Cooperative Research Report of
Public Works Research Institute
No.366

Report on Japan-Thailand-China Joint Symposium on Current Policy and Directions on Flood Damage Mitigation

March 2007

Public Works Research Institute

Japan Science and Technology Agency

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Report on Japan-Thailand-China Joint Symposium on Current Policy and Directions on Flood Damage Mitigation

Editors

Junichi Yoshitani — Public Works Research Institute (JST/CREST)
Katsuhide Yoshikawa — College of Engineering, Nihon University (JST/CREST)
Yoshiki Motonaga — Chuo University (JST/CREST)

Outline

As a research activity of JST/CREST Basin–wide Policy Scenario Study Project led by Prof. Kengo Sunaga, Yamanashi University, sub-themes for Chao Phraya River Basin and Chanjiang River Basin Case Studies hold a Japan-Thai-China joint symposium on Current Policy and Directions on Flood Damage Mitigation with support of several local organization. This is the record of this joint symposium.

Keyword: Flood, Policy scenario, Chao Phraya River, Chanjiang River, Ayase River, Tsurumi River

Foreword

This symposium was organized jointly by CREST (Core Research for Evolutional Science and Technology) project and Thai Hydrologist Assembly in corporation with many Thai organizations. CREST is a scientific project funding mechanism in Japan Science and Technology Agency (JST) supported by the Japanese Government and one of the CREST projects is “Basin-wide Water Policy Scenario in Monsoon Asia” led by Prof. Kengo Sunada at the University of Yamanashi. This project focuses on water policy case studies in river basins in Monsoon Asia, two of which are Chao Phraya River Basin, Thailand and Chanjiang (Yangtze) River Basin, China. The former study is led by Prof. Katsuhide Yoshikawa at Nihon University and the latter is led by Mr. Junichi Yoshitani of Public Works Research Institute. These two study groups hold joint symposium in the past, as both have a lot of common on flood problems, particularly land use management in highly urbanized mega-cities. We started this type of symposium in Tokyo with our colleagues in Thailand and China. This is the first symposium held out of Tokyo. We believe this symposium report is beneficial to share experience and views on flood management among countries with similar problems.

Katsuhide Yoshikawa, Nihon University
Junichi Yoshitani, PWRI

CONTENT

1. Program

Symposium on Current Policy and Directions on Flood Damage Mitigation

14 October 2006
Royal River Hotel, Bangkok, Thailand

Organized by
Thai Hydrologist Assembly and CREST/JST

Supported by
Royal Irrigation Department
Department of Water Resources
Department of Public Works and Town & Country Planning
Thai Meteorological Department
Bangkok Metropolitan Administration
The Environmental Engineering Association of Thailand
ASDECON CORPORATION CO., LTD.

OBJECTIVE

Rapid population growth and an expanding scope of human activities that began in the latter half of the 20th century gave rise to a wide variety of water issues. Among several water issues increased flood damage is the common and most important problem in many countries in Monsoon Asia. As many countries in this region experienced the limitation of traditional flood management approaches, the more fundamental management for land use and its coordination with flood management policy has been highlighted. This symposium aims to exchange country level policy shift implications on flood damage mitigation with a focus on integration of land and flood management programs and practical implementation in Thailand and some other countries in Monsoon Asia.

PROGRAM

8.30-9:15 Registration

9:15 Opening

Chairperson: Mr. Junichi Yoshitani, Public Works Research Institute of Japan

9:15-9:30 Opening addresses by representative of Vice president of Thai Hydrologist Assembly and representative of CREST/JST

[Report from China and Japan]

9:30-10.00 On the Comprehensive Flood Damage Mitigation in the Basins of Gently-Flowing Rivers on Low-Lying Plains,
Mr. Katsuhide Yoshikawa, Nihon University, Keio University/Kyoto University

10.00-10:20 Recent Progress in Flood Management in China,
Mr. Cheng Xiaotao, China Institute of Water Resources and Hydropower Research

10:20-10.45 Break

10:45-11:05 Best Practices Found in China's New Flood Management
Mr. Junichi Yoshitani, Public Works Research Institute of Japan

11:05-11:25 Policy Evaluation of Comprehensive Flood Control Program in Japan
Mr. Minoru Kuriki, Public Works Research Institute of Japan

11:25-11:50 Question and Discussion

11:50-1:00pm Lunch

Chairperson: Mr. Subin Pinkayan, Vice president of Thai Hydrologist Assembly

[Report from Thailand]

1:00-1:30pm Rainfall Estimate Based Satellite Images and Conceptual Framework of Its Application for Flood Landslide Early Warning
Ms. Saisunee Bhudthakuncharoen, Mahanakorn University

1:30-2:00pm Flooding Situation & Mitigation Measures in Thailand
Mr. Siriphong Hangsapruek, Director General of Department of Water Resources

2:00-2:30pm The Current Situation (Oct. 2006) on Flood Management in Chao Phraya River Basin
Mr. Suwit Thanopanuwat, Professional Engineer for Planning of Royal Irrigation Department

2:30-2:50pm Break

2:50-3:20pm Bangkok Drainage and Flood Control System
Mr.Teeradej Tangpraprutgul, Former Director of Drainage and Sewerage

	Department
3:20-3:40pm	Flood Situations for the next 30 days of Lower Chao Phraya River Basin Pornsak Suppataratarn, ASDECON Corporation
3:40-4:30pm	Questions and discussion
4:30-4:40pm	Closing Remarks by Mr. Kasemsan Suwarnarat, Chairman of the Board Directors, Waste Water Management Authority

DATE AND VENUE

The symposium will be held on Saturday, 14 October 2006 at the Royal River Hotel, 219 Soi Charansanitwong 66/1, Charansanitwong Road, Bangplad, Bangkok 10700, Thailand; phone 66-(0)-2422-9222, fax 66-(0)-2433-5880.

LANGUAGE

The official language in the symposium is English.

REGISTRATION

The registration is free of charge. Participants from out of Thailand shall register your full name, organization, and email address by email to Mr. Junichi Yoshitani (yositani@pwri.go.jp). Participants from Thailand shall register to Thai Hydrologist Assembly by email to Dr.Piyaporn Songprasert (piyapornna@yahoo.com or tik_pooh@hotmail.com) The deadline is **October 12.**

2. On Flood Damage Mitigation in the Basins of Gently-Flowing Rivers on Low-Lying Plains

Katsuhide Yoshikawa
Professor of Nihon University

On Comprehensive Flood Damage Mitigation in the Basins of Gentle-Flowing Rivers on Low-Lying Plains

14, Oct., 2006
Prof.,Dr. K.Yoshikawa

Nihon University
Keio University/ Kyoto University

I will report on comprehensive flood damage mitigation measures for gently-flowing river basins on low-lying areas.

Contents

(1) A fundamental theory and basic flood damage mitigation measures

(2) Implementation of comprehensive flood damage mitigation measures ;
the eastern suburbs of both the Tokyo and Bangkok metropolitan areas

(3) Non-structural measures, particularly land use guidance and regulations

(4) Conclusion:
the effectiveness of comprehensive flood damage mitigation measures

As you can see from this slide, the contents of my presentation are divided into four sections:
(1) Setting out a fundamental theory with respect to alleviating flood damage and outlining basic flood damage mitigation measures
(2) Report on the implementation of comprehensive flood damage mitigation measures in river basins that have experienced rapid urbanization in the eastern suburbs of both the Tokyo and Bangkok metropolitan areas
(3) Discussion of non-structural measures, particularly land-use guidance and regulations
(4) Conclusion: verifying the effectiveness of comprehensive flood damage mitigation measures

1.Theory :formulae

$$D = D\left(F, F_0, S\right) \quad (1)$$

$$\overline{D} = \int_{F_0}^{\infty} P_r(F) \cdot D\left(F, F_0, S\right) dF \quad (2)$$

D：Total damage，F：External forces (factors such as rainfall, flow, water level)，
S：Potential damage，F_0：Capacity of flood mitigation facilities，
D bar ：annual average damage，
Pr(F)：Probability density function of external force

2.Variation of Flood Dmagae

$$\Delta\overline{D} = \frac{\partial \overline{D}}{\partial F_0} \cdot \Delta F_0 + \frac{\partial \overline{D}}{\partial S} \cdot \Delta S + \varepsilon\left(\Delta F_0, \Delta S\right) \quad (3)$$

Basic flood damage mitigation measures

①Structural Measures （F_0 improvement measures）
② Structural Measures (S reduction or limitation measures)
③A combination of ① and ②

This slide outlines a basic theory with regard to alleviating flood damage. Basically, the total flood damage [D] is calculated based on external forces in the form of rainfall, the capacity of flood damage mitigation facilities and the social structures susceptible to flood damage [S], as shown in Formula (1). S therefore represents the potential flood damage. The D bar indicating annual average flood damage is calculated by multiplying and integrating the probability density function [P_r(F)] of external forces [F], as shown in Formula (2). The increase or decrease in annual average flood damage is then calculated using Formula (3). This basically explains changes in the total flood damage; while reinforcing F_0 by installing flood damage mitigation facilities will reduce the total damage, a rise in the potential flood damage will increase the total damage.

Flood Damage Mitigation Measures

(1) Structural measures :
to increase the capacity of flood damage mitigation facilities [F0]

(2) Non-structural measures:
to limit any increases in the number of social structures susceptible to damage (the potential flood damage S)

(3) Comprehensive measures :
combining both structural and non-structural measures
Comprehensive flood damage mitigation measures

Consequently, measures that can be used to reduce flood damage are as follows.

(1) Structural measures to increase the capacity of flood damage mitigation facilities [F_0] .

(2) Non-structural measures to limit any increases in the number of social structures susceptible to damage: the potential flood damage S.

(3) Comprehensive measures combining both structural and non-structural measures: Comprehensive flood damage mitigation measures.

In river basins undergoing rapid urbanization, comprehensive flood damage mitigation measures are considered effective from a social and economic standpoint.

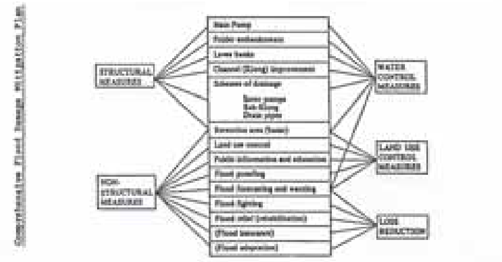


Fig.1 Comprehensive Flood Damage Mitigation Measures

This slide outlines the aforementioned comprehensive flood damage mitigation measures, which consist of a combination of structural and non-structural measures. As shown on the right hand side of the slide, comprehensive measures are made up of measures to control the flow of flood water, measures relating to land-use guidance and regulations and other measures designed to limit damage.

The Flood Damage Mitigation Program for the Naka/Ayase River Basin

In this next section, I will examine the comprehensive flood damage mitigation measures implemented in the Naka/Ayase River Basin in the eastern suburbs of the Tokyo metropolitan area. The author supervised the design, planning and finalization of this project on site.

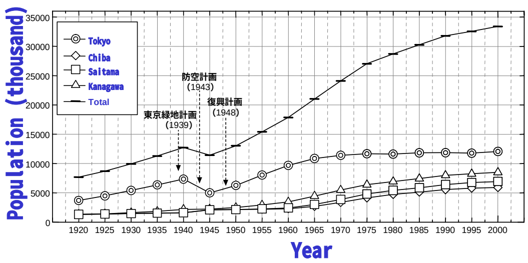


Fig.2 An Increase in Population of Tokyo Metropolis

This slide shows increases in population in the Tokyo metropolitan area. Over the course of the century, the area's population has increased from approximately 5 million to around 35 million.

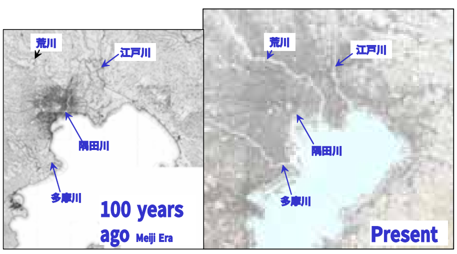


Fig. 3 The Expansion of Urbanized Areas of Tokyo Metropolis (Black Areas)

This slide outlines the growing extent of urbanization during the last hundred years. The black areas are urban areas. On the right you can see the current situation in Tokyo, compared to the urban areas roughly 100 years ago on the left.

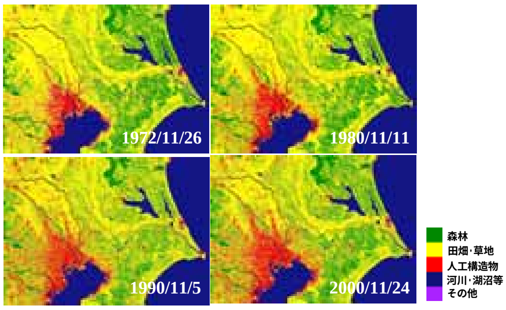


Fig. 4 The Expansion of Urbanized Areas from 1972 to 2000 (Red colored areas)

This slide shows satellite photographs of urban areas taken in 1972, 1980, 1990 and 2000, underlining the rapid progress of urbanization over the course of the latter half of the 20th century.

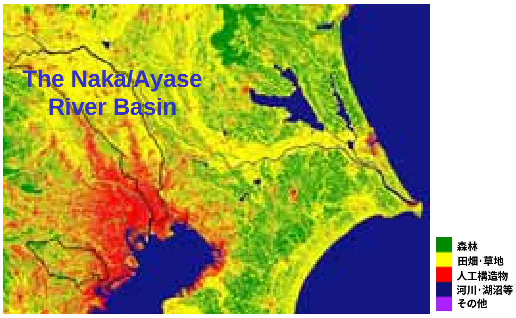
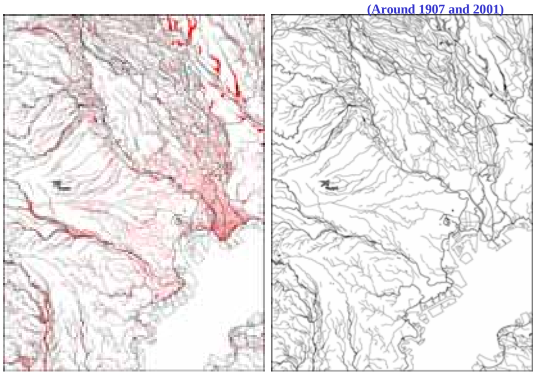


Fig.5 The Naka/Ayase River Basin: The Eastern Sub-urban Area of Tokyo Metropolis

This slide shows the extent of the Naka/Ayase River Basin in the eastern suburbs of the Tokyo metropolitan area, which I will come back to in a moment.

Fig.6 The Disappearance of Rivers, Streams and Marshy Lands (Around 1907 and 2001)



As you can see in this slide, a large number of rivers and waterways have disappeared from the Tokyo metropolitan area in line with the progress of urbanization. The rivers, agricultural waterways and canals marked in red on the diagram on the left have all disappeared, being turned into underground sewers or reclaimed to build roads or other facilities. This is another factor that has increased flood damage.

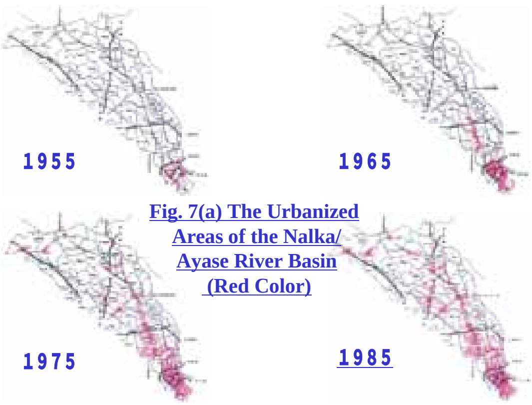


Fig. 7(a) The Urbanized Areas of the Nalka/ Ayase River Basin (Red Color)

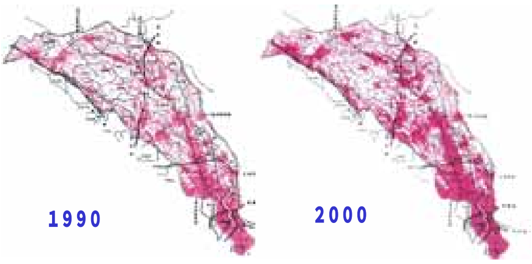


Fig. 7(b) The Urbanized Areas of the Naka/ Ayase River Basin (Red Colored areas)

This slide shows the progress of urbanization along the Naka/Ayase River Basin, going from 1955, to 1965, 1975 and finally 1985.

With the onset of serious problems due to flood damage as a result of the rapid urbanization of the river basin, the national, metropolitan and local authorities in the river basin agreed to set out and implement a plan for comprehensive flood damage mitigation measures in 1983.

This slide shows the progress of urbanization along the river basin after that point, indicating urban areas in 1990 and 2000. Urbanization continued even after the formulation of flood damage mitigation plans, with rapid urbanization during the period from the 1980s to 1990s in particular.

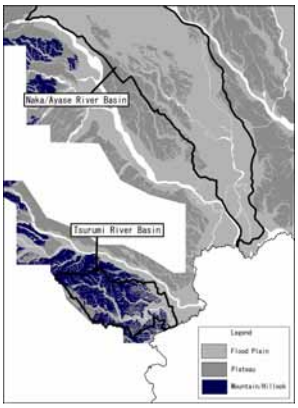


Fig. 8 The Geo-morphological map for the Naka/Ayase River Basin

This slide shows a simplified version of a flood land-form classification map, geo-morphological map, indicating the characteristics of the land along the Naka/Ayase River Basin in terms of flood damage mitigation. The river basin is made up largely of alluvial plains formed by flooding from the Tone, Arakawa and Watarase rivers and has always been an area susceptible to damage from flooding. The other parts of the basin apart from the alluvial plains consist of loam plains formed by deposits of volcanic ash. Although the land was previously used for paddy and dry fields, subsequent urban development led to the urbanization of the river basin.

Fig.9 The Comprehensive Flood Damage Mitigation Measures for the Naka/Ayase River Basin

This slide outlines the comprehensive flood damage mitigation measures implemented along the river basin, as mentioned previously.

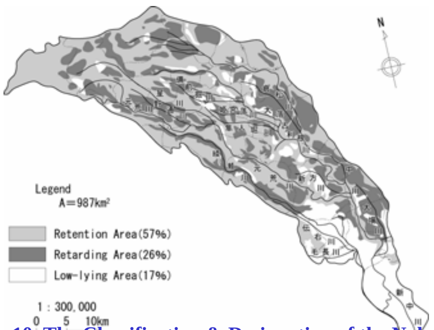


Fig.10 The Classification & Designation of the Naka/Ayase River Basin into Three Areas (1983) ; Retention, Retarding and Low-lying Areas

This slide classifies the river basin into three areas; flood water retention areas made up of woodland and fields that accumulate rainwater and allow it to infiltrate, flood water retarding areas made up of paddy fields that help to store flood water and to control flooding. Low-lying areas that are protected as urban areas.

The comprehensive flood damage mitigation measures essentially restricted urbanization to preserve water retention and retarding areas in an effort to preserve the river basin's natural flood retention and retarding capacity and, as an essential part, not to increase the potential flood damage. The plan was to prevent any increase in Potential flood damage as a result of development in such areas. In low-lying areas, the plan was to implement flood damage mitigation measures to protect against flooding and encourage urbanization to remain within such areas.

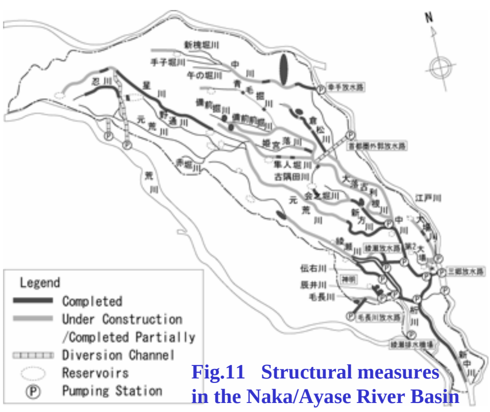


Fig.11 Structural measures in the Naka/Ayase River Basin

This slide outlines the structural measures implemented. These basically consisted of measures in line with the characteristics of the river basin, in view of the river's increased outflow capacity and the fact that it is a gently-flowing river in a low lying area, and included measures to drain the flow of flood water through multiple bypass drainage channels and reduce the downstream flow of water, measures to drain flood water using drainage pumps and measures to retain and regulate levels of flood water based on the installation of retarding basins as structural measures.

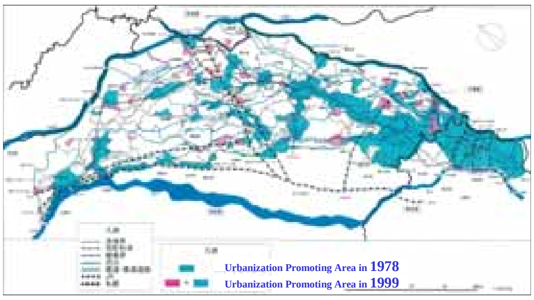


Fig. 12 The Urbanization Promotion Areas in the Naka/Ayase River Basin in 1978 and 1999

This slide indicates urbanization promotion areas under land-use plans, a key part of non-structural measures. In addition to urbanization promotion areas, there are also urbanization control and adjustment areas subject to restrictions or limits on urbanization. The slide shows urbanization promotion areas in 1978 and 1999. Over the course of the 20 intervening years, urbanization promotion areas increased in size slightly as the parts marked in yellow were incorporated into urbanization promotion areas.

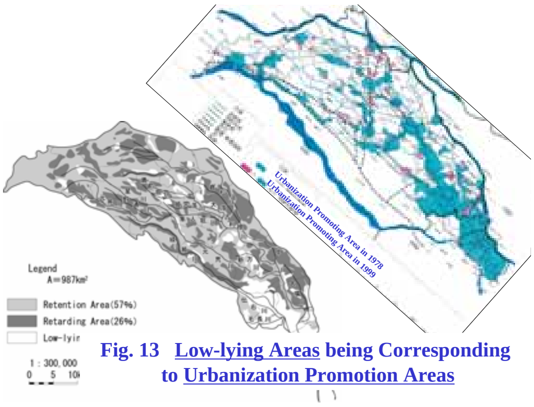


Fig. 13 Low-lying Areas being Corresponding to Urbanization Promotion Areas

This slide shows how the urbanization promotion and urbanization control areas correspond to the three areas mentioned previously. The white parts on the diagram on the left show low lying areas that were subjected to flood damage mitigation measures and continued urbanization, meaning that these were set out as urbanization promotion areas. The other areas are urbanization control and adjustment areas, consisting of woodland and fields expected to function as water retaining areas for the purposes of flood damage mitigation and paddy fields expected to function as water retarding areas. Development was restricted in these areas to preserve the river basin's natural flood (damage) mitigation capacity.

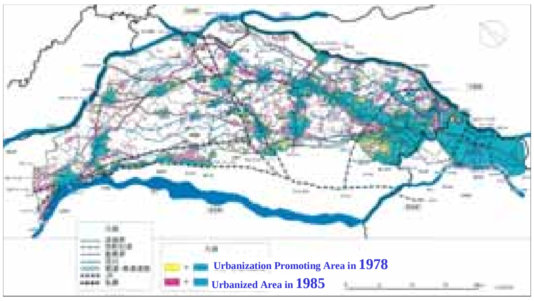


Fig.14 Urbanized Areas (blue, yellow and red) in 1985
with Urbanization Promotion Areas (blue and yellow)

This slide shows urbanized areas in 1985.

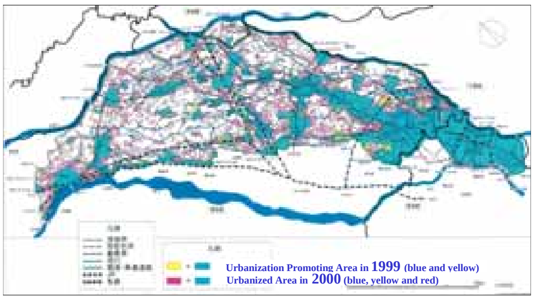


Fig. 15 Urbanized Areas (blue, yellow and red) in 2000
with Urbanization Promotion Areas (blue and yellow) in 1999

And this slide shows urbanized areas along the river basin in 2000, 17 years on from the implementation of comprehensive flood damage mitigation measures. It is evident from the diagram that urbanization has progressed not only in the urbanization promotion areas marked in blue and yellow, but also in urbanization control and adjustment areas outside of such areas.

Despite the fact that developers working in urbanization control and adjustment areas are obliged to implement rainwater retention and infiltration measures in line with the scale of development, it is clear that development has gone above and beyond the original concept and principle of comprehensive flood damage mitigation plan.

The reason for this is that restrictions on development were relaxed from around 1985 onwards due to economic and political factors, not the least the revitalization of the economy on the back of private sector activity.

The authorities responsible for flood damage mitigation actively supported development during the latter half of the 1980s as plans were drawn up and initiated for a hugely expensive metropolitan outer drainage channel in the midstream area in an effort to supply the area with quality housing. This was a change in principles with regard to flood damage mitigation policy.

In spite of developments such as these however, the extent of urbanization promotion areas under land-use guidance and regulations set out for the purposes of flood damage mitigation in the Naka/Ayase River Basin have remained largely unchanged from the initial plans. As urbanization is encouraged with flood damage mitigation in mind, the original concept is still more or less in place and can be said to have proved effective to date.

This slide outlines changes in the levels of flood damage along the Naka/Ayase River Basin. Whereas floods for the same amount of rainfall, the total inundated area and number of buildings experiencing flooding have decreased significantly. Although this is largely the result of the implementation of structural measures, comprehensive flood damage mitigation measures can be regarded as having been highly effective in this case.

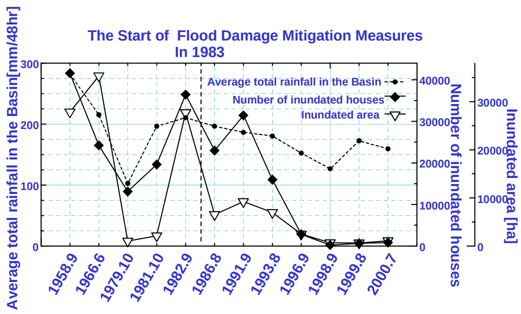


Fig. 16 Changes of Inundated Areas and Houses
at Time of Recorded Flooding in the Naka River/Ayase River Basin

The Flood Damage Mitigation Program for the Eastern Sub-urban Bangkok Areas (Basin)

In this next section, I will examine comprehensive flood damage mitigation measures implemented by the Bangkok Metropolitan Administration (BMA) in the eastern suburbs of the Bangkok metropolitan area in Thailand. The Japanese government provided technical assistance at the planning stages of this project through the Japan International Cooperation Agency (JICA), an initiative in which I myself was involved.

Since then, the BMA has continued to make improvements and alterations in line with changes in levels of flood damage and social, economic and political conditions and investigate and observe measures carried out, while (whilst) still keeping to the original basic plan.

The majority of the data that follows is from staff at the BMA or staff at the Thai Royal Irrigation Department (RID), an organization with which I myself subsequently had chance to get involved as part of technical cooperation from the Japanese government with the formulation of flood damage mitigation plans for the full length of the ChaoPhraya River.

Most of you will probably already be familiar with the following section of my presentation, so I will try to be as concise as possible.

This slide shows the full length of the ChaoPhraya River.

Fig. 17 The Chao Phraya River Basin

This slide shows the Bangkok metropolitan area, which is located in the downstream area of the Chao Phraya River.

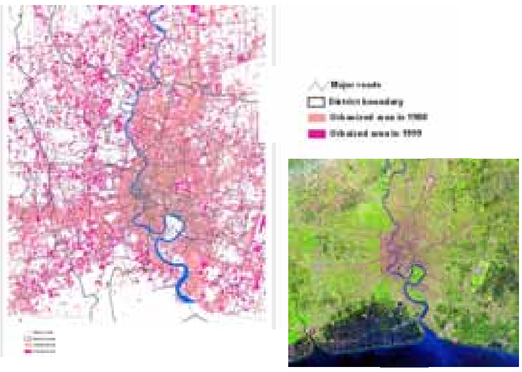


Fig.18 The Bangkok Metropolis

This slide shows the midstream area of the Chao Phraya River and the network of rivers and agricultural channels in the downstream area of the river. Despite (some) flooding in the Bangkok metropolitan area, this network of channels discharged large volumes of water from the north to the Bangkok metropolitan area, during major flooding in 1983.

