Survey Report:

Tripod Scheme in Flood Disaster Management in Japan

Hirotada Matsuki

Himeji Office of River and Road, Kinki Regional Development Bureau,
Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
1-250 Hojo, Himeji, Hyogo 670-0947, Japan
E-mail: matsuki-h86ww@kkr.mlit.go.jp
[Received July 17, 2012; accepted September 8, 2012]

Japan has suffered from natural disasters but sustained economic activity on not so commodious islands. This social resiliency is based on a time-honored risk management scheme that, like a tripod, consists of self-help, mutual help, and public help. This study analyzes the social infrastructure from Japan's disaster-fighting history. Japan's first political documents tell how the ancient Japanese people broke ground on floodplains to develop rice-paddy agriculture and underwent repeated water-related disasters after the Nara era (710-794). People had to deal with flooding and commence risk management to survive in flood-prone areas. During the Edo era (1603-1868), people expanded paddy agriculture to all arable land in the islands and tried to protect rice production from endless flood disasters in the same places. An effective flood-fighting scheme was then invented and expanded to nationwide. Its essence was coalition among people, a primary community and a local government. In Japan's modernization since 1868, traditional social rules have been enshrined into laws. The indigenous scheme for anti-flood measures has been translated into 3 major acts: the Disaster Management Basic Act, the Flood Fighting Act, and the River Act. These acts have been working and evolving, during qualitative transforming of Japanese society due to industrial restructuring, rapid urbanization, population fluidity, etc. Under such a legal infrastructure, the MLIT Himeji Office conducted a pilot program in an inundated community just after a downpour disaster in 2009 to improve local anti-flood measures. Output has indicated the importance of independency and interdependency of self-/mutual/public help. The "tripod" scheme provides recommendations for living with disaster not only in Japan but also in other countries in Asia.

Keywords: history, disaster management, self-help, mutual help, public help

1. Introduction

Japan has succeeded in sustaining its economic activity over 2,000 years on not so commodious islands that have earthquakes, volcanoes, floods, storm surges, tsunamis, fires, etc. In its history, the Japanese people produced a unique disaster-resilient society based on a combination of self-help, mutual help, and public help [1]. The author calls it a "tripod" scheme and tries to understand its roots in flood-disaster management. Because flooding, that has repeatability, predictability, and locality, has fostered a culture for making preparation for subsequent disasters.

Flooding is a natural event on alluvial plains and flood disasters are caused by floods and human factors on floodplains [2]. In the case of Japan's history, the major industry was rice cultivation and all arable floodplains were developed for paddy use. People had no land to emigrate to, even though they were hit by repeated floods. They therefore tried to protect assets in the community and to minimize total damage in society. The inseparable relationship of flood fighting and flood control formed the background of Japan's flood-disaster management [3] and has fostered the tripod scheme.

The author reviews the history of self-help, mutual help, and public help, scoping in flood fighting and flood control told in old literary documents. There are 3 important periods in which flood-disaster management was formulated:

(1) the Nara era (710-794) during which people started to suffer from flood disasters,

(2) the Edo era (1603-1868) during which local governments intervened in communities, and

(3) since the Meiji Restoration (1868-) while Japanese society was ruled by a central government.

On the above basis, a pilot program of the MLIT Himeji Office has clarified today's problems in Japan's local flood-disaster management. This analysis finally proposes directions for an advanced tripod scheme for reinforcing Japan's disaster management and contributing to international cooperation.

2. Commencement of Flood Disaster in the 8th Century

2.1. Until the 7th Century

Once rice cultivation passed from the Korean Peninsula to northern Kyushu Island over 2,000 years ago, paddy

Table 1. Chronicle of Japan continued edited in the 8th century.

Pioneer	Achievement
Monk Dosho (700)	Monk Dosho was dead. He was dispatched to Tang in 653. After returning, he went around regions. He dug wells near roads, built boats at harbors and threw bridges over waterways. He was the first builder of Uji Bridge in Yamashiro Province. His engineering journey longed over 10 years. (文武天皇四年) 道照和尚物化．･･･初孝徳天皇白雉四年，随使入唐．･･･於後周遊天下，路傍穿井，諸津済処，儲船造橋．乃山背国宇治橋，和尚之所創造者也．和尚周遊凡十有余載．
Administrator Obitona (718)	Administrator Obitona was dead. He studied laws and orders in his young days to be an elite bureaucrat. He built new reservoirs such as Ajiunoike in Higo Province and many ponds in Chikugo Province which has been bringing benefits to people up to now. All achievements were instructed by Obitona. (養老二年）筑後守正五位下道君首名卒．首名、少治律令．暁習吏職．･･･興築陂池，以広漑灌，肥後味生池，及筑後往往陂池皆是也．由是，人蒙其利，于今温給，皆首名之力焉。
Monk Gyoki (749)	Great Monk Gyoki was dead. He civilized people around the capital. He and his disciples built bridges and dikes at barren grounds. People, who knew his fame, assisted him to complete his works promptly. Now the people benefit from his works. (天平勝宝元年) 大僧正行基和尚遷化．･･･既而周遊都鄙，教化衆生．･･･又親率弟子等，於諸要害処，造橋築陂．聞見所及，咸来加功，不日而成．百姓至今，蒙其利焉．

Table 2. Yoro Code enacted in 757.

