

***Critical Facility Experiences and the Lesson Learnt From 2011 Flood Disaster in
Ayutthaya Province, Thailand***

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Abstract

In disaster management, critical facility plays a vital role in providing services and functions essential to community for minimizing damages and losses from disaster. Critical facilities include government offices, schools, hospital and place of worship. These facilities should be given special consideration when formulating disaster management plan. This research aims to determine critical facility damages and recovery from 2011 flood experiences in Bang Pa-in district, Ayutthaya, and identify the gaps for facilities in developing potential supports to flood prone communities. Narrative analysis was applied to semi-structured interviews conducted with key personnel from 34 critical facilities. The flood caused damages to public facility, assets, and impact on environmental health and food security. Recovery and reconstruction ranged from one week to six months. Facilities indicated that teamwork, cooperation and support from stakeholders led to prompt recovery. However, recovery was delayed due to budget, equipment and personnel limitations. Most facilities respond effectively and communicate with staff during flood. Nevertheless, many facilities should apply measures and communicate instruction to victims more beneficially. Moreover, flood-related data were not available for most of the facilities. Therefore, they need more accurate information on water level, weather forecast, warnings, shelter locations and key assisting persons. This research highlights the demand from facilities which concern immediate response, authoritative data, and effective communication and monitoring system. Strategies to improve the capability of critical facilities were discussed. Findings underscore flood experiences, responses, and reflections from critical facility that contribute to developing effective guideline for disaster management plan in flood prone community.

Keywords: Critical Facility, Disaster Management Plan, Flood Experiences, Narrative Analysis

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Introduction

In 2011, Thailand experienced the worst flood in over half a century. The excessive heavy rain and tropical storms led to severe flooding. The water made its way from the north downstream to the central plain in Chao Phraya River basin. The total damage and loss from the flood amounted THB 1.43 trillion (approximately USD 46.5 billion) affected 12.8 million people caused 728 deaths (World Bank, 2012). The flood caused tremendous damage and loss of lives and properties across 66 provinces in Thailand. One of that was Ayutthaya province in the central part of Thailand where many of industrial parks were based. The flood were two to three meters high for over extended period, from three weeks to three months. Consequently, the industrial areas were flooded and the business were interrupted. Not only business operations were affected, but also livelihoods have disrupted in both urban and rural areas. Poor and marginalized households were affected. Wages have been lost due to the flood and large proportion occurred within vulnerable population (GWP, 2017).

In flood disaster management, Critical Facility (CF) plays a vital role in providing functions and supports essential to community. The key elements for resilience of CF should not be limited to the location and structural factor. It is necessary to also address CF in relation to organizational coping strategy, data management and communication in all time period, before, during and after the disaster.

Most of the previous literatures on CF provided the structure design guidance, training manual, and toolkits for disaster management (for instance, Bach *et al.*, 2013; ADPC, 2015). Some studies have evaluated resilience status of critical infrastructure in South Asia (Mukherjee *et al.*, 2023) and some investigated public expectations of critical infrastructure in time of crisis (Petersen *et al.*, 2018). One study also reviewed on the relationship between critical infrastructure and climate change (Huddleston *et al.*, 2022). They were explored to understand the need to adapt critical infrastructure to climate change so that communities are not left without fundamental supplies and services. Previous research also analyzed the integration of critical infrastructure components to the flood risk management concepts (Fekete, 2019). The impact of disaster on critical facility have been explored in several studies, including an investigation of natural hazard impacts of CF (Krausmann *et al.*, 2019) and particular research on flood disaster impact (Oh *et al.*, 2010; Yusoff *et al.*, 2017; Gangwal *et al.*, 2022).

However, there have not been many studies that investigate experience of CF in flood disaster. It is important that the national and local authorities understand CF preparation and response experiences in the past and identify potential flood coping strategy and challenges in order to strengthen the CF roles to minimize damage and protect the community in disaster events more effectively. As such, this research aims to determine CF damage and recovery period from the 2011 flood in Ayutthaya and identify the gaps from CF experiences.

This study explored the 2011 flood experience from the CF interviews. The damage were determined and recovery period were revealed. Then the flood preparation and response for the facility and staff were examined. The descriptions of measure to support the victims were followed. Finally, the study identified the information accessibility and key considerations from coping experience. Finally, the strategy for developing a more effective coping strategy and resilient recovery were discussed.

Study Area and Methodology

The area of study covered two kilometers catchment areas of Bang Pa-in industrial estate which is located in Bang Pa-in district, Ayutthaya province. Totally ten sub-districts are incorporated in this study, including Klong Chik, Ban Len, Ban Phlap, Ko Koet, Bang Krasan, Chiang Rak Noi, Wat Yom, Ban Pho, Ban Wa, and Ban Pang sub-districts.

