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Lessons Learned from the Flood Disaster in Industrial Estates/Parks/Zones in Thailand

— Based on the experience of the 2011 flood —

International Centre for Water Hazard and Risk Management
under the auspices of UNESCO (ICHARM)

PUBLIC WORKS RESEARCH INSTITUTE (PWRI)

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International Centre for Water Hazard and Risk Management under the auspices of UNESCO (ICHARM),

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Abstract

The flood that occurred on the Chao Phraya River in Thailand in 2011 was a severe disaster that claimed more than 800 lives and caused more than approximately $40 billion in economic damage (estimated by World Bank). The Chao Phraya River Basin is a flood-prone area because of its topographical characteristics and even though extensive flood control countermeasures have been taken, it is still at risk of flood disasters.

This collection of lessons learned was prepared based on the results of an interview survey of Japanese companies carried out in cooperation with the Japan International Cooperation Agency (JICA) and the Rojana Industrial Park in Thailand in November 2012. In order that the extremely valuable direct recollections of local representatives of Japanese companies who dealt directly with the 2011 flood disaster, will not dim now more than 3 years later, this booklet will broadly disseminate “the lessons learned” based on the results of the survey.

Key words: Chao Phraya River, flood, lessons, industrial estate, interview survey.

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Summary of the lessons learned from the 2011 Chao Phraya River Flood

Lesson 1 :
Flood manuals applying past flood experience or Business Continuity Plan (BCP) hypothesizing floods must be prepared.

Lesson 2 :
To ensure that the hypothesized BCP is effectively applied in the future, practice and training must be conducted regularly to increase every manager and employee's crisis response capability.

Lesson 3 :
Methods of quickly obtaining accurate information such as inundation predictions (depth and time of inundations, etc.) must be ensured.

Lesson 4 :
Arrangements must be made with business partners in advance concerning actions to be taken in response to disasters.

Lesson 5 :
Countermeasures to protect machinery and materials in the event of an inundation must be planned in advance.

Lesson 6 :
Confirming the safety of employees must be a top priority.

Lesson 7 :
In order to absolutely minimize the effects on business partners, restoration work must be carried out promptly.

Lesson 8 :
In an emergency, it is vital to strengthen the command system and to establish an information sharing system.

Lesson 9:
We must be aware that social progress is accompanied by the transformation of disasters, and not be bound by past convention.

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Introduction

The flood that occurred in the Chao Phraya River Basin in Thailand in 2011 was a severe disaster that claimed more than 800 lives and caused more than approximately $40 billion in economic damage (estimated by World Bank). The largest part of this estimated economic damage was damage to industry, which accounted for more than 70% of the total cost, and in particular, the inundation of 7 industrial estates/parks/zones (Saha Rattana Nakorn, Rojana, Hi-Tech, Bangpa-in, Factoryland, Nava Nakorn, and Bangkadi) from Nakhon Sawan southward in the Chao Phraya River Basin not only impacted the economy of Thailand but countries around the world. But, by December 10, 2012, more than about 80% of the companies with production facilities in these 7 industrial estates/parks/zones had resumed all or part of their production [1], and overall, the domestic economy of Thailand appeared to have recovered fully from the flood. And even now in August 2014, when political instability has appeared as another risk of concern in addition to natural disasters, many foreign companies are continuing to expand into Thailand by making direct investments, so Thailand still holds a position as one of Asia's leading spots for production and investment.

One should note, however, that the Chao Phraya River Basin is a flood-prone area because of its topographical characteristics. Even though extensive flood control countermeasures have been taken, it is still at risk of flood disasters. Further in 2013, although river floods did not occur, local torrential rainfall caused inundation of the Amata Nakorn Industrial Estate in Chonburi province in eastern Thailand. Considering these circumstances, we have concluded that it is vital to share past flood experiences and lessons in order to prevent future flood disasters.

This collection of lessons learned was prepared based on the results of an interview survey of Japanese companies carried out in cooperation with the Japan International Cooperation Agency (JICA) and the Rojana Industrial Park in Thailand in November 2012. In order that the extremely valuable direct recollections of local representatives of Japanese companies who dealt directly with the 2011 flood disaster will not dim now more than 3 years later, this booklet will broadly disseminate "the lessons learned", the results of the survey. We hope that these lessons will be of some use to all of you. We are deeply grateful to the representatives of Japanese companies who cooperated with us for this survey. We are also thankful to Mr. Tadashi Nakasu (former Research Specialist in ICHARM, PWRI and now Researcher at the National Research Institute for Earth Science and Disaster Prevention, Japan) and Mr. Toshio Okazumi (former Chief Researcher at ICHARM, PWRI, and now Director, Overseas Project Division, Policy Bureau, Ministry of Land, Infrastructure, Transport and Tourism, Japan) for their efforts for this survey.

October 2014

International Centre for Water Hazard and Risk Management (ICHARM),
Public Works Research Institute

About ICHARM

The International Centre for Water Hazard and Risk Management (ICHARM) was established at the Independent Administrative Agency Public Works Research Institute of the Ministry of Land, Infrastructure, Transport and Tourism with backing from the United Nations Educational, Scientific and Cultural Organization (UNESCO) in March 2006 with its mission, reducing the severity of water-related disasters around the world[2]. Since its founding, ICHARM has vigorously implemented various activities to prevent or to mitigate water-related disasters in cooperation not only with the Japanese Government (Ministry of Land, Infrastructure, Transport and Tourism, and the Ministry of Foreign Affairs) and the Japan International Cooperation Agency (JICA), but also with government agencies of developing countries and international bodies such as the United Nations and the Asian Development Bank.

Regarding the flood in the Chao Phraya River Basin in Thailand in 2011, the Rainfall-Runoff-Inundation Model (RRI Model)[3] developed by ICHARM was applied to the JICA's Chao Phraya River Basin flood management project (support for developing a flood management system), contributing to strengthening the Government of Thailand's capacity to manage floods.

Contents of the Survey

This survey was conducted as part of "A Study on the Chain-Reaction Impact of the Chao Phraya River Flood", conducted by ICHARM from 2012 to 2015. The following are the contents of the survey.

