide and long-term plan.

## PRESENT SOCIAL FRAMEWORK FOR FLOOD DISASTER MANAGEMENT

The tripod scheme of self-help, flood fighting, and river management has been identified clearly in many acts (Table 5), with the adjustment to catch up with socio-economic development in recent 130 years. Today's most important regulations in Japan for flood disaster prevention are

- Disaster Countermeasures Basic Act
- River Act
- Flood Fighting Act

These three acts identify three parties that have basic responsibility for flood disaster prevention (Table 6), namely

- Residents in flood-prone area,
- Flood fighting administration body and flood fighting teams, and
- River administrator.

These parties work collaboratively and construct a systematic network for flood disaster management, which had formulated through people's experience in Japanese history (Fig. 3).

**Table 5.** Rulemaking Process for Flood Disaster Management in Japan.

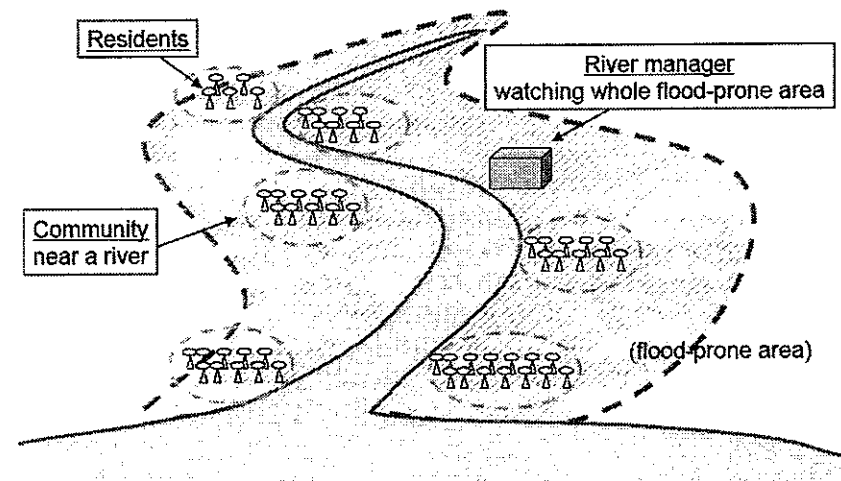
In the Meiji modernization since 1868
1880 Municipality Act to establish organization in charge of water-related affairs
1890 Water Association Act to establish irrigation/flood fighting association
1894 Fire Service Code to identify flood fighting by fire service office
1896 River Act to clarify responsibility of river administrator/municipalities for flood disaster management
After 1945 of the World War II closing
1948 Fire Service Act to clarify responsibility of municipality for disaster management
1949 Flood Fighting Act to definite roles of municipality and flood fighting team
1949 Land Development Act to establish irrigation association
1955 Flood Fighting Act revised to flood warning
1958 Flood Fighting Act revised to definite local/central government's budgetary responsibility
1961 Disaster Countermeasures Basic Act to identify people's responsibility
1964 River act revised to arrange water use in the river basin
1997 River act revised to take resident's participation into river management
2001 Flood Fighting Act revised to inundation mapping
2005 Flood Fighting Act revised to flood hazard mapping

**Table 6.** Legislation for Flood Disaster Prevention in Japan.

Disaster Countermeasures Basic Act (Article 5 and 7-2)
<i>Residents have to adopt measures to provide for disasters and prepare and to make efforts to participate to voluntary activities to prevent disasters.</i> A Municipality has the responsibility to formulate and implement a Municipal Disaster Management Plan
Flood Fighting Act (Article 3 and 5)
<i>Municipalities (Flood Fighting Administration Body in many cases) have the responsibility to sufficiently perform flood fighting in their areas.</i> The Flood Fighting Administrative Body may maintain a Flood Fighting Team
River Act (Article 8, 9, and 10)
<i>A River Administrator executes river works in order to increase public benefits or eliminates or diminishes public losses caused by the water of the River.</i> The administration of a class A river shall be performed by the Minister of Land, Infrastructure, Transportation and Tourism. The administration of a class B river shall be performed by the Prefectural Governor.

### Self-Help

To secure one's own life, self-help action is the most fundamental and effective countermeasure. But it does not work perfectly when an actual flood comes. Residents in flood-prone area do not consider flood risk seriously, although there are a lot of slogans to remind it around them. Unfortunately in fact many residents do not take action for evacuation,

**Fig. 3.** Residents and Communities in a River Basin.

after hearing flood alert. In some cases, people do not recognize real flooding risk. Especially in urbanized area, flooding events have decreased, and new comers have increased. Most people lack in ability to protect themselves from flooding and, instead of that, have greater reliance on public services. Vulnerability of urban area in Japan to a large-scale flooding is getting greater and greater in recent decades.

In some community where a good communication is maintained, some resident campaigns are covering individual misunderstandings. These are carried on specialized events every year in the form of a traditional festival, a stage show, an athletic game, etc. These events are only amusing and attractive for participants, but people can gain resiliency against all accidental disasters.

