10th THAICID National Symposium
21 JUNE 2017, Bangkok , Thailand

Progress of Flood Management in China

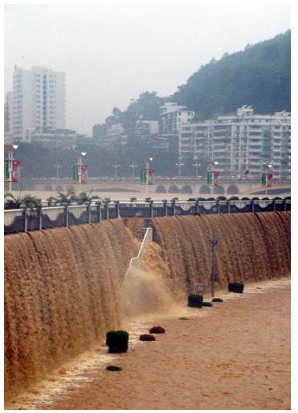
CHENG Xiaotao, Professor

China Institute of Water Resources and Hydropower Research (IWHR)

Contents

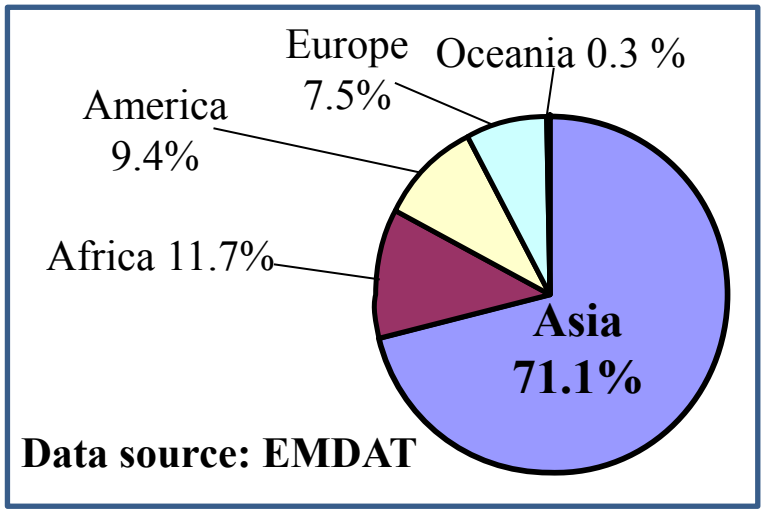
- Introduction
- Changes of flood control situation in China
- Shifting strategy from flood control to flood management
- Approaches to restrain the increasing flood risk
- Conclusions