- **Objective:** To understand the response by local Japanese affiliated companies to the 2011 Thai flood, and future challenges they face.
- **Target of the survey**: Total of 25 Japanese affiliated companies in Thailand (industrial estates/parks/zones: (Saha Rattana Nakorn, Rojana, Hi-Tech, Bangpa-in, Factoryland, Nava Nakorn.)
- **Survey period:** May to November 2012
- **Methodology:** Conducting interviews and a questionnaire survey at each company
- **Contents:** Good practices and challenges in preparing for and responding to the flood that are organized in a time series from the time of inundation, shutting down operations, restoration, and resumption of production.
- **Survey questions:**
  - Awareness of and predictions of flooding before the 2011 flood,
  - Ensuring safety of, supporting, and contacting employees at the time of the 2011 flood,
  - Deciding locations and time for evacuation,
  - Deciding to stop and restart business operations,
  - Transmission and reception of information,
  - Links with business partners,
  - Moving and reordering machinery and materials.

Structure of this Booklet

This booklet restructures the survey results by thematic field and presents them in the form of "Nine Lessons Learned" as material for reference to prepare future flood countermeasures. Related information thought to be useful when preparing flood countermeasures is presented in the columns in text-box format.

Lesson X: —Lessons derived from the interview results—

< **Explanatory Note** >

- *Outline of the interview results and improvement measures derived from the results*
-
-
-

＜**Relevant remarks quoted from the survey responses**＞

Relevant remarks are quoted from the interview and questionnaire survey results.

- Good points (quoted)
- Challenges (quoted)
- Other comments (quoted)

Column Y: —Information concerning each lesson—

Related information thought to be useful when preparing flood countermeasures is presented.

Table of English Abbreviations

Abbreviations	Term	Japanese translation
BCP	Business Continuity Plan	事業継続計画
BCM	Business Continuity Management	事業継続マネジメント
ICHARM	International Centre for Water Hazard and Risk Management under the auspices of UNESCO	(独立行政法人) 土木研究所 水災害・リスクマネジメント国際センター
JAF	Japan Automobile Federation	(一般社団法人) 日本自動車連盟
JETRO	Japan External Trade Organization	(独立行政法人) 日本貿易振興機構
JICA	Japan International Cooperation Agency	(独立行政法人) 国際協力機構
PC	Personal Computer	パーソナルコンピューター
RRI	Rainfall-Runoff-Inundation	降雨流出氾濫
SARS	Severe acute respiratory syndrome	重症急性呼吸器症候群
SMS	Short Message Service	ショートメッセージサービス
UNESCO	The United Nations Educational, Scientific and Cultural Organization	国際連合教育科学文化機関
UPS	Uninterruptible Power Supply	無停電電源装置

Flood in the Chao Phraya River Basin in Thailand in 2011

The Chao Phraya River differs from most rivers in Japan in that it has very moderate river slope. It flows from north to south across the central plain of Thailand, reaching the ocean at the capital city, Bangkok. Its total basin covers the area of approximately 160,000 km^2, which nearly equals 1/3 of the total land area of Thailand. The Chao Phraya River formed by the convergence of four upstream tributaries passes through Nakhon Sawan province in its middle reaches. Nakhon Sawan is an important point for the flood management of the river because a flow rate of 3,600 m^3/second or more at its observation point can indicate whether inundation would occur nearby. One can open the flow rate graph of Nakhon Sawan from the web site of the Chao Phraya River Flood Forecasting System operated by the Royal Irrigation Department of the Government of Thailand (See Column 3 in Page 6). It is reported that five typhoons that struck Thailand from June to October 2011 brought the rainfall of approximately 1,400 mm (140% of average rainfall during the same duration) to the Chao Phraya River Basin, and a flow rate of more than 3,600 m^3/second was recorded continuously at the Nakhon Sawan observation point from mid-September to early-November 2011[4].

Chao Phraya River Basin
(Source: FAQ AQUASTAT)

The 2011 flood caused particularly severe economic losses in 7 industrial estates/parks/zones (Saha Rattana Nakorn, Rojana, Hi-Tech, Bangpa-in, Factoryland, Nava Nakorn, and Bangkadi) located between Nakhon Sawan and Bangkok out of more than 60 industrial estates/parks/zones located throughout Thailand. More than half of the total of 804 companies damaged by the disaster in these 7 industrial estates/parks/zones were Japanese affiliated companies[5].

The following summarizes the flood damage in 2011.

Affected area: 65 of all 77 provinces in Thailand[6]
Fatalities: 815[6]
Population affected by the flood: approximately 9.5 million[6]
Estimated economic damage & loss: about 1.425 trillion Bahts
(about $45.7 billion, about 3.8 trillion yen)[7]

If indirect damage and losses caused by shutting down plant and office operations in the non-flooded region to ensure the safety of employees, and disruption of the international supply chains etc. are included, the economic impact probably exceeded the above estimated amount.

Lesson 1: Flood manuals applying past flood experience or Business Continuity Plan (BCP) hypothesizing floods must be prepared.

<Explanatory Note>

- Many interviewees answered, “The scale of the 2011 flood was unexpectedly large.” Indicating that many companies had difficulty dealing with it.
- On the other hand, during the 2011 flood, there were also companies that survived by taking advantage of their experience of the 2010 flood.
- The Chao Phraya River Basin is basically susceptible to floods. However, we were not fully aware of the potential danger.
- Learning from the 2011 flood disaster, Business Continuity Plans (BCP) and manuals need to be developed to prepare adequate countermeasures for the next flood**.**

＜Relevant remarks quoted from the survey responses＞

Good points (quoted)

✓ Learning from the 2010 flood damage, we discussed in advance, water level and water volume of dams and reservoirs as indicators for decision-making.

Challenges (quoted)

✓ Local employees cooperated and tried hard. However, as this large scale of flooding was not anticipated, there were many points that the company had to reconsider.

✓ There was no manual for crisis management concerning floods.

✓ Our manual for crisis management covered BCM for SARS, political instability etc. , but did not cover flooding.

✓ Our BCP primarily hypothesized the risk of political conflicts, and not flooding. Therefore, our response to the flood was not according to the one prescribed in the BCP.

Other comments (quoted)

✓ We intended to prepare for the inundation, but the preparations were not effective against the unanticipated flood.

✓ We did not think that the industrial estates/parks/zones would be flooded.

✓ We prepared sandbags, but the flood disaster was much larger scale than expected in all aspects.