Article No.	Description
Infrastructure No. 16	A provincial governor and district commissioners have to patrol dikes around major rivers, and to order people to repair any damage after harvesting rice in autumn. For dike breach, however, command urgent repair as soon as possible. (営繕令16-近大水条) 凡近大水，有堤防之処．国郡司，以時検行．若須修理，毎秋収訖．量巧多少，自近及遠，差人夫修理．若暴水汎溢，毀壊堤防．交為人患者，先即修営．不拘時限．
Paddy No. 28	After a flood shifts a river course eroding paddy field, grant the emerging land to people who have lost their paddy. (田令28-為水侵食条) 凡田．為水侵食，不依旧派．新出之地，先給被侵之家．
Community No. 1	Each community has 50 families. 1 leader manages family resister, promote agriculture, prevent crimes and provide labor services. (戸令1-為里条) 凡戸以五十戸為里．毎里置長一人，掌．検校戸口，課殖農桑，禁察非違，催駈賦役．
Community No. 9	5-family group members work together and help each other. 1 head checks the group and keeps order. (戸令9-五家条) 凡戸．皆五家相保，一人為長．以相検察，勿造非違．

field spread throughout Japanese islands. After the 3rd century, advances of iron blade edge helped the earthwork capability of building dikes and reservoirs. People expanded paddy agriculture, selecting arable ground that was easy to plough and irrigate. Such favorable fields spread along the edges of alluvial plains and many clans dominated areas less prone to flooding until the 7th century [4].

2.2. Land Development in the 8th Century

After unifying Japan, the Yamato dynasty dispatched diplomatic envoys to Sui/Tang (China) and directly imported the latest legal frameworks, Buddhist concepts, and cultural advancements. One of these was civil engineering. Systematic and rational methods were studied by bureaucrats and monks at the end of the 7th century. The Chronicle of Japan Continued [5] threw light on 3 master engineers of the 8th century: Dosho, Obitona, and Gyoki as shown in **Table 1**. The masters were thanked by local people because they succeeded in building excellent dikes, reservoirs, bridges, and harbors to develop new paddy fields.

These pioneers educated a number of successors, who would expand land use barren or marshy areas in many provinces. The frontier was relatively vulnerable, however, to water-related disasters. The Chronicle and The Chronicle Continued told of flood disasters increasing from the 750s [6]. The Yamato dynasty then had to legislate disaster recovery. The oldest Yoro Code, coming into force in 757, ordained fundamental rules for flood-disaster management [7] as shown in **Table 2**. The Code stated that provincial governors and district commissioners bore the responsibility for flood countermeasures [8] They had to patrol and maintain dikes of major rivers, but they could do nothing but resettle farmers after a natural river-course change. Besides that, the Code established 50-family communities and 5-family groups in local administration. People had to be involved in collective duties in the community.

2.3. Flood-Disaster Management in the Initial Stage

In the Nara era, the Yamato dynasty appointed provincial governors and district commissioners. One of the obligations was the dike management of major rivers – it was the first example of public help. Basic local administration was conducted in communities and neighborhood groups. It would become the standard form of mutual help in subsequent eras.

3. Flood Fighting and Flood Control in the 17-19th Centuries

3.1. Until the 16th Century

In the 9-12th centuries, while the dynasty lost its unifying power, noble clans and self-governed temples/shrines

Table 3. Farmer's Common Sense (Chapter Flood Risk Management) published in 1680-82.

Article No.	Description
General Principle	It is important for farmers to keep efforts to maintain river/reservoir facilities year-after-year, which have been existing in our villages since ancient days. --- It has been farmer's task to take care of river dikes, irrigation system and riverbank protection since the beginning of rice cultivation. If we fail to keep up the efforts, our posterity is going to suffer from flood disasters in the future. (序) 我々が住国村里に, 往古より有来る池・河をば、年々歳々修理を加へ, 水災のしのぐ心得肝要なり．･･･堤・井溝・川除普請は，世に耕作初りし上代よりこのかた，土民の役たり．末代も猶油断ありては，子々孫々水災にあふべし.
Riverbank Protection	Riverbank protection is a preparative work to prevent dike breaches. --- Repair any damages around waterways and keep all facilities functional. This is a key lesson for the sustainable life with river. --- Once a flood occurs, all people, living in possible inundation area, gather and protect the dike not to allow outflow even late at night. Nowadays, a state officer is in charge of flood disaster prevention. Following his emergent orders, go to a crucial point as soon as possible and take part in flood fighting activities. All of the local officials, village leaders and 5-family groups have to raise awareness of flood at any time. (川除こゝろへの事) 河除は堤をきらさぬ備へなり．･･･水を流す処をば，急度修理し，拵置べし．是常住の備へ也．･･･万一洪水の節，水下の村里より出て，堤をかかゑる人足等のつもりをしてしり，･･･夜中たり共出集り，堤をかかゑて水難をのがるる心得かんやうなり．まして御当代は御公儀の御奉行衆，左様なることに油断なし．其節は御指図にまかせ，少もはやく罷出，堤をふせぐことほんいなり．国々村里に御定の郡司・庄官・五人組，猶以油断致間敷事なり.