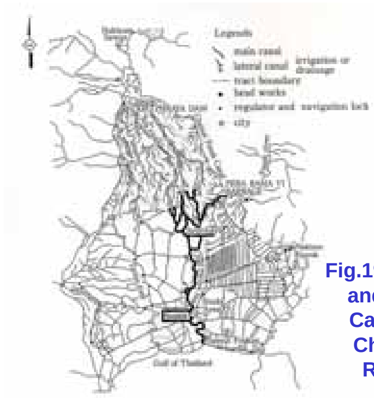


Fig.19 The Rivers and Irrigation Canals in the Chao Phraya River Basin

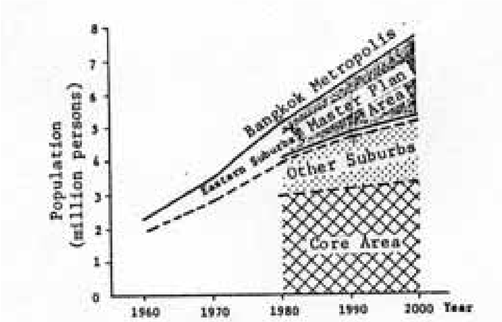


Fig. 20 An Increase in Population in Bangkok Metropolitan Areas (predicted at the time of the Program started)

This slide indicates estimated increases in population at the time that flood damage mitigation plans were drawn up for the eastern suburbs of the Bangkok metropolitan area in the wake of major flooding in 1983. In actual fact, I believe that the population has probably grown and urbanization progressed at an even faster pace in reality.

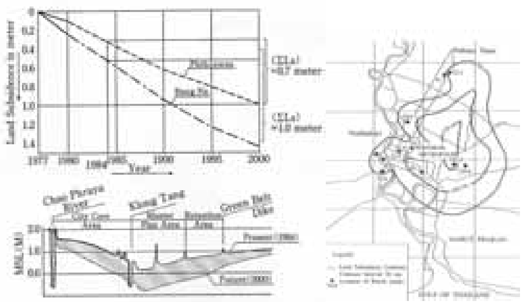


Fig. 21 The Land Subsidence of Bangkok Metropolitan Areas
(left: prediction, right: subsidence from 1933 to 1986)

This shows land (ground) subsidence in the Bangkok metropolitan area, particularly in the eastern suburbs where flood damage mitigation plans were drawn up. Although this subsidence was caused by the pumping of underground water, it became particularly severe around 1983. Although the subsidence has been alleviated to some extent by current measures, it has not been stopped completely. The scope of subsidence is also growing and changing.

Subsidence has aggravated the conditions for flood damage. In areas such as Phra Khanong, where flood damage was most severe in 1983, it was not possible to drain flood water into the ChaoPhraya River, resulting in areas remaining flooded for up to three months and suffering major damage.


Fig.22 Rivers and Klong
(old time)

This slide shows the network of waterways in the Bangkok metropolitan area in old time

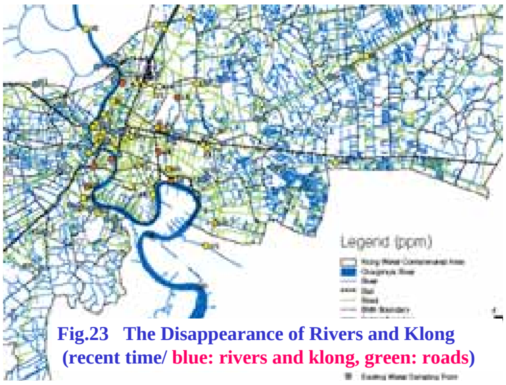


Fig.23 The Disappearance of Rivers and Klong (recent time/ blue: rivers and klong, green: roads)

and this slide at present time. As is the case in the Tokyo metropolitan area, the disappearance of canals and agricultural channels as a result of advancing urbanization has also made conditions worse in terms of flood damage.

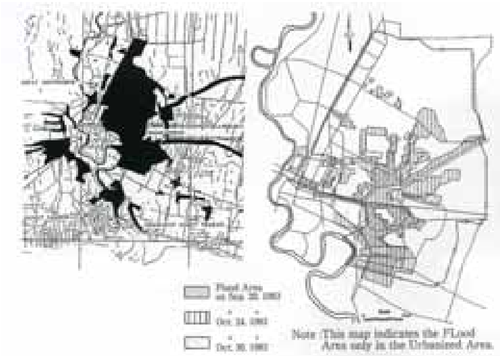


Fig. 24 Inundated Areas for the 1983 Flood

This slide shows the areas that became flooded during flooding in 1983.

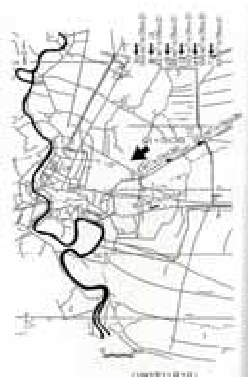


Fig.25 The Inflow Discharge from the Northern Agricultural Areas

This slide outlines measurements of the volume of water flowing from the north during flooding in 1983 taken by myself and a JICA consultant. Despite the fact that urban areas of Bangkok were flooded, $80m^3$ of water per second continued to flow through from the north.

Photo 1. The Scene of the 1983 Flooding

This is a photograph of the flood in 1983. It shows the flood damage in Bangkok at the time, as a city reliant on vehicles saw its roads flooded. The scenes of flood (water) damage were something new to the city at the time.

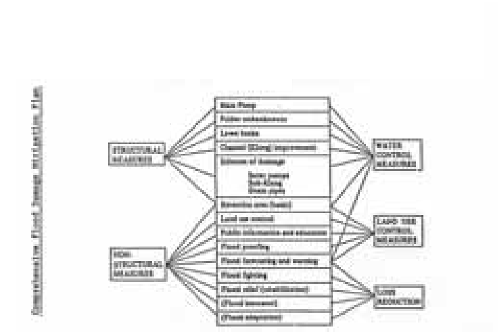


Fig. 26 The Comprehensive Flood Damage Mitigation Measures
for the Eastern Sub-urban Bangkok Area (Basin)

This slide outlines the comprehensive flood damage mitigation measures that were implemented. Essentially, the almost same comprehensive measures were implemented as in the aforementioned case of the Naka/Ayase River Basin.

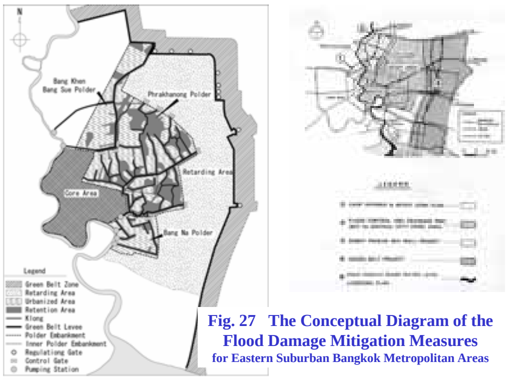


Fig. 27 The Conceptual Diagram of the Flood Damage Mitigation Measures
for Eastern Suburban Bangkok Metropolitan Areas

This is a simple diagram outlining comprehensive flood damage mitigation measures in the eastern suburbs of the Bangkok metropolitan area.

It shows both structural measures, including waterway improvement work, the installation of drainage pumps, levees (polders) to prevent flooding from rivers and waterways (klong), an outer embankment called the King's Dike and flood gates, and non-structural measures, including the preservation of flood water retarding capacity in the green belt area on the outside of the King's Dike and on the outer side of the secondary barrier positioned inside the King's Dike and the provision of rainwater retention areas to retain rainwater inside the secondary barrier.

Fig. 28 Structural measures

This slide shows the structural measures. Plans were set out in line with the characteristics of the river basin and included blocking off the flow of flood water from outside the area, development work on rivers and klong to improve flood drainage capacity, positioning levees (polders) and installing facilities such as drainage pumps and flood gates along the Chao Phraya River, and so on.

Fig. 29 Green Belt, Retarding Area and Retention Area as Non-Structural Measures

This slide shows the non-structural measures. It is an essential part of plans not to increase the potential flood damage and to keep the natural function for flood damage mitigation. Plans included the King's Dike and the green belt area on the outside, flood water retarding areas between the King's Dike and the secondary barrier and flood water retention areas on the inside of the secondary barrier. These measures were planned in order to preserve flood water retention and retarding capacity in line with the characteristics of the river basin.

As areas that have always been susceptible to flooding during floods, plans were set out to restrict and control urbanization in these areas.

There were no land-use plans formulated for the Bangkok metropolitan area during the planning stages. Instead, land-use plans for the area were drawn up at a later date by the Ministry of Interior. Authority for the formulation of land use plans was then transferred to the Bangkok Metropolitan Administration, BMA, after that.

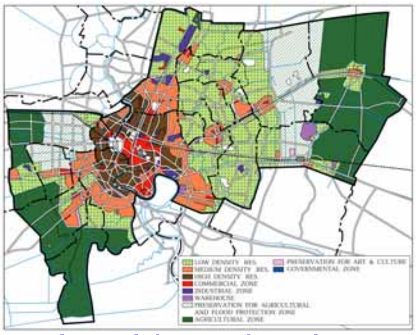


Fig. 30 The Bangkok Metropolitan Administration's Comprehensive City Plan

This slide shows the BMA's current land use plan.

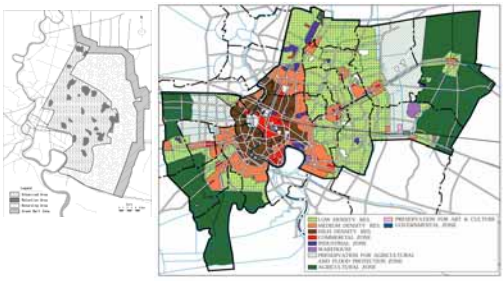


Fig. 31 The Comparison between the Plan for Flood Damage Mitigation and the Land Use Plan

This slide features an outline diagram of the aforementioned land-use plan set out from the standpoint of flood damage mitigation, compared to the current land-use plan for the Bangkok metropolitan area.

Although the land-use plan does not exactly match the originally envisioned flood damage mitigation plans, a significant portion of the original plans are still in place today. Specifically, the green belt area remains in place in the Bangkok metropolitan area today as it was initially.

The flood water retarding areas outside the secondary barrier have been designated as low-density land use areas. The flood water retention areas inside the secondary barrier have also been designated as low-density land-use areas, with flood water retarding basins as structural measures also being installed in several places.

As in the case of the Naka/Ayase River Basin, land use is not determined exclusively from the standpoint of flood damage mitigation.

Although development has also continued in the Bangkok metropolitan areas resulting from social, economic, political and other such factors, in broad terms the flood damage mitigation-based land-use guidance and regulations are still in place to some extent and would be fair to say that they have been effective to date.

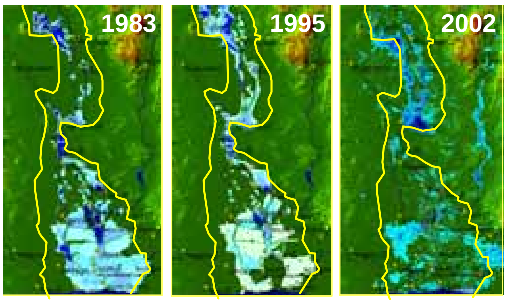


Fig.32 The Recent Flooding Areas in the Chao Phraya River Basin (inundated areas)

This slide shows the main flood damage in the downstream area of the Chao Phraya River Basin since 1983.

Despite some partial flooding, the eastern suburban river basin in the Bangkok metropolitan area has not flooded since 1983. Moreover, any partial flooding has been short term, lasting a matter of days or hours rather

than several months, marking an end to the sort of flood damage that occurred in 1983.
Although this is largely the result of the implementation of the aforementioned structural measures, it would be fair to say that the comprehensive flood damage mitigation measures have proved effective.

Fig. 33 Flood Protection Walls (levees) along the Chao Phraya River
(left: usual days, right: flood season)

This is a photograph of a retaining wall (levee or embankment) designed to guard against flooding from the Chao Phraya River.
Although the risk of flooding from the Chao Phraya River has been significantly reduced thanks to the installation of levees such as these in most areas, they may have sparked controversy with regard to their impact on the scenic waters around Bangkok.

Conclusion

(1) Setting out a fundamental theory and a basic flood damage mitigation measures .

(2) The results of comprehensive flood damage mitigation measures in the eastern suburbs of both the Tokyo and Bangkok metropolitan areas.

(3) Comprehensive flood damage mitigation measures: positive effect in gently-flowing river basins in low-lying areas experiencing rapid urbanization.

(4) Non-structural measures: Land use guidance and regulations being effective as an essential part of flood damage mitigation.

My conclusion consists of four points, as shown on this slide.
(1) I have set out a fundamental theory with regard to alleviating flood damage and used this as the basis upon which to outline a basic flood damage mitigation measures .
(2) I have reported on the results of comprehensive flood damage mitigation measures implemented in river basins in the eastern suburbs of both the Tokyo and Bangkok metropolitan areas.
(3) As a result, it has become apparent that comprehensive flood damage mitigation measures have a largely positive effect in gently-flowing river basins in low-lying areas experiencing rapid urbanization.
(4) I have discussed non-structural measures in the form of land use guidance and regulations in particular in detail in my report, as a result of which it has become apparent that land-use guidance and regulations (measures to limit increases in potential damage) are effective to a

certain extent as an essential part of flood damage mitigation.

I would emphasize the 4th, on non-structural measures.

Thank you for your attention.

Thank you for your attention

Questions and Discussion

Chaired by Junichi Yoshitani, Public Works Research Institute

Chair: Although the time for questions has been scheduled for after the complete presentation, specific doubts and opinions can be expressed at this point.

Question: He does not live in Thailand, but I believe that the project he began in 1982 has always been on his mind. Dr. Yoshikawa emphasized that he would like to see a comprehensive and more active approach to the water policy related issues. In fact, he has revisited us quite often and maintained regular contact. However, I believe that the use of the retardation basin has not been effective because of the difficulty in propagating the idea that storing water can reduce the risk of floods. It appears that constructing pumping stations and the like have been more successful. I am unsure of whether we are comparing the idea proposed here with that proposed for the Ayase river area. Has retardation been more successful than pumping in Japan? Further, how would you convince people that the two technologies are the same and that both should be implemented?

Answer: Although this is a slightly difficult question, in truth, the situation in Japan is similar to that in Thailand. People are actively concerned with how to mitigate floods soon after it; however, with time, people tend to forget. In Japan, the improvement of the drainage system continues.

In our plan, we had hoped to maintain the natural flood retention and retardation in the urbanization control and adjustment area, which is on the periphery of the urbanization promotion area. The urbanization promotion area was determined in 1983. After 17 years, in 1999, the urbanization control and adjustment area remains on the periphery of the urbanization promotion area. This suggests that our plan is currently still effective, and perhaps, this is stricter in comparison to other cases.

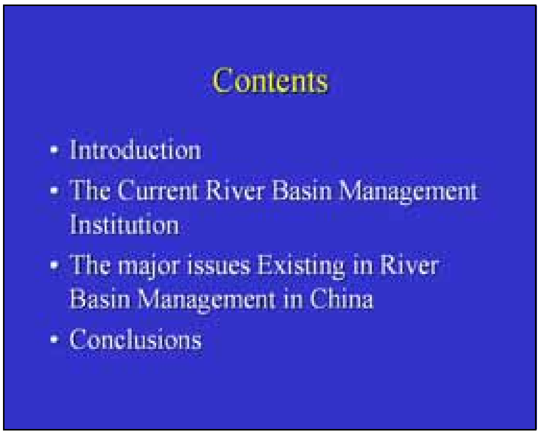
Question: I am in favor of a retardation basin. The Governor of Bangkok recently proposed a housing project in which each house would be equipped with a water holding facility. Although this is a good idea, I believe that it is extremely difficult to implement. For instance, estate prices are very high in Bangkok and accommodating a holding pond will require 30% to 50% of the total land for the project. Thus, the housing project will be unfavorable to the developers and expensive for the consumers.

I believe that Bangkok as a whole should be considered for flood alleviation. A King's dike system similar to the holding pond but much bigger, perhaps 5 to 15 million cubic meters, should be constructed. This is because a small pond in one housing project maybe insufficient and difficult to implement. I fear that the Bangkok Metropolitan Administration will introduce this concept and reclaim the housing estate to build holding ponds.

3. Recent Progress in Flood Management in China

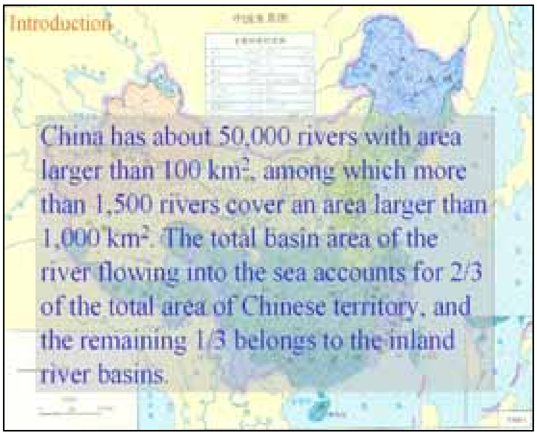
Cheng Xiaotao

Director, Professor of China Institute of Water Resources and Hydropower Research

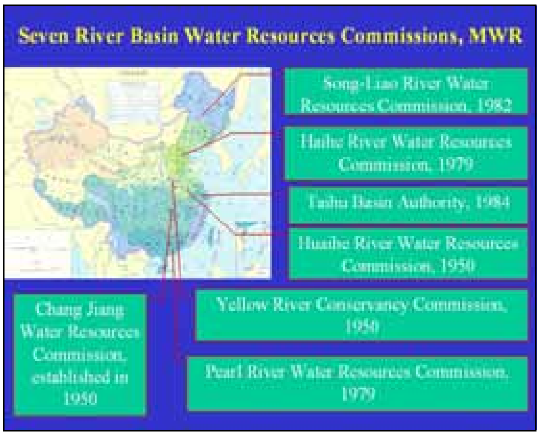


I will begin my presentation with an introduction of river basin management; then, I will discuss the current river basin management institutions, the major issues existing in river basin management in China, and conclusions.

China is a large country on the east of the Eurasian continent. Topographically, it is higher in the west and is lower in the east; consequently, some major rivers flow eastwards to the sea. Further, China can be divided into three steps: the Qinghai-Tibet plateau with an elevation of 4,000 meters or more, the plateau and basins with an elevation of 1,000 to 2,000 meters, and the vast plains and hills with elevation of 500 meters or lower.

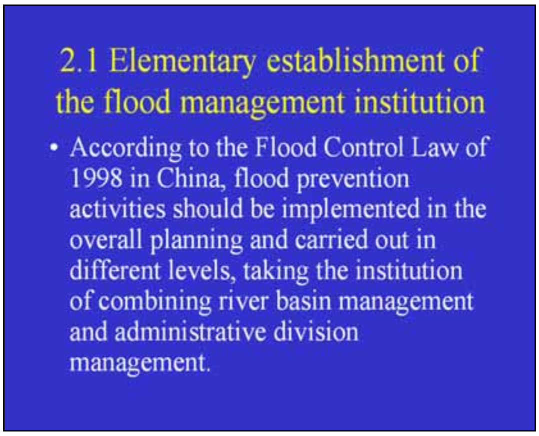


Further, China has a few major rivers, including the Pearl river in the south, the Yangtze river, the Huaihe river, the Yellow river, the Liaohe river and the Changjiang river. There are several smaller rivers as well. A total of 50,000 rivers in China cover an area of 100 square kilometers or more; among them, more than 1,500 rivers cover an area of 1,000 square kilometers or more. The total basin area of rivers flowing into the sea accounts for two-thirds of the total Chinese territorial area; the remaining one-third is the inland river basin.



At present, there are water resources commissions responsible for improving the management of the seven major river basins. The Chang Jiang Water Resources Commission, the Yellow River Conservancy Commission, and the Huaihe River Water Resources Commission were established in 1950. The Haihe River Water Resources Commission and the Pearl River Water Resources Commission were established in 1979. The Song-Liao River Water Resources Commission was established in 1982; the Taihu Basin Authority, in 1984.

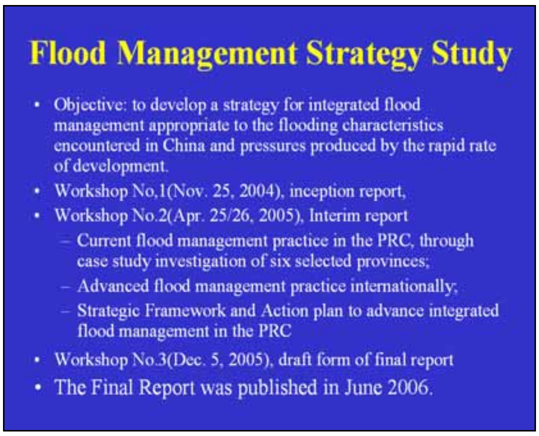
The current river basin management institution.



According to China's Flood Control Law of 1998, flood prevention activities should be considered during the overall planning; the execution should be at different levels, combining river basin management with administrative division management.

At present, a system of laws and regulations concerning flood damage mitigation is in place. The Water Act, the Water Course Management Regulation, and the Guidelines for Security and Construction of Flood Detention Area were implemented in 1988; the Flood Fighting Regulation, in 1991; the Flood Control Law, in 1998; and the statute for compensation for flood detention area, in 1999. Further, in the recent years, schemes pertaining to significant activities against the existing floods with regard to the Yellow, Yangtze, Huaihe, and Yongding rivers have been authorized.

The process of evolving from flood control to flood management began in the 1980s when China established reforms and opened its economy. Following which, several issues concerning flood management arose; thus, in 2003, China moved from flood control to flood management. A series of countermeasures such as enhancing the policies and regulations, institutionalizing and improving flood prevention and drought relief schemes, initiating specific planning, promoting the development of the information system for flood and drought management, and undertaking research projects, were taken.



The Asian Development Bank supported a research project that aimed to develop a strategy for integrated flood management suitable for the flooding characteristics observed in China and the increasing pressures encountered due to rapid urbanization. Several workshops were organized, including one on November 25, 2004, for which an inception report was made available; another one was held on April 25 and April 26, 2005, for which an interim report containing the current practices in flood management in the People's Republic of China and a case study on the six selected provinces that differ in terms of their river basins and economic development zones, was made available. The third workshop was held on December 5, 2005, for which a draft of the final report was made available. The final report was published in June 2006.

2.2 Achievements of Flood Zoning for the Whole Nation

- In order to serve for the flood management, China has made flood zoning for the whole nation as an important fundamental work in the Tenth Five-Year National Flood Control Planning. The outcomes of flood zoning are divided into Flood zone, Transition zone and Non-flood zone (see Table 2 and 3).

China made flood zoning of the whole nation a fundamental activity in the 10th Five-Year National Flood Control Planning (2001–2005). The 11th Five-Year National Flood Control Planning will commence this year.

The Flood Zoning Achievements for the Whole Nation (statistic data in 1999)

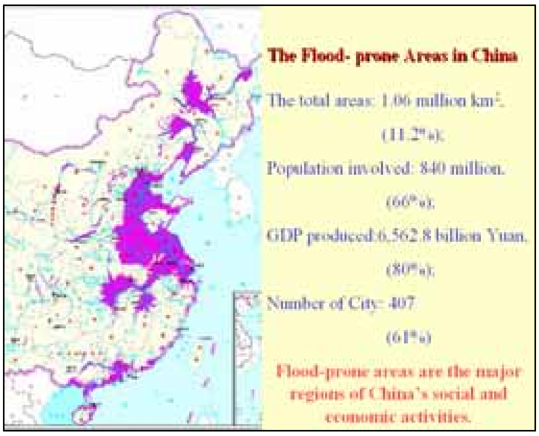
	Flood Zone	Transition Zone	Non-Flood Zone	Calculated area
Total area (10^3 km^2)	1,059.5	5.691	2,706.6	9,457
Percentage (%)	11.2%	60.18%	28.62%	100%
Population (10^6 person)	836.844	416.319	5.92 74	1,259.09
Percentage (%)	66.46%	33.07%	0.47%	100%
GDP(10^9 Yuan)	6,562.79	1,594.28	34.02	8,191.09
Percentage (%)	80.12%	19.46%	0.42%	100%
Density of Population (people / km^2)	790	73	2	133
GDP per capital (Yuan / person)	7,842.3	3,829.5	5,739.7	6,505.6

This table shows the figures of zoning.

Flood Zone distributed in Seven Major River Districts (statistic data in 1999)

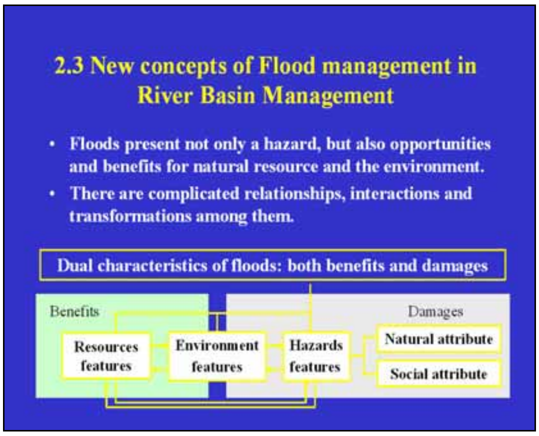
Name	Area		Population		GDP	
	km^2	%	million	%	billion Yuan	%
Songhua River	133,662.00	12.62	20.716	3.92	180.688	4.09
Liaohe River	63,418.44	5.99	15.246	2.88	157.032	3.55
Haihe River	135,012.56	12.74	88.559	16.76	704.416	15.94
Yellow River	45,938.88	4.34	22.504	4.26	137.597	3.11
Huaihe River	209,344.47	19.76	142.701	27.01	623.438	14.11
Changjiang	210,081.10	19.83	113.327	21.45	784.615	17.76
Taihu Lake	31,927.65	3.01	23.749	4.49	407.287	9.22
Pearl River	39,939.73	3.77	20.805	3.94	438.950	9.93
Sum up	869,324.82	82.05	447.607	84.71	3,434.023	77.71

We divide the zone by seven major rivers.

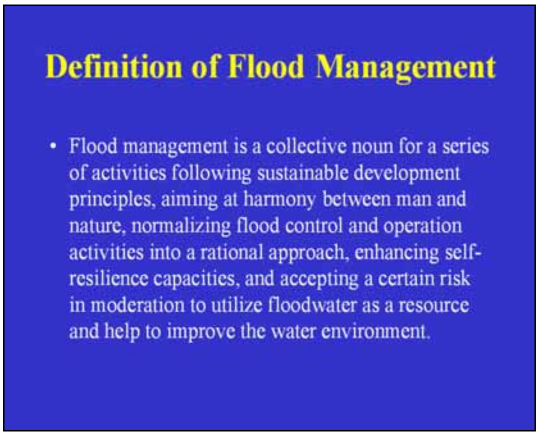


The seven major river basins, especially in the lower reach, are major flood prone areas with an area of 1.06 million square kilometers (11.2% of the total area) and 407 cities within it (61% of the total number of cities). A population 840 million (66% of the total population) resides in the flood prone areas. The GDP produced from this area is 80%. Therefore, the flood prone areas are the major socio-economic zones in China.

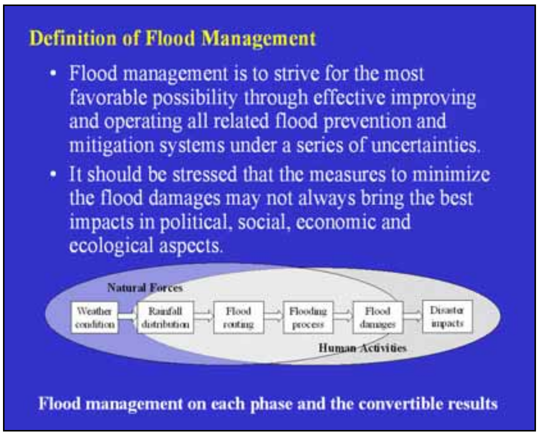
From this map, we can understand which parts the flood is severe under our standard of flood prevention.



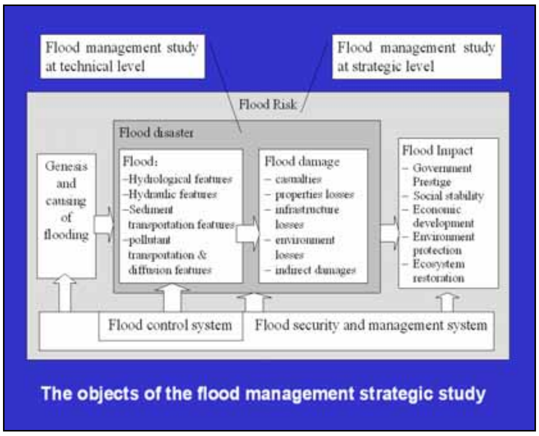
Originally, we regarded floods as hazardous and only understood its natural characteristics; however, we now understand its social attributes and regard it as having resources and environment features. Subsequently, we understand the complicated relationships, interactions, and transformations among these features. Thus, we believe that the damages caused by floods can be beneficial, and conversely, the benefits can be destructive.