Note: BCM: Business Continuity Management
SARS: Severe acute respiratory syndrome

Column 1: Preparing for flooding— Business Continuity Plan (BCP)

- Business Continuity Plan (BCP) is defined as “a plan that stipulates policies, systems, procedures and so on in order that an unexpected event does not cause interruption to the business, or, when it does, that the business can be resumed as soon as possible[8].

- In Japan, nowadays, various handbooks or manuals concerning the preparation of BCP can be found. The Cabinet Office, Japan, for example, compiled relevant information of manuals and guidelines on business continuity planning that are prepared by various ministries and agencies, local governments, and economic and industrial organizations [9].
  http://www.bousai.go.jp/kyoiku/kigyou/keizoku/sk.html

- “Guideline for Business Continuity (Third edition)” which Cabinet Office, Japan published in August 2013 reflects the increasing attention on BCP in recent years, lessons learned from the Great East Japan Earthquake and Tsunami and the flooding in Thailand, and other recent international trends in disaster prevention.
  (Source: Business Continuity Guideline, Third Edition, August 2013)[8]
  http://www.bousai.go.jp/kyoiku/kigyou/keizoku/sk_04.html

- In flood-prone regions, it is necessary to include in BCP some advanced countermeasures for flooding. The Arakawa Downstream River Office of the Ministry of Land, Infrastructure, Transport and Tourism, Japan, located in the capital region, prepared a handbook on the matter, “Flood Countermeasures : BCP for Industry and Business Establishments (June 2011)” [10]. It defines characteristics of a flood as follows; (1) “Lead time” of a flood event (time from the announcement of warnings or alerts until the moment when phenomenon exceeds certain threshold) is longer compared to that of other disaster events such as earthquake, so, we have more time to prepare; (2) A flood events normally separates inundated areas and non-inundated areas, so, BCP can consider the non-inundated areas as lower risk areas in its planning; and (3) Some floods last long. So, it is necessary to make plans to prepare for longer inundation periods.
  http://www.ktr.mlit.go.jp/ktr_content/content/000040973.pdf

Lesson 2: To ensure that the hypothesized BCP is effectively applied in the future, practice and training must be conducted regularly to increase every manager and employee's crisis response capability.

<Explanatory Note>

- If an action cannot be taken at normal times, it definitely cannot be taken in an emergency, either.
- Once a BCP has been developed, its implementation should be ensured so that it can be effectively applied when an emergency has occurred. It is necessary to improve the capacity and skills of not only managers but also all the other employees through regular practice and training. The BCP should be constantly enhanced so that it will become more realistic.
- It is important to regularly practice how to respond to disasters. An example is “simulation practice approach” that uses a non-scenario-based method. The approach intends to improve capacity and skills in crisis response in the event of an unexpectedly large-scale disaster. A summary of the training was published on the BCP/BCM web site of the Ministry of Economy, Trade and Industry, Japan (See Column 2).
- Flood countermeasure manuals or BCP must also include a list of disaster prevention equipment and training programs.
- If certain systems that are only usable during emergencies, are provided, it is often the case that, considering their high cost, they cannot be used at normal times. It is better that systems used at normal times be also usable during emergencies.

＜Relevant remarks quoted from the survey responses＞

Problems (quoted)

- ✓ Disaster prevention measures of normal level were taken and emergency stocks were prepared. However, they were found insufficient, as the 2011 flood was of unexpected scale.
- ✓ Training activities were discussed just before the inundation, but they were not implemented in reality.

Other comments (quoted)

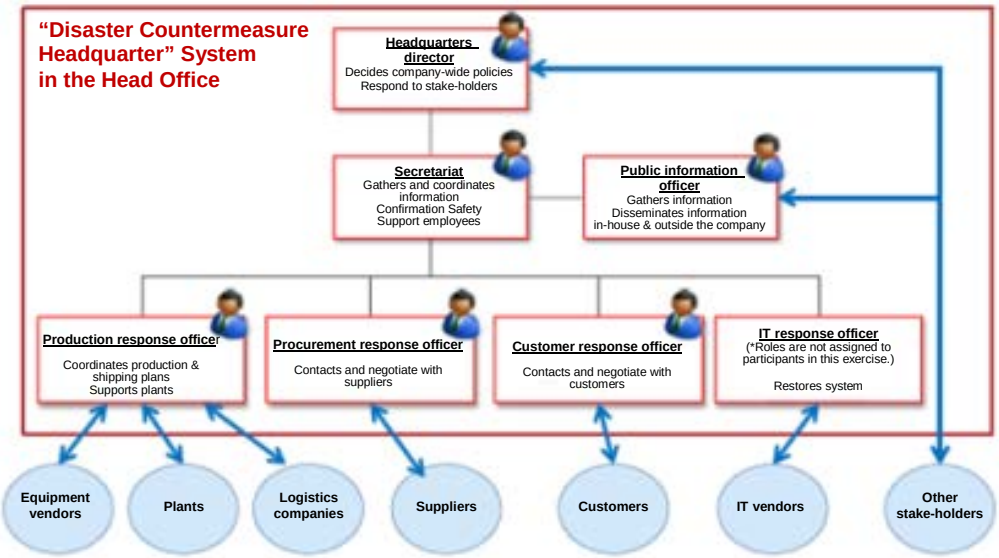
- ✓ No inventory was available for emergency stocks or equipment. We were not prepared for the flood, at all.

Column 2: Example of disaster response training in Japan for corporations to improve the effectiveness of BCP

In Japan, many companies have already developed BCP, but their effectiveness is still not fully ensured. There are three ways to improve the effectiveness of the BCP; (1) “Hard measures”, which is providing necessary physical countermeasures, equipment, and materials etc.; (2) “Soft measures” such as dividing roles when danger occurs, or setting criteria for judgment; and (3) Enhancing practical skills for responding to a danger. Of these, many pointed out that the third point, “practical skills for responding to danger” was insufficient after the Great East Japan Earthquake and Tsunami in 2011 [11].

