International Program on Resilient Society Development

Under Changing Climate (RSDC)

2112681 Engineering for Water Disaster Mitigation

Thailand's Floods 2011

Prepared by

Mr. Nantawoot Inseeyong

6070231821

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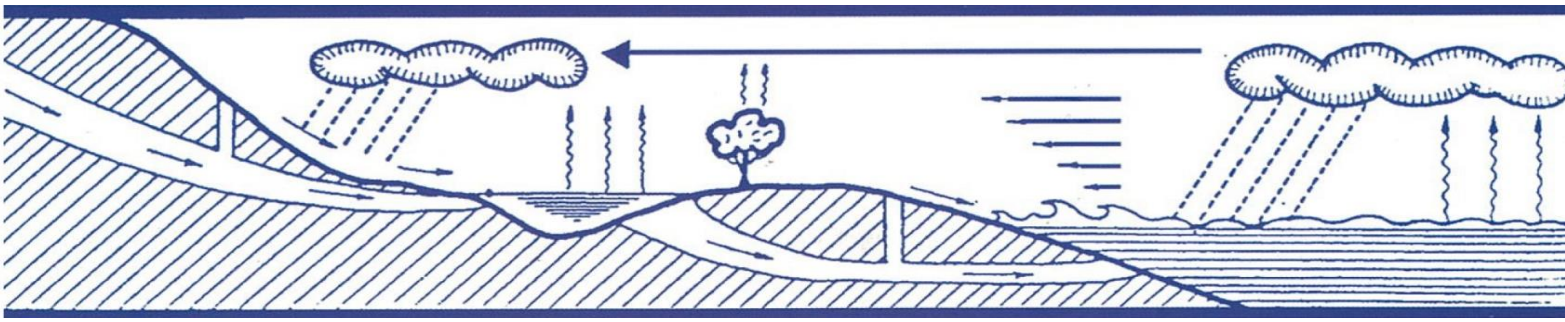
Chulalongkorn University, Thailand



Contents

List of figures

Figures **Page**

List of tables

Tables **Page**

Chapter 1

Introduction

A disaster is a serious disruption, occurring over a relatively short time, of the functioning of a community or a society involving widespread human, material, economic or environmental loss and impacts, which exceeds the ability of the affected community or society to cope using its own resources.

In contemporary academia, disasters are seen as the consequence of inappropriately managed risk. These risks are the product of a combination of both hazards and vulnerability. Hazards that strike in areas with low vulnerability will never become disasters, as in the case of uninhabited regions.

Disaster risk is defined as “the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, and capacity”. In the technical sense, it is defined through the combination of three terms: hazard, exposure and vulnerability.

Figure 1-1 Element of disaster risk

Hazard is defined as “a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation”. Hazards may be single, sequential or combined in their origin and effects. Each hazard is characterized by its "location, intensity or magnitude, frequency, and probability". Exposure is defined as “the situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas”. As

stated in the UNISDR glossary, “measures of exposure can include the number of people or types of assets in an area. Vulnerability is defined as “the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards”.

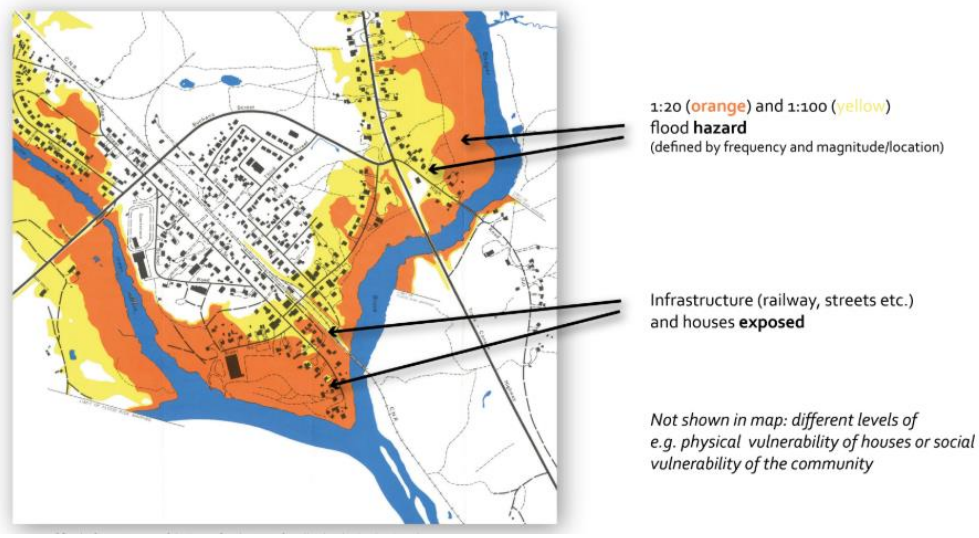


Figure 1-2 Definitions of disaster risk’s element

Disaster Risk Management is the application of disaster risk reduction policies and strategies, to prevent new disaster risks, reduce existing disaster risks, and manage residual risks, contributing to the strengthening of resilience and reduction of losses. Disaster risk management actions can be categorized into; prospective disaster risk management, corrective disaster risk management and compensatory disaster risk management.

This report will be about the Flood Risk Management in Thailand by use the floods in 2011 as a case study. Moreover, the additions of flood risk management from working with DDPM and knowledge from RSDC program are combined in this report as well.

Chapter 2

Meteorological Background

This chapter will be had details about the sources of precipitation that will lead to be the main cause of floods disaster in Thailand. The among of precipitations in Thailand will come from 2 sources consist of Monsoon and Tropical storms.

2.1 Monsoon

According to the Thai Meteorological Department (TMD), the country's climate endures three separate seasons: Rainy, Winter and Summer. The various regions of Thailand are typically prone to seasonal flash floods and river flooding even though dams, irrigation canals and flood detention basins have been built in recent years to mitigate flood damage.

The Rainy Season typically occurs between mid-May and mid-October. During this time, the Southwest Monsoon pattern prevails over central and northern sections of the country with the peak levels of precipitation normally received in August and September. The monsoon is supported by a stream of very warm, moist air approaching Thailand from the Indian Ocean. It should be noted that along the West Coast of Thailand's southern region, tremendous rainfall occurs on the windward side of the local mountainous terrain. Moreover, the arrival of tropical cyclones also provided enhanced moisture to create the precipitation in central part of Thailand.

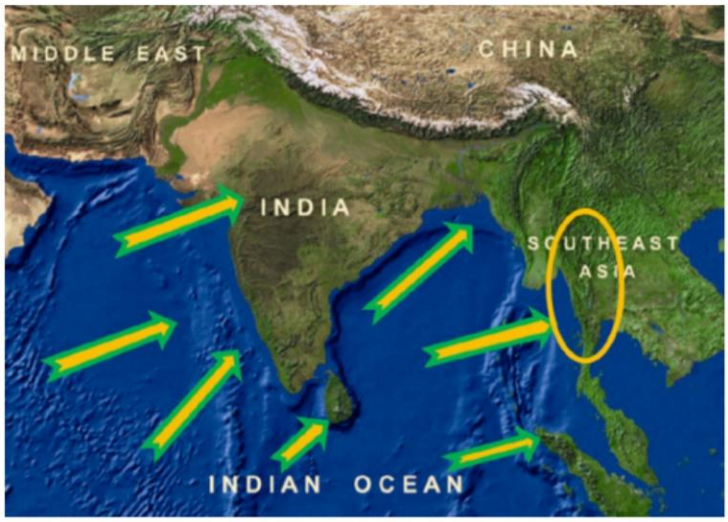


Figure 2-1 Southwest Monsoon and Wind Direction

The Winter Season typically occurs between mid-October and mid-February. During this time, the Northeast Monsoon pattern brings cool and dry air across northern and northeastern sections of the country due to the positioning of a strong ridge of high pressure over China's mainland. While this pattern brings dry and cool to the north, it also signals the start of a mild and rainy season for southern sections of the country—particularly along the east coast.

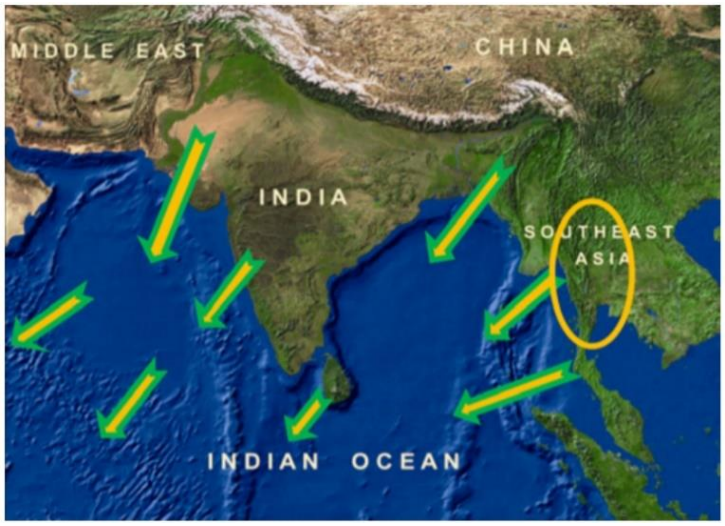


Figure 2-2 Northeast Monsoon and Wind Direction

The Summer Season typically occurs between mid-February and mid-May. This time is marked as a transitional period from the Northeast Monsoon to the Southwest Monsoon. Climatology suggests that the weather will become warmer, with April normally the hottest month in Thailand.

2.2 Tropical storms

A tropical cyclone is a rapidly rotating storm system characterized by a low-pressure center, a closed low-level atmospheric circulation, strong winds, and a spiral arrangement of thunderstorms that produce heavy rain. Depending on its location and strength, a tropical cyclone is referred to by different names, including hurricane, typhoon, tropical storm, cyclonic storm, tropical depression, and simply cyclone. A hurricane is a tropical cyclone that occurs in the Atlantic Ocean and northeastern Pacific Ocean, and a typhoon occurs in the northwestern Pacific Ocean.