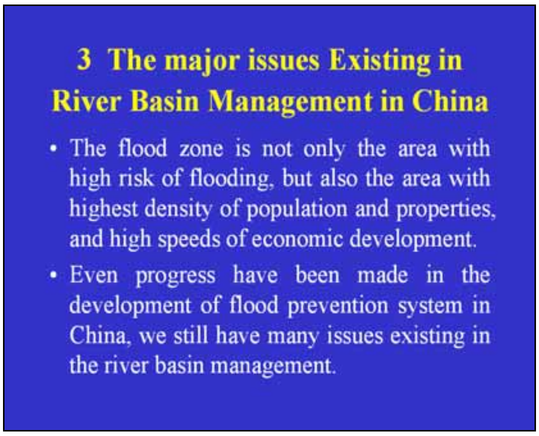
Flood management is defined as a collective noun representing a series of activities that follow sustainable developmental principles, aim at creating harmony between man and nature, rationalize flood control activities, enhance self-resilience capacities, accept the risk involved in utilizing flood water as a resource, and help to improve the water environment.



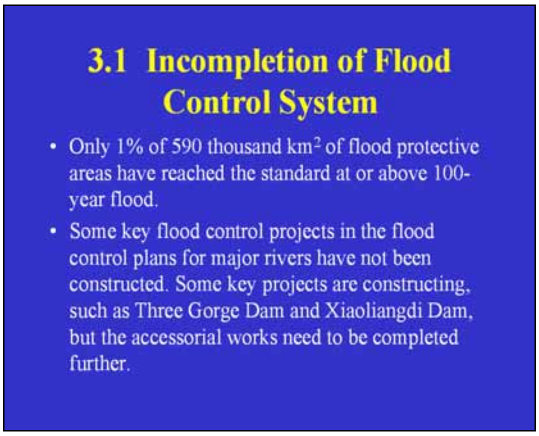
Hence, we believe that flood management is an endeavor to achieve the most favorable circumstances by effectively improving and operating all related flood prevention and mitigation systems under a series of uncertainties. Thus, I would like to emphasize that measures taken to mitigate flood damage may not necessarily have the best impact on the potential social, economic, and ecological aspects.



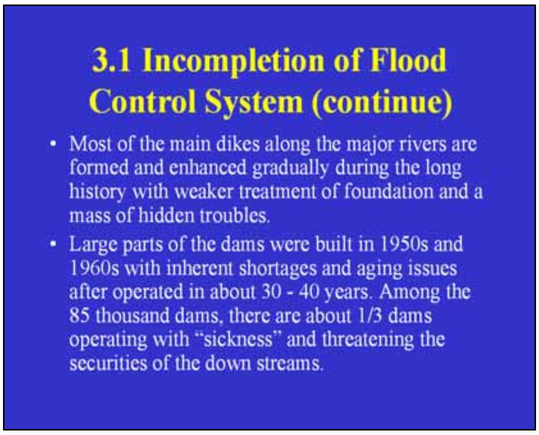
Recently, we realized that the impact of floods on the government's prestige, social stability, economic development, environmental protection, and the restoration of the ecosystem, must also be considered. Considering the risk involved in improving these aspects needs to be examined at the technical and strategic level.



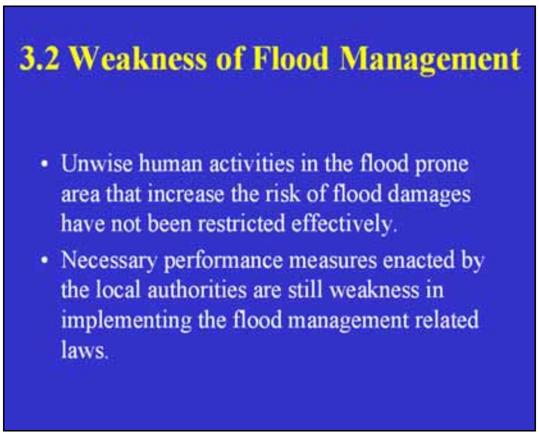
With regard to the major problems that exist in river basin management, the flood zone is not only a flood prone area; it is also an area with the highest density of population and an area of rapid economic development. Although the development of flood prevention systems in China has considerably progressed, many issues pertaining to river basin management still exist and have not been dealt with.



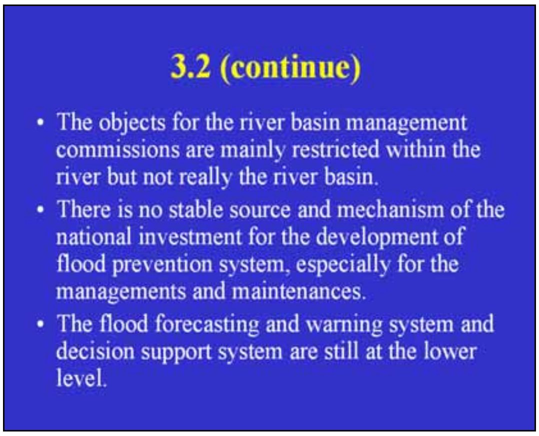
Incompletion of Flood Control System.



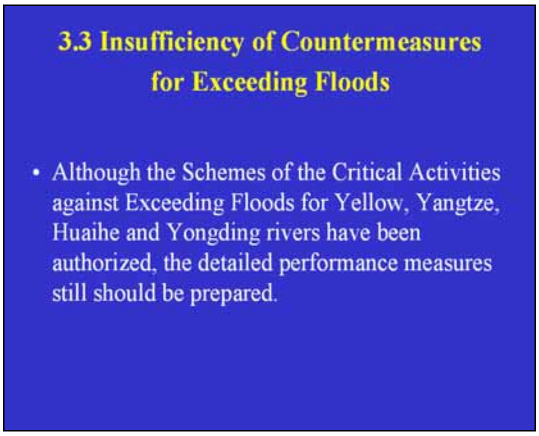
Further, most of the main dikes along the major rivers have been built gradually over a period of time; hence, their foundation is weak. Most of the dams were built in 1950s and 1960s; after operating for about 30 to 40 years, major problems have arisen. One-third of the 85,000 dams are in poor a condition.



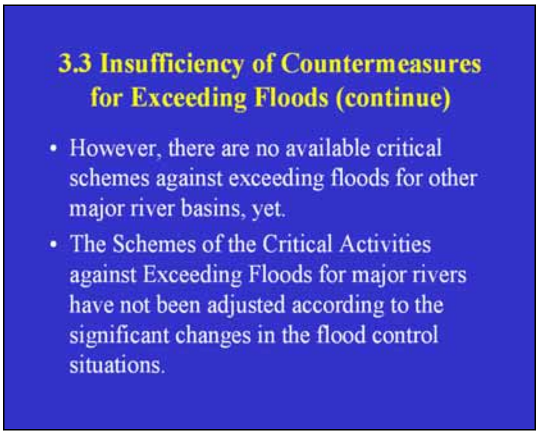
Moreover, activities that increase the risk of flood damage have not been effectively restricted by the local authorities, and the laws related to flood management have not been implemented.



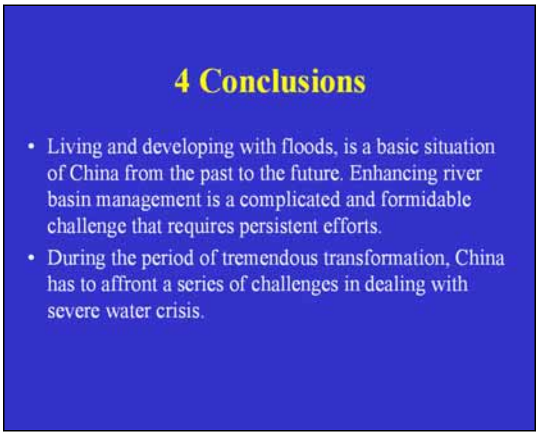
The development of a flood prevention system lacks the stable source and mechanism required for national investment.



In addition, although the countermeasures to prevent exceeding floods have been authorized for certain rivers, they are still in a nascent stage.

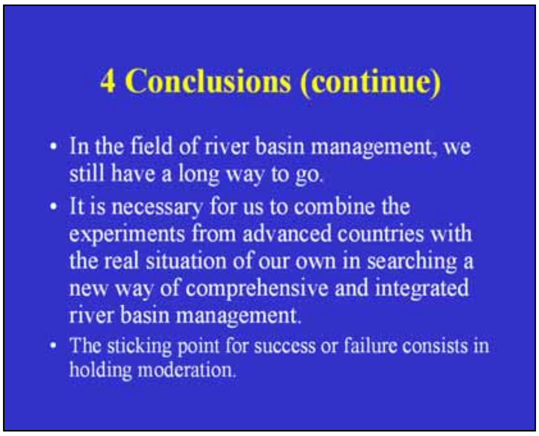


And for other major rivers, they are still undefined.



In conclusion, the people of China have lived and evolved alongside floods from time immemorial. The improvement of river basin management is considerably challenging and requires persistence. During China's developmental period, it encountered a series of challenges when dealing with extreme water crisis.

Presently, new issues on flood management and flood damage mitigation have arisen and will continue to do so with the rapid increase in urbanization. After establishing a sound legal and managerial system, the improvement of the flood management system to facilitate socio-economic development will be the main area of focus.



It is imperative that we incorporate experiments and tests conducted in developed countries into our present situation to develop a comprehensive and integrated river basin management system.

Questions and Discussion

Question: Presently working as scientists, we are looking for effective parameters on which to build. We believe that due to the misuse of land and due to increased operation, deforestation has risen and its effects have been detrimental. Looking into the past, the population and deforestation was less; we believe that changes in the global climate have had a significant impact on floods.

The Tone river in Japan can be regarded as a fine example of flood damage mitigation. According to the policy, people in the city are evacuated to a safer area to prevent flood damage caused by the Tone riverfront. However, in Bangkok, we are unable to evacuate people to another area. Even though we are aware of the capacity of water needed and the extent to which the Chao Phraya river and the river mouth need to be widened, we are unable to do so. In your country, the decision to construct a dam is made regardless of the challenges involved. This is because the people are aware of their responsibility towards flood damage mitigation.

In Bangkok, the land belongs to the king. Regardless, the people have agreed to the projects approved by the government. However, many large-scale projects that have been approved cannot be constructed. Although we are aware of the existing problems, as scientists in Thailand, we are unable to solve them despite several discussions.

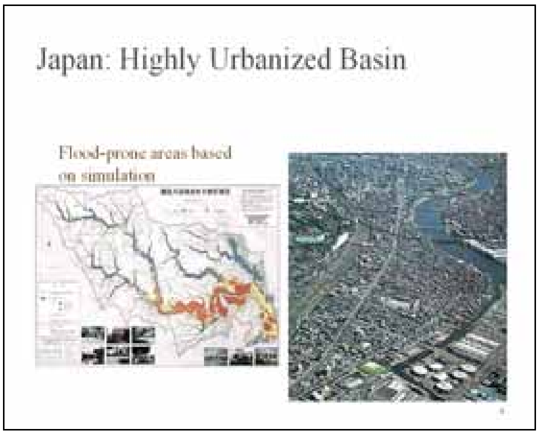
Answer: Even in China we have attempted to implement several measures, particularly after the 1998 floods. Although the government has established 32 policies, problems still exist because of our population and the need for basic resources. Consequently, we believe that moderation is crucial in flood damage mitigation.

4. Best Practices Found in China's New Flood Management

Junichi Yoshitani
Public Works Research Institute of Japan

Dr. Xiaotao and I have been working together on analyzing the water and flood management policy in the Changjiang river basin. This slide shows typical flood control measures. We build dams and reservoirs across streams and levees around rivers to control floodwater. We also build retardation basins around rivers or construct diversion channels to control floods. In this presentation, I will focus on retardation basins.

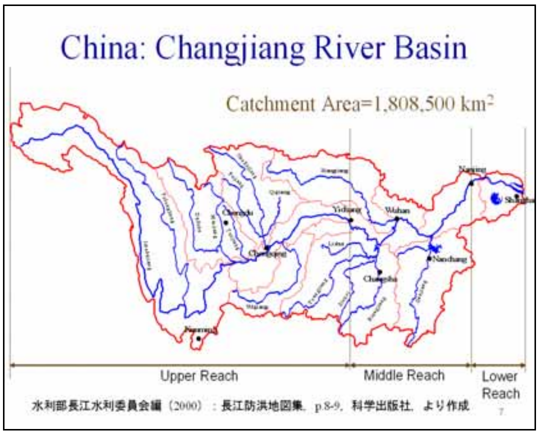
In yesterday's issue of The Nation, it was reported that the king has granted the RID permission to divert the flood water into his properties at Pathum Thani and Saraburi. Such methods are extremely unique to Japan as well as China and are perhaps possible only in Thailand.



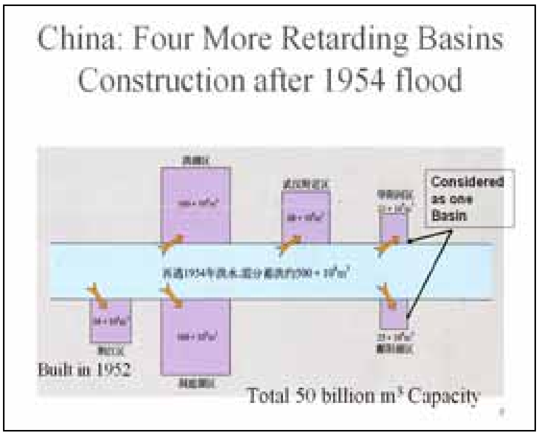
The Tsurumi river basin is an example of land use management for flood control in Japan. It is in a highly urbanized area of Japan with limited space.

In this river basin, the developers have built small-scale storage facilities that in most of time serve as tennis courts or playgrounds but can be used for retention of rainwater during floods. This is regulated by the land development code under the city ordinance.

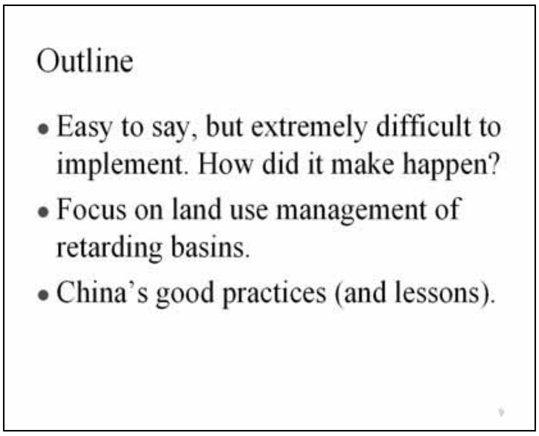
The tributary of the Tone river that flooded in 1886 can be regarded as another example. Following the floods, the government revised a plan for flood mitigation under which a retardation basin was constructed. In order to construct the retardation basin, certain residents were relocated; moreover, the government and the landowners signed an agreement that was not under any law or ordinance and was termed as an easement. According to the easement, the government was required to pay some money to the landowners at the time of signing; however, the government was not responsible for paying any damages or compensation after the agreement was signed.



The next is the Changjiang river flood management case. This slide shows the whole basin of the Changjiang river and the Three Gorges Dam.

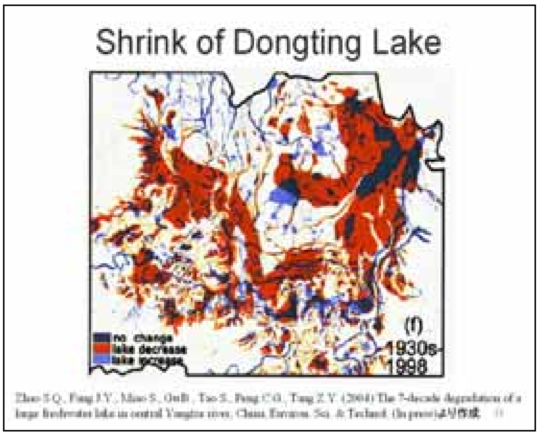


The Chinese Government built huge retarding basins along the Changjiang River. Now, total capacity is 50 billion cubic meters.

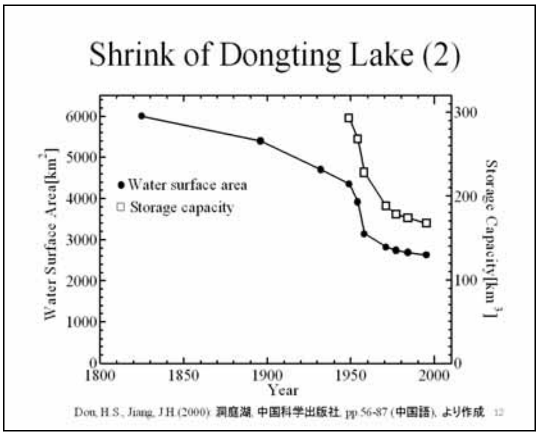


My topic outline is this.

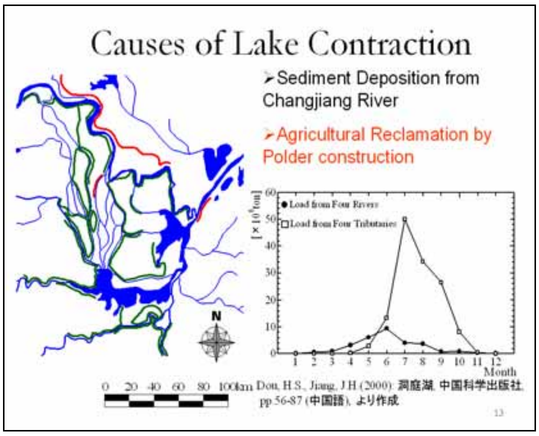
In this presentation, I will focus on issues concerning land use management, such as the authorization of land, ownership of land, and flood control system (structural or non-structural), for constructing retardation basins, particularly in China.



Dongting Lake (one of China's largest retardation basins) has been shrinking with time.

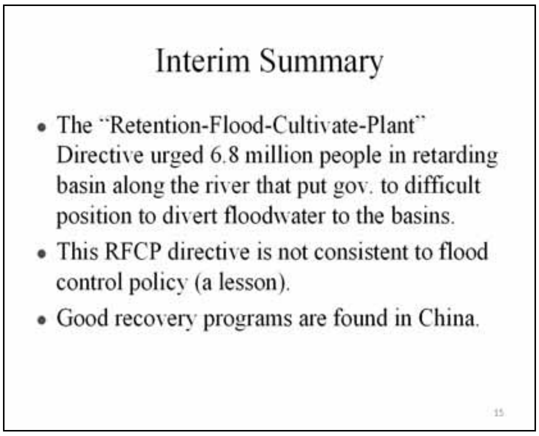


During the 1950s and 1960s, the lake shrunk drastically as seen in this graph.

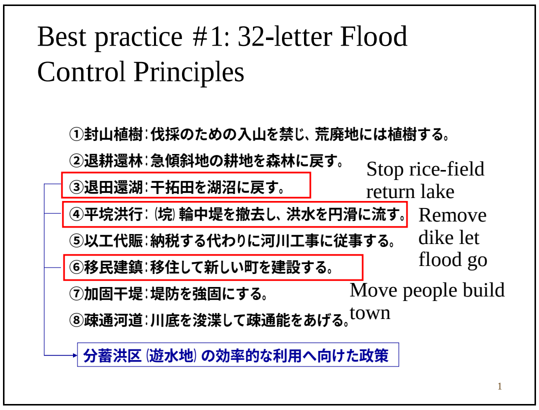


It was due to reclamation by the local farmers, although it was said that the sediment deposited from the Changjiang river was a contributing factor.

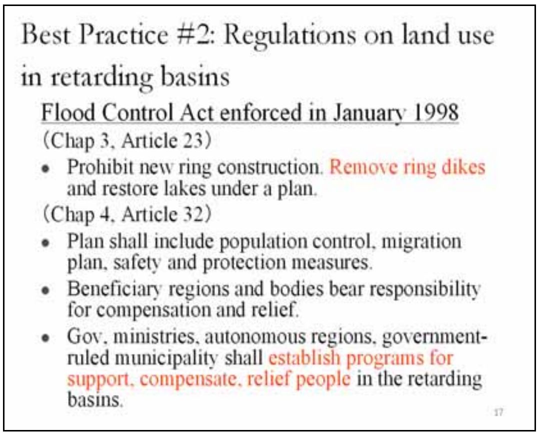
The reason why this lake reduced in size stems from the flood policy of the Chinese government. According to this policy, the lake should have a retention function; however, at the same time, it can be used for agricultural purposes.



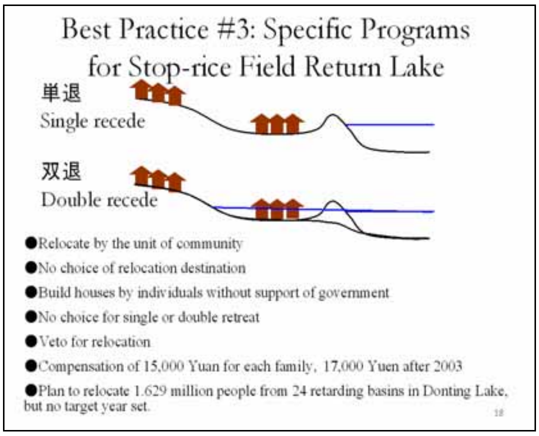
Thus, while such policies may result in an effective land use, they are not necessarily consistent with flood control purpose. Owing to this policy directive, the Chinese government is unable to divert floodwater into retardation basins because of the 6.8 million people residing there. These are important lessons that have been learned.



Following the severe damage caused by the 1998 floods in the Changjiang river basin, the Chinese government has commenced an excellent recovery and adopted 32-letter flood control principles.



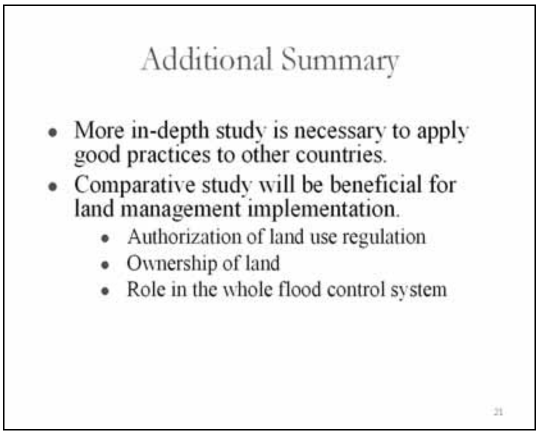
Further, the Chinese government enacted the Flood Control Act in 1998 and began the process of removing people from the retardation basin. It also proposed the removal of the ring dikes and the establishment of related agencies that would implement specific programs to support and provide relief to the people residing there. Moreover, the Chinese government has initiated programs to compensate the people still remaining in the retardation basins, who are affected by the diversion of flood water.



It looks very successful so far, and the Chinese government is removing huge number of people from retarding basins.

These are some more details about accomplishment of these programs.

The Chinese government started flood damage compensation programs because still some people are remaining in the retarding basins, and this is also a successful practice.



In sum, we at CREST believe that China's good practices can be applied to other countries, including Japan, because of their uniqueness. A comparative in-depth study is required for Japan to be able to implement these practices. For instance, a comparison of the two countries' social conditions such as the authorization of land, ownership of land, or flood control systems is necessary to determine whether these programs can be applied to Japan.

Questions and Discussion

Question: In Thailand, dikes signify borders, and we have been building one border after another. Removing dikes would imply removing the borders, and I am unsure of how this should be communicated to the public. In Thailand, we need to conduct a serious simulation study (maybe even request Dr. Pornsak to build this model) to remove all borders and witness the quick recession of the floods.

Answer: I believe that this is a very interesting point that should be addressed in the discussion session.

5. Policy Evaluation of Comprehensive Flood Control Program in Japan

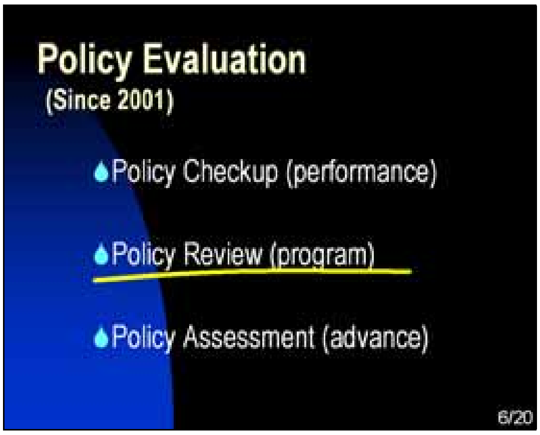
Minoru Kuriki
Public Works Research Institute of Japan

CFC (Comprehensive Flood Control) was evaluated recently, and we will discuss the results of this evaluation.
Let me first discuss flood control evolution. Initially, an ad hoc crisis-provoked response was implemented, in which local variables were measured. Since this was inefficient, a long-term plan was introduced on a more river-basin basis. A comprehensive approach was then adopted and an inclusive flood control strategy was proposed. River administrators, city planners, and sewage managers were involved in this.

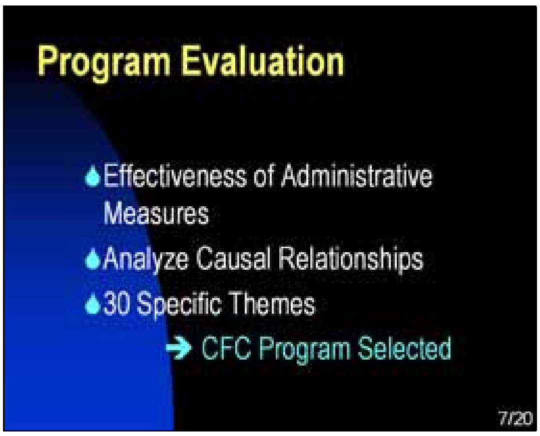
When implementing CFC in Japan, we had to consider that the population and assets are concentrated in the river basins and not in the flood plains. Rapid urbanization occurred in this area, making it difficult to retain and hold water. Therefore, the volume of flood flow increased and flood concentration time decreased, increasing the probability of flooding.

CFC followed three measures. First: protective structures for basin improvement and water retention areas. Second: basin improvement measures. Third: loss prevention, publishing previous flood reports.

After 20 years of CFC, the need to evaluate it was felt. Policy Evaluation will clarify administrative measures and then compare the results of these measures to consider the people's perspective. Administration should be effective, the measures should focus on outcomes from the perspectives of people's reactions, generate synergism, and be accountable.



After policy evaluation began, three activities were emphasized: policy checkup (general policy performance evaluation); policy review (evaluating specific themes); and policy assessment (prospective policy effects before implementation).

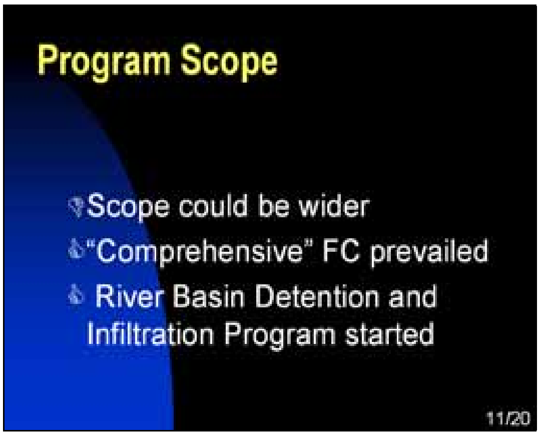


I will discuss policy review, which is undertaken to evaluate the effectiveness of administrative measures and analyze causal relationships. Objectives and proposed results of such measures are evaluated after selecting 30 themes by the ministry, MLIT, CFC is chosen as a theme because of the need to evaluate its effectiveness.

Since the Japanese socioeconomic condition has changed, it is necessary to decide whether this policy should be continued. Moreover, an evaluation was necessary to determine whether further investment or a collaborative approach was required.

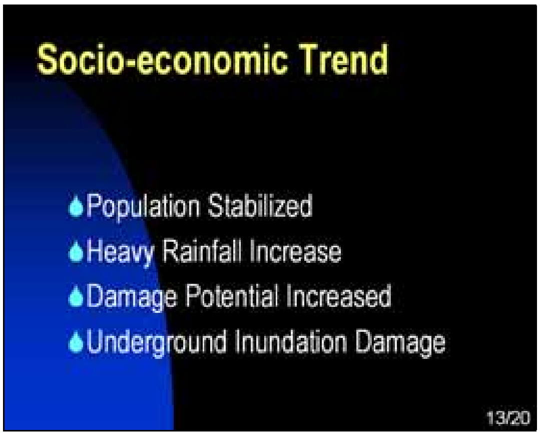
The evaluation was undertaken during 2002 to 2003, and five points highlighted. First: whether CFC was required in light of rapid urbanization and failure of the traditional approach.