To improve such skills, the Ministry of Economy, Trade and Industry, Japan carried out a simulation practice that uses “non-scenario-based method” in June 2013 with the participation of managers from private corporations. A summary of this training exercise can be found at the following link: http://www.meti.go.jp/policy/safety_security/bcp/index.html

The exercise, which was open to public, simulated a sequence of events after a large-scale earthquake equivalent to magnitude 9, assuming that it occurred at 2 p.m. Approximately 60 participants undertook the exercise of initial response after the disaster (Practice 1) and business continuation activities (Practice 2) based on the hypothesis that they are members of the disaster countermeasure headquarters of a certain imaginary manufacturing business (representing design, development, manufacturing, and sales sections of the department of electronics). Participants, divided into 10 teams of 5 or 6 people each, played a variety of roles as shown in the diagram below. Strong leadership, teamwork, and strong capacity of analyzing relevant information were required in order to respond to the rapidly-changing scenarios (reflecting the situation that is changing from moment to moment) in a limited time period [11].



Lesson 3: Methods of quickly obtaining accurate information such as inundation predictions (depth and time of inundations, etc.) must be ensured.

<Explanatory Note>

- Because it is generally possible to ensure adequate time to respond to a flood disaster, more accurate flood forecasting helps to reduce damage. More specifically, information such as the time and depth of inundation, and the time the flood water recedes.
- According to the interview results, at the time of the 2011 flood, accurate information was extremely hard to obtain. Many answered, “The information exchanged with other occupants of the industrial estate/park/zone was the most reliable and useful.” It is therefore necessary to establish information networks and an emergency liaison system in each industrial estates/parks/zones that can be used to exchange reliable information in an emergency.
- Communicating by e-mail is efficient. However, because mail servers can be overloaded, another communication method should be ensured in addition to e-mail.
- The Government of Thailand strengthened its river management tools for Chao Phraya River after the 2011 flood. One of these tools, the Chao Phraya River Flood Forecasting System, was made available to the public in September 2013 (see Column 3).

＜Relevant remarks quoted from the survey responses＞

Good points (quoted)

✓ Fortunately we were able to secure reliable information through good coordination with our local staff and the staff of contractors.

Challenges (quoted)

✓ Information which were needed during the flood, were (1) whether inundation would really occur, (2) when it would occur, and (3) what the water level would be during the inundation.

✓ Accurate information and quantitative forecasting that are not influenced by political motives, wishful thinking, or preconceptions were needed.

✓ It was found vital to verify the given information with multiple sources. We had to prepare for the worst case scenario without blindly accepting the information from government or media.

Other comments (quoted)

✓ We decided almost everything by in-house discussions. Our problem was the lack of reliable flood information. Some said until the last moment that inundation would not occur, which prevented us from starting full-scale evacuation.

✓ There was no reliable news source, so we had to confirm any information by ourselves. As the situation was unprecedented, nobody including Thai media, had any reliable information.

✓ Information from Thai Government was not so accurate, consistent, or specific. Therefore, we were not certain how to respond to the flood. (The promise “The industrial estates/parks/zones will be

protected without fail" was immediately broken.)

- ✓ Overall, there was a shortage of accurate information, but we trusted and followed information and requests from the industrial estate/park/zone.
- ✓ We did not sense the occurrence of inundation until the warning message was issued about the breaching of levees around the industrial estate/park/zone.
- ✓ We tried transmitting relevant information, but our e-mail messages were stuck in the server.
- ✓ Some Japanese staff and Thai security staff remained at the plant, and reported timely and detailed information of the surrounding area. These information were further reported to our Bangkok office and the headquarters (in Japan) by phone.

Column 3: Operation of the Chao Phraya River Basin Flood Forecasting System by the Government of Thailand

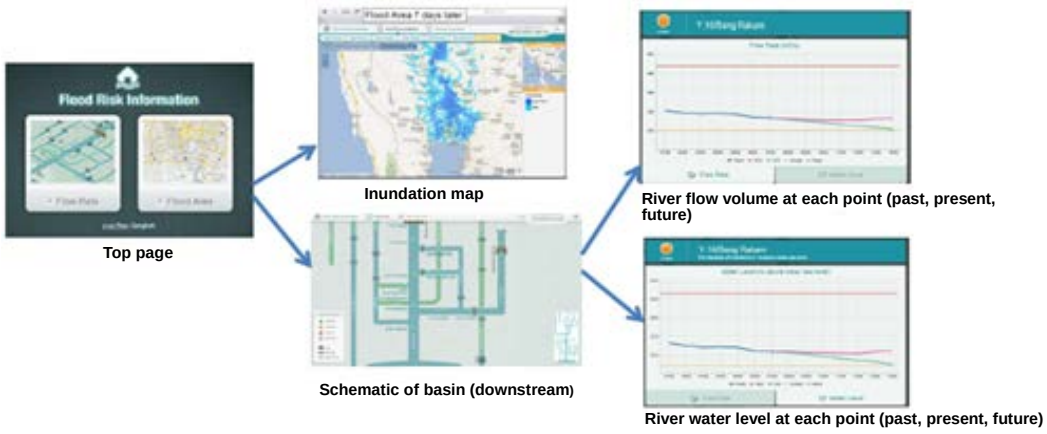
Link: http://floodinfo.rid.go.th/ (The website provides information in both Thai and in English.)

Background:

- ➢ In response to the 2011 Chao Phraya River Flood, the Government of Thailand, with the support of the Government of Japan, developed a flood management system consisting of a simulator for water management for Thai government's internal use and a flood forecasting system for both the government's and public use. The latter started its operation in September 2013[12].
- ➢ The Chao Phraya River Basin Flood Forecasting System was developed with Japan International Cooperation Agency (JICA), the Foundation of River & Basin Integrated Communication, Japan (FRICS) and ICHARM.

Special features:

- ➢ The System's webpage opens with two simple screen images, one, a schematic structure of the river and its flow volume, and the other, a map of the inundated region. The System shows the rise in water levels on the river and the state of inundation.
- ➢ The System displays prediction of future river water level, flow volume, and inundated region. From these information, users can predict when and to what degree a risk of danger increases.
- ➢ Users can also see changes in the above items over the past 7 days. The System shows the state of the direction and speed of the expansion of inundation and its depth, permitting its users to make reference to it for future preparations.



Lesson 4: Arrangements must be made with business partners in advance concerning actions to be taken in response to disasters.