Table 4. Dike Rehabilitation Directives issued in 1733.

Article No.	Description
1	Local state officials. Pay attention not to get severe damage on dikes, irrigations, gates, bridges, etc. Never omit maintenance work. (一) 諸國代官所委託地の堤防，溝洫，閘樋，橋梁等･･･都て注意して大壊に及ばさるを要し．必らず其修築に怠懈する勿れ.
2	Repair small damage to prevent severe damage on dikes maintained by both the state and the community during every agricultural off-season. (二) 毎年農隙を候し, 小破の際を以て官修所及び民修所を修築し, 水荒の難を防御するを最も専務となす.
4	Draw a master plan for river management with investigation of normal/flood flow and cost analysis on expected benefit. (四) 沿岸修築の方法は，平水の觸激する所と盈水の觸激する所とを量り，其水勢の強弱を檢考し，以て計畫するを緊要となす．･･･修築は全體の損益を勘定するを緊要とす.
10	Flood damage brings revenue shortage and costs much budget. It is caused by sloppy preventive work. Educate community members on this matter through instructive patrols and ordinary notifications. (十) 常年の洪水に破壞せられ，多少の耗損を招くは，全く其各村胥吏等豫防の疎略なるに基き，收租に響障し且つ冗費を散消するに由り，各自巡村の際は言を俟たず．日常之を注意指揮すべきは，職務上最も緊要と爲す.

developed private manors. After warriors won political power in 1192, the feudal government dispatched retainers to each region as provincial constables or estate stewards to govern farmlands. The new land-owners defended their lands against both human enemies and natural floods. During the civil wars from 1467 to1590, feudal lords tried to expand their territories and ensure rice production using flood control techniques [9].

3.2. Flood-Disaster Management in the 17-19th Centuries

In 1603, the Edo government started its administration and brought peace to Japan. Local governors conducted state management and expanded paddy agriculture to the utmost to gain more and more rice production, so rice was circulated as the currency in the Edo economy. In villages, head groups encouraged annual farm work and paid rice harvests as taxes to state officers.

These situations were recorded in a textbook, The Farmer's Common Sense [10], written in 1680-82 by a master of civil engineering. The writer used one chapter for flood risk management to indicate the roles of villagers and state officers, as shown in **Table 3**. The writer explained that farmers had a duty to maintain river facilities and that state officers were newcomers to farmers' communities but in charge of flood-fighting operation. The writer warned local officials, village leaders, and 5-fimily groups to always be aware of river facility maintenance to protect their posterity from flood disasters.

Among many ordinances as river management issued by the Edo government, the most important doctrines were carried in the Dike Rehabilitation Directives [11] in 1733. As shown in **Table 4**, the directives required strict awareness among state officers and regulated their tasks. Officers had to prevent dike breaches, repair damage, draw up master plans, and supervise villagers.

The Dike and Irrigation Standards [12], written in the first half of the 1800s by a famous critics, summarized river management based on learning. The writer's remarks explained basic concepts of flood-disaster management at the end of the Edo era. Its introduction highlighted functions of state officers in river management

Table 5. Dike and irrigation standards of the 1800s.

Article No.	Description
Introduction 1	An expert should be appointed as the state officer for river management. He has a mandate to patrol communities in his jurisdiction and to estimate cost for any damage repairing. (前段一) 豫テ其業ニ鍛煉ナル者ヲ撰テ普請奉行ノ役ニ申シ付，常々村里ヲ巡廻セシメテ，井路ト川附ノ土手ヲ見分シ，少シニテモ危キ場處アラハ速ニ此ヲ目論見ヘシ．
Introduction 4	During a flood, the state officer for water/land management has to direct his subordinate officers to survey flooding flow from place to place. Also he has to study rivers out of state proactively. (前段四) 水土ヲ司ル役人ハ洪水ノ出タル時ニハ諸方ニ手分ヲ定メテ、川々ヲ巡回シ處々ノ水勢ヲ精シク熟覧シテ置クベシ．且ツ，水土ノ事ヲ司ル者ハ心ヲ用ヒテ，諸國諸川ヲ視ヨ．
Task 5	The state officer always has to rigorously enforce community leaders and neighboring groups to conduct river maintenance work, such as repair of riprap stone or random piles. (御普請處取計ヒノ事 五) 御普請場ノ御定法ハ，川附村々ノ名主，組ミ頭、惣百姓共マテニ兼テ嚴シク申シ渡シ置キテ，隄防ノ石一箇抜ケタルモ早速ニ挿石ヲ致スベク，亂杭一本脱タルモ即時ニ此ヲ打チ足シテ，聊モ麁畧ニ致シ捨テ置クマジキノ旨，年々三四度ツツモ申シ渡シ置クベシ．
Task 6:	In order to pile up sandbags or to stop seeping water before out-flowing, the state officer has to gather people for flood fighting in the early stage of a flood. (御普請處取計ヒノ事 六) 馬蹈ノ卑キ処ニハ土囮ヲ積ミ並ヘテ杭ヲ打タセ, 漏リ水スル處ニハ杭ヲ打テ速カニ此ヲ塞キ，大水ノ時ハ役人共早ク出テ人夫ヲ數多川端ニ集メ置キ，水防キヲ嚴重ニスベシ．