The first aim is reduced inundation damage as explained by Dr. Yoshikawa, which was achieved over a longer time. The initial aim was, in 10 years, protection when rainfall intensity is 50 mm/h.



Second, with regard to program scope, 17 small rivers were chosen for CFC implementation. More rivers could have been included. Although comprehensive flood forecast and control measures were implemented, the benefiting areas were lesser. Under CFC, river basin detention and infiltration were also initiated.

The multifaceted collaboration was examined; it was considered that a Detention Infiltration Facility should be installed, and that the planning was not sufficiently detailed. Few infiltration facilities plans were introduced. Further, although many sewage projects were undertaken, the influence was greater, and coordination with river administration was insufficient. Finally, flood mitigation information was published, such as potential inundation area maps. Among the 17 rivers, maps of only 7 rivers were published. Further, only 48 of 180 municipalities published such area maps.



The Japanese socioeconomic trend was also examined, and population and urbanization pressures were observed to decrease. This was ideal for CFC execution; however, continued heavy rainfall and economic activities aggravated. Underground inundation damage occurred, and during heavy rainfall, water flowed underground, leading to some deaths; therefore, underground inundation damage should also be considered.

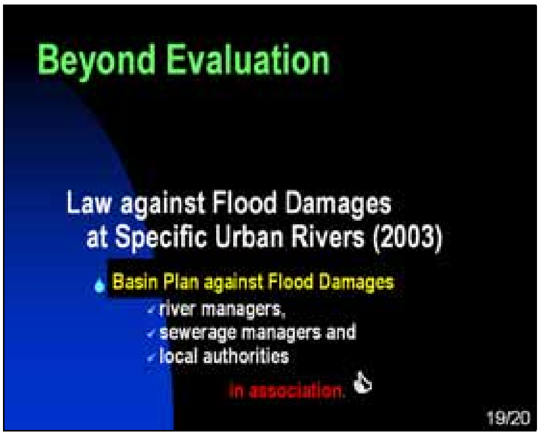
The evaluation committee proposed a new future direction for flood control. River basin measures were necessary. CFC concentrated on investing on few rivers. Such investment or concentration can be eased through additional measures like involvement and participation of locals and water circulation. Conservation investment was proposed along different points including environment, water circulation, and participation. The collaboration of different administrative fields was considered necessary.

The Japanese experienced that CFC was not completely successful.

What we succeeded was that we chose a few river basins that were already pressurized by rapid urbanization, and concentrated investment; this aided flood damage mitigation.

The first drawback was in basin management: the run-off in water regulation was tentative and not permanent, and therefore imperfect; land-use control was executed through administrative guidance, without legal authority to introduce damage control. Additionally, collaboration with sewage projects was not sufficient.

After evaluation, in 2003, we introduced a law on flood damages for specific urban rivers. Run-off regulating ponds can be permanently installed by the river administrator. For land-use control, legal force was provided only in designated areas.



The law stipulates collaborative measures by river managers, sewerage managers, and local authorities.

Thus, after CFC was introduced in 1980, it took more than two decades for Japan to establish a strategy that legally allows administrators to comprehensively address flood problems. Importantly, since this approach is comprehensive, it transcends the engineering aspect and includes the human perspective. This complicated the issue, delaying the introduction of a new law or approach in Japan. I now conclude my talk.

Questions and Discussion

Question: I laud your efforts. In our country, however, we have power hungry authorities. During a flood, everyone should cooperate and fight it together. You seem to have faced the same problem, but have you stabilized the situation? I think that in Japan, and we need an establishment that is on par with the authorities. Do you agree? We can discuss this later, though.

Chair: In this discussion, I want to bring up two issues. The first is land-use regulation or management. The other is directing water flow in upstream and downstream conflict areas. With regard to land-use regulation or management, Dr. Cheng, you mentioned identifying a flood-safe zone. Do you have a strategy for that?

Answer: In the flood-risk zone, this work was undertaken by the Ministry of Water Resources. In China, however, land use is managed by the Ministry of Land and Resources. It is now the responsibility of the former body to share relevant information so that appropriate measures can be implemented.

Chair: Will the Chinese government successfully implement land-use regulation?

Answer: I cannot answer this because I do not know what the plans of the other ministry are. Since this map was generated for flood-control planning, flood-risk zones will be excluded; thus, different standards (including investment) should be considered for different areas.

Chair: The Japanese government concerned a lot about the impact of the real estate when we publicize this flood risk map. In early 1980s when the local office released a flooding map first, Japanese government did not get any negative response from the public, or real estate, or any other else. Then, we released some more comprehensive risk map. Again there was no negative impact. Finally, we expanded this to the whole nation, so we did little by little.

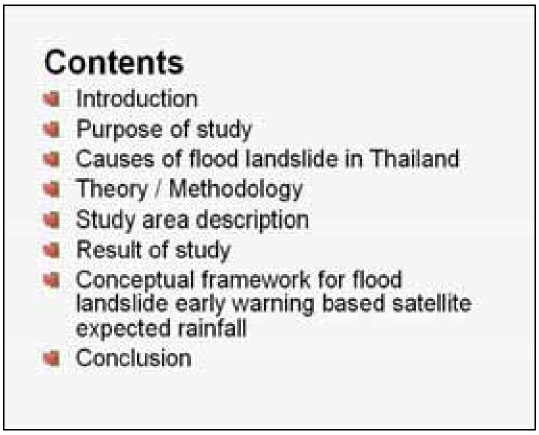
Question: While designating an area as a "protected," were the people informed about the investments? Although it is relatively unknown, Bangkok spent considerable public money for this. However, I feel the need to publicize this information because some unfair transactions might have been conducted by using the public money. Your maps and examples indicate that when one region is inundated, another region is saved. Only certain institutes can provide dates to authenticate the investments. The common perception is that money is continually being spent for some flood damage mitigation, but no one enquires about the money source. When more capital is needed, there is no justification for it. Politicians and economists make major decisions, albeit without consulting engineers. This should be rectified.

Chair: You mentioned laws for the removal or easing of conflicts between upstream and downstream communities. In the legal system of modern Japan, each river basis is individually considered. However, a master plan should be drawn to avoid such conflicts. Before implementing the legal system, conflicts were rampant in Japan. Thus, although there are many negative effects, such a plan can resolve such conflicts. In Japan, where river basins were tackled in an organized manner, flood problems were severe, and CFC was therefore implemented. It was common knowledge that the river basins were under threat.

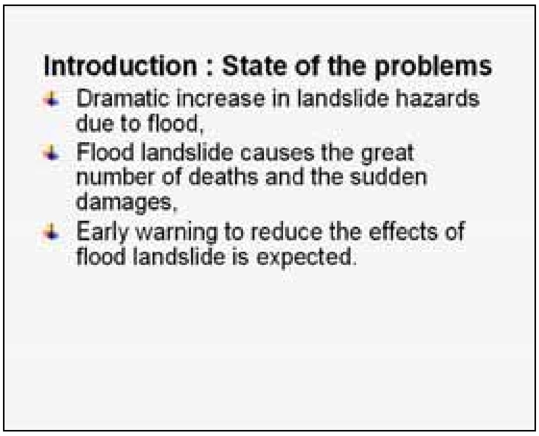
The locals asked the Government for help. Despite the conflicts, since flood mitigation was prioritized, CFC was successful. Thus, working in collaboration and sharing information is the key. There is no quick solution to this; such communications and sharing is imperative for the success of CFC. Additional issue of easing conflicts: for example, many people need to be relocated before dam construction. Much can be learned from such cases that did not lead to grave conflicts; in such cases empathizing and dedicated government officials play a crucial role. Thus, this approach might be the key to successful implementation. With this, we conclude the morning session.

6. Rainfall Estimate Based Satellite Images and Conceptual Framework of Its Application for Flood Landslide Early Warning

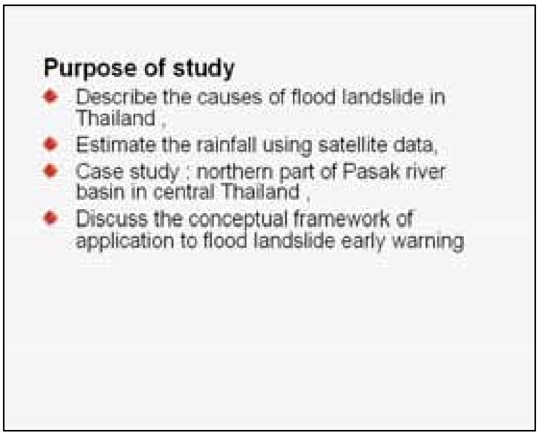
Saisunee Bhudthakuncharoen
Professor of Mahanakorn University



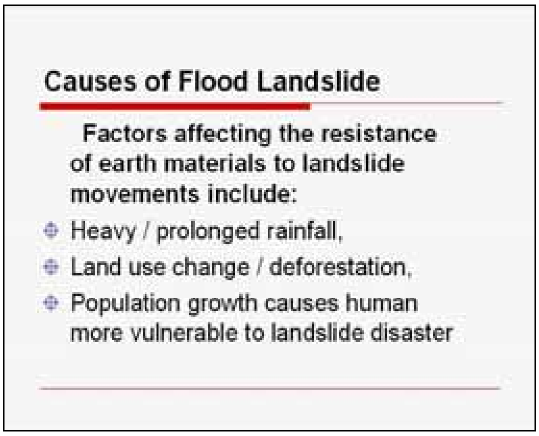
My Presentation: Rainfall Estimate Based Satellite Images and Conceptual Framework of Its Application for Flood Landslide Early Warning. These are the contents.



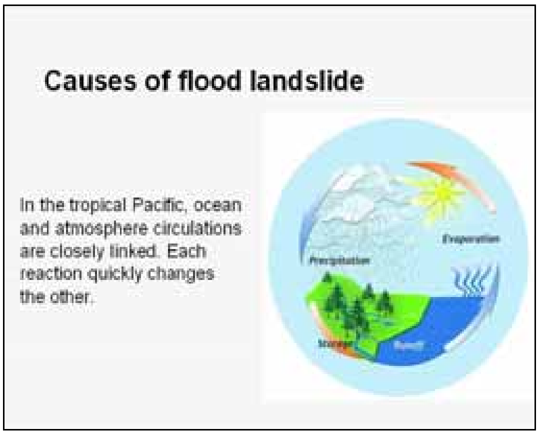
I will discuss the dramatic increase in landslides due to floods, which leads to sudden deaths and damages. Early warning is important to avoid such catastrophes.



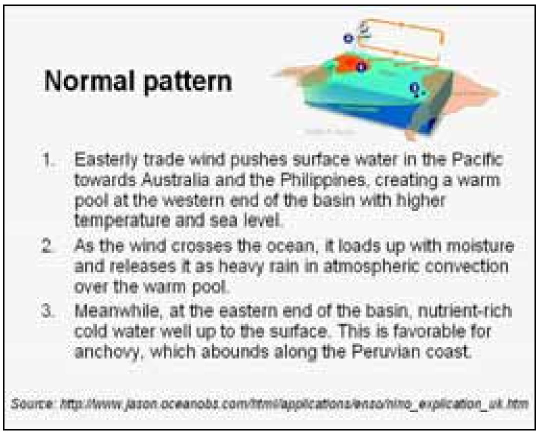
This study aims to describe the causes of flood landslides in Thailand, and then, estimate the rainfall using satellite data with the help of a case study of the Pasak river basin in Central Thailand, followed by the discussion on the conceptual framework of the early warning system.



The causes of flood landslides, factors affecting earth resistance after heavy and prolonged rainfall, land use change, and deforestation. In addition, population growth increases human vulnerability to these disasters.



In the tropical Pacific Ocean, the ocean and atmospheric circulations are closely linked. Each reaction quickly changes the others.



Normally, easterly trade winds (the red arrow) push Pacific surface water toward Australia and the Philippines, creating a warm pool (No.1) at the basin's western end, resulting in higher temperature and increased sea level. As the wind crosses the ocean, it gets saturated with moisture, releasing it as heavy rain in atmospheric convection over the warm pool (No.2). Thus, normally, this region faces heavy rainfall. Meanwhile, at the eastern end of the basin, nutrient-rich cold water rises to the surface, which is favorable for anchovy that is abundantly found along the Peruvian coast.

La Niña pattern

1. The trade wind strengthens, shrinking the warm pool and cooling the Tropical Pacific. The climate is drier and colder off the coast of America.
2. Atmospheric convection is confined to the western end of the basin. Rain is abundant over Indonesia.
3. Cold water well up more strongly along the west coast of South America; anchovy is plentiful.

Source: http://www.jason.oceanobs.com/html/applications/enso/nino_explication_uk.htm

In the La Nina pattern, trade winds strengthen, shrinking the warm pool and cooling the tropical Pacific waters. The climate is drier and colder off the America coast. Atmospheric convection is confined to the western end of the basin. There is abundant rain over Indonesia. Cold water rises more strongly along the west coast of South America, where anchovy is abundant.

La Niña Years*	Major landslide disasters in Thailand	Locations
1970-1971	Nov. 1970	Thap Sakae District, Prachuab Khirikhan
1973-1976	Jan. 1975	Ron Phibun, Nakhon Sri Thammarat
-	Dec. 1982	Sri Ban Phot Sub-district, Phattalung
1988-1989	Nov. 1988	Phipun and Lan Saka Districts, Nakhon Sri Thammarat
1998-2001	Aug. 1999	Khao Kitchakut District, Chantaburi
1998-2001	Sep. 2000	Lom Sak District, Phetchabun
1998-2001	May. 2001	Wang Chin District, Phrae
1998-2001	Aug. 2001	-Lom Sak District, Phetchabun -Khao Kitchakut District, Chantaburi

Rainy season
-North:Jun-Aug
-South:Nov-Jan

*: Source : Climate Diagnostics Center of U.S. National Oceanic and Atmospheric Administration (NOAA)

This table presents the historical record of major landslide disasters that occurred in Thailand. The first column compares the La Nina, discovered by CDC of NOAA. In certain parts in our country, monsoon lasts from June to August, and in certain parts, from November to January.

La Niña Years*	Major landslide disasters in Thailand	Locations
-	Oct. 2002	Mae Sariang District, Mae Hong Son
-	May. 2004	-Sop Moei District, Mae Hong Son -Om Koi District, Chiang Mai -Mae Ra Maad District, Tak -Mae Jaem District, Chiang Mai
-	Jul. 2004	-Mae Ai District, Chiangmai -Fang District, Chiangmai
-	Sep. 2004	-Mae Sariang District, Mae Hong Son -Muang Districts, Mae Hong Son -Mae Ai District, Chiangmai -Mae Jaem District, Chiang Mai -Long District, Phrae

Rainy season
-North:Jun-Aug
-South:Nov-Jan

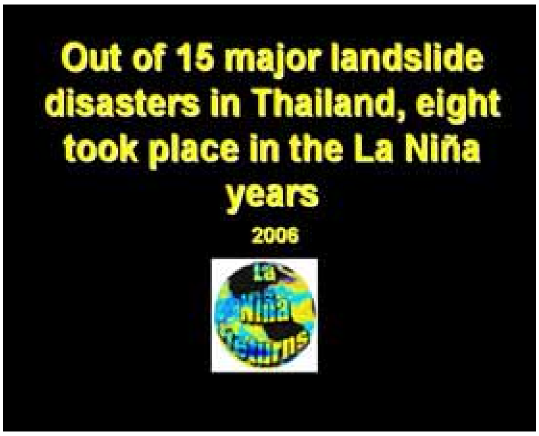
Many landslide disasters also occurred during 2002 and 2004, which were not La Nina years.

La Niña Years*	Major landslide disasters in Thailand	Locations
-	Oct. 2004	Muang District, Krabi
-	Aug. 2005	Pang Ma Pha District, Mae Hong Son
2006	May. 2006	Lab Lae District, Uttaradit, Phrae and Sukhothai

*: Source :NOAA

Rainy season
-North:Jun-Aug
-South:Nov-Jan

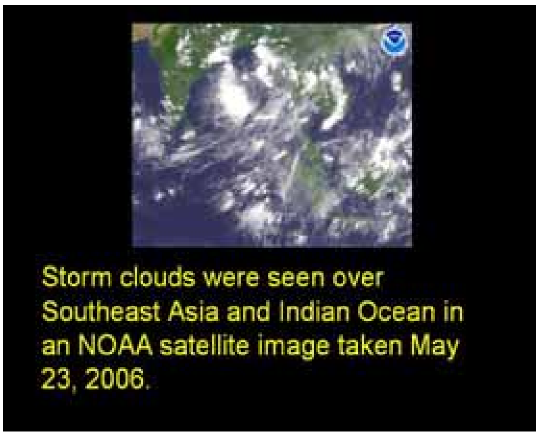
In May 2006, the flood landslide occurred in Uttradit and Sukothai. As predicted by NOAA, the Pacific Ocean temperature is increasing, and next year will be the El Nino year, and the rainfall amount will be less. Since all reservoirs are already full, there is no reason for concern, unless the El Nino lasts longer.



Eight of the 15 major landslide disasters in Thailand occurred during El Nino years.

This figure shows major landslide disaster locations in Thailand during the past three decades; as we can see, landslides occurred in the highland areas in the northern part of our country, hilly areas in the eastern part, and the southern peninsula.

The monsoon forecast predicted flash floods and landslides in Uttaradit and Sukothai from 21-23 May this year.



Storm clouds were spotted in South East Asia and Indian Ocean by a NOAA satellite image taken on 23 May.

Maung District Uttaradit

City of Uttaradit.

Maybe the Japanese tourists got stuck on the roof of the train.

Additional images.

Land use varies from forest to banana plantations in the northern part of our country. Landslides occur in the banana plantation area.

Deforestation decreases vegetation,

and affects human settlement

Soil erosion after heavy and prolonged rainfall.

Shallow landslide.

This is from USGS.

River bank failure due to erosion.

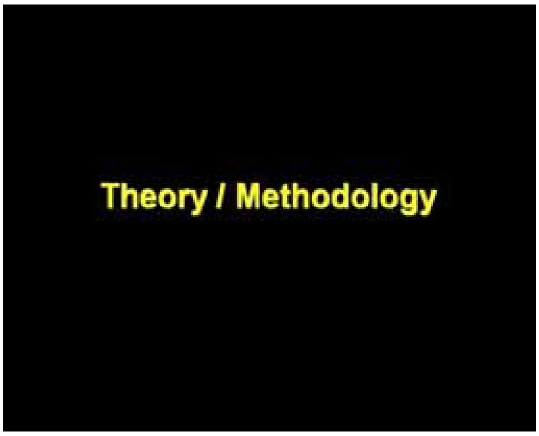
Slope failure.

Mudslide.

Additional images.

In urban-rural areas, we try to implement a more efficient warning system, a public communication system.

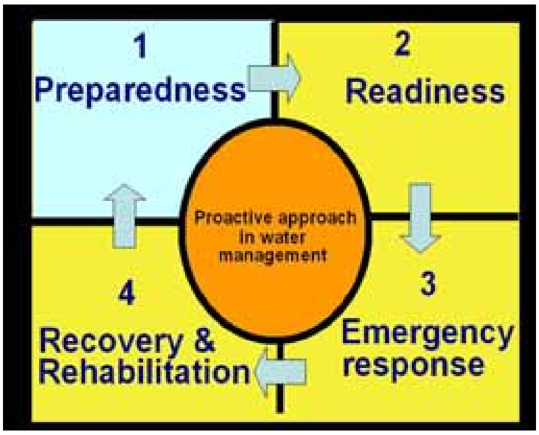
Even a gauge station is in Uttaradit.



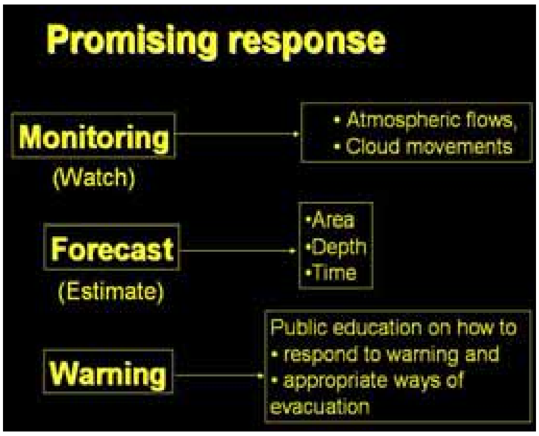
Theroy and methodology.

Reactive approach is out of trend.

Although landslide disaster mitigation mainly focuses on rescue operations and rehabilitation, we should try to adopt the proactive approach rather than the reactive one.

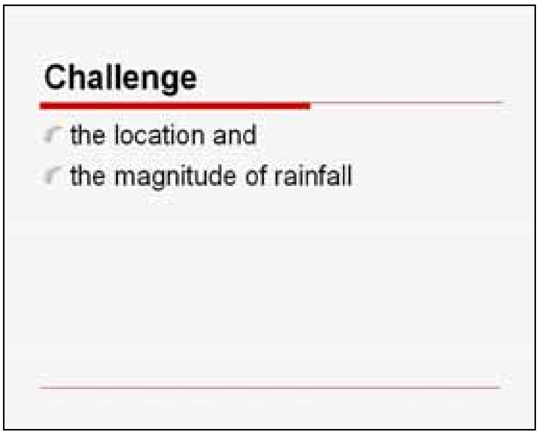


We should prepare ourselves for the disaster by planning emergency responses, recovery, and rehabilitation.

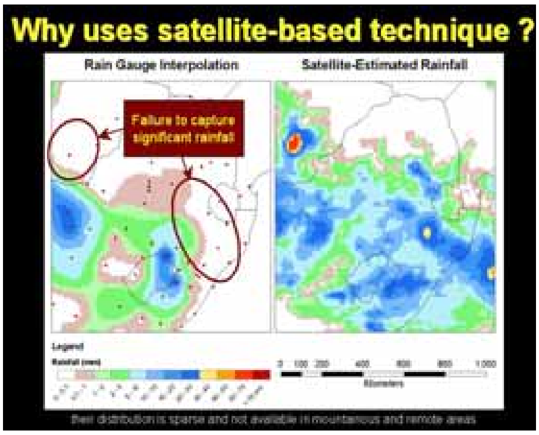


One probable solution is monitoring the atmospheric flows and cloud movement causing rain and forecasting areas under risk. This also includes public education on responding to warning and appropriate evacuation methods. Currently, we may not be able to establish an efficient network for monitoring and forecasting. Thus, the only solution is estimating.

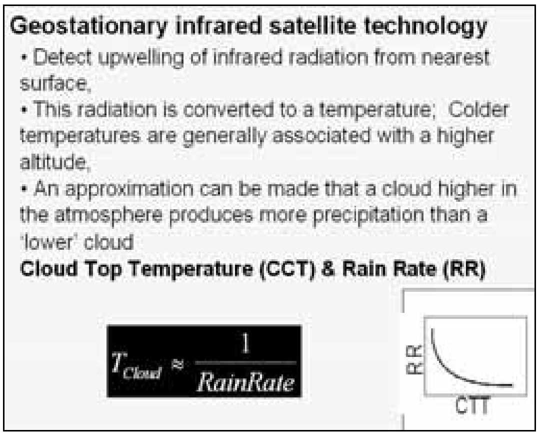
We observe the rainfall because it is the major factor controlling the hydrology and is also the primary source of floods.



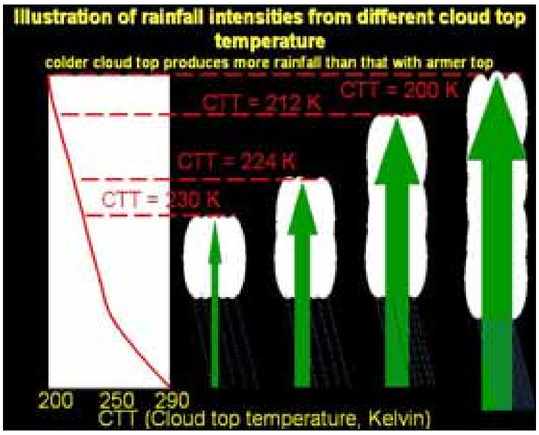
Determining the rainfall location and magnitude is a challenging task.



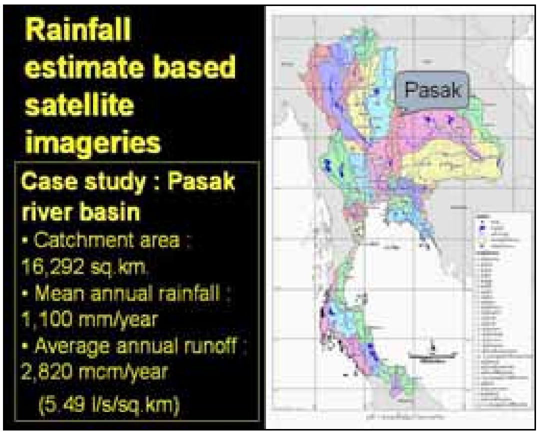
The present study uses satellite reading to gauge rainfall distribution of the rain. We might have faced this problem because the rainfall distribution is sparse and data is not available for mountainous or remote areas.



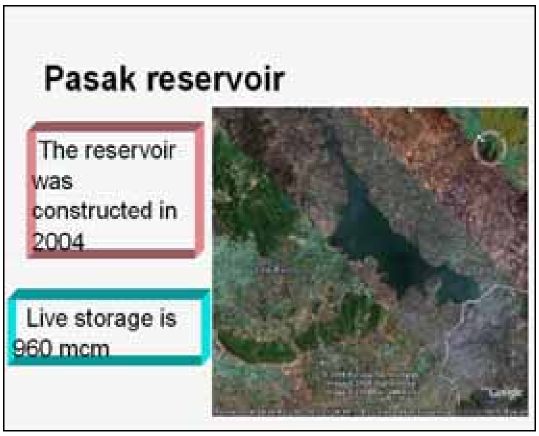
Geostationary infrared satellite technology detects the increase in infrared radiation from the nearest surface. This radiation is converted to temperature: colder temperatures are associated with higher altitudes, which is clear from the connection between the cloud top temperature and the rate.



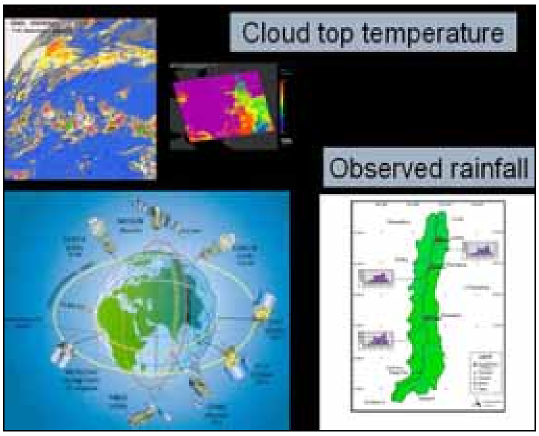
It can be generally assumed that higher clouds cause greater precipitation than lower clouds. This figure shows rainfall intensity from different cloud top temperatures.



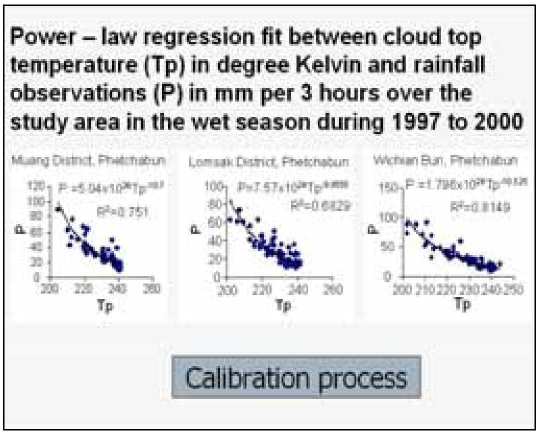
This slide presents a case study on the Pasak river basin. The catchment area of the basin is 16,300 sq km; the mean annual rainfall, about 1,100 mm; and average annual run-off, 2,800 million m3 or 5.5 l/s/ sq km.



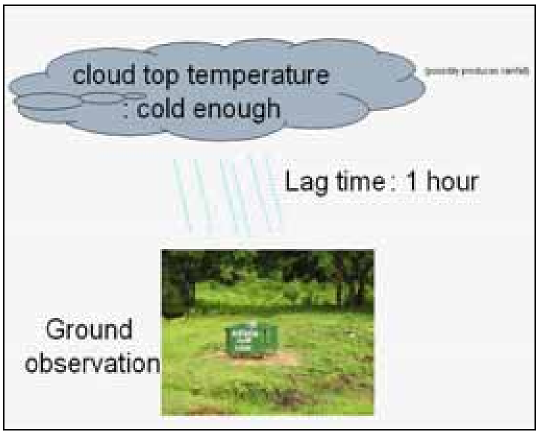
This basin has the large Pasak reservoir downstream, which was constructed in 2004 with a live storage of 960 million m3.