In Thailand, Storm will be created in the Philippine sea or the South China sea, then flow to the west direction which have a chance to pass through Thailand. From historical data, Thailand faced with a lot of tropical storm as in figure 2-3

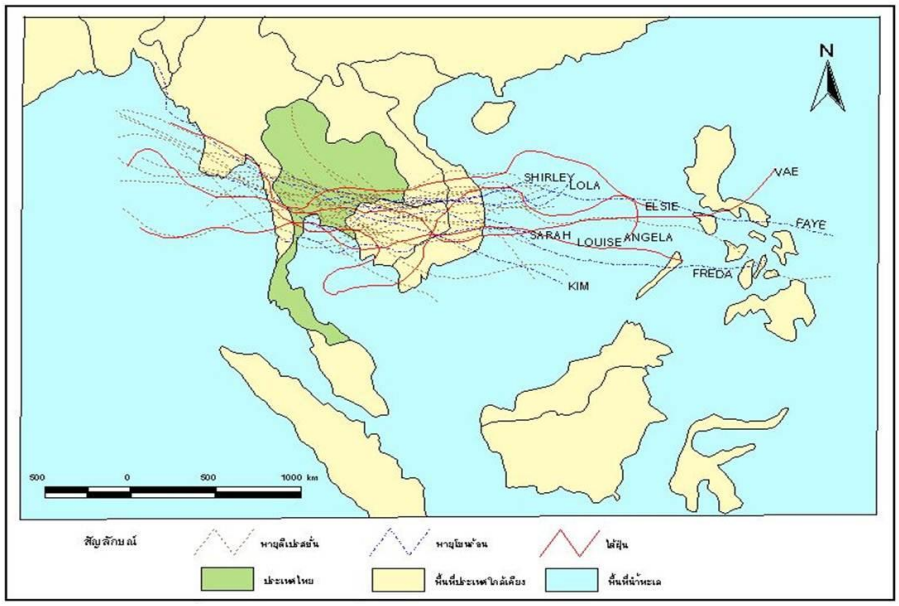


Figure 2-3 Storm route in Thailand

As mention previously, the climate of Thailand is monsoonal, with 80% of the normal annual rainfall occurring between May and October from the Southwest Monsoon. During the wettest months of August and September rivers carry high runoffs and can overflow, leading to flooding. In extreme rainfall years the flooding may spread along Thailand's main water artery, the Chao Phraya River basin, towards Bangkok, the country's capital, before emptying into the sea. The Chao Phraya River basin is home to about 20 million people (30% of the total population) and a lot of Thailand's manufacturing industry. The basin's relatively flat means that floodwaters drain away slowly and that floods have long durations. Due to its tropical location, Thailand also experiences the remnants of northwest Pacific tropical cyclones, which bring additional heavy rainfall that can also initiate or exacerbate flooding during the monsoon season. From the past information, we found that that if Thailand receives only 1 storm in that year, the next year will be the drought year. If Thailand receives 2 storms, the next year will be normal year. If Thailand receives more than 2 storms, the next year will be the flood year.

Chapter 3

Thailand's Floods, 2011

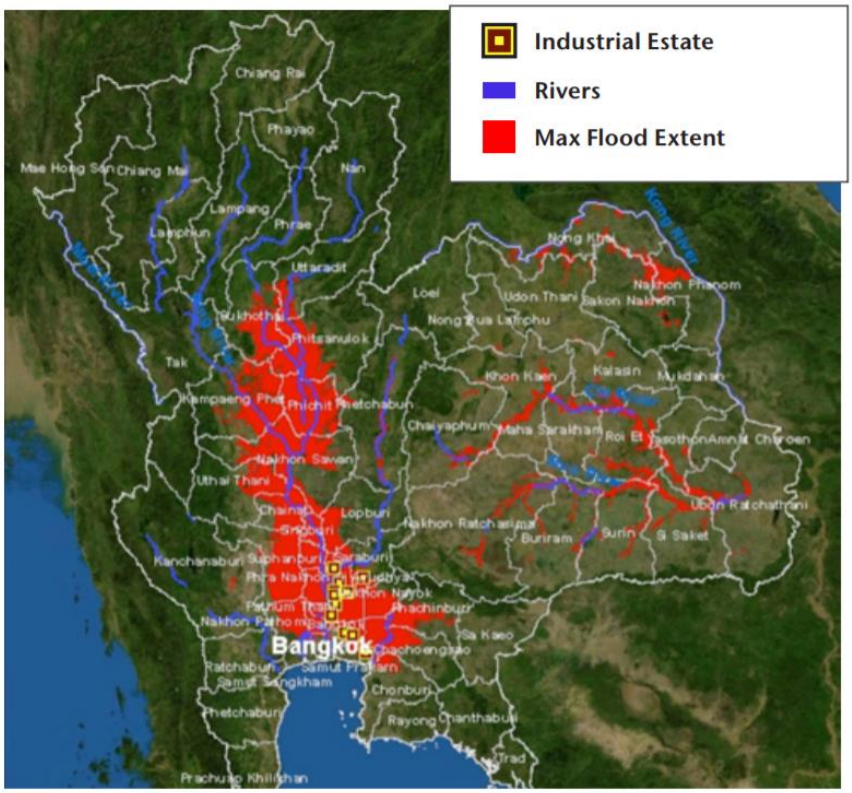
2011 was a very notable year in Thailand as the country endured enormous damage in the wake of the worst flooding in at least five decades. Throughout the entire calendar year, more than 815 people were killed and millions of residents were either left homeless or displaced following significant flooding. The most extensive flooding occurred between late July and early December across nearly every section of the country. In total, 65 of Thailand's 77 provinces were impacted during this timeframe and damage was widespread and severe in many locations. Economic losses were estimated by the World Bank at 1,425 trillion baht (US$46.5 billion), which makes the floods one of the top five costliest natural disaster events in modern history.

3.1 Overview of the Floods

Severe flooding occurred during the 2011 monsoon season in Thailand. The flooding began at the end of July triggered by the landfall of Tropical Storm Nock-ten. These floods soon spread through the provinces of northern, northeastern, and central Thailand along the Mekong and Chao Phraya river basins. In October floodwaters reached the mouth of the Chao Phraya and inundated parts of the capital city of Bangkok. Flooding persisted in some areas until January, 2012 and resulted in a total of 815 deaths and 13.6 million people affected. Sixty-five of Thailand's 76 provinces were declared flood disaster zones, and over 20,000 square kilometers of farmland was damaged. The disaster has been described as "the worst flooding yet in terms of economics and people affected."

The World Bank has estimated 1,425 trillion baht (US$46.5 billion) in economic damages and losses due to flooding, as of 1 December 2011. Most of this was due to the manufacturing industry, as seven major industrial estates were inundated in water as much 3 meters deep during the floods. Disruptions to manufacturing supply chains affected regional automobile production and caused a global shortage of hard disk drives which lasted throughout 2012. The World Bank's estimate for this disaster means it ranks as the world's

fourth costliest disaster as of 2011 surpassed only by the 2011 Tohoku earthquake and tsunami in Japan, Great Hanshin earthquake in 1995, and Hurricane Katrina in 2005.



Source: Thailand's GISTDA, Impact Forecasting

Figure 3-1 Map of the Maximum Extent of the Floods: September – November 2011

Many of the primary sectors that form the backbone of the Thai economy (such as agriculture, manufacturing, tourism and personal property) were dealt a severe blow during the flooding of 2011. The loss of production throughout the duration of the floods led to a notable disruption of the global supply chain for major industries such as automobiles and electronics The insurance industry, which plays a vital role in the risk management of various sectors.

3.2 Causes of flooding

The main Thailand floods of 2011, which primarily occurred between late July and early December, first became prevalent in northern sections of the country as a result of the start of the typical monsoon season. The arrival of the remnants of Tropical Storm Nock-ten in late July accelerated the severity of the rainfall (and floods) across the northern, northeastern and central portions of Thailand. As the calendar turned to August and

September, a vigorous and on-going monsoon season brought continued elevated rainfall totals to central and northern sections as flash floods, river flooding and landslides became more prevalent. An active tropical season in the Northwest Pacific Basin also added to the heightened floods and rainfall totals, with the remnants of four additional systems (Haima, Haitang, Nesat and Nalgae) reaching Thailand.

Figure 3-2 Track Map of the Five Tropical Systems in 2011

The timeframes in which the remnants of the five systems affected Thailand is noted, in addition to a map on the following page that provides the tracks of each:

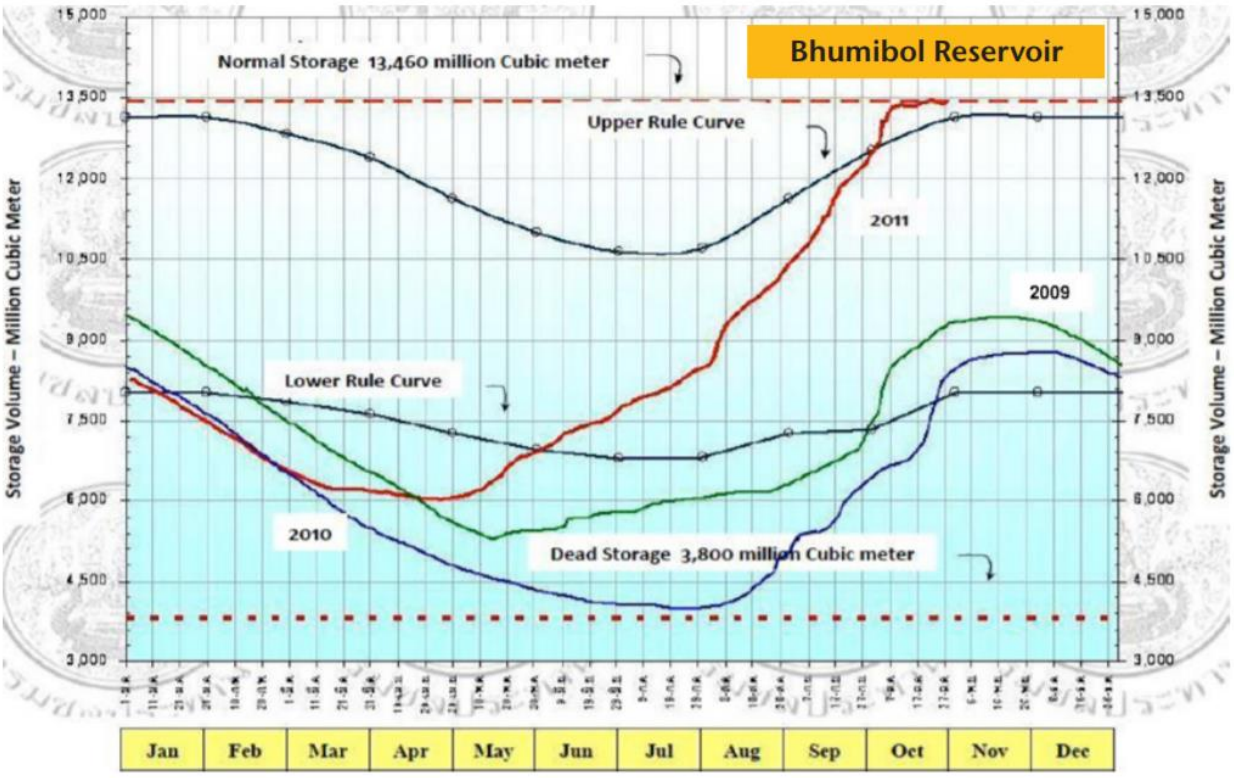
- Haima (Red), June 24–26, 2011
- Nock-ten (Blue), July 30–August 3 2011
- Haitang (Green), September 28, 2011
- Nesat (Yellow), September 30–October 1, 2011
- Nalgae (Pink), October 5–6, 2011

The excessive rainfall that came from the tropical cyclones brought even more water throughout central and northern Thailand, in addition to rainfall from the seasonal monsoon.