### Flood Fighting

Flood fighting is still alive in self-defensive activities of local communities. The voluntary team plays a role of subordinate squad of disaster preventive service of a fundamental municipal government and keeps local security of neighboring companionship. While flooding, the voluntary team gathers information such as weather forecast, water level, inundation area, and so on and reports it to the mayor. The mayor, who is legally responsible to lead

flood fighting activities, is able to make decisions for flood alert, evacuation warning, and emergency rescue. In 2008, about 50,000 members of 800 flood fighting teams went into action in Japan. The voluntary team plays the most important role in present systematic flood fighting. They are always recruiting younger members in their community and training them. New members are willing to contribute to their neighbors.

However in reality, the voluntary team has a couple of problems. For example, aging of core members, shortage of staff members, absence of members employed in a remote company, and so on. Most severe one is lack of experience. As same as deterioration in self-help ability in urban area, due to decrease of chance, know-how of actual flood fighting work has been lost in some teams. Annual flood fighting training is not able to exercise without support of the river administrator, especially in technical matters.

#### *River Management*

River administrator makes a long-term river management plan for each river and construct hard/soft infrastructure, to minimize risk of flood damage by watching the whole river basin. One method of risk reduction is to make flow discharge smaller by run-off control facilities such as a flood-control dam, retarding ponds, and diversion channels. Another is to enlarge water flow capacity of the channel by embankment and dredge, that is called river improvement.

Besides, maintenance and operation of these facilities are more important. To do it successfully, on-time information of actual conditions is demanded. Therefore, the river administrator dispatches patrol teams around the river; however, more helpful information can be sent from residents who are watching the river in daily life. On the matter, a river administrator requires resident's support. And the river administrator has to prepare against flooding in the near future. Materials for urgent recovery after getting damage are stocked near riverbank with confirmation of flood fighting teams. For river management, close cooperation with the teams is also necessary.

Moreover, extra service is expected to support flood fighting and evacuation. River administrator sends direct flood alert to the mayors by hot line, concerned to forecast flooding and disseminates flood-risk information for people living in/visiting flood-prone areas. All actions to minimize damage on human livelihood are considered a mission of river administrators.

## CHALLENGES FOR TECHNICAL TRANSFER TO THE NEXT GENERATION

It is a fact that this tripod scheme for disaster prevention has been supported and promoted Japanese recent socio-economic growth in the disaster-abundant nature. To hand off flood resilient society for the next generation, it is rational and realistic way to maintain the three-party system and to transfer techniques of each section, because each section has different motivation and countermeasures. If, in one party of the system, their techniques will not be transfers to the next generation successfully, a flood resilient community in flood-prone area changes its nature to a flood fragile community as a consequent. Toward the future all parties have to be identified, to enhance its own function and to support one another (Fig. 4).

#### *Self-Help by Individuals*

People cannot survive in a flood-prone area without self-help mind. The mind is an essential ability and normally nurtured by some traditional trainings that are involved in annual events, primary educational curriculum, or local traditional festivals. Through daily/yearly life in community, people become able to know what flooding damage is and how to deal with undesirable water. The only way people can achieve this is to participate in

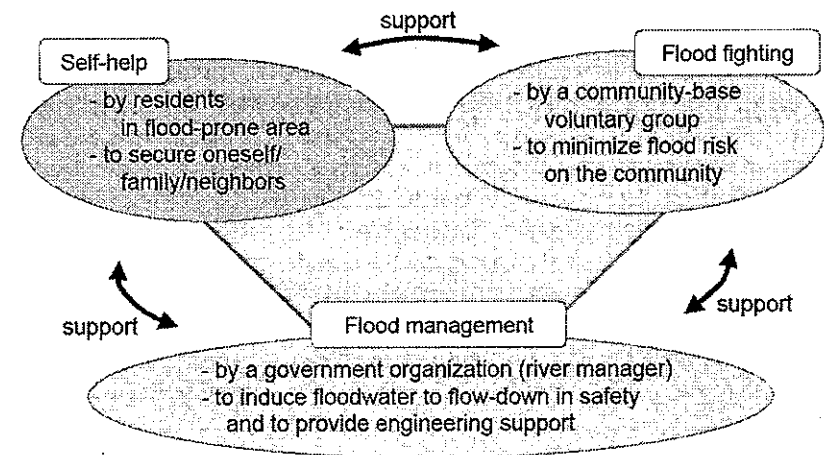


Fig. 4. Tripod Scheme for Flood Damage Prevention/Minimization.

their community. On the contrary, people living near the river always have a lot of chances to observe fish and birds, the riverbank, and the stream flow. Those must be quite important information for the flood fighter and the river administrator. Daily river watchers are required to be a sensor for the municipal leader or the river administrator.

#### *Mutual Support by a Flood Fighting Team*

Community-based flood fighting team has to transfer its know-how to the members in the future. One important thing to be transferred is topographic/meteorological character of flood on the site, which can be told only by a person who has excellent knowledge and experience in the village. Another is technique of field activities that include patrol before a flood, temporally embanking during a flood, and checking after a flood. Actual flooding experience would be an effective on-the-job training for the young generation; however, the chance has been decreasing due to progress of river improvement. Already, unfortunately, some of flood fighting teams have lost its ability of technical transfer. It is a fact that the annual training around major rivers is planned and supported by the river administrator.