Table 6. Acts related to flood-disaster management after the Meiji Restoration in 1868.

Year	Act	Key point
1880	Municipality Act	to establish community-level voluntary association
1890	Water Association Act	to establish irrigation/flood fighting association
1894	Fire Service Rule	to identify fire service (including flood fighting)
1896	River Act	to clarify responsibility of river managing authority
1948	Fire Service Act	to reconfirm fire service (discarding flood fighting in 1949)
1949	Flood Fighting Act	to reconfirm responsibility of flood fighting association
1949	Land Improvement Act	to establish irrigation association (leaving flood fighting association)
1955/58	Flood Fighting Act (amendment)	to define responsibility of municipality and financial support for flood fighting association
1961	Disaster Management Basic Act	to identify responsibility of people, municipalities, prefectures and the central government
1964	River Act (revision)	to re-clarify responsibility of river managing authority and to reconcile water-use disputes
1997	River Act (amendment)	to improve river environment and to take care of flood-prone areas
2001/05	Flood Fighting Act (amendment)	to install flood forecasting and hazard mapping
2012	Disaster Management Basic Act (amendment)	to reconfirm responsibility of all relevant parties and to emphasize historical hazard traditions and pre-disaster education

such as frequent patrols, river surveys during flooding, and self-motional study of other rivers, as shown in **Table 5**. Subsequent articles on site management required officers to supervise village leaders and neighborhood groups in time of both ordinary occurrence and floods.

3.3. Combination of Flood Fighting and Flood Control

Japan's framework of flood-disaster management was completed in the Edo era. Local people saw themselves as main players in flood fighting and took group action to defense their irreplaceable community. These were the primary motivation of self-help and mutual help. Based on this understanding, state officers supervised daily river management, emergency flood measures, and uninterrupted flood control. Their mandates were to minimize flood damage and to maximize rice revenues. This was public help. The tripod scheme of the 3 helps made it possible to sustain local society while producing rice for hundreds of years despite repeated flooding.

4. Legislated Disaster Management After 1868

4.1. Legislation Process After the Meiji Restoration

Japan re-established itself in the 1868 Meiji Restoration as a unified nation under the rule of law. For flood fighting and flood control, the central government compiled many local rules into new standardized acts and amended them, adjusting to social evolution [13]. Acts related to flood-disaster management are shown in **Table 6**.

4.2. Evolution of Flood-Disaster Management in Acts

Conventional anti-flood measures in communities were taken over in a new association. The 1880 Municipality Act established "voluntary" associations that would be divided into irrigation associations and flood fighting associations by the 1890 Water Association Act. In addition to this, the 1894 Fire Service Rule opened the gates to firefighters for engaging in flood fighting. These acts shifted flood fighting from Edo conventions to Meiji ad-

Table 7. Tripod scheme in Disaster Management Basic Act, Flood Fighting Act, and River Act.

Act	Key point
Disaster Management Basic Act Article 7 (2)	A resident has to prepare against subsequent disasters by oneself and contribute disaster management through participating in voluntary activities for disaster prevention, studying historical hazard traditions and other approaches. (災害対策基本法 第7条2項) 住民は，自ら災害に備えるための手段を講ずるとともに，自発的な防災活動に参加，過去の災害から得られた教訓の伝承その他の取組により防災に寄与するように努めなければならない.
Flood Fighting Act Article 3/5 (3)	A municipality has responsibility to complete flood fighting in its area. The flood brigades and the fire service conduct flood fighting activities under command of the flood fighting leader (the mayor). (水防法 第3条/第5条3項) 市町村は，その区域における水防を充分に果すべき責任を有する．水防団及び消防機関は，水防に関しては水防管理者（市町村長）の所轄の下に行動する.
River Act Article16-2	The river manager has to take measures to prevent flood disaster or mitigate flood damage on particular flood-prone area due to its precipitation, topography, geography, etc. (河川法 第16条の2) 河川管理者は，降雨量，地形，地質その他の事情によりしばしば洪水による被害が発生している区域につき，災害の発生を防止し，又は災害を軽減するために必要な措置を講ずるよう特に配慮しなければならない.
River Act Article 22	In a case of emergency due to flood or storm surge, the river manager has power to occupy ground, stone, sand, timber, bamboo, cars, tools, etc. and command residents to take part in the emergent works in order to prevent disaster or mitigate damage. (河川法 第22条) 洪水，高潮等による危険が切迫した場合において，水災を防御し，又はこれによる被害を軽減する措置をとるため緊急の必要があるときは、河川管理者は、その現場において，必要な土地を使用し，土石，竹木その他の資材を使用し，若しくは収用し，車両その他の運搬具若しくは器具を使用し，又は工作物その他の障害物を処分することができる．2 河川管理者は，前項に規定する措置をとるため緊急の必要があるときは，その附近に居住する者又はその現場にある者を当該業務に従事させることができる.