As the monsoonal and tropical cyclone-triggered rains continued in northern Thailand, and excess rainwater drained into the Chao Phraya River and its tributaries, the river swelled and breached its banks while flowing southward. The floods eventually covered an area from Chiang Mai Province in the north to Ayutthaya Province in the central plains. As the water

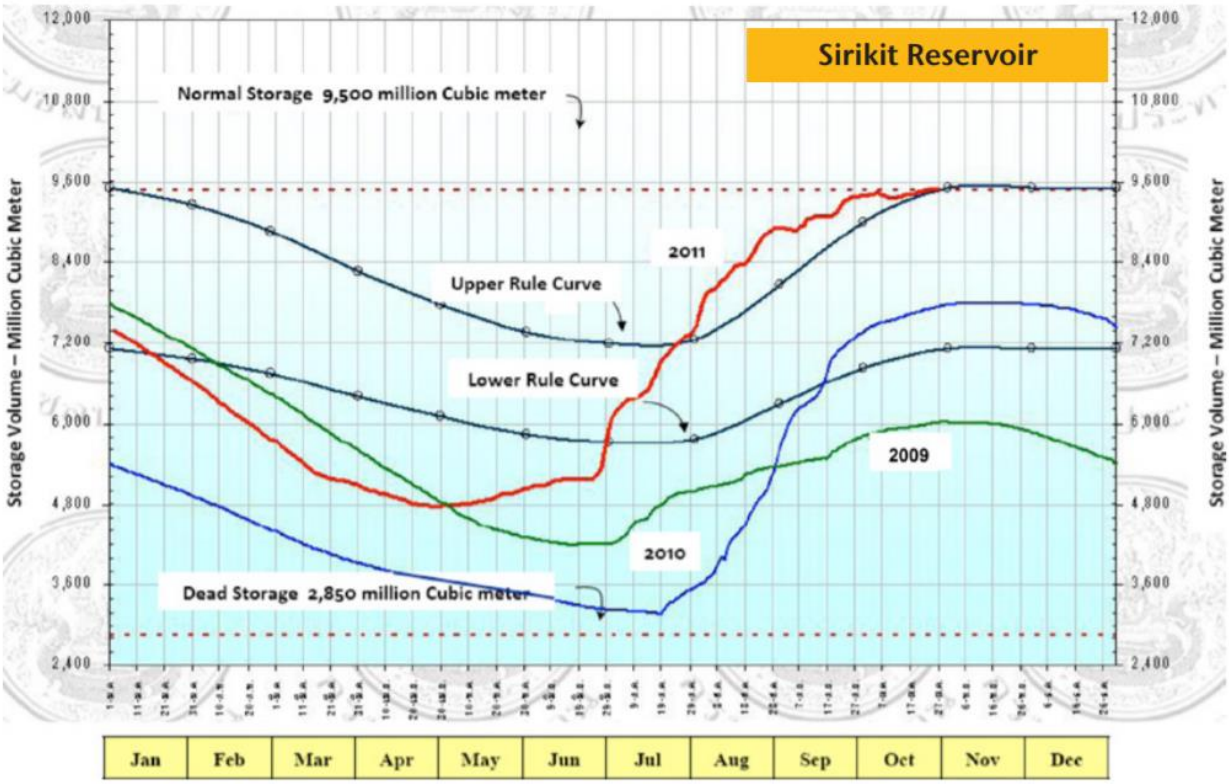
flowed southward along the Chao Phraya River into Ayutthaya, Pathum Thani and Nonthaburi provinces, it broke floodgates which prompted the water to traverse through irrigation canals and into large areas of paddy fields.

During this time period, the Bhumibol and Sirikit dams in the north began to discharge water as the dam reservoirs could not manage the level of water that was building up. Figure 3-3 and 3-4 show the progression of water storage in the Bhumibol and Sirikit dams for the entire year in 2011. The graphics also show the 2011 water levels in comparison to 2009 and 2010, as provided by Thailand's Royal Irrigation Department.



Source: Thailand's Royal Irrigation Department

Figure 3-3 Water Storage Levels of the Bhumibol Reservoir Red=2011; Blue=2010; Green=2009)



Source: Thailand's Royal Irrigation Department

Figure 3-4 Water Storage Levels of the Sirikit Reservoir Red=2011; Blue=2010; Green=2009)

In 2011 between June to July we got only 2 storms, so the government kept the water in reservoir for the next year. However, between September to October we got more 3 storms. So, the reservoir could not release more water because we didn't prepare enough storage for these 3 storms. This situation causes from changing in frequency of storm and Thai government didn't prepare for it before. The addition of rainfall from these 5 tropical storms leads to be the increasing of precipitation during the calendar year in 2011.

Total Rainfall in 2011

For the full year, every section of Thailand saw an elevated amount of rainfall when compared to the typical 30-year average. The combination of an active monsoon with the remnants of multiple tropical cyclones helped fuel the increase in precipitation during the calendar year in 2011.

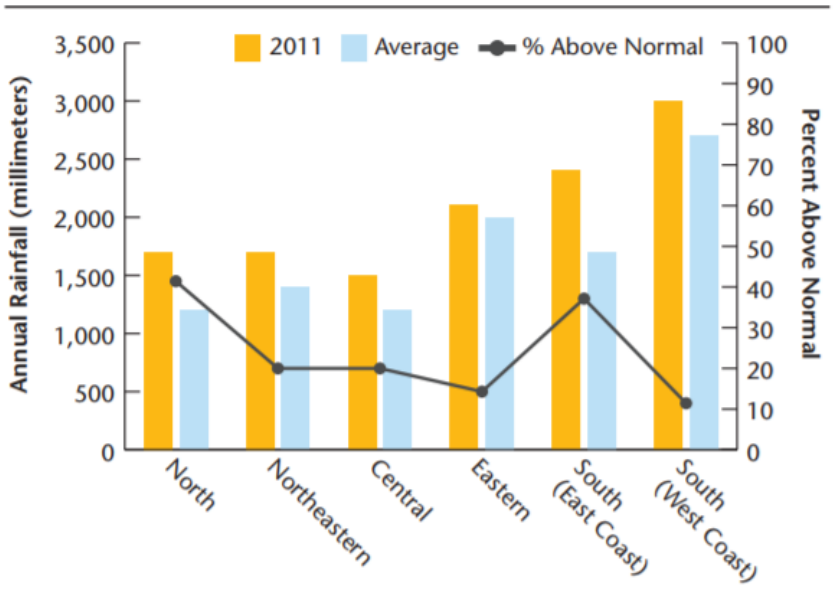


Figure 3-5 Regions of Thailand—Total 2011 Rainfall as Compared to the 30-year Average

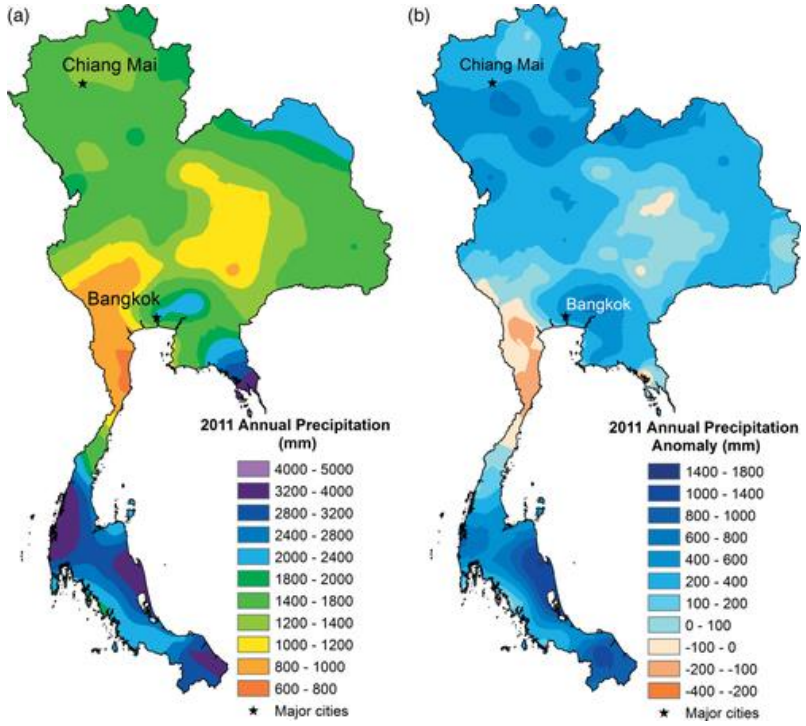


Figure 3-6 (a) Annual precipitation and (b) precipitation anomaly for Thailand in 2011

3.3 Damage Impacts

The impacts felt from the flooding between late July and early December were widespread across the large majority of Thailand. In total, as many as 10 million people were affected in some way by the floods across 65 of the country's 77 provinces. The following sections will take a closer look at some of the damage and impacts caused by the extended flooding.

3.3.1 Personal Property Effects

Reports from the government suggested that as many as 1.5 million homes and other structures were impacted throughout the duration of the floods. According to the Thai Real Estate Information Center (REIC), as many as 300,000 homes were damaged in the greater Bangkok metropolitan region alone. When counting additional damage to all residential facilities in the region, the REIC noted that 700,000 total residential units were impacted. The World Bank reported that total economic losses to households were estimated at THB84.0 billion (USD2.7 billion).