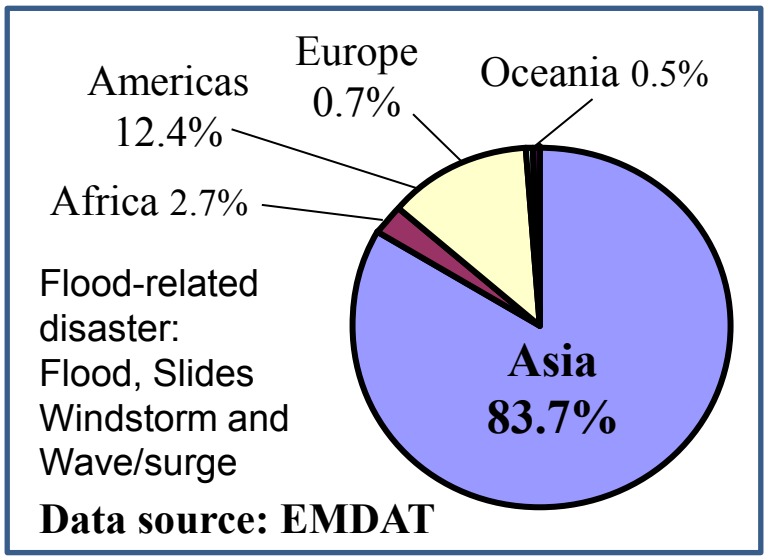


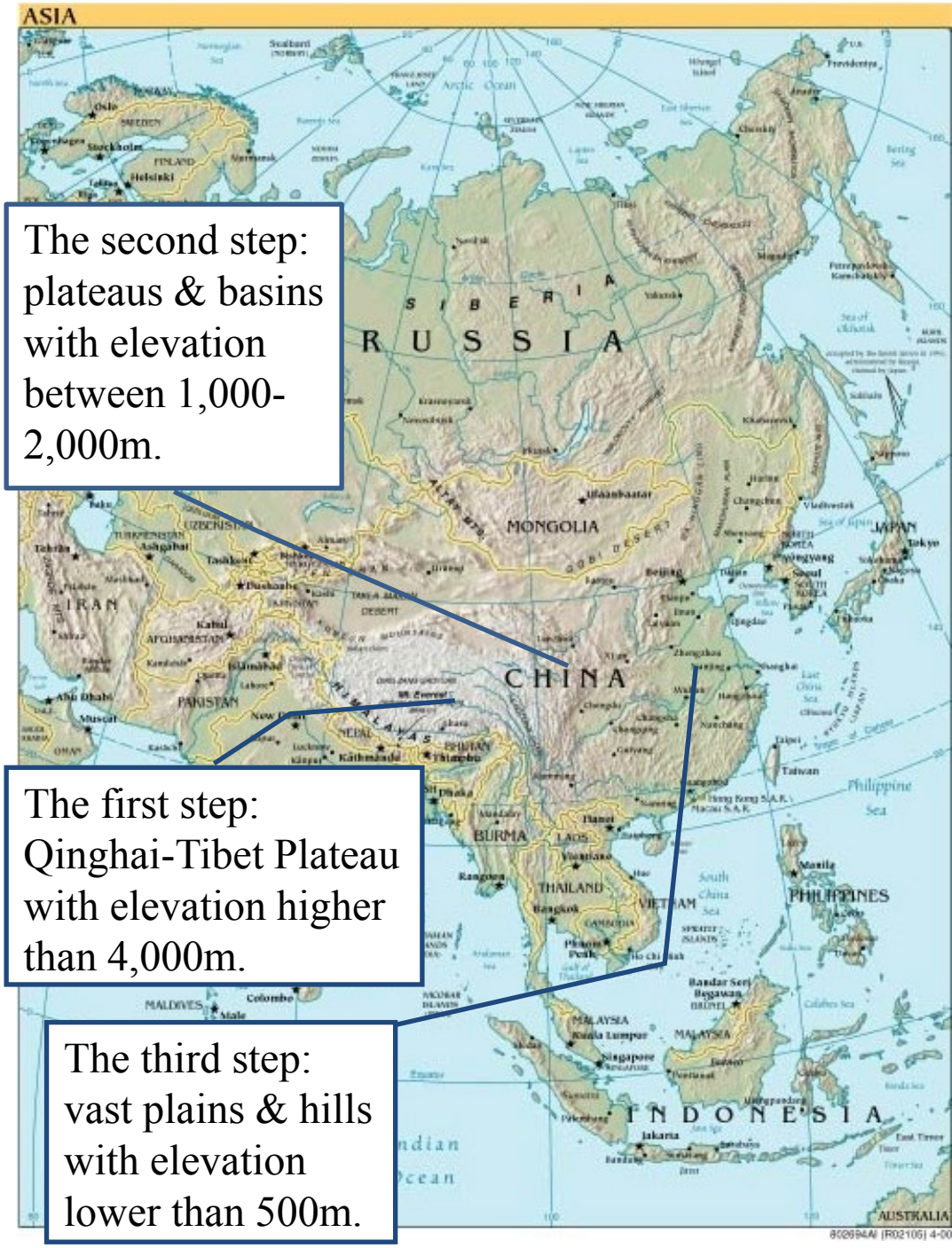
1 Introduction

Global Total Fatalities of All the Natural Disaster from 1986 to 2006