ministration. Although the name was changed, its actual organization and local cost burden were conserved in each community.

For flood control, the 1896 River Act established river managers – prefectural governors for common rivers or a minister in charge of difficult or costly rivers. In fields, river officers, instead of state officers in the Edo era, played an active role excepting taxation. The River Act also defined the authorities' emergency command of flood fighting and ordinary supervision of river management.

After World War II, Japan reviewed its legal system. The 1949 Flood Fighting Act provided legal identity to activities by flood brigades or fire brigades. The Act was amended in 1955 and 1958 to introduce municipalities' beneficiary contribution and prefectural subvention for flood-fighting expenses. It was just a part of qualitative transformation of Japanese society but had a heavy impact on flood fighting itself. Community-motivated flood fighting action would be involved in local institutional administration.

In 1959, Japan was hit by a terrible water-related disaster, Typhoon Isewan (Vera), that led to the Disaster Management Basic Act in 1961. This comprehensive act clarified the responsibility for disaster prevention by the central government, prefectures, municipalities, and residents. The role of municipalities was highlighted to support flood and fire brigades and voluntary anti-disaster groups. All residents were to prepare themselves against disaster and to endeavor to contribute to disaster prevention.

The River Act was revised in 1964 to re-clarify prefecture governors for common rivers and the Minister for Construction (today's the Minister for Land, Infrastructure, Transport and Tourism) as the river manager for prioritized rivers. Taking over tasks for flood management from the old act, the revised act put in an additional function to reconcile water-use disputes among water users.

In order to tackle recent heavy rainfall, the River Act and Flood Fighting Act were amended last. The River Act amended in 1997 stipulates that river managers take special action in the most flood-prone areas to prevent flood disaster and to mitigate damage. The Flood Fighting Act was amended in 2001 and 2005 to enhance flood forecasting, to disclose inundation areas, and to support evacuation using hazard maps.

In the recovery process from the 2011 Great East Japan Earthquake Disaster, the central government strengthened the Disaster Management Basic Act in 2012. Adding to reconfirmation of all relevant parties' responsibility by the entire nation, historical hazard traditions and pre-disaster education were highlighted in the amended act.

4.3. Tripod Scheme in Acts

The tripod scheme of self-help, mutual help, and public help, which was completed in the Edo era, has been taken over in the present legal system. Self-help defensive action is now the obligation of local residents. Voluntary mutual help is conducted by flood and fire brigades and residential anti-disaster groups under municipality supervision. Basin-wide public help is one of the main tasks of the river managers. The essence of the tripod scheme can be found typically in the Disaster Prevention Basic Act, the Flood Fighting Act, and the River Act, as shown in **Table 7**.