3.3.2 Commercial Effects

The hardest-hit industries were electrical appliances and equipment, medical equipment, automobiles and food and beverage manufacturers. The Department of Industrial Works reported that more than 7,510 industrial and manufacturing plants were damaged by floods in 40 separate provinces.

Ayutthaya Province was one of the most heavily impacted areas, where at least 900 out of 2,150 factories were heavily damaged. In Ayutthaya province, all five industrial estates (Rojana, Saha Rattana Nakorn, Hi-Tech, Bang Pa-in and Factory land) were inundated. Two additional industrial parks near Bangkok (Bang Chan and Lat Krabang) were also forced to temporarily suspend production due to inundation. The extended shutdown of the industrial estates led to a substantial loss of production, with the supply of automobiles and electronics particularly seeing a sharp decrease in availability all around the world. The loss of production led to negative impacts to each company's bottom line.

Figure 3-7 Flood Inundation at the Rojana Industrial Park

According to the Department of Industrial Works, damage costs to the industrial parks and estates were estimated at THB230.0 billion (USD7.4 billion). The World Bank noted that the overall economic cost to manufacturing nationwide (including business interruption) was THB1.0 trillion (USD32.5 billion).

3.3.3 Infrastructure Effects

The agricultural and transportation infrastructures were both heavily impacted during the floods. The subsections below will provide a more detailed look at sustained effects.

- Transportation Infrastructure

  The transportation infrastructure sustained major damage during the floods, with a high number of roads and bridges having been submerged or washed away. The Department of Highways and the Department of Rural Roads reported that parts of 1,700 roads, highways and bridges were damaged or destroyed. The economic cost to roadways alone was listed at THB139.0 billion (USD4.5 billion). Airports around Thailand were also hit, including in Bangkok. The city's secondary airport (Don Mueang) was forced to close in October 2011 after floodwater crept into the main terminal building and also over the facility's runways. Train services were also disrupted as rail tracks were left submerged or washed away on multiple routes.

Figure 3-8 Flooded Highway

- Agricultural Infrastructure

More than 1.9 million hectares (4.7 million acres) of land—including 1.4 million hectares (3.3 million acres) of rice fields—were damaged. This represented 12.5% of all available cropland nationwide. The country's rice crop was particularly affected, where some estimates suggested that up to 25.0% of the crop sustaining damage. Thai government estimates stated that total economic losses to the farm sector from the floods was THB73.0 billion (USD2.4 billion).

3.4 Economic Impacts

According to the World Bank, total economic losses from the July-December floods were estimated to be THB1.4 trillion (USD45.7 billion). The Thailand government also confirmed these economic losses.

Table 3-1 Breakdown of Economic Losses

Sector	Economic Losses (Billions THB)	Comments
Manufacturing	1,007	Most losses sustained at industrial factories
Tourism	95	Loss of tourism revenues over a 6-month span
Households/Personal Property	84	Includes structural and indoor content losses
Agriculture	40	Loss of agricultural production

Source: World Bank

Chapter 4

Disaster Risk Management

Flood will be not able to predict precisely even if we have enough information. However, we can reduce an impact of flood by disaster management method. It has an effective management system before, during, and after the flood or disaster cycle. Disaster cycle has 4 phases, Prevention, Preparedness, Response and Recovery.

Figure 4-1 Disaster cycle

4.1 Review DRM of Thailand use during floods disaster

This topic will be about the flood risk management that Thailand has ever use before, by using the case study “Floods in 2011” Actually, we know that disaster risk management consists of 4 steps which are Prevention, Preparedness, Response and Recovery. However, if the disaster occurs, we often do the response first and follow by recovery. Then when we have money, we will plan for prevention and preparedness.

4.1.1 Prevention

National Disaster Fund

In the aftermath of the 2011 floods, the Thai government initiated a National Disaster Fund of THB50.0 billion (USD1.6 billion) to support the provision of natural disaster risk coverage to households, small firms and industries.

Figure 4-2 Give the foods to the people

Forecasting metrological

There are department that are responsible for forecasting metrological and announce to public, for example, Thai Meteorological Department (TMD).

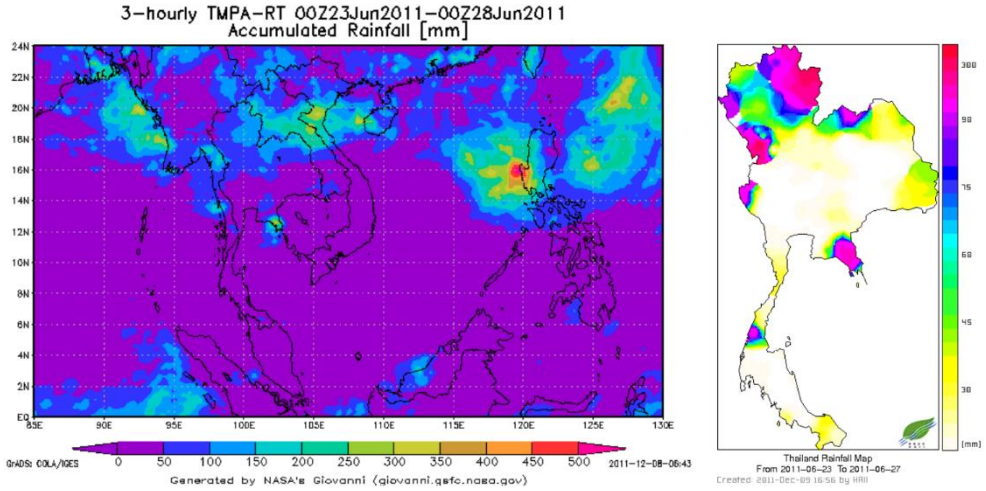


Figure 4-3 Example of precipitation forecasting model

Early warning system

In the case of 2011 floods, despite the constraints of existing forecasting tools and the associated limitations on authorities' ability to predict flood behavior, early warning information was issued in a timely manner by Department of Disaster Prevention and Mitigation. That said, conflicting information from different government bodies responsible for varying areas of flood information management resulted in lack of clarity on the part of the public.

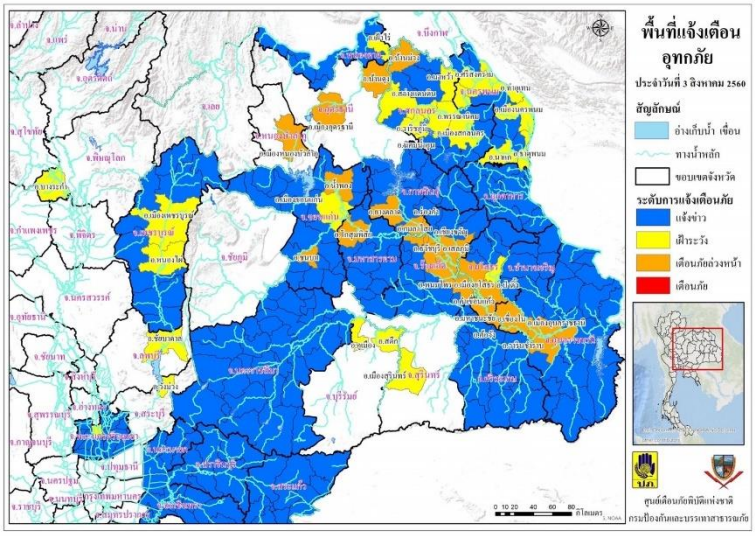


Figure 4-4 Example of flood warning of DDPM

Annual maintenance for drainage systems for channels and reservoirs

Excavate the sediment in reservoirs and take the flow obstruction out of the channel.

Figure 4-5 Maintenance for drainage systems and reservoirs

Prepare the capacity of the main river

Increase the capacity of the river by increasing the height of the river bank.

Figure 4-6 Prepare the capacity of the main river

4.1.2 Preparedness

Government agency about disaster warning (DDPM)

Department of Disaster Prevention and Mitigation (DDPM) was established on the 3rd of October 2002 as an agency under Ministry of Interior (MOI) to handle disaster management responsibilities. As disaster situations in Thailand got worse due to population increase, urbanization and impact of climate change, the establishment of DDPM is to have a better and more effective mechanism to prevent disaster damage and loss and to mitigate calamity due to man-made and natural disasters.

Figure 4-7 Department of Disaster Prevention and Mitigation

Food & material stockpiling

In that time, government prepared a lot of foods and water for the victims in flood disaster before the flood come to their areas.

Figure 4-8 Food & Material stockpiling

Preparation of emergency equipment

Prepare some of the equipment that need for the victims helping and flood prevention such as pump, sand back, ship, tuck.

Figure 4-9 Preparation of emergency equipment of DDPM

Flood Risk map

The map that presents the levels of seismic hazard of Thailand in the form that can be compared with those in the U.S. and several other countries. This measure is very important because we have to use flood risk map for evacuation planning.

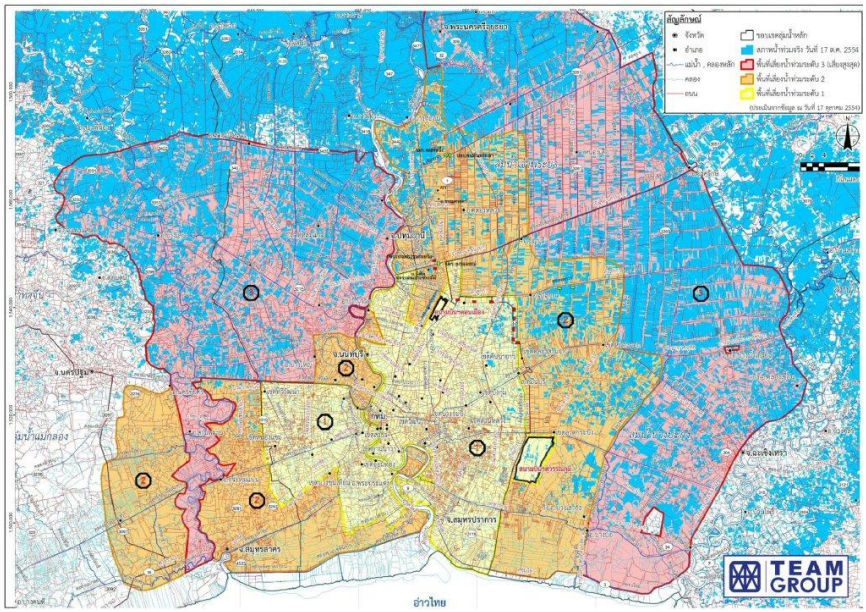


Figure 4-10 Example of flood hazard map

4.1.3 Response

Humanitarian logistic

We use the soldier tucks as the main vehicles because they are higher than the water elevation. In some places where very deep, we will use ships to help people.