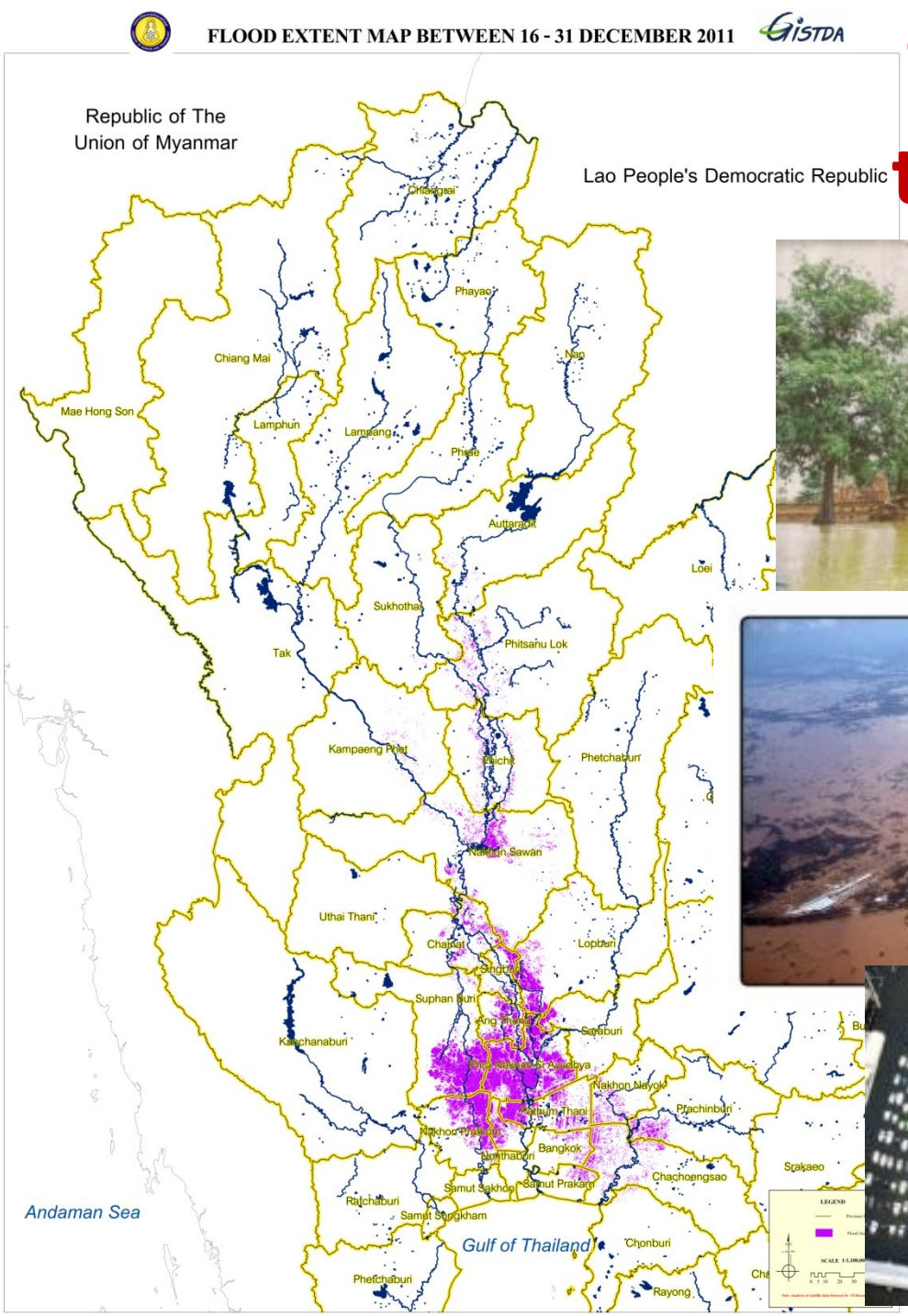


Global Total Fatalities of Flood-related Disaster from 1986 to 2006