<Explanatory Note>

- According to the interview results, it appears that until the very last minute, many managers agonized over how to fulfill their company's obligations to business partners.
- It is normally not possible to casually halt production because of the relationship with business partners. Therefore, it is necessary to simulate several cases of emergency response in advance. Then, one should discuss with business partners to agree on how to respond to unexpected events.

＜Relevant remarks quoted from the survey responses＞

Challenges (quoted)

✓ In order to fulfil our obligation with major customers who were in operation, we could not make our own decisions of (stopping) our operation.

Other comments (quoted)

✓ Until just before the flooding, our major customers instructed us not to stop supplying components. We, supplier, could not decide our shutdown because it would make our customers' production line halt. When we decided to evacuate, the inundation of the industrial estate/park/zone had already started. As a result, we could not take any action to minimize our damage.

✓ Continuing production in order to fulfil our obligation as a supplier was clearly the first priority.

✓ Because the delivery dates were near, we were caught in a dilemma between continuing our production and evacuating.

✓ We rented and temporarily operated a plant in another industrial estate/park/zone.

✓ We could not respond to the flood, because our customers did not share enough information with us.

Column 4: Cases in Japan to strengthen cooperation on BCP/BCM between companies or between companies and the government

The Great East Japan Earthquake and Tsunami of March 11, 2011, not only caused dreadful loss of lives but also wide-spread economic loss in Japan. The Japan Business Federation (Keidanren) compiled a request to the Japanese Government in February 2014 highlighting the importance of strengthening not only BCP/BCM of individual firms, but also cooperation between companies or between companies and the government. The request was submitted to Keiji Furuya, Minister of State for Disaster Management, Japan on February 18, 2014. The request, which was made out of the results of an interview survey, emphasized the three areas; (1) cooperation between the companies forming supply chains; (2) regional cooperation; and (3) cooperation in each industry. It summarized cases of companies and organizations that were already undertaking advanced activities in these three areas [13]. For reference, some advanced cases are extracted and introduced below.

Advanced cases of cooperation on BCP/BCM in Japan

	Cooperation between companies forming supply chains	Cooperation in a region	Cooperation in each industry
Summary	➢ Redesigning the supply chain and allotment of resources by visualizing information of a company and its partners with the utilization of IT etc. ➢ Clarifying the goals of BCP/BCM and the items to be restored on a priority basis, and sharing these information with business partners ➢ Supporting small and medium-sized companies	➢ Using regional associations to strengthen coordination between companies or with local governments. Forming human networks within the region ➢ Conducting joint training throughout the district, and jointly preparing emergency supplies and in-house electric power generators etc. ➢ Signing agreement on substitute production based on the cooperation between companies ➢ Signing agreements on cooperation between companies or with local governments	➢ **Cooperation** and information sharing between companies in the same industry ➢ Exploring **standardization** of components that are not directly related to competition ➢ **Developing guidelines** concerning BCP/BCM for the industry ➢ Performing **joint training** in the industry
Advanced cases	➢ (IT manufacturer) Utilizes IT to visualize supply chain information, and thoroughly **manages supply and demand of essential components** to prevent occurrence of problems and halve the decision-making period ➢ (Retailer) Clarifies the item-wise inventories in the company and in its supply chain, estimates potential increase of production, and **installs basic fuel supply bases** in its own logistics center. ➢ (Logistics company) Arranges **alternative transport** using trucks or vessels when some areas become impassable during large-scale disasters. ➢ (Automobile manufacturer) **Clarifies important items** to be restored or produced on a priority basis during a disaster. Specifically sets the target number of days required to restart production, and holds meetings with suppliers etc. in order to share these information.	➢ The East Kashima Industrial Complex was quickly restored from the 2011 earthquake and tsunami disaster as it had already built a foundation for **communicating with plant managers**, gained their trust and shared information with them. ➢ In the Daimaruyu district (Ootemachi, Marunouchi and Yurakucho) in Tokyo, a cooperative association consisting of companies and administrators was formed to develop a Regional Disaster Prevention Plan in advance. **Through the cooperation with local governments, joint training was conducted for the people who cannot easily return home at the time of disasters.** ➢ In the Akemi District Industrial Ares in Aichi Prefecture, Japan, **a joint evacuation plan was developed and joint training is conducted.** ➢ Industrial associations in remote parts of Kanagawa and Niigata Prefectures in Japan signed an agreement on substitute production. ➢ A certain retailer signed an agreement with many local governments for collaborating in many fields including disaster prevention measures.	➢ The telecommunications industry explores mutual cooperation regarding **joint use of wireless LAN circuits, etc.** ➢ The petroleum industry developed a system of **joint use of facilities** coordinated with concerned authorities ➢ In the beverage industry, **container standards are unified** so that it is easy to obtain products from alternate suppliers during a disaster ➢ In the non-life insurance industry, based on a manual developed by the industry, a survey of the state of damage in the disaster region was conducted jointly by some companies. ➢ In the banking industry, some members of their industry association have conducted joint training with related authorities.

Lesson 5: Countermeasures to protect machinery and materials in the event of an inundation must be planned in advance.

<Explanatory Note>

- According to the interview results, many answered that moving equipment etc. to the second floor or using sandbags were not effective as abnormally deep inundations occurred in the 2011 flood.
- Through predicting floods as much as possible, decisions need to be made quickly whether to move the equipment to higher floor or whether to move them to another location. These decisions should be implemented at an appropriate time.
- Considering the risk in advance, potential alternative sites should be examined in advance to store materials and to install equipment.
- Submersion of metal dies or loss of data due to submersion of PCs/servers are both particularly fatal. Thus, means of transporting them to another location or means of making back-up data should be secured.
- It is presumed that when inundation occurs, the power fails. It is expected that the power failure will affect the transfer of materials and machinery. Necessary material and equipment such as electric power generators, simple pure fresh water production equipment, and disinfectant chemicals should be secured.

＜Relevant remarks quoted from the survey responses＞

Good points (quoted)

- ✓ Beginning in late September, we checked the water level at the nearby river and canal. Then, we prepared sandbags, an electric power generator, pumps, and so on.
- ✓ Led by Thai security staff, we built a 1.5m-high embankment, piled up sandbags, and sealed the server room in the plant. In the afternoon of October 8, 2011, the power was cut off earlier than the scheduled time of 6 p.m., but we continued these inundation countermeasures using an uninterruptible power supply (UPS).
- ✓ We had already moved finished products and movable equipment to the second floor of the office. Before the disaster, finished products were transferred to each customer with their cooperation. This action secured our supplies to them for about 1 month.