Figure 4-11 Humanitarian logistic in flood 2011

Life-saving search Nursing, hygiene, food, water and clothing

The rescue team and organization in Thailand should have fundamental knowledge about first-aids.

Figure 4-12 Life-saving search Nursing in flood 2011

Social network system

Announce the event which may happened in Thailand suddenly and give some fundamental knowledge to people by social network. The most famous page which gives the information to public is Ru-Su-Flood Facebook page.

Figure 4-13 Ru-Su-Flood Facebook page

Donation

We need to use a lot of money to help the victims in flood disaster.

Figure 4-14 Example of donation in flood 2011

Evacuation center

We change the temples, schools, university to be a temporary evacuation center.

Figure 4-15 Evacuation center

Pump

Pump the water out of the dike especially in the coastal area.

Figure 4-16 Pumping station

4.1.4 Recovery

Reconstruction

The government repairs the houses or constructs the new one for the victims in this disaster. Moreover, reconstruct some hydraulic structures that were destroyed by flood disaster.

Figure 4-17 Reconstruct bang-chom-sri water gate

Delay the tax and interest

The victims from this disaster can delay the tax payment and can delay the interest payment to the bank.

Lessen to the government agency's document

Some government agencies will give the flexibility about the document to the victims during that time because their document may be inundated in the water.

Mental Health Recovery

The government established a center named Mental Health Crisis Assess Treatment Team (MCATT) as shown in Figure 4-18 for taking care victims affected by flooding. Moreover, this agency also created the book about relaxing after flood.

Figure 4-18 Mental Health Crisis Assess Treatment Team (MCATT)

4.2 Flood risk management recommendation before RSDC program participation

The disaster risk management for floods in 2011 can be concluded as in the previous topic. If I didn't go to RSDC program, I will have some recommendations from my work experience and water resource knowledge like the following table.

Table 4-1 Flood risk management recommendation before RSDC program participation

Prevention	
Measure	Recommendations and suggested activities
Continue needs assessment	Given the flood situation prevails, the damage assessment should continue in order to establish accurate, final needs
Forecasting metrological	Develop the forecasting model that can predict the right climate
Communication	A communications strategy with media and inter-governmental agencies needs to be improved to avoid confusion amongst the general public for any future disasters.
Integrated early warning system with multiple hazard mapping	Integrated and improved coordination among agencies concerned with early warning functions that monitor multi-hazard scenarios
Preparedness	
Measure	Recommendations and suggested activities
Separate policies for urban and rural recovery	Compensation policies should consider particular urban and rural needs
Evacuation Strategy	Set up urban and rural evacuation strategies, considering community needs and appropriate use of infrastructures. Engage grass-roots agencies, the defense sector and communities in the planning and implementation process
Response	
Measure	Recommendations and suggested activities
Nursing	Prepare enough doctors and equipment
Donate	Have a good management on donation money
Recovery	
Measure	Recommendations and suggested activities
Reconstruction	Give the help to the most trouble victims

4.3 Flood risk management recommendation after RSDC program participation

The objective of disaster risk management is to reduce disaster risk. Therefore, it is important to implement risk management procedures step by step. The salient steps in implementing disaster risk management, termed as risk management Flow is illustrated in the figure 4-19

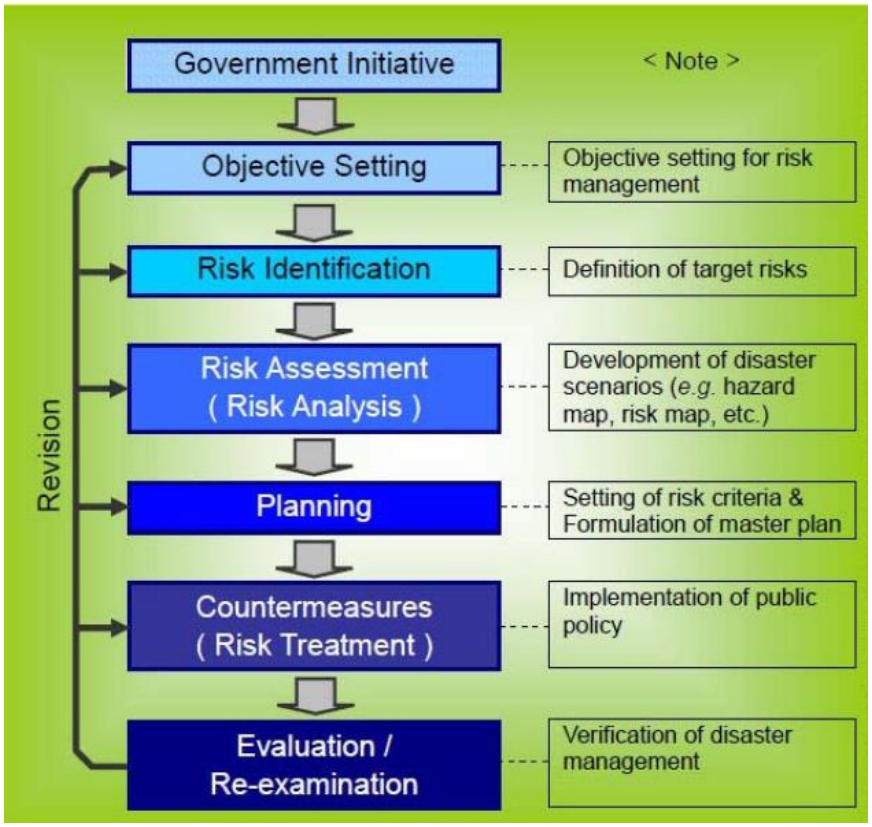


Figure 4-19 Risk Management Flow

The way to do management should be for Minimize the damage & loss by the cost constrain. The output will be new more 2P2R. Moreover, some technology from Japan and other countries can be adapted and adjusted for Thailand flood disaster risk management. Therefore, this topic will give some new ideas about flood risk management especially about additional of 2P2R.

4.3.1 Prevention

Main Channel / Side Channel

The rivers on Japan often have 2 parts consist of main channel and side channel. The main channel uses for flow of the water in every duration even flood or drought. However, the water level will increase when flood duration, so it will over flow the main channel to the side channel. Therefore, the river can receive more capacity of discharge during flood season. For drought season, people can area on side channel for any activities.

Figure 4-20 Main channel / Side channel in Japan

Floodway & Flood plain

The floodway is that portion of the flood prone area that is required to pass the design flood event without a significant rise in water levels compared to undeveloped conditions. The floodway is delineated using the flood frequency or extreme event information combined with a hydraulic analysis. Normally the floodway can be characterized as that part of the flood-prone area having high velocities, high potential for erosion, and high exposure to significant flow of debris. The flood plain is the residual area outside of the floodway where the water velocities are less and flood protection and flood-proofing measures can be considered. When both the floodway and flood plain are identified, this it termed a two-zone approach. In such cases, only one designation of zone is used, and the entire area is treated

as a flood plain. Under such circumstances, care would be taken to ensure that no new incompatible development occurs in the zone.

Figure 4-21 Floodway & Flood plain

Flood proofing of new structure

Some kinds of resident structure will failure during flood disaster by the scouring of the foundation under the column due to the velocity of the water. Therefore, some water proofing equipment can help to solve this problem by use it at the base of the column to protect the movement of the soil and the seepage of the water.

Figure 4-22 Flood proofing of new structure

Excavate more capacity of reservoir

Some reservoirs have a potential for enlarging the capacity by the soil excavation. This capacity will prepare for receive more water in flood season.

Figure 4-23 Excavate more capacity of reservoir

Floating house

There are some areas always have floods in the period of each year. The people learn to live with water by using the floating house. In drought period, the house will stay on the ground by columns. In the other hands, the house will float on the floating structure with the mooring system during flood season.

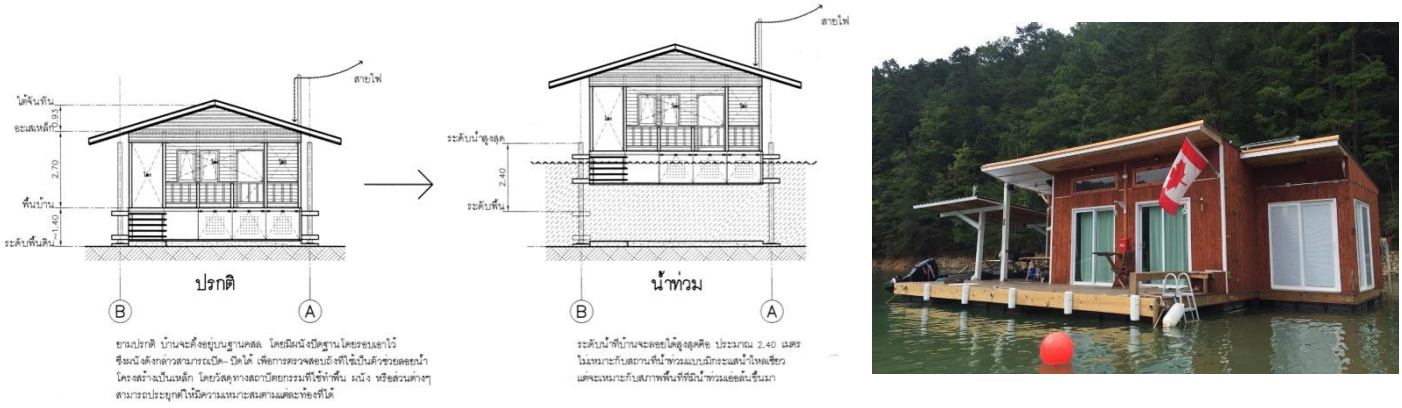


Figure 4-24 Floating house

4.3.2 Preparedness

Local government agency committee

The national disaster response committees were set up, on a basis, in response to the changing and evolving flood situation. However, the emergency and disaster management mechanisms are largely based on local needs and plans and rely on provincial and local administrative structures. Therefore, the local committee will be the best solution the solve about the need information of local victims in flood disaster. Moreover, this local committee should know about the basic information of the people in their own area such as the population in each house, the age of people in each house and the places where the disable person live. The most important is to make sure that every persons in committee or team know their own responsibility. Everyone will know that if the disaster occurs, they will go to help in their own responsibility area.