#### *Professional Engineering Service of a River Administrator*

A river administrator's main task is to minimize overflow of flood water into communities, to reduce potential damage on the society. But it is impossible to shut-out overflow because planned hard infrastructure improvement cannot be done instantly, as it takes long period of time and a large amount of budget. And a flood in the future can succeed assumptive scale in the design of river management facilities. The river administrator should make additional effort to reduce substantial damage on the communities. This framework is a kind of soft infrastructures. An active soft-infrastructure building is just a technical transfer to the flood fighters and the residents. That is a professional service of river engineers. Flood fighting training must be continued for not only flood fighters but also residents. And effective method of knowledge exchange with residents should be developed. One of the latest challenges is flood hazard mapping. This map is drawn for each community to clarify and share various potential flooding damages and appropriate responses for flood fighting and self-defense. The mapping process in the community is one of the best flood resiliency buildings.

#### *Rehabilitation of Tripod Scheme for Flood Disaster Prevention*

A river administrator implements and manages peak-cut dams, diversion channels etc. to depress flow energy and improves river channel to reduce overflow, which has the potential to provoke flood damage on human lives/assets. A flood fighting team in a local community takes action of sand bag embanking, flood warning, etc. not to receive insufferable damage and to try to reduce damage possibility within permissible level. And last, residents have primary responsibility to secure themselves during flooding. The river administrator and the flood fighting team may not always cover all residents' life/assets.

All section cannot work alone effectively. When all section conducts its duty with own responsibility and support each other, substantial flooding damage can be reduced to minimum level. It must be recognized that three sections have respective objectives and expected to work collaboratively. When we try to present this tripod scheme for our next generation, three different know-hows have to be transferred by the adequate persons with its own responsibility (Table 7).

**Table 7.** Technical Transfer in 3 Each Section.

	By Whom	To Whom	What
Self-help	Parents/elders in family/neighbors	Children and newcomers	<ul style="list-style-type: none"> <li>• Awareness rising</li> <li>• Alert watching/hearing</li> <li>• Food/equipment preparedness</li> <li>• Asset removal and evacuation</li> </ul>
Flood fighting	Veterans in the community-based group	Less-experienced members	<ul style="list-style-type: none"> <li>• Flood record keeping in the community</li> <li>• Flood fighting works (sandbag embanking, leakage treatment, etc.)</li> <li>• Flood patrol and attention call</li> </ul>
Flood management	Professional river engineers	Young engineers	<ul style="list-style-type: none"> <li>• Maintenance of river facilities</li> <li>• Flood forecasting and early warning</li> <li>• Emergent action planning</li> <li>• Communication with other disaster prevention authorities and people in flood-prone area</li> </ul>



Boys and girls, sometimes newcomers into the flood-prone area, should learn survival skill to secure oneself, family, and neighbors. Young community members are required to acquire flood fighting technique to minimize flood risk on the community. Young river engineers have to become a professional to induce floodwater to flow-down in safety and to provide engineering support for residents and flood fighting teams in close communication.

In addition, one more point should be considered in some cases of highly protected area against flooding. Where river improvement has conducted effectively in the past, the number of flooding events has decreased today, and people living in the flood-prone area have less chances to have experiences and know-hows on flooding, although all flooding events cannot be cancelled in the future. In this case, two sections of residents and community group are recommended to arrange periodical events, never to forget flooding risk. And another section of river management is required to support these two sections with some engineering-based attractions. These are also a technique to sustain socio-economic activities in a flood-prone area.

## CONCLUSION

Countries in Asian monsoon region have higher population density in severer disaster conditions than ones in other region in the world. Especially flood disaster management has been a common and urgent problem to be solved by all countries in this region. A key point on flood disaster prevention that every government has an own traditionally based system must be respected. In the case of Japan, three different types of parties, namely "residential self-help mind," "mutual support in the community," and "basin-wide river management," are executing flood disaster prevention, like a tripod upholds a heavy equipment.

The first "residential self-help mind" is a basic repression of rice producing farmer in the flood-prone area. The second "mutual support in the community" is represented by voluntary flood fighting teams. And the last "basin-wide river management" is provided as one of water-related public services. All aforementioned parties are holding each objectives and functions. Their independent actions and interactive collaboration have made it possible to achieve "growth with flood" in recent 100 years. This experience of Japan and its "tripod scheme for flood disaster prevention" can be good soft-infrastructure of economic development and social stability in flood-prone area. To establish a flood resilient society in the

Asian monsoon region, this analysis of Japanese performance can indicate that it is important:

- To review original development process of communities,
- To identify responsibility in self-defense, flood fighting, and river management, and
- To take each action independently and collaboratively.

And expecting "endless growth with flood" for our descendants in the future, it is recommended:

- To develop the tripod scheme under the topographic/historical background and
- To transfer necessary techniques with each responsibility to the next generation.

## FURTHER READING

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