Semi-structured interviews were employed to one key personnel from each of the 34 CF in the area. Narrative analysis were applied to identify damage, coping strategies and disaster management gaps. The study was conducted from February to March 2021. Due to COVID-19 pandemic at that time, most CF interviews were done by mail, phone and Line application, whereas personal interviews were done by few CF. The interviews composed of questions relating to flood damage, recovery period, coping strategies in 2011 flood, supporting strategies to victims, CF information access and suggestions to develop effective disaster management plan.

Thirty-four CF interviewed in this study were the government offices, schools, hospitals and place of worship, shown in Table 1. Only three CF are established as formal community evacuation centers. Others were assigned to provide assistances and support the victims in case of disaster.

Table 1: Critical facility included in this study

Critical facility type	Number of facility
Government office	11
Temple	9
School	9
Hospital	3
Mosque	1
Police station	1
Total	34

The key personnel from 34 CF consists of 63% male and 37% female with the average of 21.6 working years at the CF. Damage, recovery period, coping strategies, information access and key suggestions were revealed from the interview.

Damage and Recovery

The damage from 2011 flood in Ayutthaya were classified into four aspects, including assets, public facility, environmental health, food and water. The flood damage and its components are detailed in Table 2.

Table 2: Flood damage

Damages from 2011 flood	
Assets	Natural assets Farmlands, trees, crops
	Physical assets Houses, building, wooden floors, walls, fence, gate, garage, electronic home appliance, school supplies, books, hard document
Public facility	Highway, roads, drainage system, public areas, medical equipment, drug delivery
Food and water	Food and water supply
Environmental health	Waste, hygiene and sanitation, unpleasant odor

The recovery and reconstruction revealed the period of time that individuals or organization were able to restore to pre-flood condition and resume their normal activities. The flood recovery period was reported in two levels, individual victim recovery period and organizational recovery period, respectively. Out of the total 34 CF, 16 CF (47%) indicated 100% individual recovery period with a range of two weeks up to six months. Many CF were not assigned to be shelters during the flood so the recovery data were not available. In several organization, the plans to monitor the victim resettlement period do not exist. For organization themselves, 32 CF (94%) reported 100% recovered with one week up to six months.

It was noted that the period of recovery varied across CF. On the one hand, the prompt recovery was driven by strong teamwork, cooperation among agency and support from both organization and employees. On the other hand, long resettlement period was due to budget, equipment and personnel limitations.

Coping Strategy in 2011 Flood

In coping strategy as a holistic approach, this study explored two dimensions, flood response and provision of advice to staff. For flood response and decision making, most CF reported their responses in pre-flood, during the flood and post flood period, 76%, 88%, and 74% of CF respectively. Responses are summarized for each period, shown in Table 3.

Table 3: Flood preparedness and response in each stage

Pre-flood	During flood	Post-flood
<ul style="list-style-type: none"> • Preparation for the flood • Keep update the information on flood situation • Coordination with organization and assign duties to officers 	<ul style="list-style-type: none"> • Establish a control center for assistance, staff teams, and assisting equipment • Provide health services, food and vehicles • Closely monitor water level • Move necessary belongings to the higher places 	<ul style="list-style-type: none"> • Cleanup the area • Survey, assess the damage and report government agency • Develop emergency action plans

In pre-flood period, CF prepared venue and supplies including storage location for belongings, shelters, restrooms, food and sandbags. In addition, they kept up-to-date with weather news and information from the local government in order to announce the flood situation through various media. Also, they coordinated with stakeholders and assigned duties to officers to provide support in case of emergency.

During flood disaster, the organizations were functioned as control center to support flood victims, prepare necessary supplies, such as water pump and sandbag barriers. They also coordinated with agencies to prepare food and drinking water, organize staff to be ready for help, to monitor flood situation and water level closely and continuously, to provide assistance in healthcare services, vehicles and food. Moreover, they assisted in moving belongings and supplies to safe places.

After the flood, CF cleaned the area before restoration to normal condition. They conducted the survey to identify damage in the area and repaired them, assessed the damage and report the local government. Also, they healed victims' mental health and implemented health check-up services to diagnose emerging symptoms or diseases after the flood. Finally, they propose action plan in flood prevention to cope with disaster in the future.

In the dimension of advice provision to CF staff during the flood, approximately 68% of CF reported their guidance to staff. CF offered guidance to staff in various aspects including advice in supporting others and guidance for their own safety. CF staffs were guided to monitor water level, report situation to local government and visit the flooded area. In addition, advice was given on survival bags preparation, move of belongings to higher places, and steps to proceed to evacuation center. Staffs were also emphasized to take good self-care and be cautious when applying equipment during the flood, e.g. water pump.