Figure 4-25 Example of local committee

Evacuation planning & Evacuation training

To have the effective rescue during flood disaster, we should have a good evacuation planning. Evacuation plans were in place during the floods, officials expressed concern that the public were not willing to evacuate safely. We will use the evacuation plan with the local committee or team for help the people in the same way. To have all of these processes, we should have the good training as well.

Figure 4-26 Evacuation training

<u>Training to the people in every area and give them an information</u>

Information about hazard and risk is the critical first step to any comprehensive risk management plan, and community and country-wide preparedness.

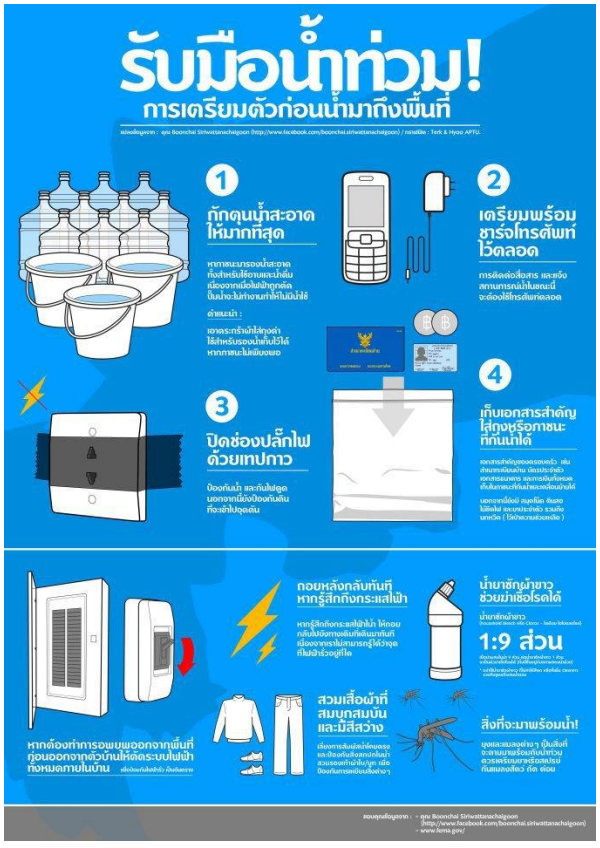


Figure 4-27 Solution for giving information about flood in 2011

Effective flood warning systems

Department of Disaster Prevention and Mitigation (DDPM) has a responsibility for make a warning system for every disaster in Thailand. In term disaster that related to the water, DDPM use the data from other government agencies such as TMD, RID and HAII. However, each government agency has their own criteria for make a warning, so it is very inconvenient for staff of DDPM to make decision for warning.

In other countries, they have a system for help the staff of disaster warning agency to make decision for warning call “decision support system (DSS)”. It is an algorithm for simulate and show the suitable warning by using the data from many sources.

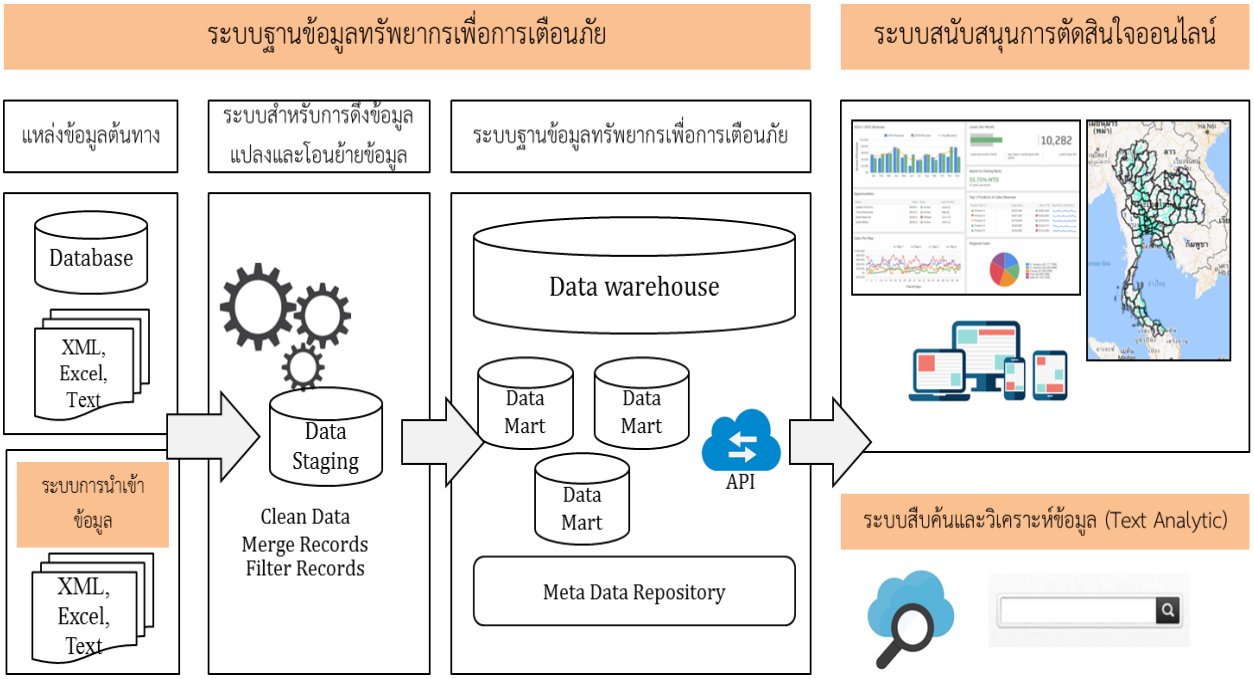


Figure 4-28 Decision support system flow chart

Application for give the information & inform

Smart phone is very comfortable today, almost of people in Thailand have a smart phone. Therefore, application on smart phone should be one measure for make the warning to the people in country. Moreover, not only give and information to the people, but also receive the information from the people as well. People can inform about the disaster that they faced with to the government by using this application.

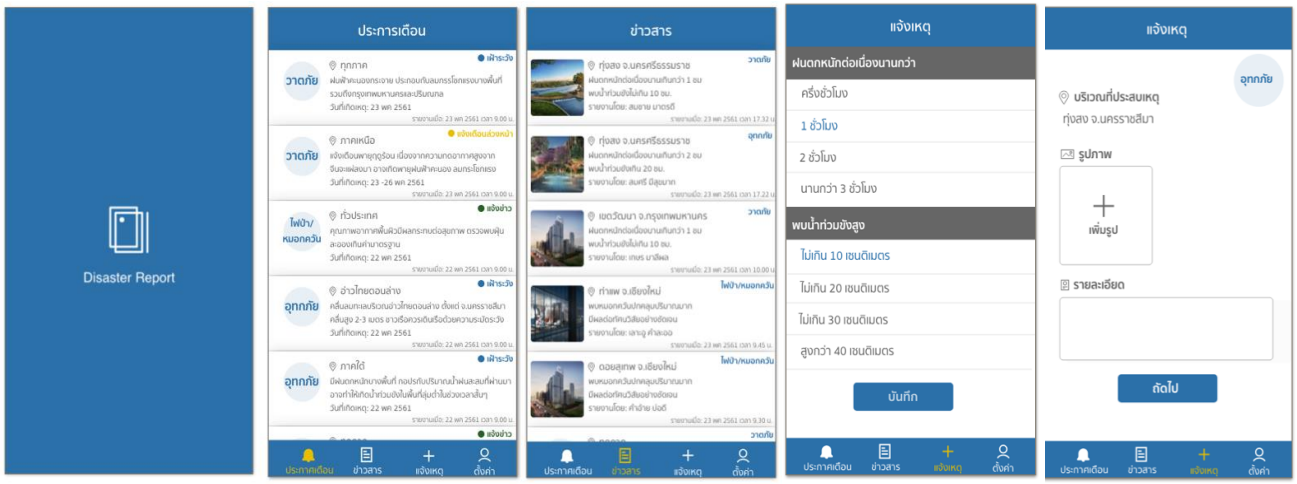


Figure 4-29 Application for Thai citizens

Moreover, the tourist didn't know about this application and it maybe in Thai language. Therefore, we should have one more application for tourists for give an information to them. As Japan, they have application for tourists call "Safty tips" which make a disaster warning in Japan to tourist by English language. This application should be made a public relation in airport before tourists come in country.

Figure 4-30 Application for tourists

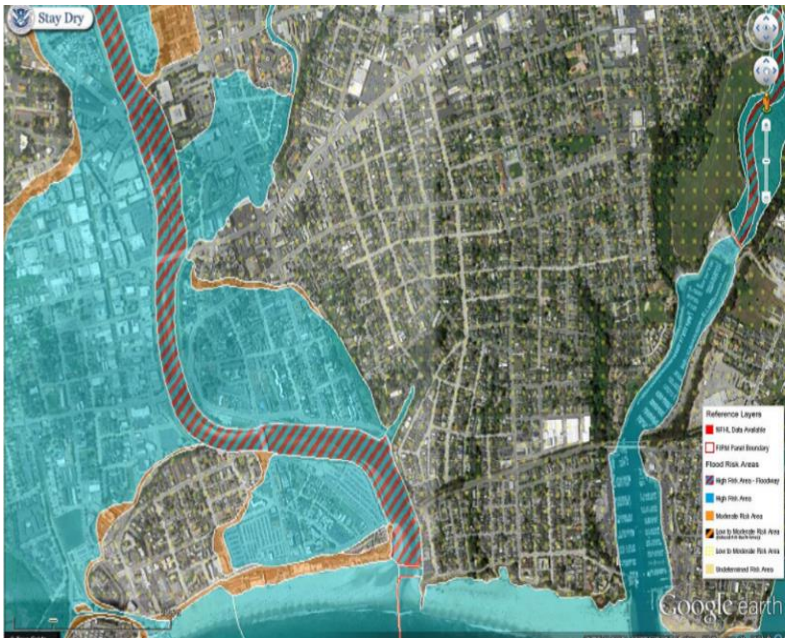
If tourists don't have internet, they provide some document to give an information about disaster in many languages.