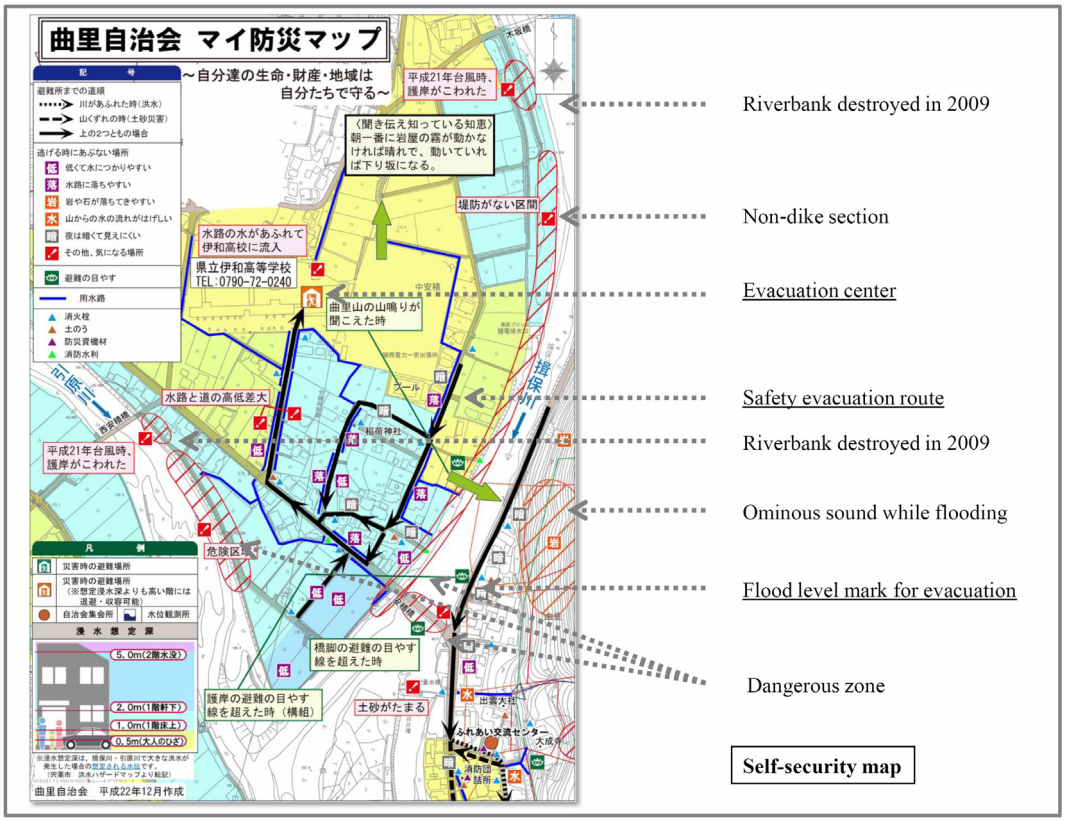


Fig. 1. Self-security map for Magari District (voices of residents).

5. Local Disater Management in 2010

5.1. Background of the Pilot Program

Recently, localized intensive rainfalls have hit many communities all over Japan irregularly. In the case of north-western Hyogo, a downpour caused flood overflows, human injury, and housing damage in Sayo Town on the Chikusa River and Shiso City on the Ibo River in August 2009. This disaster was noted for its rainfall intensity of 89 mm/h and a couple of victims during evacuation. After this disaster, the MLIT Kinki Regional Bureau set up an investigative commission on damage reduction measures for localized downpours. The commission discussed how to deliver river and disaster information, how to promote quick and adequate evacuation, etc., and finally compiled recommendations [14] for residents, municipalities, the prefecture, and river management authorities in June 2011. In the process of this discussion, the MLIT Himeji Office proposed a pilot program for the afflicted Magari District in Shiso City to consider how to improve local disaster management capabilities.

5.2. Pilot Program in the Afflicted Magari District

The pilot program was conducted from July to December 2010. Its core events were 3 workshops, 2 fieldworks including day and night inspection, warning markers for streets, and an evacuation drill. Participants in the program were a district leader, neighborhood groups, residents, a fire-fighting team, Shiso City officials, and MLIT Himeji staff (Ibo River management authority). Throughout the 6-month program, participants discussed what kind of information was needed for an actual evacuation and finally drew up a self-security map with district-level disaster management action plans in December 2010. The map indicates the easiest evacuation route from each house to an evacuation center, showing local residents' awareness and findings, as shown in **Fig. 1**. The map was printed and delivered to all families in the district.

Five months later, in May 2011, the Magari District had a flood again. Fortunately, the flood did not overflow the riverbank, but Shiso City and residents made quick reactions. Time for issuing evacuation advisories were 30 minutes shorter than in 2009 – 60 minutes compared to 95 minutes after a warning river level was recorded – and the evacuation ratio increased 10.1 points more than in 2009 – 22.6% compared to 13.5% based on against the number of residents in danger. This data showed that the flood in 2009 and the pilot program in 2010 enhanced people's awareness and promoted local disaster management capabilities.

Using this opportunity, the MLIT Kinki Regional Bureau edited the Guidelines for Self-security Maps. These guidelines will be helpful to the MLIT Himeji Office and other river management authorities in executing subsequent capability-building projects in other regions.

In addition to output, the pilot program revealed a social infrastructure preserved in the local community down through the generations. Local residents joined work-

shops and fieldworks on their own. Groups that have been neighbors since the Nara era are functional even now. District leaders exercised leadership just as village leaders did in the Edo era. The fire brigade, born in the Meiji era, had strong intent to guard the district. Self-help and mutual help still remain in the local society of the Magari District. For this self-defensive community, Shiso City and the MLIT Himeji Office tried to deliver necessary warnings before and during the flood as public help.

At the same time, the pilot project extracted problems for the future. Many residents did not know about inundation records in the past and some of them could not image overflow from the river. Residents' awareness was not sufficient. The fire brigade also had difficulty in fulfilling their expected function due to personnel shortages, and aging, and Shiso City had quite limited staff for disaster management despite its wide administrative service area. It was undoubted that the power of self-help and mutual help had gotten weakened.