Challenges (quoted)

- ✓ In retrospect, we only reported on the situation, but were unable to take proactive measures. How to secure metal dies and consider substitute production were among them.
- ✓ Because we promptly evacuated the operators, we did not have personnel to evacuate goods. If we had been provided with more accurate information more quickly, we could have responded more properly.
- ✓ In order to respond to the flood immediately before the disaster, we worked hard to prevent inundation of the plant. However, instead of our action of “protecting” or “preventing” the server or PCs, we should have

made greater efforts to take actions for "escaping" them to higher locations even during the limited time.

Other comments (quoted)

- ✓ We piled up sandbags and attached steel plates to the fence beginning 2 or 3 days prior to the inundation. We had moved part of the equipment to the second floor by the day before the inundation. We moved finished products out of the plant.
- ✓ Unable to predict the time and scale of the inundation, we could not move the PC and server.
- ✓ We could not evacuate the metal dies as planned because the power was cut off to the industrial estate/park/zone after we started our own evacuation.
- ✓ Sandbags and embankments were not so effective because, in fact, the inundation occurred faster than expected, and was deeper than 2 m.
- ✓ My company (in Thailand) thought that building an embankment of about 50 cm with sandbags was sufficient. Some in the headquarters regarded it as overestimation. They did not think that the water would surge this way.
- ✓ Inundation of and damage to the server room destroyed all the data related to purchases, accounting, inventories, and employee's wages. The PCs of individuals in the office were almost all destroyed. This situation made our restoration process terribly difficult.

Column 5: Flood plain in the Chao Phraya River Basin and flood countermeasures in industrial estates/parks/zones

- ✓ The Chao Phraya River Basin, has played an important role in the history of Thailand as the center of the country's economics and culture. The upstream region is the location of the ancient capital, Sukhothai, and its downstream region is the location of the old capitals, Ayutthaya and Thonburi and the present capital of Bangkok. The downstream region, where floating rice was cultivated with the support of rainfall and river flooding during the rainy season, has been called one of the world's leading rice growing areas. Local people had the assumption that floods would occur, living in traditional high-floored houses and traveling by boat [14].
- ✓ However, with the rapid growth and development of the Bangkok region starting in the twentieth century, canals that had been used for water transport were filled in and replaced with roads. The former flood plain was rapidly urbanized. According to past topographical maps and geomorphological land classification maps, the areas around the industrial estates/parks/zones in Ayutthaya province and Pathum Thani province that suffered disastrous flooding in 2011, were formerly paddy fields[15]. Each of the industrial estates/parks/zones was enclosed by so-called "circle levees", a flood protection measure. However, many of these were designed hypothesizing floods with a probability of recurring once in between 10 and 50 years, but not for the scale of the massive flood of 2011, which is flooding with a recurrence probability between 50 and 100 years[4]. Since 2011, most industrial estates/parks/zones located on the flood plain have strengthened flood measures, including the circle levees.

Lesson 6: Confirming the safety of employees must be a top priority.

<Explanatory Note>

- According to the interview results, many answered that at the time of the 2011 flood, ensuring safety of employees by having them evacuate the plant quickly was the top priority.
- Many companies took some response measures for their employees when the factory was shut down. These measures included providing special allowances or providing compensation for absence from work.
- Systems of regularly contacting employees (by telephone, SMS, web sites, etc.) needs to be sustained as it is necessary to communicate with them during the shutdown of the plant or for arranging the preparation for resumption of the plant.
- Mental care for the employees should be also considered.

＜Relevant remarks quoted from the survey responses＞

Good points (quoted)

- ✓ Ensuring safety of employees should be the first priority. In particular, it was good that during our response to the flood, no employee was injured.
- ✓ For ensuring safety of employees, the company made them leave the plant in the evening of October 6, immediately before the disaster. The employees were provided a special day-off on October 7.
- ✓ We stopped our operation when the government of Ayutthaya province issued evacuation advisory. The employees were left to decide individually whether to evacuate immediately as they were accustomed to flooding. They were instructed to standby at home during the shutdown.
- ✓ Fortunately, communication channels with all employees were prepared in advance.
- ✓ We built a contact network with key staff, so, we could restart our work immediately after the disaster.
- ✓ Fortunately we had employees evacuate the plant quickly, and jam or confusion was avoided.
- ✓ We managed to evacuate our employees while transportation services were still operating.
- ✓ A good point of our command system was that it included a personal communication network with the employees so that their safety was confirmed.
- ✓ We continued to pay wages (75%) to employees while they were asked to standby at home. We provided consolation payments in October, and paid 70% of our normal year-end bonuses, preventing the loss of skilled employees. We did not dismiss anyone.
- ✓ Our company supported our employees in good faith providing livelihood security and disaster consolation payments.
- ✓ As to human resource management, our response to the disaster was thought to be successful as our employees showed strong company spirit, and few resigned.
- ✓ We prepared a list of our employees' telephone numbers for maintaining contact with them. We secured temporary apartments for our employees who were given tasks of receiving and shipping consignments at our Bangkok office, helping them to continue their work in Bangkok. Because we rented a

temporary plant in another industrial estate/park/zone (outside Ayutthaya), we secured apartments for the employees who had to move from Ayutthaya to continue operations.

- ✓ Thai staff and Japanese staff had already enjoyed good relations before the flood. Thus, in an emergency situation such as this, the Thai staff did all that they possibly could to cooperate with the company, achieving early restoration. As a result of the flood, we immediately eliminated unnecessary tasks, achieving greater efficiency with smaller inventories and shorter delivery periods. Our fear to change these processes disappeared as we decided to improve them. The self-confidence gained through the cooperative restoration created bonds between the employees.
- ✓ Information exchange with local staff helped our company to find solutions to problems one after another.

Challenges (quoted)

- ✓ We must still reflect on the delay in confirming the safety of the employees.
- ✓ A serious problem during the inundation was the change in the employees' living environment and problems of providing mental care to them.