Figure 4-31 Example of disaster document in Thai language of Japan

In some countries in Europe, they have the SMS sending to give the information about the disaster in the country. The government will send the SMS to every phone in the country both their own population and tourists.

Effective floods hazard map

Flood hazard map that Thailand has now isn't cover all of the countries and lack of some detail information. The detail flood hazard map is very important for evacuation planning. During flooding disaster, we want to know which area is dry or wet, so hazard is the tools that can answer this question.



. **Figure 4-32** Example of flood hazard map in USA

This detail flood hazard map can use to create the flood zone. The different of flood zone will have the different evacuation plan and evacuation tools. USA have an agency call "FEMA" for creating criteria for identify each flood zone and have an evacuation plan for each flood zone.

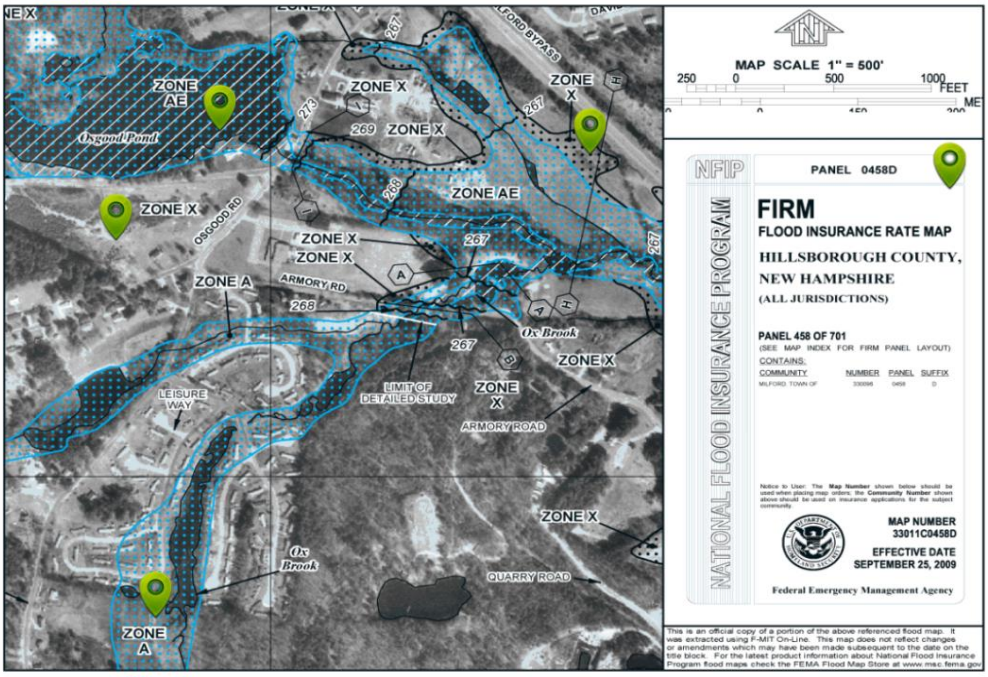


Figure 4-33 Example of flood zone in USA

Table 4-2 Definitions of FEMA Flood Zone Designations

Special Flood Hazard Areas – High Risk

Special Flood Hazard Areas represent the area subject to inundation by 1-percent-annual chance flood. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage. Federal floodplain management regulations and mandatory flood insurance purchase requirements apply in these zones.

ZONE	DESCRIPTION
A	Areas subject to inundation by the 1-percent-annual-chance flood event. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown.
AE, A1-A30	Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. BFEs are shown within these zones. (Zone AE is used on new and revised maps in place of Zones A1–A30.)
AH	Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are 1–3 feet. BFEs derived from detailed hydraulic analyses are shown in this zone.
AO	Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are 1–3 feet. Average flood depths derived from detailed hydraulic analyses are shown within this zone.
AR	Areas that result from the decertification of a previously accredited flood protection system that is determined to be in the process of being restored to provide base flood protection.
A99	Areas subject to inundation by the 1-percent-annual-chance flood event, but which will ultimately be protected upon completion of an under-construction Federal flood protection system. These are areas of special flood hazard where enough progress has been made on the construction of a protection system, such as dikes, dams, and levees, to consider it complete for insurance rating purposes. Zone A99 may be used only when the flood protection system has reached specified statutory progress toward completion. No BFEs or flood depths are shown.

Coastal High Hazard Areas – High Risk

Coastal High Hazard Areas (CHHA) represent the area subject to inundation by 1-percent-annual chance flood, extending from offshore to the inland limit of a primary front al dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources. Structures located within the CHHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage. Federal floodplain management regulations and mandatory purchase requirements apply in these zones.

ZONE	DESCRIPTION
V	Areas along coasts subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced waves. Because detailed coastal analyses have not been performed, no BFEs or flood depths are shown.
VE, V1-V30	Areas along coasts subject to inundation by the 1-percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action. BFEs derived from detailed hydraulic coastal analyses are shown within these zones. (Zone VE is used on new and revised maps in place of Zones V1–V30.)

Moderate and Minimal Risk Areas

Areas of moderate or minimal hazard are studied based upon the principal source of flood in the area. However, buildings in these zones could be flooded by severe, concentrated rainfall coupled with inadequate local drainage systems. Local stormwater drainage systems are not normally considered in a community's flood insurance study. The failure of a local drainage system can create areas of high flood risk within these zones. Flood insurance is available in participating communities, but is not required by regulation in these zones. Nearly 25-percent of all flood claims filed are for structures located within these zones.

ZONE	DESCRIPTION
B, X (shaded)	Moderate risk areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by a levee. No BFEs or base flood depths are shown within these zones. (Zone X (shaded) is used on new and revised maps in place of Zone B.)
C, X (unshaded)	Minimal risk areas outside the 1-percent and .2-percent-annual-chance floodplains. No BFEs or base flood depths are shown within these zones. (Zone X (unshaded) is used on new and revised maps in place of Zone C.)

Undetermined Risk Areas

ZONE	DESCRIPTION
D	Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

Refugees area

In Japan, they have the permanent refugee areas prepare for disaster. Institute procedures to notify appropriate people of the disaster and assemble them rapidly. However, in Thailand, we use school, temple, university etc. as the temporary refugee areas. These temporary refugee areas may not proper to help the victims from the disaster. They may lack of the helping equipment and area. Therefore, we should construct the permanent refugee areas in the risk area prepare for disaster in our country.

Figure 4-34 Refugees area

4.3.3 Response

Evacuation process

In Japan, they have the process to help the victims in floods disaster. When the flood occurs, they do 3 surveys consist of survey of the disaster affected areas, survey of the disaster affected rivers and local need survey. Then, they will send the survey information to technical assistance for do the evacuate planning. They communicate by satellite communication vehicle and rapidly do the disaster emergency response.

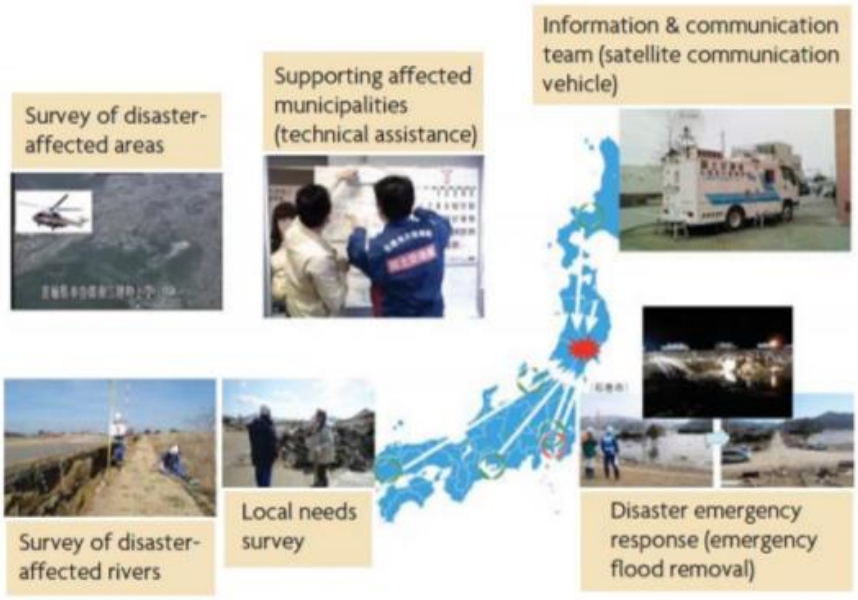


Figure 4-35 Evacuation process of Japan

The most outstanding point of disaster response in Japan is the participation of human, not only the rescue teams, but also the victims know their own duty in the disaster period. Therefore, it will be comfortable for making a response.

4.3.4 Recovery

Clear debris rapidly

In Japan, they clear the debris from flood rapidly in 1-2 days after flood removal. The government thinks that the citizens of country should have a life as same as the normal situation as soon as possible. We can see that they care people a lot.

Figure 4-36 Debris from flood disaster

Live with water

In some areas of Japan, the always have floods due to the sea tidal. Therefore, they learn to live with water by adapting their house to be very high in first floor and have a small port for boat.

Figure 4-37 Live with water

4.4 DRM with uncertainty

The uncertainty means the changing in severe of flood disaster, we can consider in term of discharge and depth of water. We should have an evacuation plan for every level of severe, so we have to know the severe in each case first. Therefore, flood hazard map will be the solution of this problem. We should simulate and establish the flood hazard map in many cases and plan for a new response and recovery in every case for cope with every severe of flood disaster.

The changing in land use will effect to evacuation plan because it will change the severe of flood disaster. The solution is to create the flood hazard map in every 5 years because the hazard will be changed by the changing of land use. The number 5 years is suitable because the changing of land use isn't the shape change, it uses a long time to develop land use.