5.3. Tripod Scheme in Society

It is tangible that the triangle scheme is still working in local communities in Japan. It cannot be denied, however, that its practical adaptive capability may be degraded in self-help and mutual help. Remaining public help is then expected to play a positive role in local-level anti-disaster measures. The river management authority especially has the capability to reinforce the tripod scheme in local communities, introducing useful information based on on-site analysis of past floods, recent disaster data in other regions, latest real-time flood forecasting, etc. The effort is required to fulfill flood fighting and flood control under today's conditions, and this direct communication among self-, mutual, and public help is an indispensable component of the tripod scheme in the present local society in Japan.

6. Upcoming Challenges in Japan and Elsewhere in Asia

6.1. Challenges in Japan

As mentioned in previous sections, Japan's systematic disaster management was born in floodplain development in the Nara era and completed in village management in the Edo era. It was standardized through legislation after the Meiji Restoration to become an underlying non-structural infrastructure that is working in present society. It is a triangle scheme of self-, mutual, and public help. Each community should understand the scheme with its local history and adjust it to obtain larger capability for effective disaster management.

Self-help: The personal-level challenge is to promote self-awareness. Today, most Japanese people have livelihoods not depending on land, and they have fewer chances to experience flood damage due to progress in river improvement. However, it is easy to get information on natural disasters in Japan and in the world through mass communication media. As a first step to living in a flood-prone area, people should educate themselves to be able to take action for disaster prevention and emergency behavior.

Mutual help: The community-level challenge is to transfer the underlying and technical know-how to the next generations. Day-to-day disaster preparedness is conducted by flood and fire brigades; however, their performance is getting weaker in some communities. Municipalities, which are fundamental administrative organizations, should recognize this fact and promote neighborhood associations into becoming anti-disaster groups. In addition, municipalities should propose and realize less hazardous land use for residents in the next generations.

Public help: The river management authority's challenge is to participate in town planning, not only for community security but also for basin-wide river planning. In order to make advices useful, river officers have to upgrade and provide their research on possible floods and preferable anti-disaster measures. Intending to promote sustainable land use and social development, the river management authority should continue close conversations among self-help, mutual help, and public help as a professional counselor for each community.

6.2. Challenges in International Cooperation

Japan's disaster prevention effort has been introduced, in addition, in international cooperation. One of its successful approaches was the Flood Hazard Mapping Project in 2002-2008 [15] under the ESCAP Typhoon Committee. Through the project, 11 member countries understood the objectives of mapping and composed original-style hazard maps. The Philippines drafted many useful maps through community-level discussions, for example, and China developed computerized maps for flood control by river authorities. Mapping has been developing in the each society.

For these countries, it is recommendable to confirm the background of the flood hazard map. The map is the result of Japan's tripod scheme based on the relationship among resident's survival, community defense, and basin-wide management, then each country should check its local society that has original backgrounds different from Japan. When the difference is clear, the mapping technique is applicable and useful in a variety of social frameworks. Especially for other Asian countries, that must be effective because they have same experience with Japan in rice production in the monsoon climate.

7. Conclusions

This study has confirmed that the tripod scheme is a time-honored social infrastructure that has been fostered in Japan's history of anti-flood measures. Self-help is an

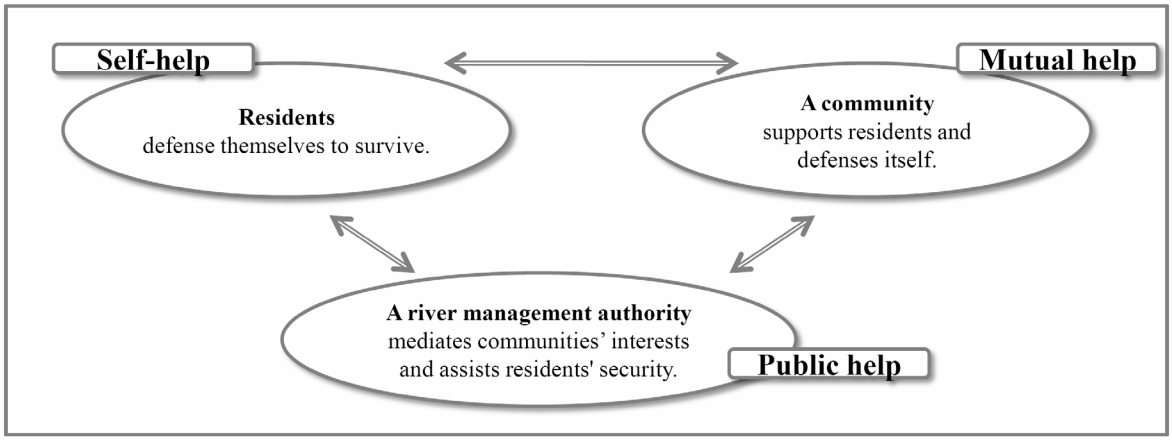


Fig. 2. Tripod scheme independency and interdependency of self-, mutual, and public help.

individual self-defensive reaction that has been indispensable to surviving in flood-prone areas since the Nara era (the 8th century). Mutual help is a self-contained operation of each community in which people took collaborative anti-disaster actions year after year. Public help has been a new administrative service since the Edo era (the 17-19th century) to mediate and minimize flood damage in total. The coalition among the people, the communities, and the river management was the essence for continuing rice production using the same rice paddies while flood disasters occurred repeatedly.