Other comments (quoted)

- ✓ Production was stopped, but we called all the employees to the office and paid them 100% of their wages except November (2011).
- ✓ The government subsidized 70% of the wages of our employees, but they mistakenly thought that they would receive normal wages from the company in addition to the allowance from the government.
- ✓ Bonuses of our company fell more sharply than of other companies, so we lost skilled employees.

Column 6: Inundation depth of the flood and its impact —Example of threshold values used in Japan—

The Flood Damage Index Analysis Handbook (trial edition, 2013)[16] published by the Ministry of Land, Infrastructure, Transport and Tourism, Japan presents the following summary of possible impacts of inundation on evacuation or electric power supply at and above a certain water depth. These indices are based on Japan's past flood damage analysis, and cannot necessarily be applied in other countries. However, they may provide a useful reference.

Relationship between inundation depth and impact on evacuation or power supply

30 cm: Water level beyond which automobiles (including ambulances) cannot travel easily and people requiring assistance during a disaster cannot be evacuated easily.

50 cm: It is difficult to move on foot.

60 cm: JAF's tests have shown that sedans and SUV cannot travel easily.

70 cm: Power fails as power outlets are submerged. (70cm = floor height of 50cm + outlet height of 20cm above floor). If fixed modular jacks of communication devices are at the same height as electric power outlets, communication function also fails.

Electric outlet and modular jack with slots 20cm from floor

Lesson 7: In order to absolutely minimize the effects on business partners, restoration work must be carried out promptly.

<Explanatory Note>

- A prior consent of the business partners could make preparations for alternate production prompt and easier.
- Some companies also benefited from their experience of the Great East Japan Earthquake and Tsunami.
- The 2011 flood cut off the power in many districts. It was found important to obtain electric power generators in advance.
- During the 2011 flood, some companies could not promptly remove submerged machinery because they had to wait insurance assessments.
- Some companies immediately ordered materials and equipment to replace submerged ones without waiting for drainage or confirming the damage. They aimed for early resumption of production.

＜Relevant remarks quoted from the survey responses＞

Good points (quoted)

- ✓ All production machinery and equipment on the first floor were submerged. Some metal dies were retrieved from the water by divers. Based on our experience of the March 11, 2011 Earthquake and Tsunami in Japan, we predicted what action to take. We responded promptly.
- ✓ We were able to restart our work promptly because we quickly prepared for alternate production, ordered machinery, and purchased generators before draining of the water or confirming the damage. Our restoration efforts were supported by our parent company.
- ✓ We restarted operation on February 1, 2012. The resumption was possible because we immediately arranged to order equipment to replace the damaged ones, and because of the participation by all employees in the restoration action plan and its solid implementation.
- ✓ We had factory servers evacuated promptly to Bangkok, which permitted us to continue our operation. Before the flood, we completed processing all effluents from our plating plat, preventing leakage of hazardous fluids in the surroundings.
- ✓ Production of some products restarted in a temporarily rented plant on November 1, 3 weeks after the disaster. On the other hand, operation in the damaged plant restarted 3 months after the disaster.
- ✓ We restored our work promptly by renting our business partner’s plant.
- ✓ Thanks to flexible ways of thinking of our Thai staff and contractors, we were able to receive new goods in the shortest possible time.

Challenges (quoted)

- ✓ Removal of damaged deposited goods was a problem. We could not discard them until insurance

procedures were completed.

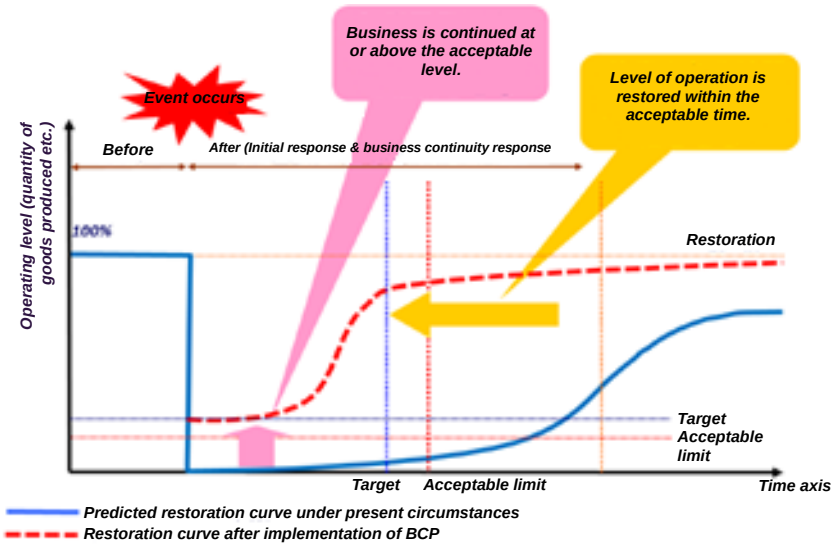
- ✓ Many problems obstructed restarting operation. They included restoring infrastructure and making adjustments with business partners.
- ✓ Resumption of operation was delayed until 7 months after the inundation. Placing the order of equipment was delayed because it took long time to decide the resumption in Japan. For the resumption, securing employees was another problem.

Other comments (quoted)

- ✓ Restoration of the plants of business partners was delayed.
- ✓ Large equipment on the first floor was submerged. We could not save it, because it was too large to move.
- ✓ A serious problem was the fact that the plant was completely inundated, submerging all the molding machines and metal dies. We quickly placed the order of new molding machines and the metal dies to their manufacturers.
- ✓ A problem with restarting operation was the delay in insurance assessment. In the case of new products, we thought all we need would be to replace some of their parts.
- ✓ Our production level has not yet returned to the pre-disaster level. The possible causes are: (1) multi-sourcing of purchases by some customers to control risks, (2) other customers shifted their order to our competitors during the disaster, (3) a decline in the actual demand, and so on.
- ✓ Problems in the delay in the resumption included insufficient time for trial operation and repeated malfunction of repaired products.
- ✓ A problem in restarting operation was that the operators had to live far from Ayutthaya and wanted to return there. As our pre-flood production facility was located in Ayutthaya, the company had to support local operators to find apartments at the new location of production. The process of settling them in the new place was time-consuming and incurred extra cost.
- ✓ The devices for electric power reception and other basic infrastructure were damaged, which cut off the factory's other life-lines. (Response: Thanks to flexible ways of thinking by the Thai staff and contractors, we were able to receive new goods in the shortest possible time.)