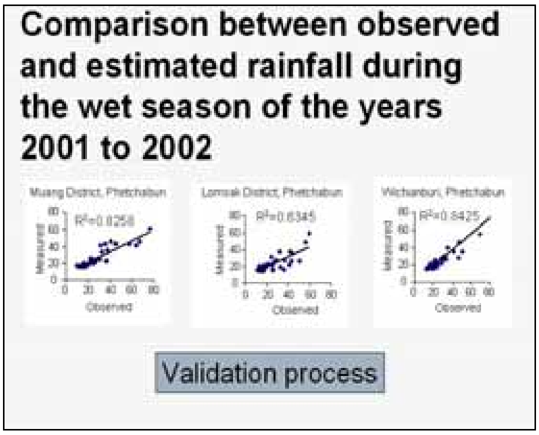
This study used cloud top temperature data obtained from the Japanese satellite GMS, and observed the rainfall in Lomsak, Upper Phetchabun, and Wichianburi. This histogram presents the mean rainfall.



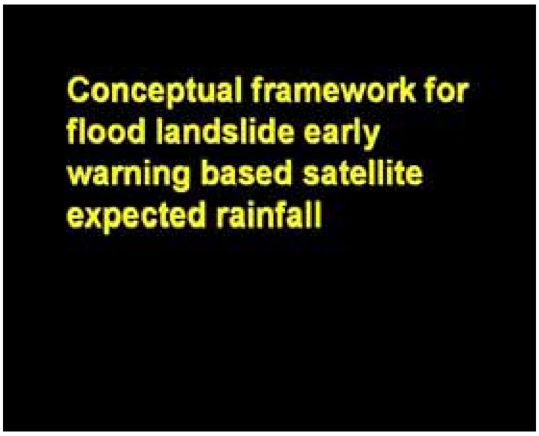
The calibration process by using the power-law regression fits between the cloud top temperature, (TP, in degree Kelvin) and rainfall observation, (P in millimeter per three hours) over the study area during the wet season from 1997 to 2000.



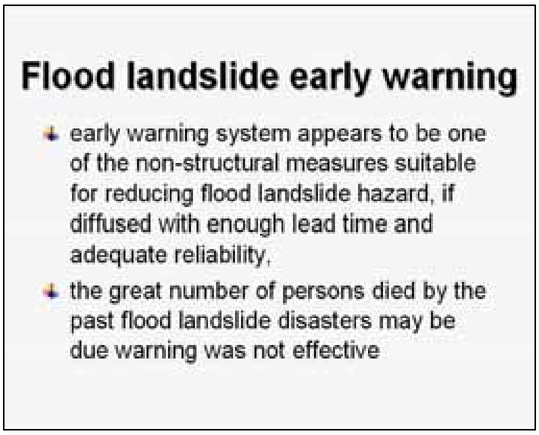
In addition, the study aims to determine the lag time and cloud top temperature integrated from satellite images. The lag time was calculated as one hour.



In the comparison of the observed and estimated rainfall during the wet season of 2001 to 2002, R2 is used to estimate consistency.

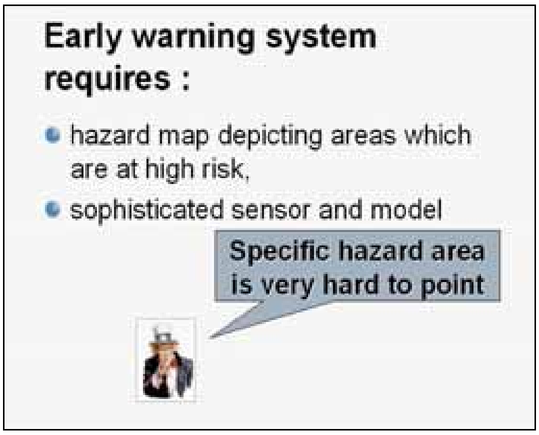


The flood landslide early-warning satellite predicted rainfall.

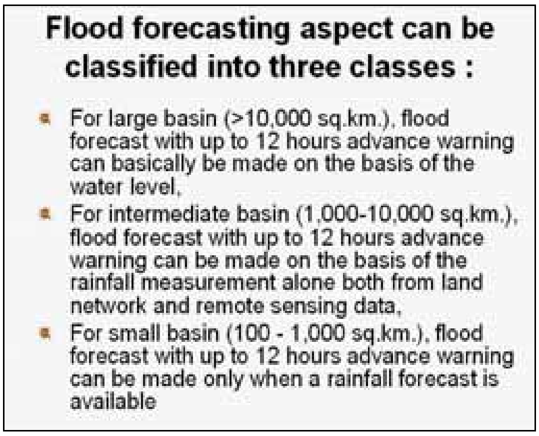


An early warning system appears to be among the non-structural measures for mitigating flood landslide disasters, if it is timely and reliable. Ineffective warning might have caused the high number flood landslide deaths.

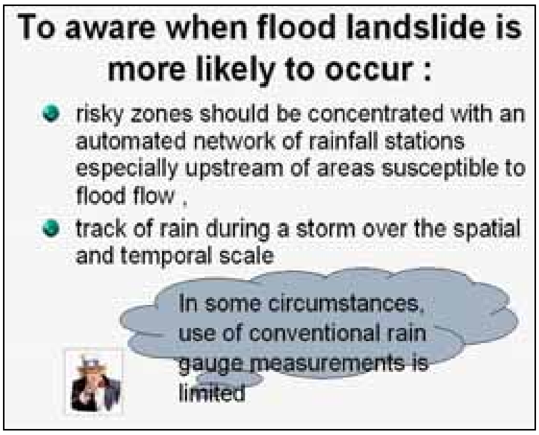
For more precise information distribution by early warning systems, a global early warning network, particularly on climate change, should be established in addition to national and regional networks. Early warning equipment should also be installed in high-risk areas.



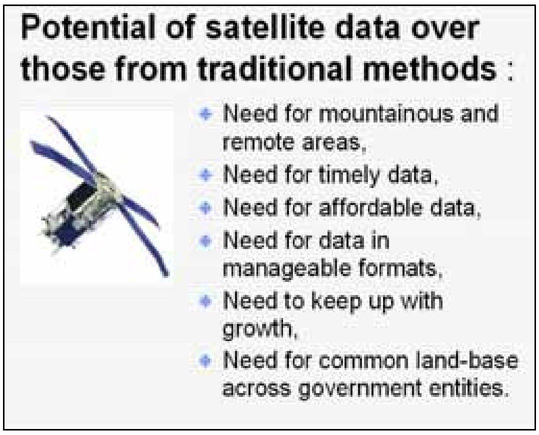
This system requires a hazard map depicting high-risk areas as well as a sophisticated sensor and model; however, despite this, equipment predicting such a disaster is very difficult.



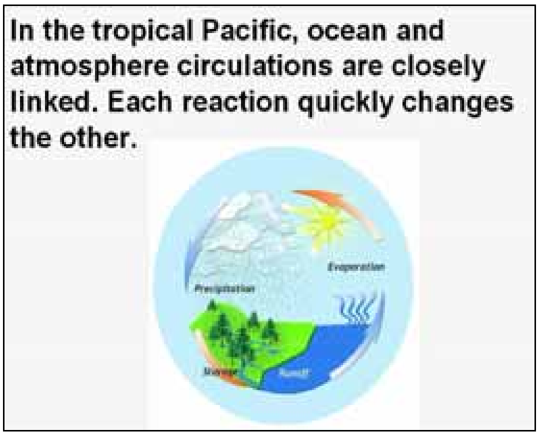
Forecasting can be classified into three groups. For large basins with an area greater than 10,000 sq km, 12-hour advance flood forecast warnings can be issued based on the water level. For intermediate basins with an area of 1,000 to 10,000 sq km, rainfall measurement both from land networks and remote sensing data (satellite/radar) should be used to issue a warning 12 hours in advance. For small basins with an area of less than 1,000 sq km, advance flood warning can be issued only when rainfall forecast is available.



To predict flood landslides, risky areas should be automatically monitored, especially upstream regions that are susceptible to flood flow. Rainfall during a storm should also be tracked over the spatial and temporal scales. The conventional rain gauge measurement cannot always be used.

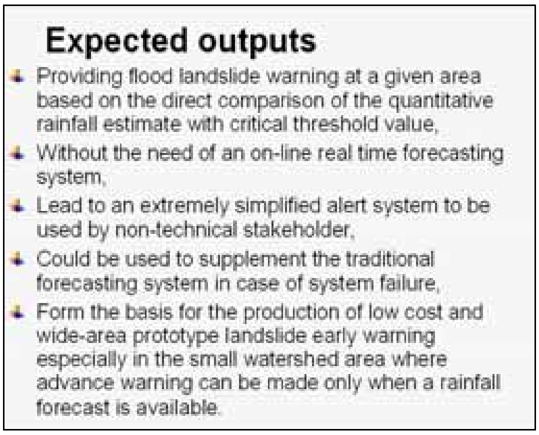


We should ensure that forecasting through satellite data for mountainous and remote areas is more accurate than the conventional method. This requires preparing timely and affordable data that is in manageable format, organizing the data as it grows, and establishing a common land base across government entities.

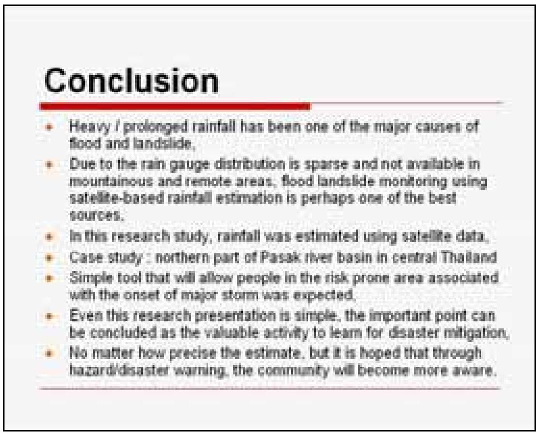


This is necessary because the tropical Pacific Ocean and atmospheric circulation are closely linked.

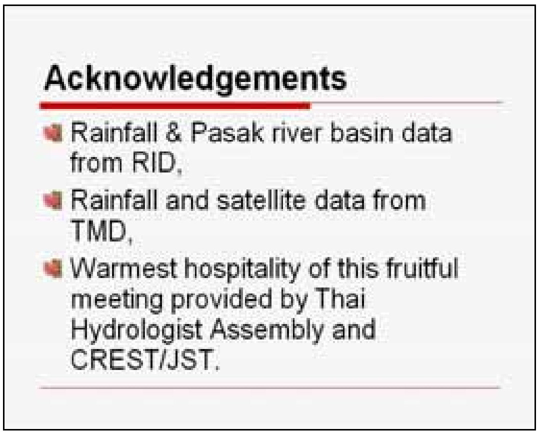
The rainfall in this conceptual framework is suggested to be estimated on near real time basis from remote sensing.



To issue flood landslide warnings in a given area based on a direct comparison of quantitative rainfall estimates, we should first evaluate critical threshold values, without an online real time forecasting system and through an extremely simplified alert system that can be used by a non-technical stakeholder. This could be used as a supplement case of system failure. Based on the low production cost and wide-area applicability, early landslide warning systems (especially in the small watershed area) can be provided only when the rainfall forecast is available.



This study concludes that heavy and prolonged rainfall has been one of the major causes of floods and flood landslide. Due to the nonavailability of rain gauge distribution in mountainous and remote areas, flood landslide monitoring using satellite-based rainfall estimation is perhaps the only reliable source. In this research, rainfall was estimated using satellite data. The aim was to determine a simple mechanism that would allow issuing warning to the people in risk-prone areas about the onset of a major storm. Disaster mitigation teaches several lessons. Irrespective of the precision of the estimate, it is hoped that community awareness will increase through hazard/disaster warning.



I thank the Royal Irrigation Department for providing rainfall data and characteristic data of the Pasak River Basin and Pasak Reservoir; the rainfall and satellite data were obtained from the Thailand Metrological Department. I am also grateful for the warm hospitality extended at this symposium by the Thai Hydrologist Assembly and CREST.

Questions and Discussion

Chairperson: Mr. Subin Pinkayan, Vice president of Thai Hydrologist Assembly

Question: The new group has developed a new technology. To my knowledge, thus far, we have been using radar systems in Bangkok. If you want to control the flood situation, you must approach the meteorological and irrigation departments and health-support officials, because your statements could be misinterpreted and your actions could either result in cooperation or panic. I am slightly ignorant about this new cloud temperature technology, but I believe it has already been standardized for commercial use. We have communicated this to the meteorological department, but your technique could also be highlighted.

Answer: Radar is a promising technique for monitoring and early warning.

Question: How different is your method?

Answer : Using radar data, forecasts can be made three hours in advance sufficient for a warning system. Unlike satellites, however, radar cannot predict rainfall in real time. The scarcity of data poses the problem.

Question: Could satellite data actually dissuade funding agencies? Is it possible that they might be made to believe that satellites are more efficient, leading them to withdraw funding for regulatory or radar rainfall systems? Could the workability of your satellite data create hindrances for the installation of telemetry systems?

Consider landslides for instance. Satellites, which provide predictions at periods of three hours or more, cannot predict landslides, which can be predicted only with more short-term monitoring. Such monitoring can only be done by telemetry systems or radar, the installation of which, in addition to satellite data study, should be advocated to funding agencies or the people in Thailand.

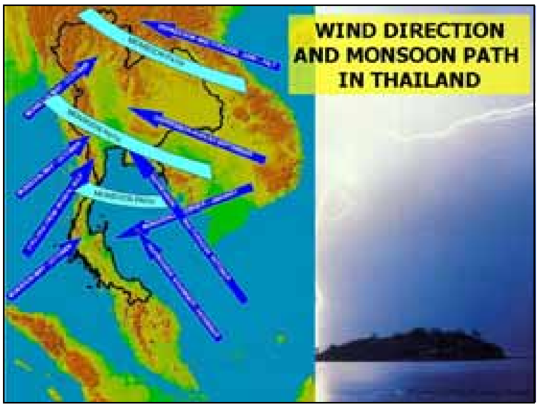
Answer: The GMS satellite data has been used only for academic research. In my subsequent research, I shall use NASA satellite data.

Question: Although satellite images first alert disaster prevention units, their current application to actual situations is inadequate, merely because satellite data provides predictions around four hours in advance: events in a shorter period might not be accurately predicted. Moreover, these images give only a comparative value of expected rainfall and might not be adequate for warning systems. Initially, we could only use these images for specific regions. Now, the telemetry system might become obsolete. However, TMD's plan to construct telemetry systems in villages to verify or recalibrate radar data with satellite data will in fact increase the accuracy of rainfall forecasts.

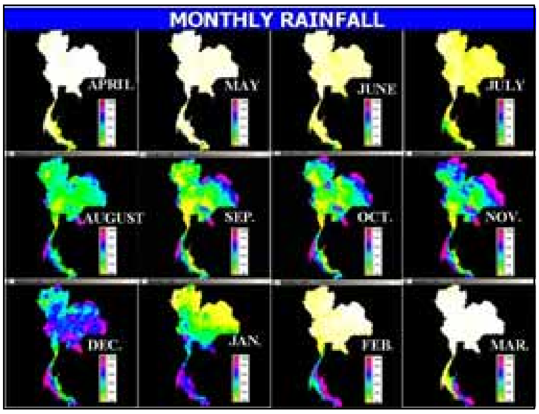
Answer: Rain tracking during storm events on spatial and temporal scales is indeed quite difficult; overlooking rain tracks, however, might mislead us.

7. Flooding Situation & Mitigation Measures in Thailand

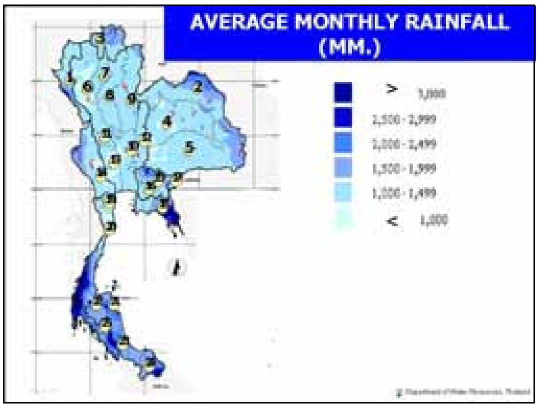
Siriphong Hangsapruek
Director General of Department of Water Resources



In Thailand, the monsoon winds that cause flooding mostly come from the South China Sea between July and December, along with monsoon winds from the Andaman in October.

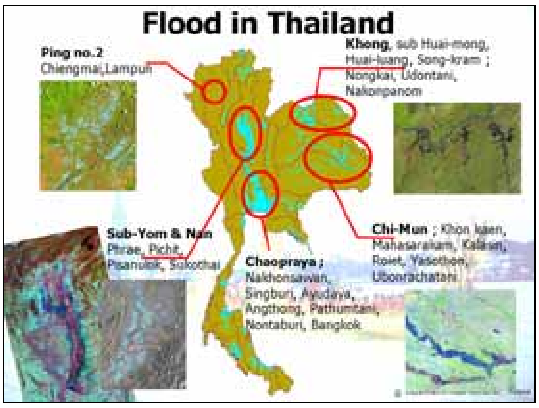


The monthly rainfall was very low in April and increased in October and November for the past 30 years.

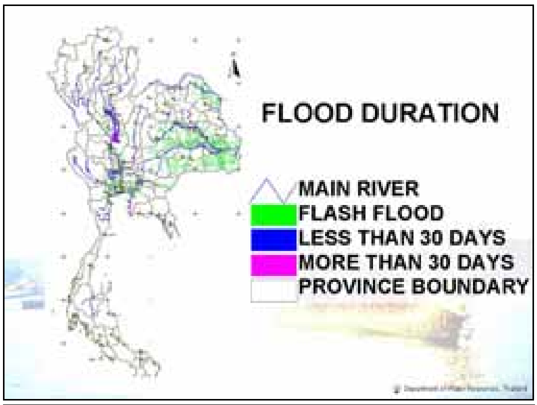


In the south, the average annual figure is 1,570 mm.

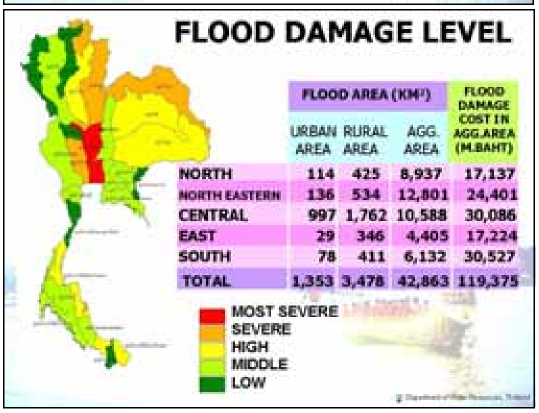
Thailand is divided into 25 river basins, which are subdivided into eight groups. The largest is the Chao Phraya river basin. Flood management is extremely difficult in these basins that range from the north and central plains to the Gulf of Thailand, covering 157,000 sq km. The second biggest group covers the northeastern part of Thailand and comprises three river basins, covering 110,000 sq km.



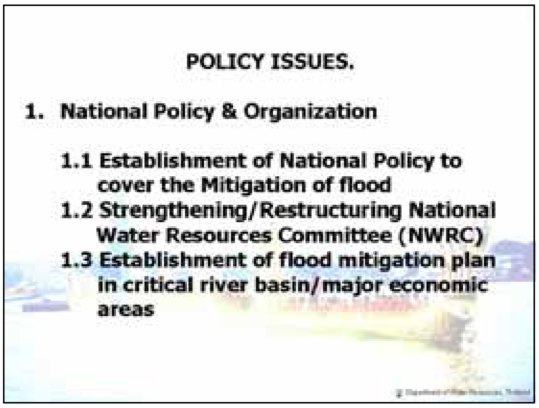
Satellite images identify the flood risk areas along these basins. The river basins of Chao Phraya, lower Yom and Nan, and the confluence of Chi and Mun are high-risk areas in that order. Other areas are the Khong and Upper Ping river basins.



The same data can be used to identify other potential risk of future flooding, inundated areas in a 30-day period.



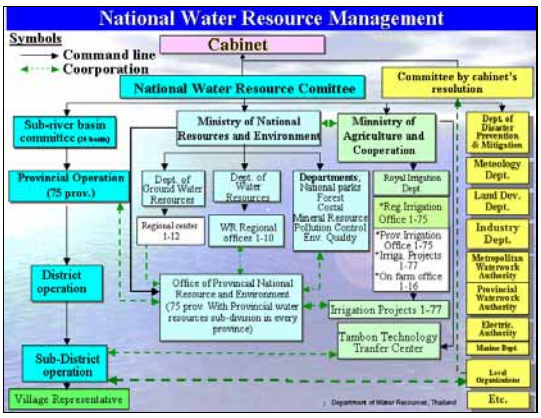
Finally, we have a risk map that shows Chao Phraya, Nan, and Mekong river basins as high-risk areas. Based on the estimate of the damage shown by the satellite images and the economic damages in these areas: we estimate the annual average of flooding losses at about $US 1,000 m or about 39,000 m Baht, and an average annual death rate of 148.



Therefore, addressing certain policy issues is crucial. The Department of Water Resources is responsible for preparing this policy. We discussed this with the Deputy Prime Minister and the Deputy Minister at the Ministry of Agriculture and Ministry of Natural Resources and Environment in the new government. It is most important to establish a national policy that covers flood mitigation, particularly in the highly economic areas. We hope that the new government will cover this in the policy; without their political support, it will be very difficult to drive the government agencies to work together for this task.

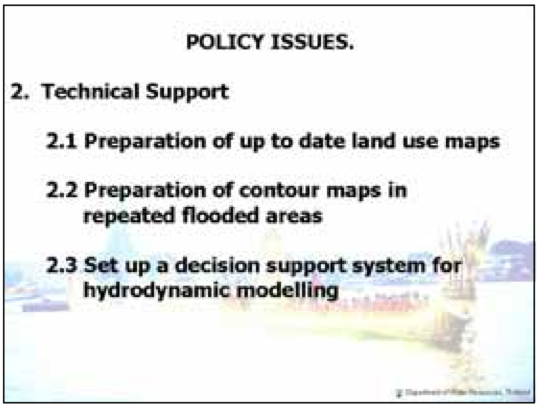
Second, the organizational aspect is also important. The current National Water Resources committee may not function efficiently, and we might need to determine ways of strengthening or restructuring it as a central body to assist various government agencies and local organizations to work together.

Third, we should draw a flood mitigation plan with well-defined objectives. We also need to know the amount of excess water in each river basin as well as prepare a mitigation program before, during, and after the crisis.

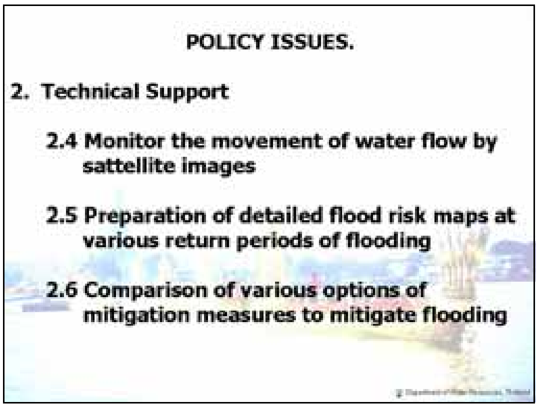


Many aspects need to be considered to ensure that the National Water Resource committee functions more efficiently. This discussion involves the concerned ministers and members from many organizations. In Thailand, about 10 organizations prefer to work in this field. Many organizations attempt to be included in the Department of Water Resources, but the Royal Irrigation Department is still under the Ministry of Agriculture. A similar situation existed in Japan in the Ministries of Construction and Agriculture. After many issues were raised, we were finally accepted in the Thai society.

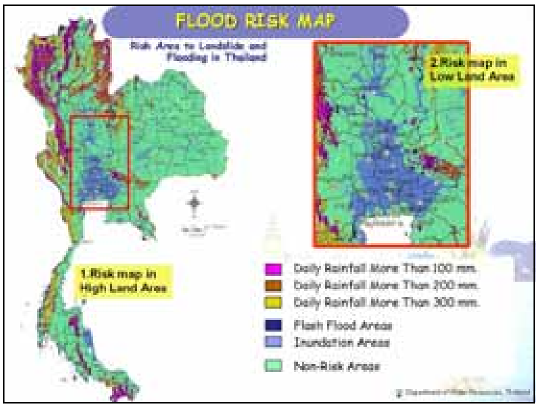
Another important area from the future perspective is local organization. We established river basin committees to manage 25 river basins. These 100,000-strong committees comprise members from the provincial, district, and sub-district levels. Using these members in water management is a challenging task.



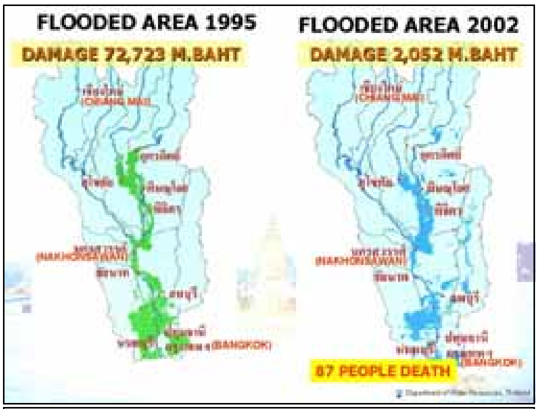
Updating land use maps is an important technical issue. Without this, flood forecasting and mitigation is difficult; a control map of the repeatedly damaged area revealed that the present data is outdated. Since contour maps are required for hydraulic generation, we need to invest more in this area. We do not have a map that covers the Chao Phraya river basin; we should be able to predict the hydrological behavior in the river basins by using other methods.



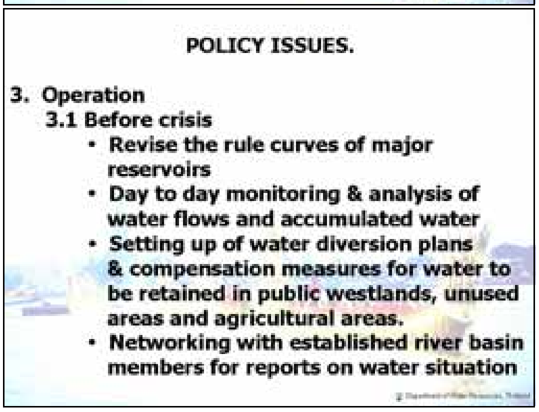
We also considered that monitoring the flow is more important than forecasting. If we can trace the path of the rainwater, it will be simpler to mitigate this water. It is imperative to prepare a log of the recurring flooding periods for the city and rural areas, because this will also help in comparing various mitigation measures.



For example, in the flood risk map of the hilly area, we identified various critical areas in about 2,300 villages and installed rainfall-measuring equipment. As a result, we could alert people about the water level before flooding in four regions. We have established 400 sites for this system, particularly in the northern part; however, many more need to be established.



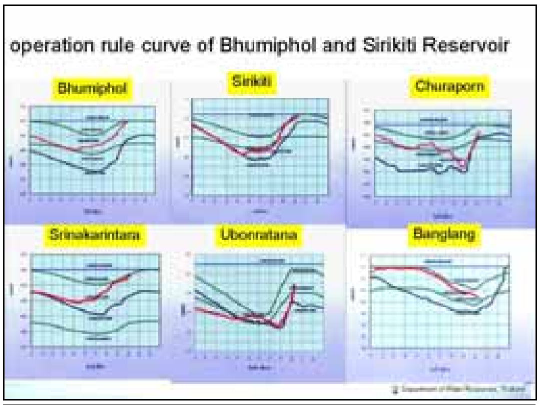
These are some of the satellite images showing the flood areas in 1995 and 2002.



The operation rules of major resources should be reviewed at a higher level. I am sure that each time this issue is raised, it will be opposed by someone who will incur a loss of revenue compared with previous figures. Further, the rules established 40 years ago may not be applicable today because the land use is different. These issues will need to be raised during policy discussions with government agencies, which have different interests. This year, the rainfall began in early August, but since it was not heavy, few paid attention. The path of this rainwater and the water level before flooding is not monitored; similarly, water diversion plans for public wetlands and unused or agricultural areas need to be prepared and relief operations, if required, need to be planned. This year this was thought of only after flooding occurred-something that could have easily been avoided with due care.