After the Meiji Restoration, the central government enshrined traditional social rules in laws. Self-help, mutual help, and public helps were clearly translated into the Disaster Management Basic Act, the Flood Fighting Act, and the River Act. Within this legal framework, the people, the community, and the river management authority have been playing major roles in local society. This is the backbone of Japan, which has promoted economic growth, fighting against natural disasters on the not so commodious islands.

The essence of the tripod scheme is generalized in **Fig. 2**. The three types of help have become closely related to each other to form a tripod framework. In this structure, the independency and interdependency of the three axes are the power source most important for building social resiliency against a number of natural disasters, and it is recommendable that the tripod scheme shall be valid to achieve sustainable land use and economic activities on low-lying fields in a severe climate, not only for Japan and but also for other countries in Asia.

References:

[1] Director General for Disaster Management, Cabinet Office, Government of Japan, "Disaster management in Japan," p. 38, 2011, http://www.bousai.go.jp/1info/pdf/saigaipanf_e.pdf [accessed at September 21, 2012]

[2] T. Okuma, "River history of flood and countermeasures (Kozui to chisui no kasenshi)," Heibonsha, pp. 13-14, 2007 (in Japanese).

[3] T. Miyamura, "Flood disaster (Suigai)," Chuokoronsha, pp. 209-212, 1985 (in Japanese).

[4] H. Matsuki, T. Esaki, Y. Mitani, and H. Ikemi, "Ancient earthwork implements and land development on Onga River basin," Journal of Japan Society of Civil Engineers, Ser. D2 (Historical Studies), Vol.67, No.1, pp. 1-8, 2011 (in Japanese).

[5] T. Ujitani, "The Chronicle of Japan Continued (Shoku-Nihongi)," Kodansha, pp. (I)27-29, pp. (I)192-193, pp. (II)71-72, 1992 (in Japanese).

[6] H. Oda, "Result and evaluation of Gyoki's projects," Magazine Kasen, pp. 64-69, 2007-11 (in Japanese).

[7] M. Inoue, "The Code (Ritsuryo)," Iwanami-shoten, pp. 225, 227, 362, 363, 1976 (in Japanese).

[8] Japan Society of Civil Engineers, "Civil engineering history before Meijii (Meiji-izen Nihon Doboku-shi)," Iwanami-shoten, pp. 6-11, 1936 (in Japanese).

[9] K. Yamamoto, "History of river planning techniques (Kadou-keikaku no gijutu-shi)," Sankaido, pp. 7-19, 1999 (in Japanese).

[10] T. Furushima, "The Farmer's Common Sense (Hyakusho Denki)," Iwanami-shoten, pp. 187-188, pp. 202-203, 2001.

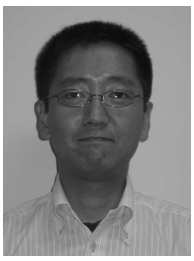
[11] As [8], pp. 1635-1638 (in Japanese).

[12] N. Sato, "The Dike and irrigation standard (Teibokoketsushi)," Meizan-kaku, 1800s.

[13] Study team for the Flood Fighting Act, "Commentary on the Flood Fighting Act (Suiboho Chikujo Kaisetsu)," Gyosei, pp. 1-21, pp. 427-440, 2005 (in Japanese).

[14] Investigative commission on damage reduction measures from localized downpours, "Recommendations," 2011 (in Japanese), http://www.kkr.mlit.go.jp/himeji/higai_kento/pdf/teigen.pdf [accessed at September 21, 2012]

[15] Typhoon Committee, "Final report on flood hazard mapping project," World Meteorological Organization/TD-No.1519, 2009, http://www.typhooncommittee.org/docs/publications/book1_FHM.pdf [accessed at September 21, 2012]



Name:
Hirotada Matsuki

Affiliation:
Director, Himeji Office of River and Road, Kinki Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

Address:
1-250 Hojo, Himeji, Hyogo 670-0947, Japan

Brief Career:
1989 Joined Ministry of Construction
1997-2000 JICA Expert for MCTPC, Lao PDR
2005-2007 Director, Onga Office of River, MLIT

Selected Publications:
• "Ancient Earthwork Implements and Land Development on Onga River Basin," Journal of Japan Society of Civil Engineers, Ser.D2 (Historical Studies in Civil Engineering), Vol.67, Issue 1, pp. 1-8, 2011.

Academic Societies & Scientific Organizations:
• Japan Society of Civil Engineers (JSCE)