Column 7: Concept of the Target Restoration Time/Target Restoration Level

In the case where business of an organization is stopped by the sudden occurrence of unexpected events such as natural disasters, accidents, terrorism or insurrection, and supply chain disruption, the organization must decide which level of restoration to aim for and by which date. The following figure shows the time after the disaster on the horizontal axis and the operating level (quantity of goods produced, for example) on the vertical axis. The figure hypothesizes a case where an unexpected event such as a natural disaster has occurred, and compares two cases: the restoration curve (blue line) in a case without BCP and the restoration curve (red-dotted line) in the case where a BCP was implemented and restoration to the target level was achieved in the shortest possible time. There are some cases reported after the 2011 Chao Phraya River flood in Thailand where early ordering of submerged production equipment and securing employees facilitated the early recovery[8].



Lesson 8: In an emergency, it is vital to strengthen the command system and to establish an information sharing system.

<Explanatory Note>

- According to the interview results, many answered that during the 2011 flood that their command system functioned well, but others answered that it did not function well. Such differences in their responses existed among the companies.
- In order to allow decisions to be made on site top down for a rapid response during an emergency, it is necessary to establish a system that allows transfer of authority to the field to a certain degree.
- It is also important to establish a single point of contact at the Thai side to prevent confusion, and omission of information. The contact point can also facilitate regular sharing of information with Japanese head office.

＜Relevant remarks quoted from the survey responses＞

Good points (quoted)

- ✓ Emergency response offices were established in Japan and in Thailand respectively within our company by our staff. A single point of contact was established at each side, which facilitated the Thai side to concentrate on their recovery work. We made a rule of requesting the Thai side to send a daily report to the headquarters (in Japan) by a predetermined time each day, which facilitated the provision of reliable and timely information.
- ✓ Company executives, Japanese staff in Thailand, and Thai Staff each fully understood their respective roles. They were able to act independently to respond to the emergency. In particular, giving the Thai managers a certain degree of decision-making authority on the front line helped them to speed up their response.
- ✓ We successfully shared information with our head office (in Japan). We asked our head office to establish a single point of contact. They did so by limiting exchanges of information with a specific staff. This action prevented confusion over the information.
- ✓ Remaining in a temporary office with local staff, we managed to collect information and unify information and actions.
- ✓ Japanese staff formerly posted to Thailand came to the country to help, which increased motivation of the employees.

Challenges (quoted)

- ✓ We cannot say that our command system was satisfactory. We must utilize local staff a little more.
- ✓ Restoration-related information and materials were concentrated in Bangkok, and we now realize that we should have assigned personnel to Bangkok to manage these.

Other comments (quoted)

✓ Beginning on October 4, our executives held response meetings every day. Basically all decisions were made in-house (in Thailand), and the situation was reported to the head office every day.

Column 8: Torahiko Terada, "the further civilization progresses, the more severe is the damage caused by the violence of nature"

(The following is excerpted from ICHARM Director Takeuchi Kuniyoshi's introductory text in ICHARM Newsletter No. 29[17])

A huge typhoon, Muroto, hit the Kinki region of Japan on September 21, 1934. Two months later, Torahiko Terada, a well-known Japanese physicist and essayist, published a short essay titled "Disasters and National Defense" in the Keizai Orai magazine. Reading this, I am amazed that his article covered almost all important concepts and perspectives in today's disaster management. Here I would like to share some of his thoughts with you.

A natural disaster strikes when people lose their memory of the previous one. This is a common saying that many believe was coined by Torahiko. He writes "… the basic cause of these misfortunes is that people … had forgotten about the possibility of such violent storms."

Torahiko wrote "The further civilization progresses, the more severe is the damage caused by the violence of nature." The reason for this is that in society, which evolved complexly to obtain "biological integration", "damage to one part might deal a fatal blow to the entire system." "When single-celled animals are cut into two, each part can continue to live on its own without any problems," but the "higher animals … can be killed if merely pierced in a certain way by a thorn." The "nerves and blood vessels," which underpin the biological integration of the higher animals, "are carefully protected by ingenious mechanisms," but a society's power lines and pipes ⋯ are exposed to the elements." In this way, "increasingly severe disasters are unavoidable", he concludes. (…)

He says that natural hazards are enemies that "issue no ultimatums before their surprise attacks," and the country needs to prepare science-based national defense equipped with observational networks. He concludes the essay stressing the importance of "long-lasting cooperation among all of our people to establish appropriate, science-based measures against the natural enemies."

Elementary school in Osaka damaged by the Muroto Typhoon (1934)[18]

Lesson 9: We must be aware that social progress is accompanied by the transformation of disasters, and not be bound by past convention.

<Explanatory Note>

- As the Chao Phraya River Basin is flood prone, local employees are accustomed to floods.
- On the other hand, believing that the industrial estates/parks/zones were protected and that they would not be flooded, the local employees underestimated the 2011 flood.
- After the 2011 flood, the levees, water barriers, etc. were enforced. However, these structures cannot completely control the flood water. Because future changes of natural and social factors can transform the environment, there is no guarantee that a disaster severer than that of 2011 will not occur.
- It is essential to constantly reinforce disaster protection measures, while carefully observing changes in the region, without being bound by precedents.

＜Relevant remarks quoted from the survey responses＞

Other comments (quoted)

- ✓ In the Ayutthaya region, either large or small flooding occurs almost every year. Local residents frequently suffer direct damage to their homes due to inundation. The flood water also blocks their commuting routes, which prevents them from going to work. Though our factory site had not been flooded before, it was flooded this time as this flood was unexpectedly large.
- ✓ We were told that the area around the industrial estate/park/zone was also flooded in 1995, but the inside of the industrial estate/park/zone was not flooded at that time. We assumed that sandbags protected the area that time.
- ✓ In Thailand, unlike in Japan, the flood water level increases gradually. So, local people normally do not regard the flood as a threat to human life. They do not think of evacuation.
- ✓ The houses of some Thai employees were flooded. However, they did not consider these incidents as unusual in Thailand.
- ✓ In order to alert our employees, we marked the highest water level inside the plant in the 2011 flood.

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Lessons Learned from the Flood Disaster in Industrial Estates/Parks/Zones in Thailand

— Based on the experience of the 2011 flood —

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