Supporting Flood Victims

In supporting the flood victims, two main strategies consist of overall supporting procedures and specific instructions to victims. For overall supports, less than one-fourth of CF had measures to support the victims in the pre-flood, during the flood and post-flood period, 24%, 24% and 4%, respectively. The key measures are provision of medical services, food and supplies in all stages, and other supports as listed in Table 4.

Table 4: Supporting measures and strategy

Pre-flood	During flood	Post-flood
<ul style="list-style-type: none"> • Identify vulnerable groups and coordinate with agency • Clean up the area • Prepare food, equipment and medical services • Assign key personnel for emergency services 	<ul style="list-style-type: none"> • Provide shelters and medical services • Prepare food • Assist the most vulnerable group as the first priority 	<ul style="list-style-type: none"> • Provide medical services • Assess the damage in affected household

In providing specific instruction to victims, one-third of CF stated their provisions in pre-flood and during the flood, 35% and 38%, respectively. The process in providing instruction to victims are detailed in Table 5.

Table 5: Instructions for communication with the victims

Pre-flood	During flood
<ul style="list-style-type: none"> • Inform community and warn people in advance to be prepared, not to be panic • Inform village headman in advance to provide this place as a shelter • Notify the community when the flood comes • Collect water level data and monitor the news closely • Prepare to cope with situation carefully and spare food, drinks, medicines and other essential items 	<ul style="list-style-type: none"> • Introduce location of evacuation center and inform that there will be staff support available 24 hours • In case of flood, evacuate to evacuation sites for safety and to get assistance • Ready to help victims, distribute food and drinks, and support one another • Advise people to take self-care and stay healthy, be aware of accident and disease • Move belongings to the higher places and monitor water level • Survey locations of victims and investigate property damage

Information Access

The study interviewed three dimensions of information access in the 2011 flood, including flood data management, identification of damage during the flood, and information needed. Results showed that approximately 41% of CF already had flood data management system

available in pre-flood period. Similarly, 47% of CF had the data system available during the flood. The details of data types and sources are shown in Table 6.

Table 6: Flood-related data collection and management

Pre-flood	During flood
<ul style="list-style-type: none"> • Data from flood control center, government agency, departments, top management level • Physical data, photo, household data • Check water level and house condition on site • Media, e.g. television, broadcast tower 	<ul style="list-style-type: none"> • News from provincial office • Field survey, photos • Household data, victim profiles, vulnerable group profiles • Assess damage and progressive damage • Assess flood data

By knowing the real-time damage during the flood would encourage the flood preparedness and prevent from further damage and losses. Seventy percent of CF indicated knowing the damage during the flood. Local government, community leader, members and victims are the main sources of news. Damage information was identified through on-site visit and photo visualization as well as news and broadcast media.

Moreover, this study identified the most important information that CF needed based on their experience in all periods of disaster events, before, during and after the flood. The important information needed in pre-flood, during and post-flood periods were provided by 82%, 79% and 74% of CF, respectively. Table 7 illustrated the variation of necessary information revealed from the CF in each period. As expected, real-time water situation was necessary for all flood periods.

Table 7: List of the important data revealed by CF

Important information	Pre-flood	During flood	Post-flood
• Real-time and reliable water (flood) level, direction, situation in the area and its surroundings	✓	✓	✓
• Weather, water, flood forecast and flood risks areas	✓	✓	
• Warnings, instructions, communication on flooding	✓	✓	
• Water drainage system	✓		
• Staff and equipment	✓		
• Real-time photo of water flow		✓	
• Location of evacuation center, shelter, food supplies, where to get assistance		✓	
• Distribution spot for food and drink		✓	
• Disaster prevention and mitigation guidelines		✓	
• Victim profiles and damaged areas			✓
• Remediation for victims			✓
• Ways to connect for assistance center and the key persons			✓

Key Considerations From the 2011 Flood Experience

CF personnel reflected some key points for consideration in developing a more effective coping strategy as summarized below.

- Assign lead responsibility to specific department and organization to provide timely response to disaster events for effective assistances to community
- Timely and reliable forecast and warnings, such as flood situation, rainfalls, water level

- Local authority providing food supply to victims, including vulnerable households
- Establish effective monitoring and forecast system
- Communication on flood situation to the public, such as real-time flood situation
- Support from other emergency responders on financial resources and public facility, such as building dams along the riverbank and waterway
- Clearance of physical obstruction along the drains or waterway and monitor local condition for drains

Strategy for Resilient Recovery

The key reflections from CF were classified into three components in developing the resilient recovery strategy. Firstly, the people-related components, organization should assign specific department to be team leader for preparing in pre-flood period and taking actions during the flood. In addition, the local authorities should ensure the provision of rapid response to vulnerable and marginalized household, including children, older adults, people with illness and people with disabilities both in urban and rural settings.