Networking with established river basin

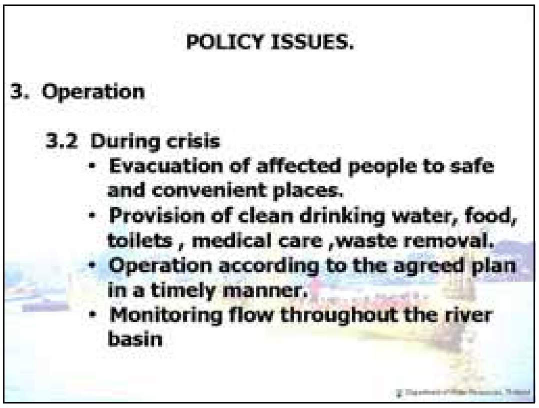
members for reporting the water situation is also crucial. Because of limited governmental budgets and personnel, we need the inputs from local communities that receive more than 30% of the national budget.



Some examples of major reservoirs in the country: a lot of water is retained at the beginning of the wet season. If this water is let down, damages might be lesser.

We have more than 100,000 wetland areas in the country now.

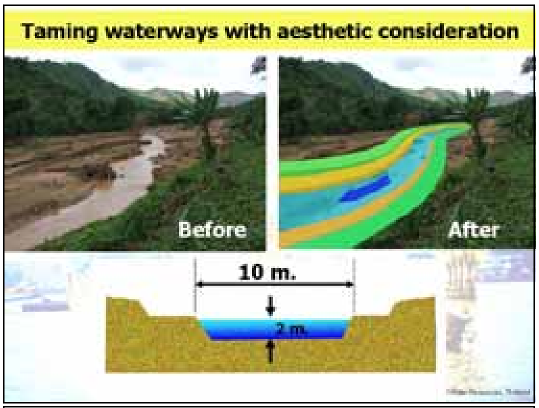
These are the organizations network of government and local communities.



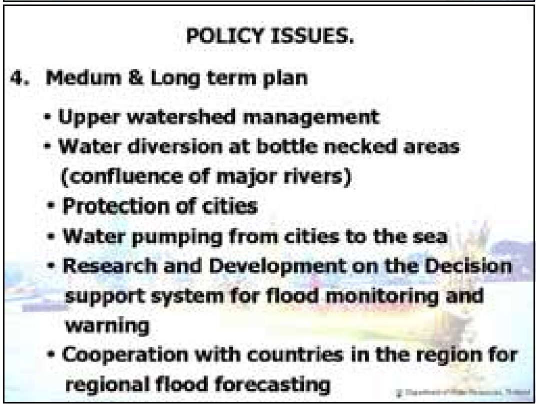
However, with the government on one side and the local community on the other, flood relief and appropriate evacuations measures are not well planned. For example, Phuket Island adopted a well-planned flood mitigation and relief strategy only after it was hit by the tsunami; however, during the floods, people did not take it seriously. Further, provision of clean drinking water, food, sanitation, medical care, and waste removal also need to be planned and executed by considering the environment of the people living in the affected area.

These are some pictures of the provision of the mobile clean water.

After a crisis, water draining and recovering shallow wells and ground water holes should be carried out. Further, water supply facilities should be rehabilitated and contamination should be tackled.



As you can see here, the width of water increased much more by the crisis. So we should make it well drained to help the people.



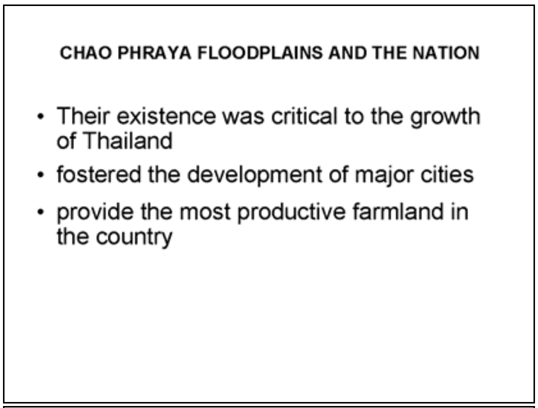
For policy issues regarding medium- and long-term watershed management plans, not only each city but also the entire river basin from the northern region should be considered and watershed management measures should be implemented. Research and development measures for the development and implementation of such a support system as well as monitoring and warning systems need to be undertaken on a larger scale. Finally, cooperation with the neighboring nations in the region for regional flood forecasting should be promoted.

8. The Current Situation (Oct. 2006) on Flood Management in Chao Phraya River

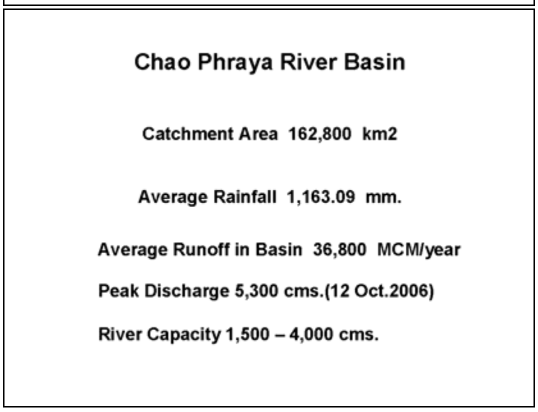
Suwit Thanopanuwat

Professional Engineer for Planning of Royal Irrigation Department

Following the 1995 floods, a comprehensive flood mitigation program was implemented by request of JICA, Japan; however, we are again facing another big flood. I will summarize the flood management situation in the Chao Phraya river basin from 1995 to 2006 but first I will briefly introduce the Chao Phraya river basin. The flood plains in the country run along the upper section of the river to the delta area in the lower section.



The Chao Phraya flood plains play a critical role in the growth of the country since they are the source of the most productive farmlands.



According to the 1995 statistic, the catchments area of the river is 160,000 sq km with irrigation and an annual rainfall of above 1,100 mm facilitates the irrigation of about 3,600 million m3. On 12th October, the water flow was 5,300 m3/s; it has been rising since then. Since the river capacity ranges from 1,500 to 4,000 m3/s, it is clear that our river capacity is smaller than the downpour, and thus, the occurrence of floods is unavoidable.

Chao Phraya River Basin

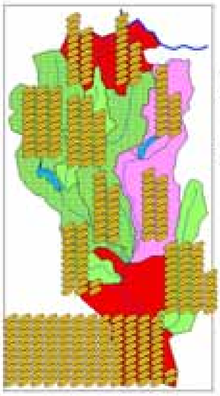
Population 23.02 Million
(37.7%of country)

GDP (Basin) 2,693,542 Million Baht
(58% of country)

GDP (Delta) 2,105,979 Million Baht
(78% of basin)

The population in this river basin is approximately 23.020 m, and the GDP of the basin is about 58% of the country. Inside the basin, the GDP from the delta area is 78% of the basin, clearly indicating that important economic activities are undertaken in the flood plains, which are financially viable, productive, and populated.

Gross Basin Product (1994)

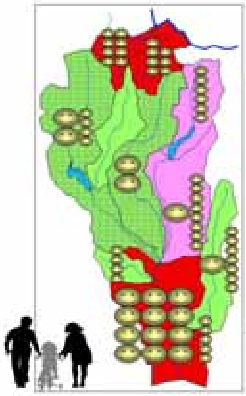


Basin	Sub-basin	Per Capita
Kok/Ing	Kok	18,400
	Ing	16,200
	Total	17,400
Upper Chao Phraya	Upper Nan	16,000
	Lower Nan	19,100
	Ping	29,600
	Wang	27,900
	Yom	18,300
	Sakae Krang	22,100
	Pasak	35,800
	Total	25,100
Lower Chao Phraya		122,100
	Total	76,000

= 1,000 Bahts/Capita

This chart demonstrated that how high values of the properties or economic are in the delta area.

Total Population



Basin	Sub-basin	(1,000 p)
Kok/Ing	Kok	780
	Ing	675
	Total	1,455
Upper Chao Phraya	Upper Nan	578
	Lower Nan	1,768
	Ping	2,372
	Wang	662
	Yom	1,989
	Sakae Krang	435
	Pasak	1,660
	Total	9,463
Lower Chao Phraya		12,478
	Total	23,396

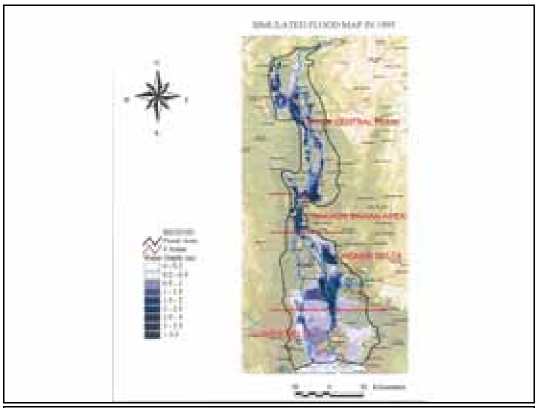
= 1,000,000
= 100,000

There is highly economic, and highly populated.

Post-evaluative Study of Flood Mitigation in the basin of gentle flowing rivers on a low-lying plain by Yoshikawa K. et al.(2005)

- "….the flood control plans of recent years were drawn up and put into practice by in-house government engineers with the help of consulting engineers, but these engineers had no interest in academia, or else the world of academia was no longer a receptive climate for this area of study. This has led to a situation where, in a country that experiences many floods, there has been no ongoing research and education about practical flood control plans or flood mitigation as a system ……"

With regard to flood mitigation, a comprehensive and integrated approach has been favored by some. According to Professor Yoshikawa's study, we lag behind in encouraging such an approach and in our capacity to deal with it. Professor Yoshikawa also mentioned that recent flood mitigation plans were drawn and implemented by in-house government engineers with the help of the consulting units; however, they shared a lack of interest in academia and the academia has no receptiveness in this area of study. As a result, in countries prone to floods like Thailand, Japan, and USA, research on practical flood mitigation has not been conducted. I work as a water engineer in the planning division. I agree that the focus is on the basin, but we are trying to work on this.



This area was inundated in 1995.

THE 1995 FLOOD REVIEW

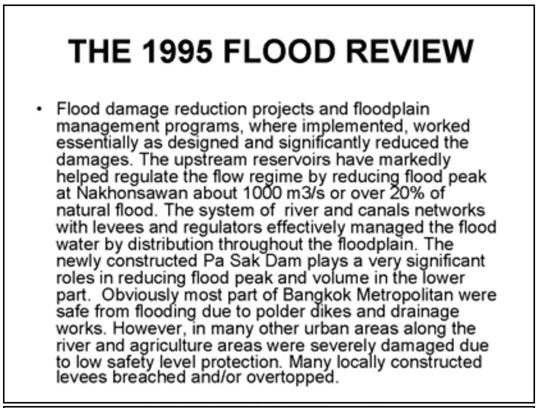
- The change in land use, loss of wetlands, flood retention areas, upland cover and modification of landscape throughout the basin over the last century significantly increased runoff and its peak.

We observed changes in land use and loss of wetlands and flood retention areas. Moreover, the basin witnessed deforestation and landscape modification during the last century.

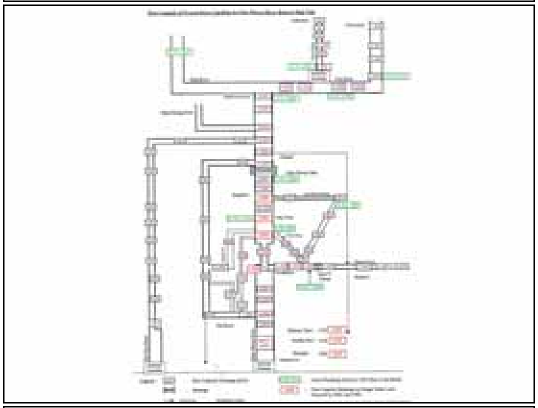
THE 1995 FLOOD REVIEW

- The costs to the nation from the flood were extensive. The fiscal damages of 72 billion Baht was estimated. In addition many costs cannot yet be quantified. Impacts on businesses in and out of the basin have not calculated. Tax losses to governments are unknown as same as the impacts of the flood on the population's physical and mental well being.

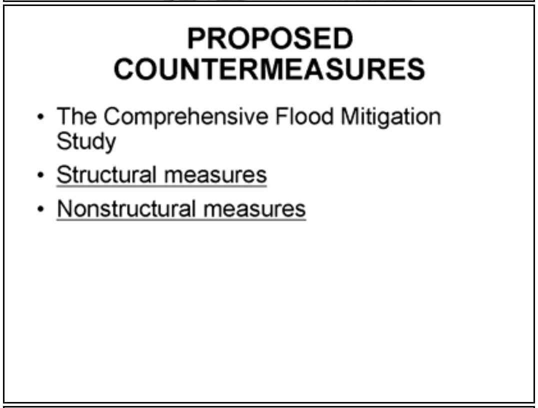
The resulting damages are increasing; in 1995, the estimated damages were as high as 72 billion Baht. This estimate did not include damages such as loss in business and internal policy. In this study, an attempt was made to estimate the damage inclusive of these statistics. However, I think that no nation can afford to report such high levels of damage.



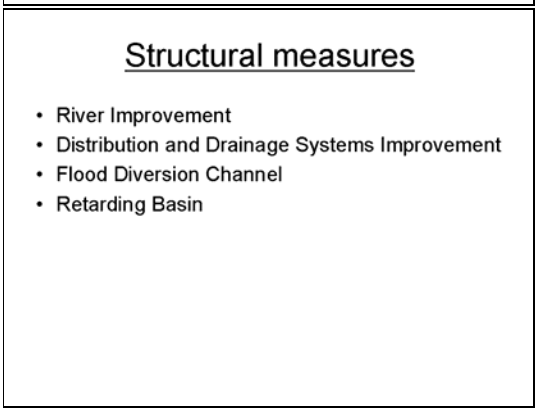
On evaluating the existing projects, we found that flood mitigation projects effectively reduced damages. The newly constructed Pasak dam also plays a very significant role. Undoubtedly, most of Bangkok is safe from floods due to a planned drainage system. However, many urban areas along the river were severely damaged due to poor protection.



This figure shows the river capacity along Chao Phraya river and its tributaries, which is an important aspect of floods in the lower region. A river that moves downstream is in less danger of overflowing, but this is not the case with the Chao Phraya. This is one of the challenges that we face and will consider when we attempt flood management in this flood plain.



Based on the 1995 study, I have proposed two categories of countermeasures: structural and non-structural.



Structural measures cover river improvements. River capacities are different in each location. We have dikes for future river stability. The flood plain of the Chao Phraya is famous for paddy fields, which are of the basin irrigation type. However, there is no canal network to distribute water to this crop. The drainage system in flood plains should be improved. Further, despite many measures, the capacity of the river in the rural areas is still insufficient for containing the remaining water. From the perspective of hydraulics, it is still essential to provide more outlets for excess water, namely, flood diversion channels.

Nonstructural measures

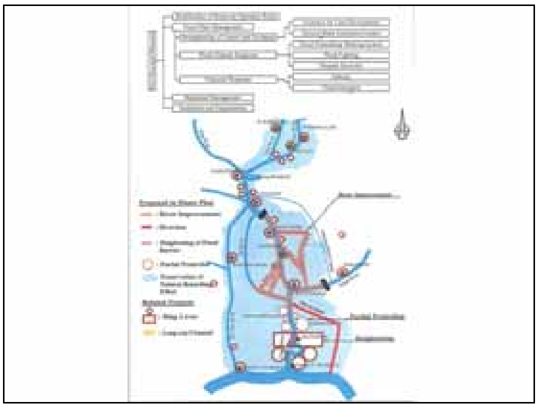
- Modification of Reservoir Operation Rule
- Strengthening of Control and Guidelines (Land use, Groundwater)
- Flood Disaster Response
- Financial Response
- Watershed Management
- Institution and Organization

Non-structural measures such as reservoir modification, operational rules, strengthening the control of flood plains for land use and groundwater are considered. Financial aspects, watershed management, and cooperation with institutions and organizations are also considered.

specific measures

- Preservation of Present Natural Retarding Effect and Minimization of Increaseof Flood Damage
- Assurance of Safety Level against Flood at Bangkok and Urban Areas
- Enhancement of Safety Level against Flood in Agricultural Areas
- Institutional Arrangement for Implementation of Measures

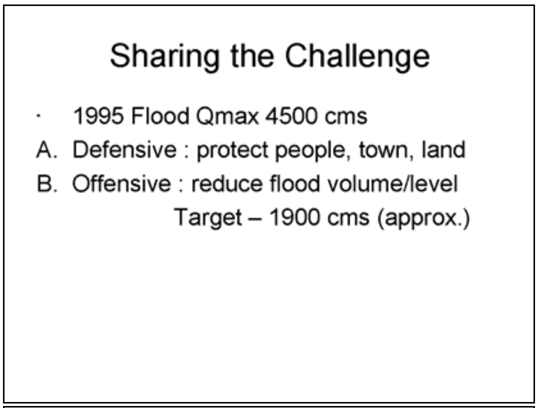
Although specific measures are formulated, the larger issues are the preservation of the basin and flood mitigation in the flood plains of the Chao Phraya. We believe that if we are able to manage the distribution of water and water storage in this field, minimum flood damage can be ensured. In order to achieve this, one of the measures we took was to build a capacity infrastructure to distribute water from high water level areas to the low water level ones.
Bangkok and other urban areas are categorized as high priority areas during flood relief and mitigation, however, agriculture, strengthening the safer areas, and institution management are equally important.



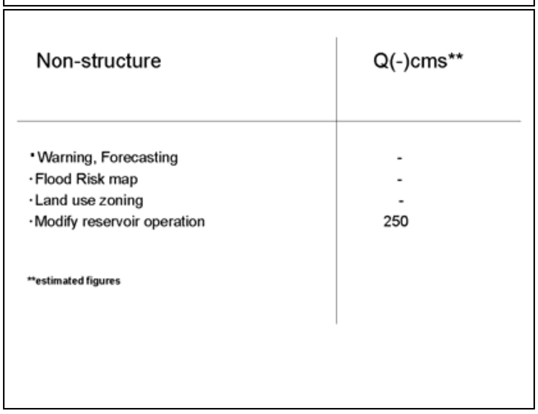
In 1995, the municipalities along the rivers were mostly flooded, except Bangkok, which was saved due to the precautions taken. Similarly, we constructed a border around those municipal areas along rivers. This was carried out by the Public Works Department and a major part of the work has been completed.
In Bangkok, a floodwall along the river has already been built; the wall is sufficiently high to avoid water from overflowing. However, protecting the Angthong province is prioritized. Therefore, greater protection of the province will adversely increase the flow to Bangkok

and reduce the safety level. This aspect was being studied and some alternatives were proposed, such as further heightening the Bangkok floodwall. The BMA officials opposed this saying that increasing the height might not be aesthetically appealing. The second alternative is to construct a diversion channel to maintain or control the downstream flow at the diversion point.

Finally, after sufficient discussions among several agencies including RID, BMA, and key project initiation offices and studying the 1995 flood reports, the diversion channel was chosen.



The maximum discharge was roughly estimated at 4,500 m3/s. Our target is discharge at the scale of 1,900 m3/s



We can implement the non-structural measures by modifying the reservoir operation and achieve about 250 m3/s

Structure	Q(-)cms**
• Polders	-
• New Reservoirs	500
• Flood plain preservation	200
• Improve drainage	150
• River Improvement	-
• Flood diversions	800
Total Structure	1650
+Nonstructure	250
Grand Total	1900

**estimated figures

Most of the reduction work can be undertaken using structural measures. The construction of the new reservoirs upstream can release 500 m3/s; flood plain reservation would be about 200 m3/s; improved drainage from the flood plain to the downstream area and out into the sea can be expected to be above 150 m3/s. River improvement cannot be ignored due to a new flood diversion for adding capacity of 800 m3/s to meet the 1,900 m3/s target.

Cost Estimate

• Project Components	• Economic Cost (mil.Baht)
• Modification of Dam Operation Rule	• 40
• Distribution and drainage system improvement	• 5,633
• River Improvement	• 2,821
• Diversion Channel	• 31,402
• Total	• 39,896

JICA/RID,(1999) The study on Integrated Plan For Flood Mitigation in Chao Phraya Basin. Main Report, p6-16.

The cost estimate of our measures was 40,000 million Baht, with the highest in the flood diversion channel.

From 1995-2006

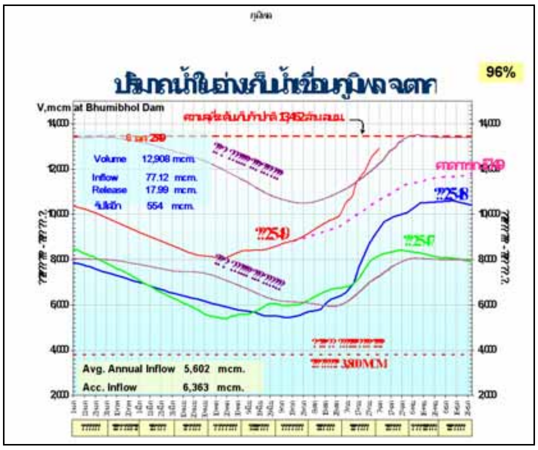
- After 1995 event, some measures have been implemented such as Flood Monitoring and Forecasting Modelling (Floodworks), Modification of Dam Operation Rule & Telemetering system (Pa Sak Dam), Dikes and Polders, and Construction of upstream storage (Quae Noi Dam). However, some other measures are not yet considered seriously such as Preservation of Retarding Areas, Drainage System Improvement, and Flood Diversion Channel.

From 1995 to 2006 some measures have been implemented, such as flood monitoring and forecasting modeling by RID using the flood works model, modification of dam operation rule, and telemetering system. The construction of dikes, polders, and upstream storage channels is underway. However, some measures are not undertaken seriously, such as restoration of cabin areas, drainage system treatment, and flood diversion channel.

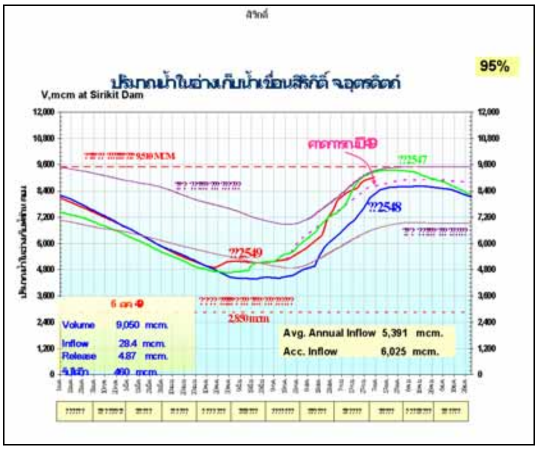
Flood 2006 (as of 12 Oct.)

- Q at Nakhon Sawan 5,300 cms.(new high) compare with 4,820 cms. In 1995.
- Most of the floodplain in lower north and central are inundated, dike breached, villages, towns, municipality areas and agriculture are damaged, except protected area of Bangkok and its vicinity.
- Q at Bang Sai 3,900 cms. (and going up) compare with BMA dike +2.70 m.msl. @ 4,000 cms.
- Protected area of Bangkok is, therefore, at risk.

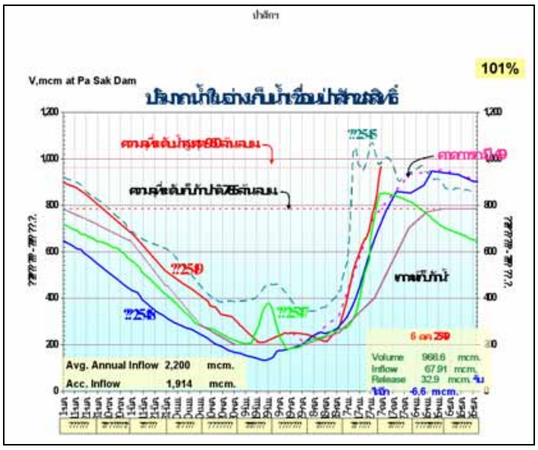
I will summarize the present situation in the flooding season. The discharge from Nakhon Sawan is as high as 5,500 m3/s today, as compared to 4,820 m3/s in 1995; we are faced with the chances of a major flood. Most of the flood plains in lower northern and central regions are inundated. The dike-breached villages around municipality areas and agricultural areas are damaged. The protected area of Bangkok is still safe. The discharge at Bangsai is 3,900 m3/s but this morning, the water level is already 4,000 m3/s.



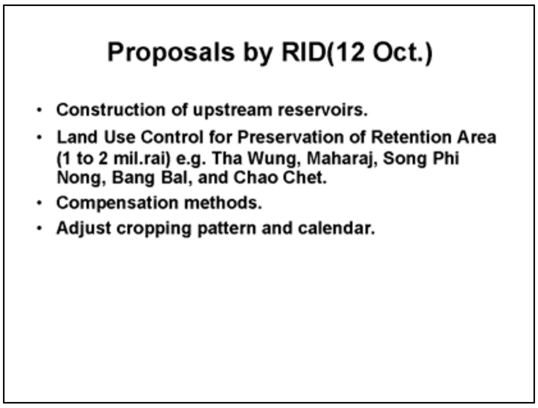
This is just to show that the water is increasing.



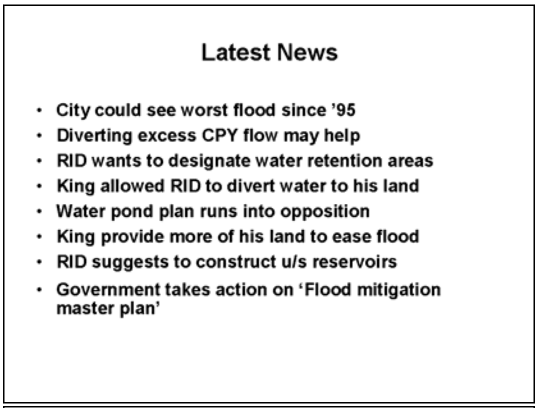
All of the reservoirs are already full.



This illustration shows how we try to upgrade Pasak dam for flood control. The water level this dam will be kept low until the end of September. At the beginning of the wet season, we release water to accommodate excess rainwater; since this is a heavy rainfall year, the reservoir is already full.



The Director General of RID has proposed ideas with regard to our measures to enhance our capacity in dealing with or managing floods. This is evident from the results of the comprehensive JICA study. One of them is the construction of upstream reservoir that is Kaen Sua Ten, a controversial issue. Land use control for preserving retention areas occurs at a scale of 1 to 2 million. It is common knowledge that in flood plains, water always collects in the most low-lying areas. With regard to compensation methods, we should consider a cropping method for rice cultivation to clear the field before it is used for water retention. At present, this suggestion is being opposed since the fields are almost ready for harvesting.



We also share the general events in this field as publicized by the media. Following by His Majesty King Rama providing more of his land, RID suggested to construct upstream reservoirs. Two days ago, the government acted on the "Flood mitigation master plan."

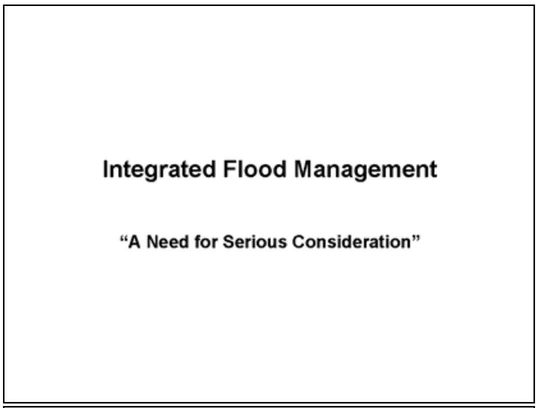
As per a local newspaper, the Deputy Prime Minister Kosit called NESDB, MONRE, MOAC (RID), and Research Institute Office, emphasizing the need to cover three key issues within six months. First: developing a coordinated work plan for implementing over five to ten years. Second: to establish a certification institution. Third: form the National Water Management Organization responsible for investment and policy related issues.

I recently took this aerial image to show the water drainage problems and water logging in the fields. We can see rainwater in the fields and a high water level in the river, both shown in different colors. Therefore, we must urgently improve the drainage system. Highways and houses are located along the river.

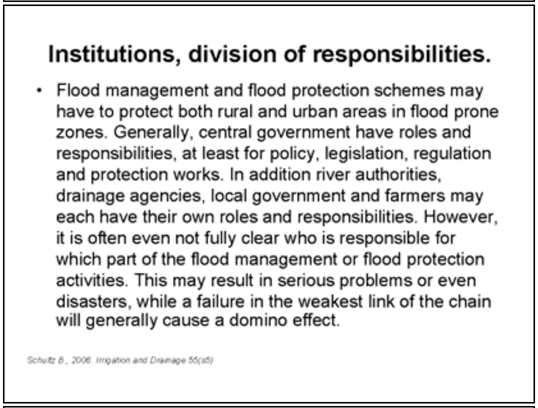
The houses are conveniently located along the river and the paddy fields are behind the houses. Flood embankments or dikes should be constructed behind the houses, confining the houses and river between the dikes and saving the paddy fields. Our case differs from that of the Chinese, and we have to think of another solution for the problem.