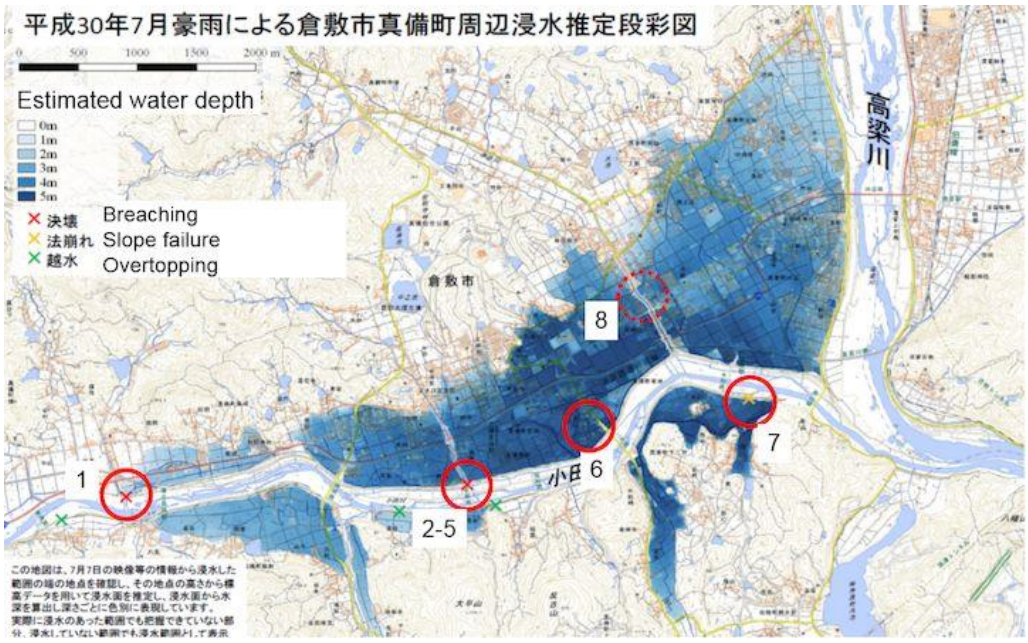


Figure 4-38 Flood hazard map of Japan

Chapter 5

Summary

The summary of flood risk management can be concluded as figure 5-1

Figure 5-1 Summery of flood risk management

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Presentation Slide

CHULA ENGINEERING

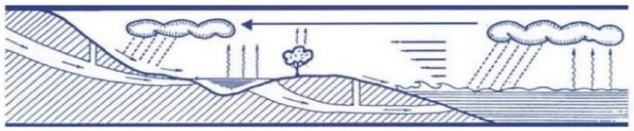
RSDC

Floods 2011

Nantawoot Inseeyong 6070231821

Department of Water Resource Engineering, Faculty of Engineering, Chulalongkorn University

International Program on Resilient Society Development under Changing Climate



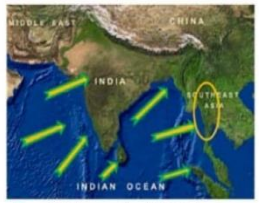
Outline

- Meteorological Background
- Overview of Floods 2011
- Disaster Risk Management

Meteorological Background

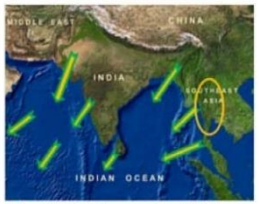
Monsoon

- Southwest Monsoon



  - mid-May until mid-October
  - very warm, moist air

- Northeast Monsoon

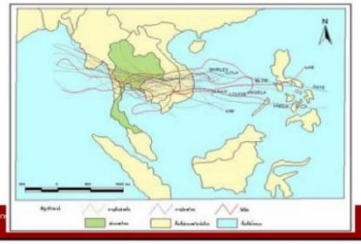


  - mid-October until mid-February
  - cool and dry air

Meteorological Background

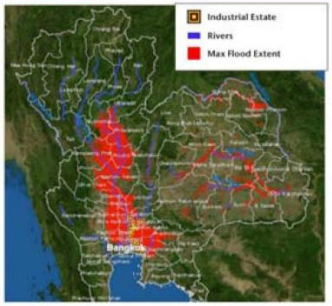
Tropical storms

- A **tropical cyclone** is a rapidly rotating storm system characterized by **a low-pressure center**, a closed low-level atmospheric **circulation, strong winds**, and a spiral arrangement of thunderstorms that produce **heavy rain.**



Overview of Floods 2011

- occurred during the 2011 monsoon season in Thailand
- The World Bank has estimated 1,425 trillion baht (US$46.5 billion) in economic damages and losses due to flooding
- world's fourth costliest disaster
- **more than 7,510 industrial and manufacturing plants** were damaged by floods in **40 separate provinces.**



Source: Thailand's GISTDA, Impact Forecasting

Overview of Floods 2011

Damage Impacts

Commercial Effects

Infrastructure Effects

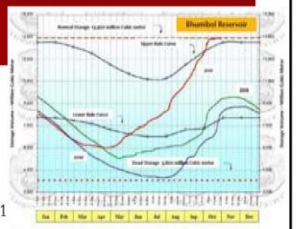
Sector	Economic Losses (Billions THB)	Comments
Manufacturing	1,007	Most losses sustained at industrial factories
Tourism	95	Loss of tourism revenues over a 6-month span
Households/Personal Property	84	Includes structural and indoor content losses
Agriculture	40	Loss of agricultural production

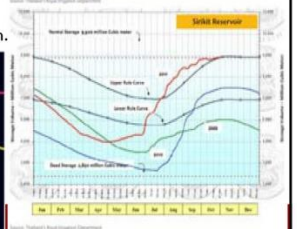
Source: World Bank

Economic Impacts

Thailand's Floods 2011

- **five storms** affected Thailand
  - Haima (Red), June 24–26, 2011
  - Nock-ten (Blue), July 30–August 3 2011
  - Haitang (Green), September 28, 2011
  - Nesat (Yellow), September 30–October 1, 2011
  - Nalgae (Pink), October 5–6, 2011
- **addition to rainfall from the seasonal monsoon.**

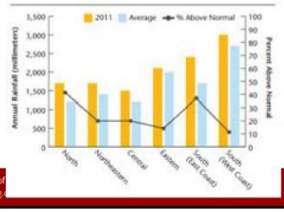


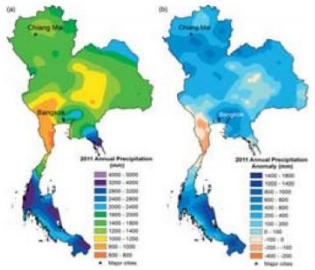


Thailand's Floods 2011

2011 Rainfall Totals

- compared to the **typical 30-year average**
- The **combination of a monsoon** with the multiple **tropical cyclones** helped the **increase in precipitation** during the calendar year in 2011.





Disaster Risk Management

Disaster Risk Management

Response

- Humanitarian logistic (Soldier tucks, boats)
- Life-saving search Nursing, hygiene, food, water and clothing
- Social network system
- Pumping station
- Donation
- Evacuation center

Disaster Risk Management

Recovery

- Reconstruction
- Delay the tax and interest
- Lessen to the government agency's document
- Mental Health Recovery

Disaster Risk Management

Prevention

- National Disaster Fund
- Forecasting metrological
- Construction of early warning systems
- maintenance for drainage systems (channel, reservoir)
- Prepare the capacity of the main river (Dike)

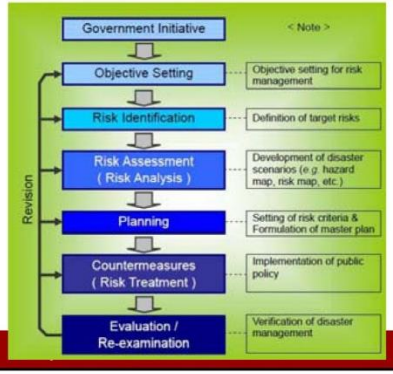
Disaster Risk Management

Preparedness

- Government agency about disaster warning (DDPM)
- Food & material stockpiling
- Preparation of emergency equipment
- Flood Risk map

Disaster Risk Management

More 2P2R from my opinion



Minimize the damage & loss

New 2P2R

Disaster Risk Management

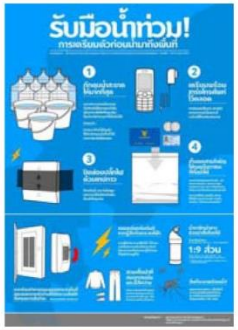
Add more Preparedness

- Local government agency committee
  - Have the **detail information** about area.
  - Everyone knows about **their own responsibility**.
- Urban vulnerability training
  - Evacuation planning
  - Evacuation training

Disaster Risk Management

Add more Preparedness

- Training to the people in every areas
  - **Information** about hazard and risk about floods in their area



Disaster Risk Management

Add more Preparedness

- Effective flood warning systems
  - Decision support system (DSS)

Disaster Risk Management

Add more Preparedness

- Application for give the information & inform (for Thai people)

Disaster Risk Management

Add more Preparedness

- Application for give the information (for the tourists)

Disaster Risk Management

Add more Preparedness

- Effective floods hazard map
- Flood Zone

Disaster Risk Management

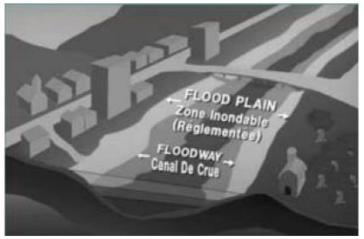
Add more Preparedness

- Refugees area
  - In **Japan**, they have the refugee areas prepare for disaster.
  - In **Thailand**, We use school, temple, university etc.

Disaster Risk Management

Add more Prevention

- Main Channel / Side Channel (Floodway + Flood plain)



Disaster Risk Management

Add more Prevention

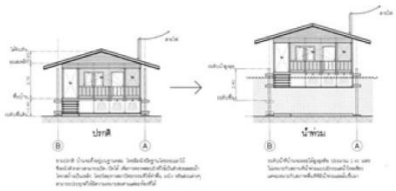
- Flood proofing of new structure

- Excavate more capacity of reservoir

Disaster Risk Management

Add more Prevention

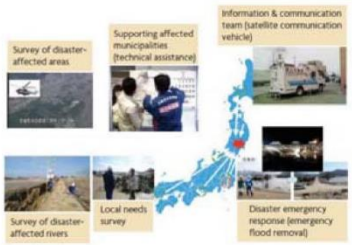
- Floating house



Disaster Risk Management

Add more Response

- Evacuation process



- Everyone knows their own responsibility and response quickly

Disaster Risk Management

Add more Recovery

- Care about people

- Clear debris caused by floods rapidly in 1-2 days

Disaster Risk Management

Add more Recovery

- Live with water

Disaster Risk Management

Uncertainty

- Simulate and establish flood hazard map in many cases.

  → plan for new response and recovery in every cases

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