Secondly, the essential physical components should be monitored and supported. For instance, maintenance of protecting structure along the riverbanks and waterways, management of food and water supplies to households that were affected, including the vulnerable groups, removal of any physical obstructions of drainage system or waterway. Moreover, some potential recovery assistance to agricultural and business sectors would benefit clean up restoration process and infrastructure repairment. These assistances would therefore facilitate their rapid restoration. Further, reviewing the land-use planning as a holistic approach would be an opportunity to reduce the vulnerability in the long-run.

Finally, the system components involved accurate and reliable data sources, clear warning message and communication on flood risk to spread awareness in the community. The hazard mapping along with the training should be available to the public to enhance understanding on disaster risks. Additionally, hazard mapping with the application of real-time data would support an effective early warning system. Importantly, dissemination of information and communication channels are the tools to help people understand the situation.

Conclusion

CF in the community play a key role in prevention of any further damage and loss in disaster events. Findings in this study examined flood damage and factors related to recovery and reconstruction. Teamwork, coordination and support of other emergency responders led to rapid restoration. These are the driving factors in promoting quick flood resilience in each area and community as a whole. However, recovery in some places delayed due to equipment, personnel and financial limitations. In coping with flood situation, only a few CF that prepared measures to support communities and provided specific instructions to staff in advance to support the victims. The systematic plan and implementation on preparedness and instruction process would minimize potential losses. This would sustain the function of CF operations and, therefore, would further secure people' livelihood and well-beings.

Additionally, the lesson learnt from CF highlights that sharing necessary information, particularly the real-time water level, and facilitating immediate access to them would allow stakeholders and population of all groups to be prepared and cope with the situation more efficiently. Lastly, in area-based disaster management, human resources, physical assets and

data communication system are the three main components and should be revised continuously and integrated into the existing disaster management procedures.

For further implication to develop coping strategy of CF in other areas, the existing strategy and coping capacity of CF in different communities should be explored. Therefore, it is necessary for the national and local government to understand the procedure of CF as well as their strategy and capacity, including knowledge and information system, and realize certain demand to develop the CF to serve as the key assistance and support in flood-prone communities.

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References

- Asian Disaster Preparedness Center (ADPC). (2015). *Guidance on Critical Facilities*. Disaster Recovery Toolkit, Tsunami Global Lessons Learned Project. www.adpc.net/tgllp/drt
- Bach, C., Gupta, A.K., Nair, S.S. & Birkmann, J. (2013). *Training Module: Critical Infrastructures and Disaster Risk Reduction*, National Institute of Disaster Management and Deutsche Gesellschaft for Internationale Zusammenarbeit GmbH (GIZ), New Delhi, 72p.
- Fekete, A. (2019). Critical infrastructure and flood resilience: Cascading effects beyond water. *WIREs Water*, 6, 5.
- Gangwal, U., Siders, A.R., Horney, J., Michael, H.A. & Dong, S. (2022). Critical facility accessibility and road critically assessment considering flood-induced partial failure. *Sustainable and Resilient Infrastructure*, 8, 337-355.
- Global Water Partnership. (2017). *The 2011 Thailand Floods in the Lower Chao Phraya River Basin in Bangkok Metropolis*. Global Water Partnership (GWP).
- Huddleston, P., Smith, T., White, I. & Elrick-Barr, C. (2022). Adapting critical infrastructure to climate change: A scoping review. *Environmental Science and Policy*, 135, 67-76.
- Krausmann, E., Girgin, S. & Necci, A. (2019). Natural hazard impacts on industry and critical infrastructure: Natech risk drivers and risk management performance indicators. *International Journal of Disaster Risk Reduction*, 40.
- Mukherjee, M., Abhinay, K., Rahman, M.M., Yangdhen, S., Sen, S., Adhikari, B.R., Nianthi, R., Sachdev, S. & Shae, R. (2023). Extent and evaluation of critical infrastructure, the status of resilience and its future dimensions in South Asia. *Progress in Disaster Science*, 17.
- Oh, E.H., Deshmukh, A. & Hastak, M. (2010). Disaster impact analysis based on inter-relationship of critical infrastructure and associated industries: A winter flood disaster event. *International Journal of Disaster Resilience in the Built Environment*, 1, 1, 25-49.
- Petersen, L., Fallon, L., Reilly, P. & Serafinelli, E. (2018). Public expectations of critical infrastructure operators in times of crisis. *Sustainable and Resilient Infrastructure*, 5, 62-77.
- World Bank. (2012). *Thai Flood 2011: Rapid Assessment for Resilient Recovery and Reconstruction Planning*. Bangkok: The World Bank.
- Yusoff, N.A., Shafii, H., & Omar, R. (2017). The impact of floods in hospital and mitigation measures: A literature review. *IOP Conf. Series: Materials Science and Engineering*, 271.

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