This is another picture.

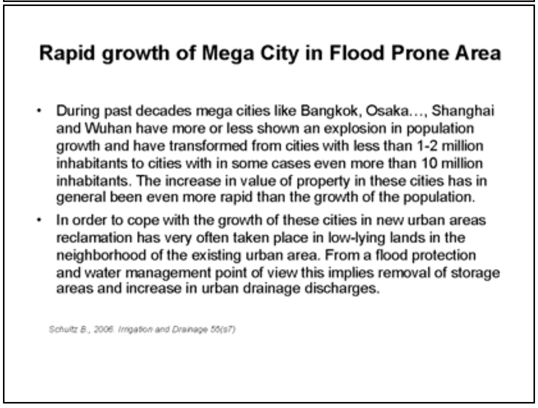
This is too.



I am also a member of the Thai ICID. I have found that a special issue of the ICID journal focused on integrated flood management. This is what I found. We might also consider some of the suggestions in this issue.



One very difficult aspect we commonly identified was the division of responsibilities among institutions. It is often unclear as to who is responsible for which part of flood management or flood mitigation and/or relief. Continuing with this chaos might result in a series of problems or even disasters. I now turn to a paper by Professor Shultz.



There is a concern about the rapid growth of mega cities in flood prone areas. During the past decades, mega cities like Bangkok, Osaka, Shanghai, and Wuhan, have recorded an explosion in population growth and have transformed into major and highly populated cities. The increase in the value of property in these cities has been more rapid than the population growth. This indicates that it is very important to carefully invest in the flood protection scheme. While coping with the pace of growth of these cities, reclamation has often ignored in the neighborhood low lying lands.

When cities expand, they will occupy the low-lying areas. From the perspective of a hydraulic engineer, this translates into a reduction in water storage areas and an increase in urban drainage discharge.

This is a picture of paddy fields near Bangkok that we can store water.

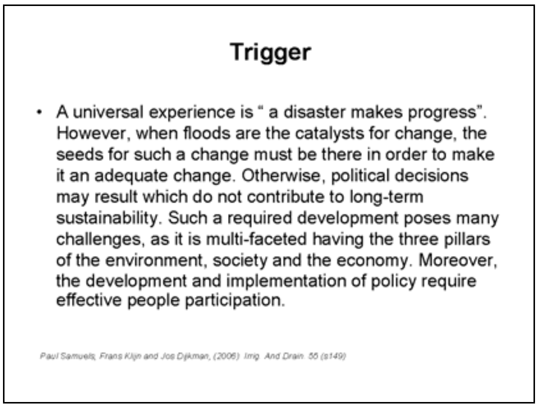
But the land across the paddy fields is occupied by a community.

The new airport in Bangkok was previously a water retention area, which has been completely modified as a solely urban area.

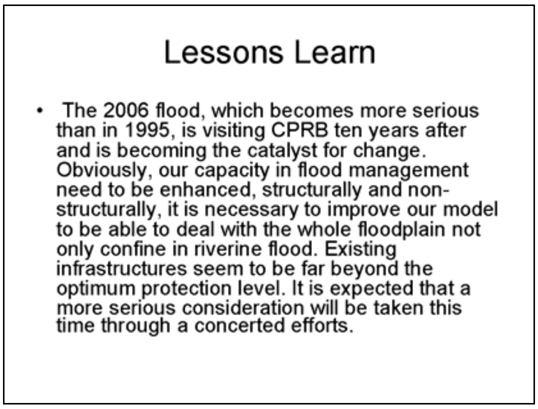
Consequences

- Protection levels that are generally far below the economic optimum (actual levels between 1/20 and 1/100 years)
- Serious risk of loss of a large number of human lives when an extreme event occurs
- Costs of purely physical solutions are generally unaffordable.

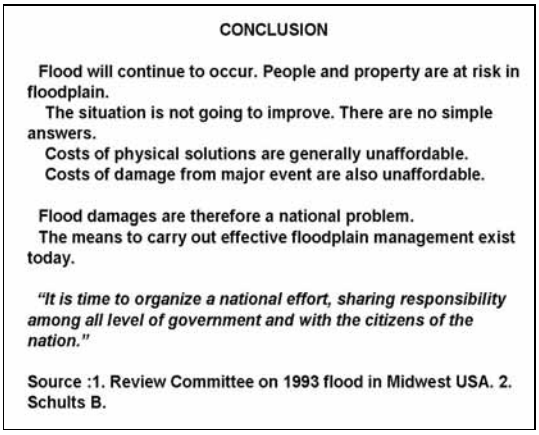
I believe that we should seriously invest in flood mitigation and protection. A change is urgently needed, especially in light of past experiences with similar disasters.



The change must be appropriate and necessary, or else political decisions, which do not contribute to long-term sustainability, may result. This is the kind of long-term flood mitigation and relief plan that we have to prepare, and we now have the information, alternatives, and solution readily available. We should hopefully be able to put thought into action at the earliest.



Following the 1995 floods, we realize that the Chao Phraya river basin is playing a crucial role as a catalyst for change. Our capacity in flood management needs to be enhanced structurally and non-structurally. The existing infrastructure seems to be far below the optimum protection level. We expect this matter to be given due consideration for appropriate and early corrective action. The Director General made an attempt to determine ways to divert water into the fields, but we need an official to find such areas. From the ministry's perspective, it appears that we need the model of a flood plain that can help us use the flood plain effectively.



In conclusion, floods will continue to occur, and the people and property in the flood plains will be at risk. The situation will not improve because the cost of a physical solution is unaffordable. Consequently, although it is challenging, an effective flood plain management needs to be implemented and an integrated flood management program needs to be prepared.

9. Bangkok Drainage and Flood Control System

Teeradej Tangpraprutgul
Former Director of Drainage and Sewerage Department

I will address flood management in and around Bangkok. I will also address the cause of flood and assess drainage system facilities for flood protection.

Some people, many years ago…

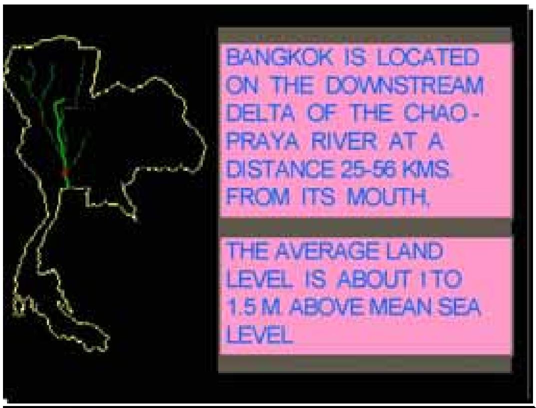
They used to live in a boathouse.

But happy, they are not going back to Chao Phraya river.

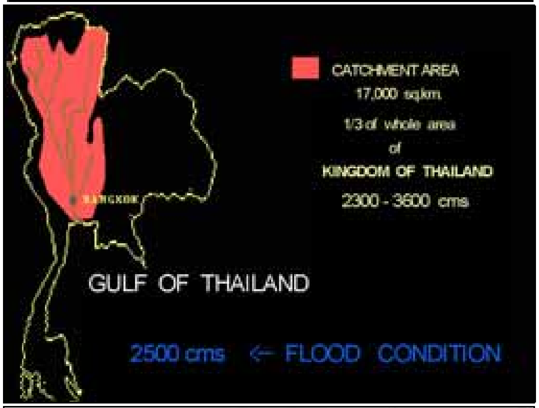
Things have been changed very rapidly; we have many high-rise buildings now.

Regarding the effects of floods in Bangkok, the two largest and most important dams are the Bhumibol and the Sirikit dams. The water storage capacity of these two dams and the Pasak dam are closely monitored with regard to the water from the Chao Phraya river. The Chao Phraya and the Rama VI dams together amount to the total water that the RID is responsible for.

At the end of August this year, the water from these two dams was only 400 m3/s. However, this is gradually increasing. At present, water from these two dams amounts to approximately 5,500 m3/s. On October 11, the water level was approximately 2.12 meters-the highest; this morning, the water level was above 1.97 meters. Based on these figures, it is evident that a good flood protection system is essential in Bangkok.



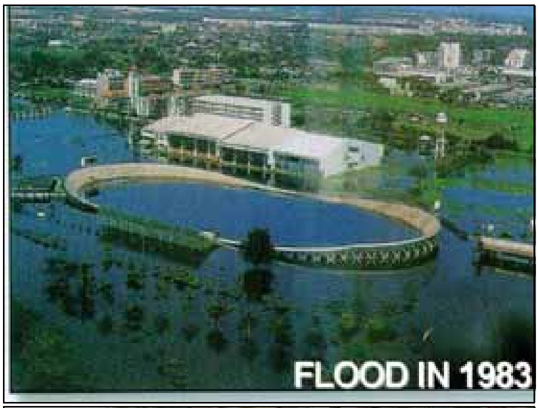
The city of Bangkok is approximately 25 to 56 kilometers from the Gulf of Thailand; the average land level is about 1.5 meters above mean sea level.



It was established that the average maximum inflow passed through Bangkok should not exceed 2,500 m3/s. At present, the water passed through the Chao Phraya and Rama VI dams is 4,500 m3/s.

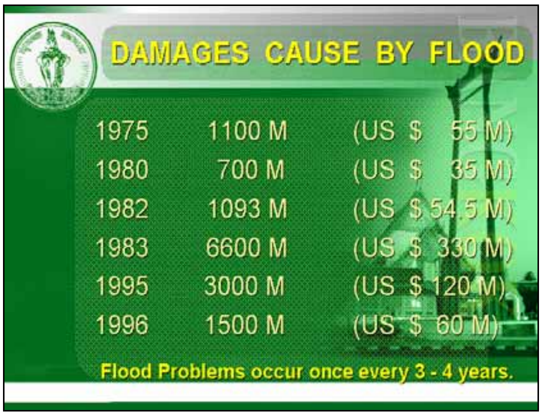
Normally, the city of Bangkok is a flat land and very good for agriculture.

But we had a big flood in 1942.



In 1983, *** area in Bangkok was a very popular housing site; however, at the time, the water supply was not adequate. Consequently, groundwater was extracted, resulting in severe land subsidence; hence, this area witnesses flooding for more than 2 months every year.

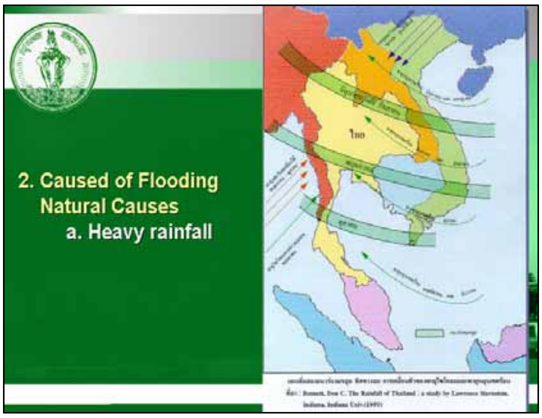
In 1995, the water flow from the Chao Phraya and Rama VI dams was above 4,500 m3/s. Following this flood, the BMA considered constructing a road along the Chao Phraya river. Consequently, the RID constructed a road away from the river; it also served as a flood barrier.



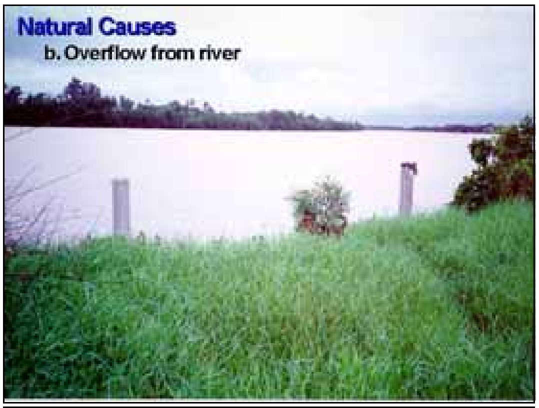
Flood damage in many areas.

The tropical rain in this area essentially causes the floods in Bangkok. For instance, heavy rain causes the water from the Chao Phraya river basin to overflow leading to floods in that area. Further, there is significant inflow from the surrounding area, especially in the eastern part of Bangkok. Many years ago, this part used to be an agricultural area, and the people living here had grown accustomed to the floods. However, at present, people living in this area are voicing their dissatisfaction. Further, 80 kilometers of the coastline is also affected by the tides, particularly from the end of September to December.

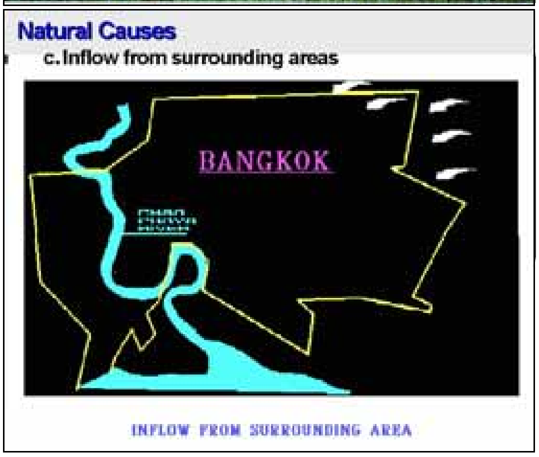
Besides natural causes, man-made causes, misuse of land, low efficiency of drainage systems, and land subsidence (although this has been significantly reduced) are equally responsible for floods.



This is the way of rain. The rain comes from South China Sea when the low pressure is past after 23 October. Normally, it will pass through southern part of Thailand.



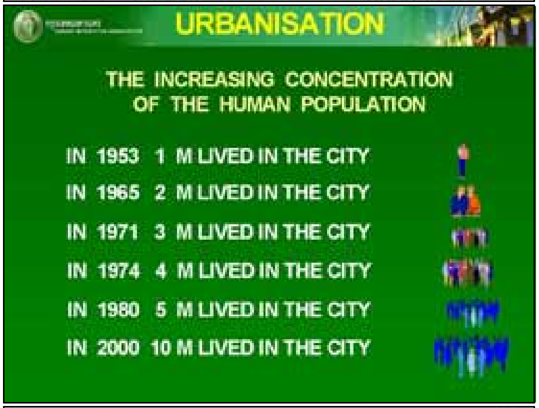
Overflow from the river.



Just see the picture.

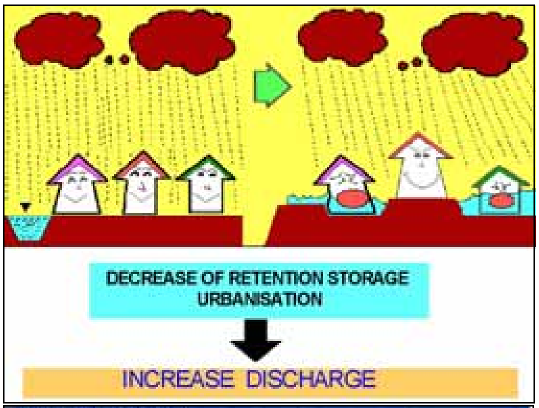
Tidal effect.

There are tall buildings in this area.

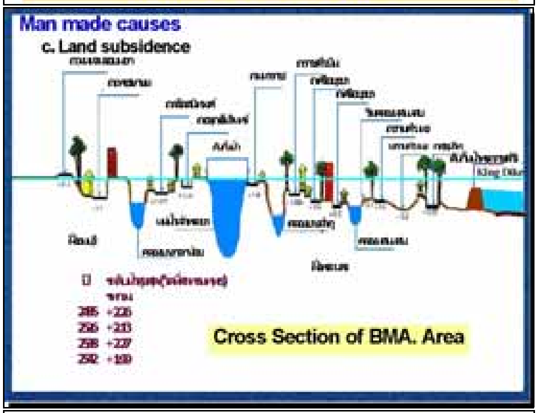


Urbanization has also affected the floods in Bangkok; although the number of registered people living in Bangkok is approximately 5 to 6 million, the actual number is perhaps 10 million.

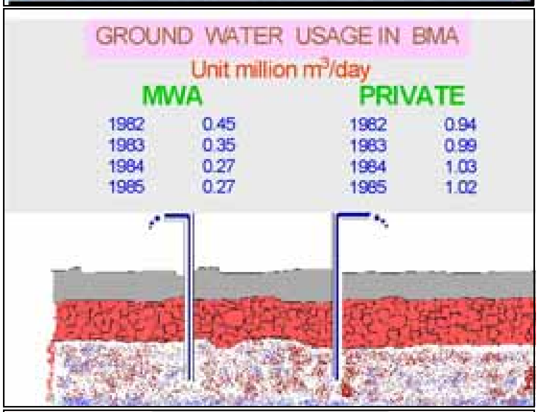
Formerly, Thailand had many canals that effectively functioned as a drainage system. At present, however, as a result of the rise in squatters who live along the canal, the efficiency of the drainage system has also reduced.



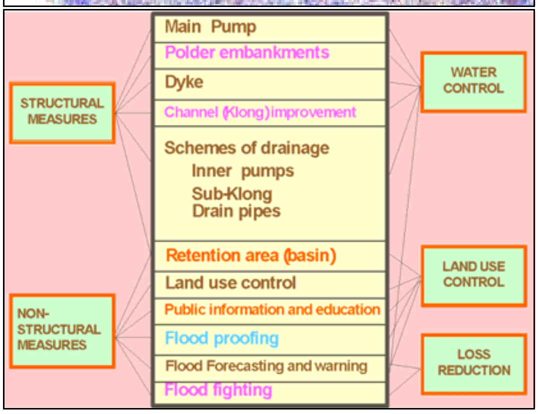
Each city should have storage.



This was a flood-prone area many years ago.



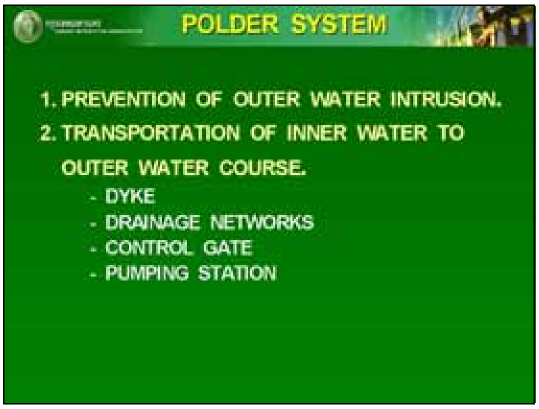
Ground water extracting is not allowed now.



Given the above, let us address the steps that have been taken towards the mitigation of floods. A total of 2,000 pumping stations have been installed in Bangkok, with 110 large pumping stations along the Chao Phraya river. Having adequate pumping stations is crucial because gravity does not facilitate water flow in low lying areas. Moreover, the environment was also considered in the planning flood mitigation. For instance, in colder environments, we have constructed dikes to prevent the water from flowing into the city. Further, the efficiency of the canals has been improved by constructing retaining walls. These are the structural measures taken for flood mitigation.

Non-structural measures include improving the capacity of the water retention area. According to the King's suggestion, a basin with a capacity of 12 million cubic meters has been constructed as a retention area. In addition, a system of controlling land use has also been introduced; further, a flood map has been made available to inform people of the frequency and intensity of floods. Moreover, people living in low lying areas have been informed of using flood-proof material in their houses. Typically, these areas will be flooded once in 5 or 10 years. At present, Dr. Pornsak is responsible for flood forecast and warning for our department.

Since we have our own radar, we are able to forecast the time and direction of rain; further, we are able to determine the intensity and the time the rain will take to travel from one point to another. For instance, if we monitor the rain in Nakhon Pathom, the time interval before the rain reaches Bangkok is approximately 2 hours; hence, we can issue a warning to the people to avoid the flood prone areas.

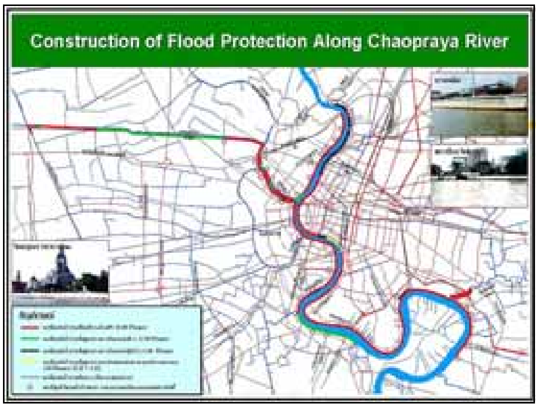


Polder system.

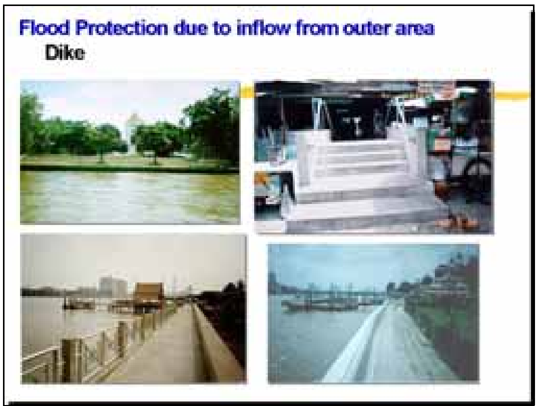
In Bangkok, flood mitigation is conducted in four zones. The first zone is along the Chao Phraya river as well as the Bangkok Noi and Maha Sawat canals. Earlier, the Chao Phraya river used to be a slow-flowing river; however, at present, the river current is extremely fast. Consequently, RID have constructed Lad Pho gate that allow only the floodwater to pass through and are impervious to saline water.

The second zone in Bangkok is the city area that is home to the wealthier citizens. The King's dike as well as the greenbelt, which passes through to the Gulf of Thailand, is present in this area. Moreover, since the airport was constructed, two big canals connected to Gulf of Thailand have also been built. Since this area requires significant protection against floods, many retention basins and tunnels have been constructed. Since the people living upstream as well as those in Bangkok are farmers, at times, we cooperate with the AIT and allow the water to flow through. In certain areas, water is allowed to enter the catchments in the Bang Pakong river basin.

Another zone is Thonburi Sai that used to have many canals, including the Mahasawat canal. In cooperation with RID, we attempted to construct a large pumping station here. Previously, this area was referred to as the Venice of the east; at present, many canals still exist and people continue to use boats as transportation.



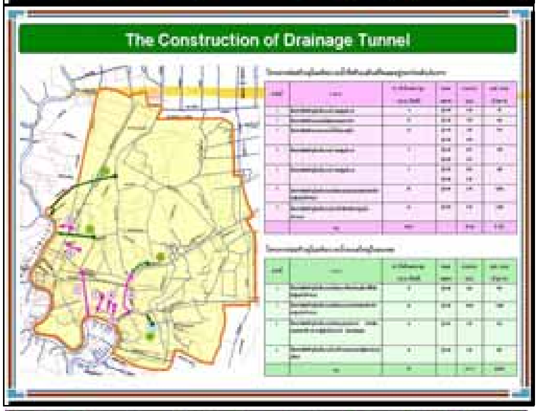
In this picture, you can see that the retaining wall, which is 80% complete, will perhaps be completed next year. Prior to the construction of the retaining wall, sandbags were used to protect against floods. In the northern part of Bangkok, many pumping stations have been installed on both sides of the Chao Phraya river. Often, people ask why the water is not pumped out during high tide. The answer is simple; if you pump out the water into the Chao Phraya River during the high tide, the neighboring country and its people will be inconvenienced. As a result, we use a tilo to determine the volume of water pumped out during low and high tides.



The tidal dike.

Flood protection in the city core area.

The retention basin published in the paper.



The construction of tunnel: we have proposed many constructions.

This is the eastern part of Bangkok.

With regard to flood mitigation, a flood control center that operates 24 hours a day has been established.

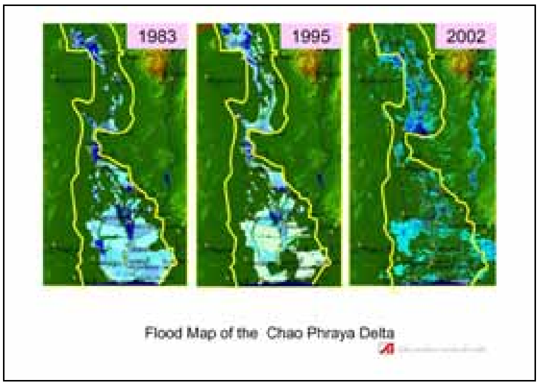
A flood control system has been implemented.

We have a monitoring station as well.

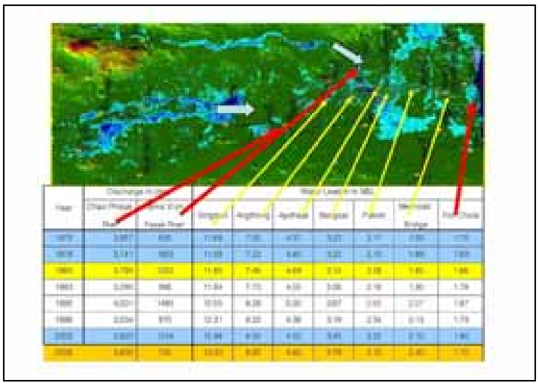
That is it for my presentation.

10. Flood Situations for the next 30 days of Lower Chao Phraya River Basin

Pornsak Suppataratarn
ASDECON Corporation

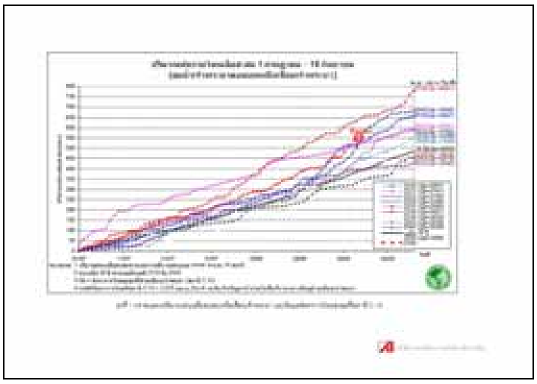


In 1983, the lower Chao Phraya region and its limits were flooded; consequently, we pumped out water during high tide. However, as a result, certain areas were flooded for up to three months. In 1995, again this area was flooded with water flowing from the north. In 2002, similar floods occurred; however, the 2002 floods were at a smaller scale owing to the various measures taken for flood protection. Further, following the 2002 floods, several dikes were constructed along the river; consequently, most of the area is now safe and only a few low lying areas are affected by the floods.

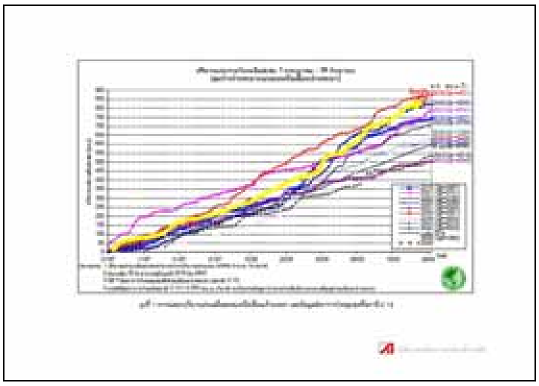


This is the water level along the river at the time of the major floods during the last 30 years. As is evident, several changes in the water level with regard to the direction have been observed. In the lower region, in a large area of Bangkok and Bangsai, Pakret, the water level increased from 50 to 60 centimeters.
This is my forecast for the year 2006.

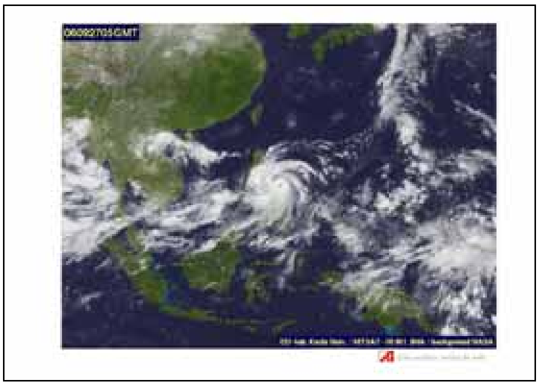
This is the rain in the upper basin of the Chao Phraya dam. At the time, Dr. Sutat forecasted that the volume of water in the Chao Phraya dam would rise to more than 4,000 cubic meters, but nobody believed him. However, as is evident, Dr. Sutat's forecast was correct.



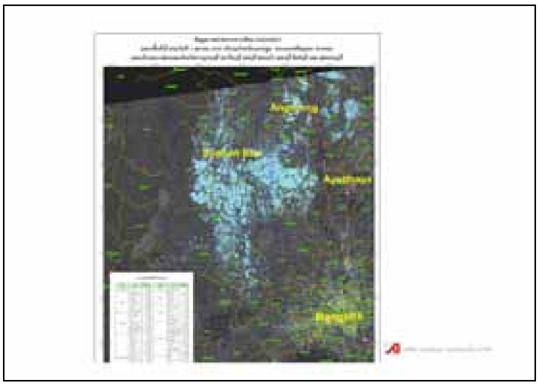
If you notice the pattern of the rain, you can see that at the end of last month the total rain was almost equivalent to the rain in 1995 in the upper region and was delayed by a week.



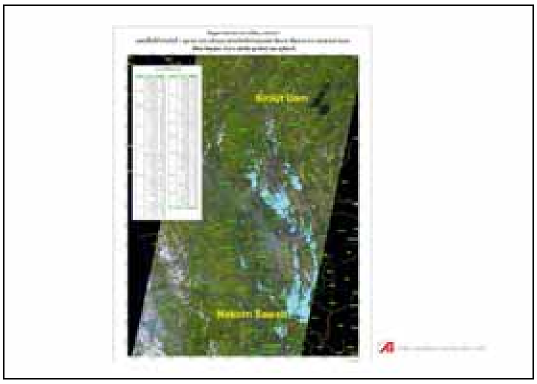
Consequently, with the high tide and storm winds gathering, it is predicted that it will rain for a long period of time and result in another flood.



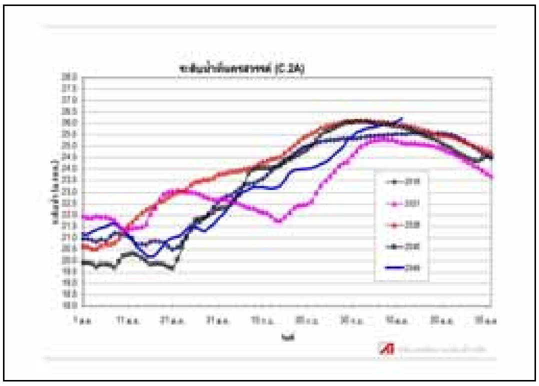
It occurs even though it is not really high intensity.



With regard to the lower region, it had already begun flooding in October.

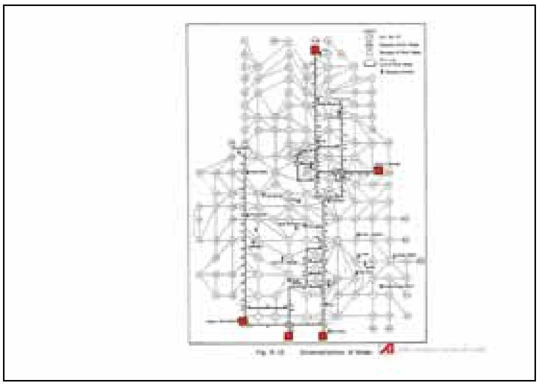


This is the flood situation; Nakhorn Sawan is the blue colored area.

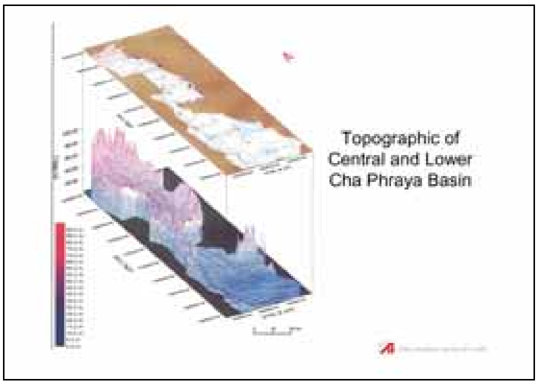


Further, on comparing the water level of this month with that of the same month in 1995, it was evident that the water level this month was higher. I believe that this is due to confining or some other effect.

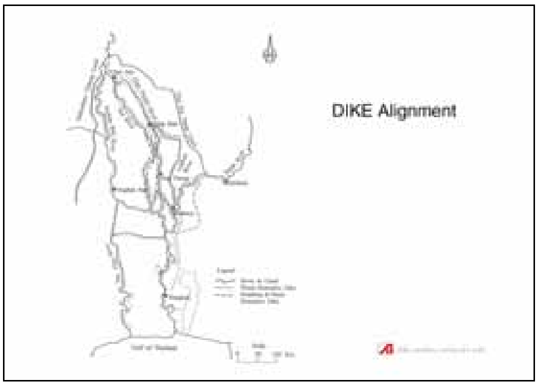
I will now discuss the forecast model that I had developed when I was working at AIT under the supervision of Dr. Sutat.



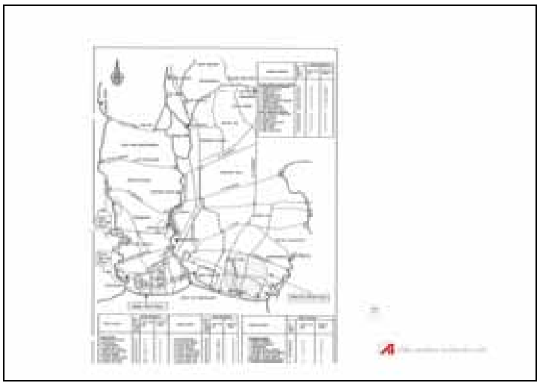
Based on the model, we need to further develop on the Chao Phraya and Rama VI dams. Moreover, we need to further improve the forecasting system and develop the topography of area.



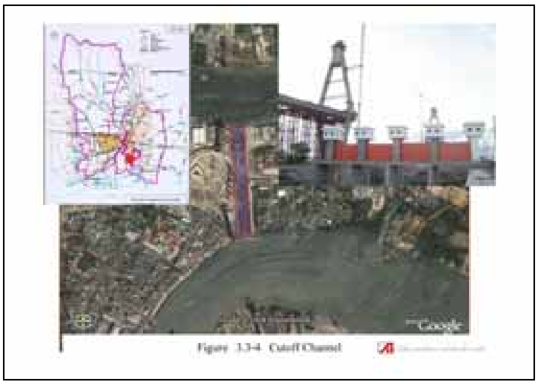
Subsequently, we should also be able to predict the water level of the Chao Phraya dam.



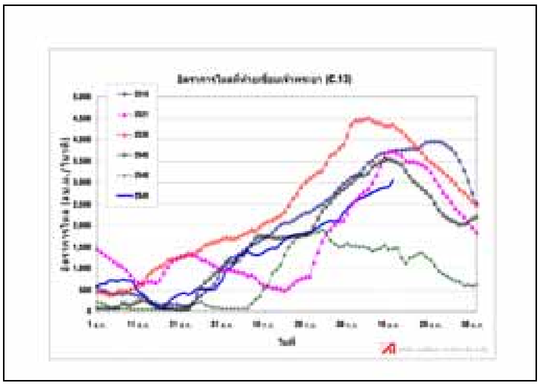
This is the dike alignment.



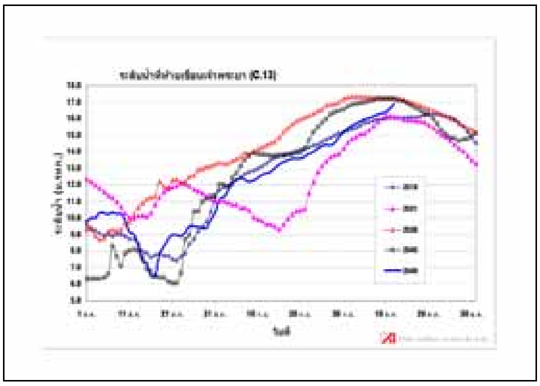
The structural system can be responded and can be operated for better effects.



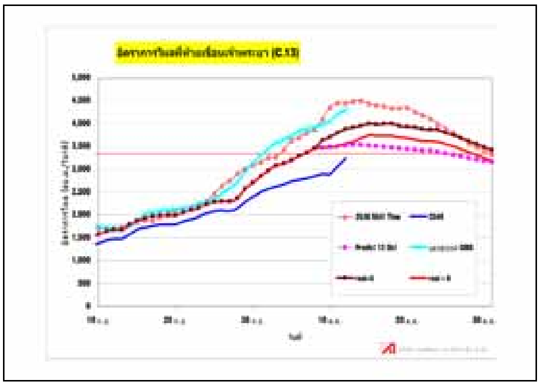
This is cutoff channel, which is now operating.



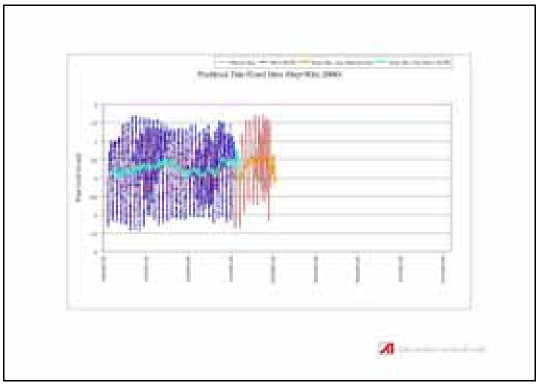
The other thing we need to do is to monitor Chao Phraya dam. The blue one is this year. In the first part, the water level is much lower than 1995. I think this is due to the relocation.



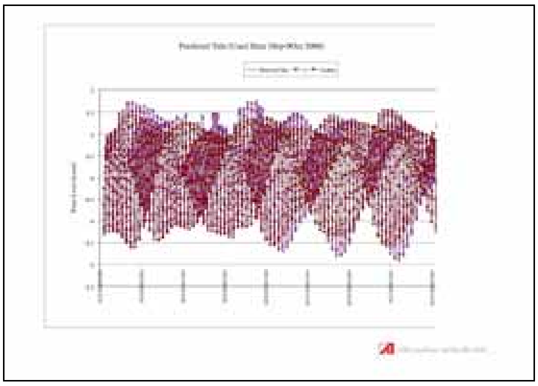
The water level goes up to almost same level as 1995, but it is about two weeks late compare to the 1995 flood.



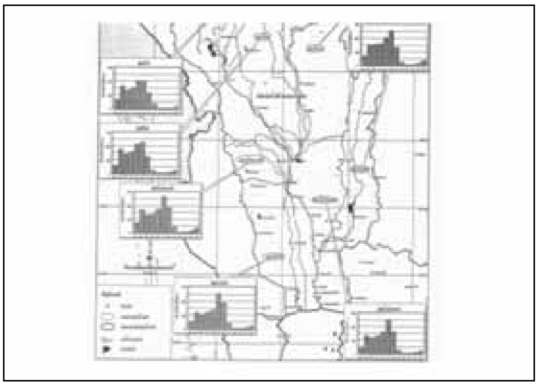
The volume of water passing through the lower Chao Phraya dam is forecasted to be 3,800 cubic meters. With regard to the tide, I have used the tidal pattern of the last two months to forecast the tidal behavior for the next month.



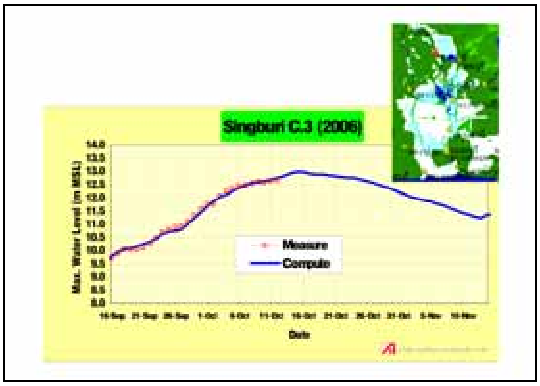
With regard to the tide, I have used the tidal pattern of the last two months to forecast the tidal behavior for the next month.



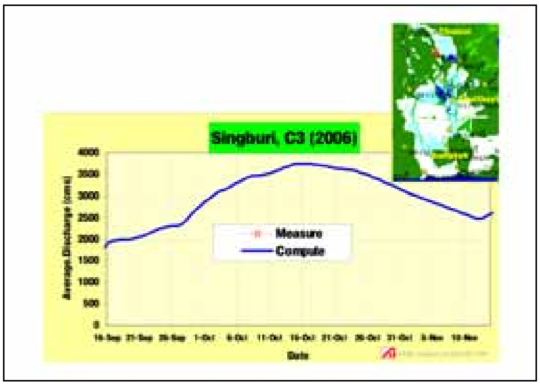
This is water forecasting.



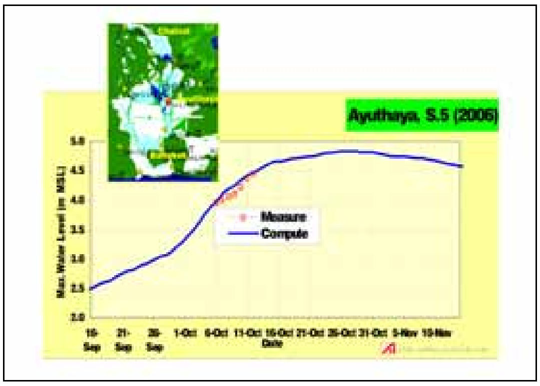
We need forecasting using these data.



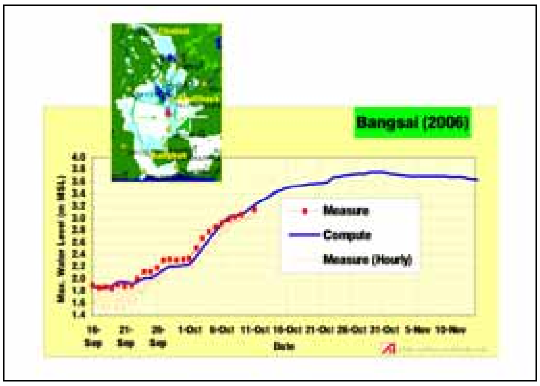
The results predicted by the model were considerably accurate.



It was found that the discharge was similar to the Chao Phraya dam.

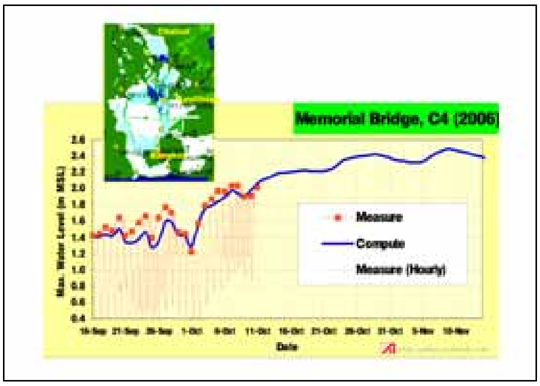


At Ayuthaya, the water level was slightly lower. However, Ayuthaya will reach its peak in the next 10 days and the water level will rise by 20 to 37 centimeters and it lasts for 2 or 3 days.



Bangsai: this is the reference point for Bangkok that is used to check the degree of damage incurred by the city-the discharge was computed based on the water level. At its peak, the water level will rise by 40 centimeters during high tide. It is forecasted that the situation will be severe for at least a month; however, I could be wrong.

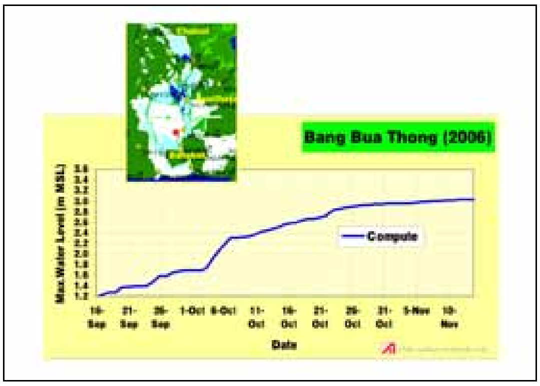
The discharge in Bangsai area is 3,500.



Memorial Bridge is a reference point to Bangkok.

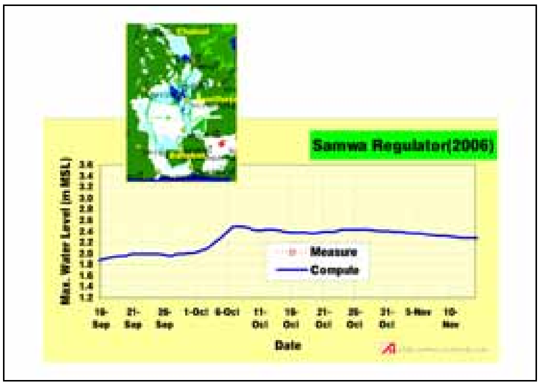
This year there will be a series of high tides because the water that overflowed into the flat plain area in the west bank will be lesser.

It will cause a small high tide in the flat plain area also. Unfortunately, however, this information was not available to me at the time of developing this model.

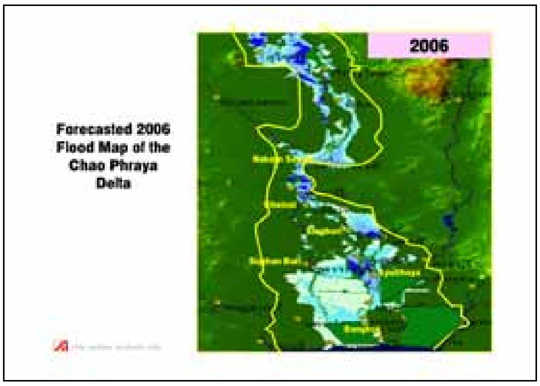


Situation in the lower part Bang Bua Thong.

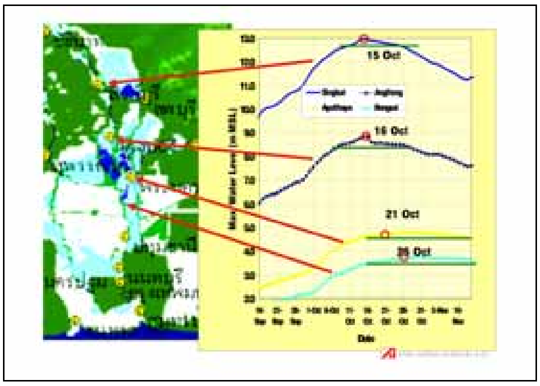
Bangya: more populated area and this is a monitoring point.



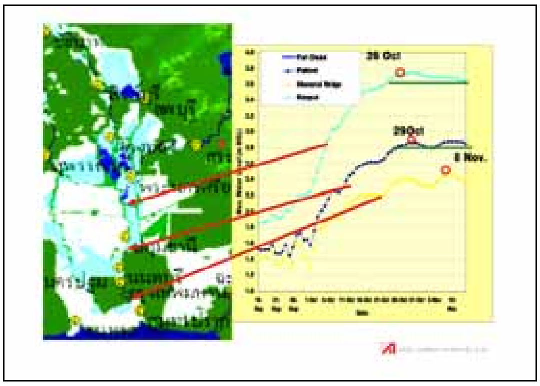
Samwa: reservoir in the east. It is more controllable in this area.



I believe that the flood map of 1995 will be extremely useful in forecasting floods for this area, although I believe that this year the situation in and around Bangkok is more controllable.



The peak appears like this: on 15 at Singburi, on 16 at Angthong, on 21 at Ayuthaya, and on 26 at Bangsai



The peak moving out to the lower part: on 29 at Pakret, and on 8 November at the Memorial Bridge.

We should cut the peak and not the base because if we cut the base it will be more detrimental.

11. Questions and Discussion

Chairperson: Mr. Subin Pinkayan, Vice president of Thai Hydrologist Assembly

1 I agree with the speakers who addressed us in the morning session and with the issue of land subsidence that was discussed in the afternoon session. Heavy groundwater pumping has caused land subsidence in many cities such as Tokyo, Osaka, Mexico City, Shanghai, and Bangkok. In Bangkok, land subsidence has been considerably controlled particularly in central area where groundwater pumping is prohibited, however, in the outskirts of Bangkok and its adjacent provinces, heavy groundwater pumping is prevalent. I would like to draw your attention as well as that of the Thai authorities, such as the BMA and RID, to the fact that land subsidence is a major cause for severe flooding. Thus, mitigation policies should be implemented with this fact in mind.

2 I agree with you in that land subsidence is an important factor that affects flooding. In Bangkok, despite the fact that land subsidence is under control and its rate is gradually reducing, the land has subsided by 1 meter over the last two decades. Previously, the land would subside at the rate of 10 centimeters a year; however, at present, owing to the effective measures taken, the rate has reduced to 2 or 3 centimeters a year. Regardless of this, I will attempt to amend the mitigation measures under the current policy by recommending that the control of land use and groundwater be added to it.

3 With regard to the Kaeng Sua Ten project, has its progress been affected by the floods this year? Further, regarding the canal across the Chao Phraya river, have the floods affected its functioning?

4 At the RID, we have carefully studied the Kaeng Sua Ten project and consider it to be feasible as well as have an acceptable environmental impact. However, we believe that in order to obtain an approval for the construction of such a project, we need a declaration on the EIA. Nevertheless, we are confident that the Kaeng Sua Ten dam-when constructed-along with the *Manwan* dam will considerably benefit the water management of the Chao Phraya river basin. However, this decision has not yet been made by the government. With regard to the second part of your question, the canal is currently operating efficiently.

5 What is the status of the EIA? I understand that it has already been passed.

6 My colleagues have stated that in general, it can be regarded as having been passed; however, certain issues that I am unaware of are still pending.

7 When I was working with the RID, I was involved in the Kaeng Sua Ten project. Although I

am now not with the RID anymore, in retrospect, I believe that if we are going to support this project, there are certain issues that need to be resolved. This is because the study on the Kaeng Sua Ten project focused on the project at a structural level and did not consider the contribution towards flood mitigation. The uncontrolled water in the Chao Phraya river during the wet season is more than 30 million cubic meters per year, and this is only in the wet season; in contrast, the storage capacity of the Kaeng Sua Ten reservoir is approximately 1 million cubic meters. Thus, while the Kaeng Sua Ten reservoir may be beneficial at the Yom River basin, we still need to address the issue of whether it will be beneficial in flood mitigation in the lower Chao Phraya river basin.

8 I think that this is a good time to evaluate the contribution of the Bhumibol and Sirikit dams in terms of whether they have met the expectations of the feasibility study that was conducted earlier. I believe that Bangkok would have experienced severe flooding without these two dams.

9 Regarding the Kaeng Sua Ten project, after our study on the developmental impact had already been passed, the Chulalongkon University Report suggesting that the construction will affect the animals living in that area was prepared approximately two years ago. At the time, NGOs were a small power. Regardless, due to the nature of the issue the government was silent. Further, since the RID was responsible for the demand and supply of this project they were eager to begin; hence, we were also silent. Recently, however, we have all agreed on the manner in which the construction will proceed because it was a good time to address issues pertaining to flood mitigation. Therefore, we gradually proceeded with the development and contacted several agencies such as the media. However, it was proposed that the final consent for construction would be given based on a comparison of the cost of construction with the benefits. Since our cost estimation focused only on construction and did not include the mid-term effect or the livelihood of the people, it did not meet the required cost benefit. Consequently, the government rejected the proposal to build the dams.

10 I believe that we are here representing various groups of people who are interested in flood mitigation. I am certain that collectively we have amassed considerable data as well as knowledge pertaining to this issue. I propose that Dr. Siriphong take this comprehensive book, containing the pooled information, to the government.

11 I believe and hope that Dr. Siriphong is willing to accept this responsibility, and I am sure that he is eager to actively contribute in this endeavor.

12 I believe that by the end of this discussion we will have reached a concrete conclusion. Further, I would like to state that I support the idea of conveying this information to a higher authority. As Secretary of the National Water Resource Committee, I am willing to

undertake this responsibility and will be communicating our message to the Deputy Prime Minister. In addition, I would like to invite some of participants at this meeting to a workshop that is being organized by the Department of Water Resource and the National Water Resource Committee.

13 I have been working on issues related to water management for a long time, and I would like to confirm that the information presented here is thus far the best and most accurate. Besides the alarming flood forecast for Bangkok, I believe that the area around Nonthaburi will also experience severe flooding. As everyone is aware, the water in the Bhumibol dam has already reached its maximum capacity; subsequently, water will be drained in order to protect the dam. In fact, even Pasak and Sirikit dams have reached their maximum capacity. Although this information pertaining to the worsening situation cannot be verified, it is the only information that is available.

14 I believe that the Dr. Pornsak's forecast should be provided to Dr. Siriphong so that he is able to use the information for the next meeting. I believe that this prediction might be beneficial in facilitating a reaction from the government.

15 I was in the water resource committee of the government of Thailand prior to my retirement. I would like to comment on the Bhumibol and Sirikit dams. I have been informed about people complaining that the two dams are extremely big, and as a result, there is considerable empty space and only two or three of the reservoirs in Thailand are full. Thus, I would like to reiterate the fact that the feasibility of the Kaeng Sua Ten project be determined.

16 I would like to make an observation. During the last 30 years, that is, from 1977 to 2007, a pattern with regard to floods has been noticed. In 1979, there was severe drought, but in 1980, we experienced severe floods. Then, in 1994, there was severe drought; in 1995, severe floods. Moreover, last year we experienced severe drought, and this year we are plagued with severe floods. I found the cycle is 10 to 15years. Based on this, I believe this pattern-severe drought, followed by severe floods will persist. Thus, the people responsible for allocating water should be aware of this pattern.

17 I believe that we will have to forecast the weather in advance by observing the temperature in the Pacific Ocean. The NOAA is currently working on this and has set up a station in the Pacific Ocean for the same. For example, before the end of last year, we were warned that this year would be a La Nina year and that next year will be an El Nino year. Unfortunately, they only have a station in the Pacific Ocean and not in the Indian Ocean; hence, we are unable to register and benefit from it.

18 Forty years ago, research on the cycle of nature was common. The sunspot was recorded,

and its activity was used in forecasting. However, after 1965, the cycle of the nature has not been discussed. In addition, I believe that observing the ocean temperature to predict weather will be beneficial, and I hope that we are successful in this endeavor.

19 I would like to make one minor observation. This is a symposium on the current policy relating to flood management. Given that we are confronted with municipal floods, Dr. Pornsak's presentation regarding the prediction of the current flood appears extremely practical and urgent. I would like to know if this is a voluntarily study or a government study.

20 Typically, many forecast models are developed by our researchers or the technocrats. I believe that among us there are at least five or ten models, and Dr. Pornsak's model is one of them. I would like to ask Dr. Pornsak to respond to the question: Is this a voluntary study or a government study?

21 This is a voluntary study, although I have received support from the government in the form of data that was needed to make this model more accurate. If I am provided with more data, I aim to further develop this model and increase its accuracy.

22 I believe that several predictions have been made, including those by Dr. Suphot from the Water Resource Department and by the BMA. I would like to ask Dr. Sutat to comment on the same.

23 I would like to add to what Dr. Pornsak has stated. At present, there are some models that provide the RID with the information that they need in order to make decisions; however, Dr. Pornsak and I would like to provide them with further information in order to enable them to make the correct decision at the right time. Further, I would like to add that although my forecast for the discharge may have been ahead by one month, a skeptical analysis indicated high discharge; this information has already been given to the RID.

24 I would like to direct my question to Dr. Siriphong. In your presentation, you had mentioned political view; I would like to ask you whether you think it exists in our present government?

25 On the October 12, the Deputy Prime Minister convened a meeting with certain people to draft the national policy; he has agreed that flood mitigation in the highly economic areas will be included in this policy, focusing on the prioritization of the project and the organization to be responsible for the activities. Hence, I believe that political view is present.

26 I would like to request Dr. Suphot to present the concluding remarks for this meeting. Before we conclude, if no one has any more comments, I would like to present one more issue.

We already have three ministries involved in the water problem, namely, the Ministry of Agriculture, the Ministry of Water Resource and Environment, and the Ministry of Interior, perhaps even the Ministry of Public Health and the National Committee of Water Resource chaired by the Deputy Prime Minister. I believe that the new government is willing to work toward flood mitigation and that we should share our ideas and suggestions with the authorities. I would like to propose that only one institute or agency to be responsible for coordinating or executing water related activities.

27 I believe that you have raised a very difficult issue; a problem that we are currently facing while working at the National Water Resource Committee is that there are many ministers with their own specific mandates. Hence, if they are not pleased with the decision made by the National Water Resource Committee, they are able to bypass the committee by going directly to the cabinet. Further, in our democratic society, regardless of the decisions made at the governmental level, politicians like to benefit; often, they intervene and change the prioritization of the project plan or programs. Thus, even though we have a central body, problems still exist.

28 Everyone in this room is already aware of the existing situation; moreover, this was the experience with the last government. I addressed this issue more from a business perspective rather than that of a democratic government. I believe that this is a good time to express our concern. On behalf of the Thai authority’s assembly, I would like to thank the participants from Japan Science and Technology as well as those from China. I regret that the focus of this symposium was Thailand and its problems. I am pleased that everybody participated in this meeting and followed the presentations extremely well; I hope that the symposium will be regarded as being successful and that you will continue to participate in it. I would like to express my gratitude to everyone present here.