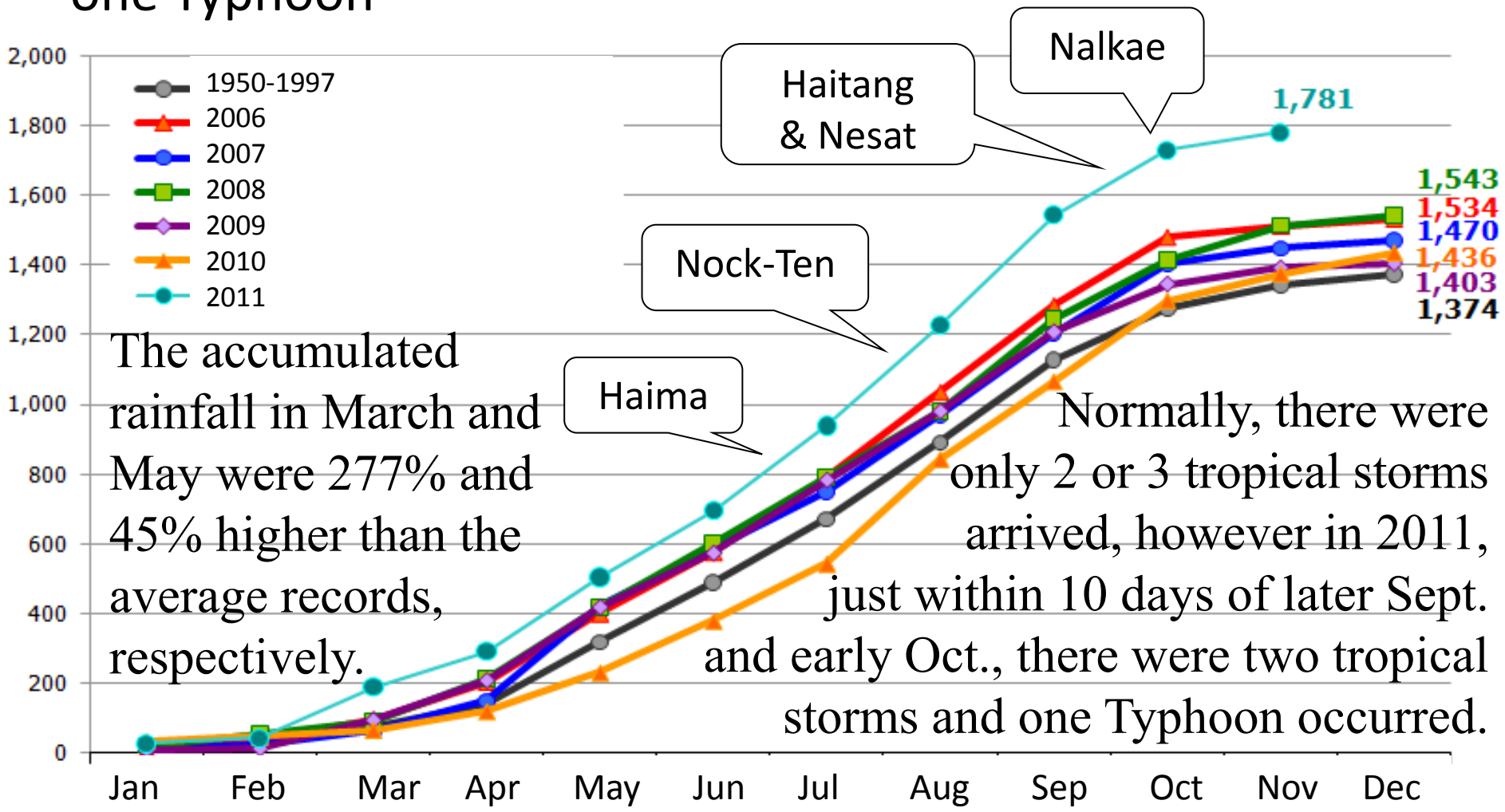


The 2011 big flood of the Chao Phraya River



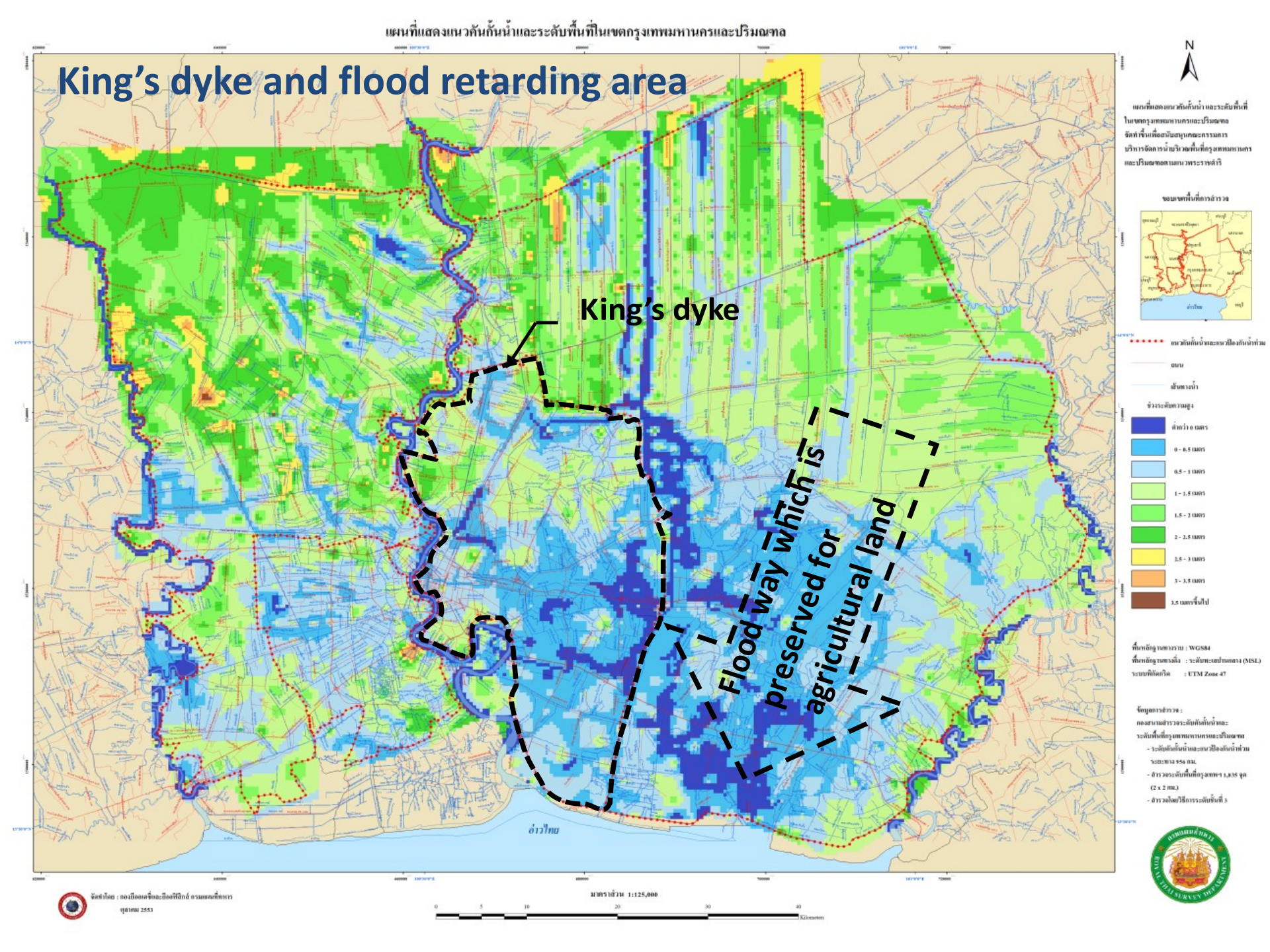
Meteorological background of the 2011 large flood in Thailand

- In 2011, there was a large amount of rain in Chao Phraya River Basin area, caused by four major tropical storms, and one Typhoon

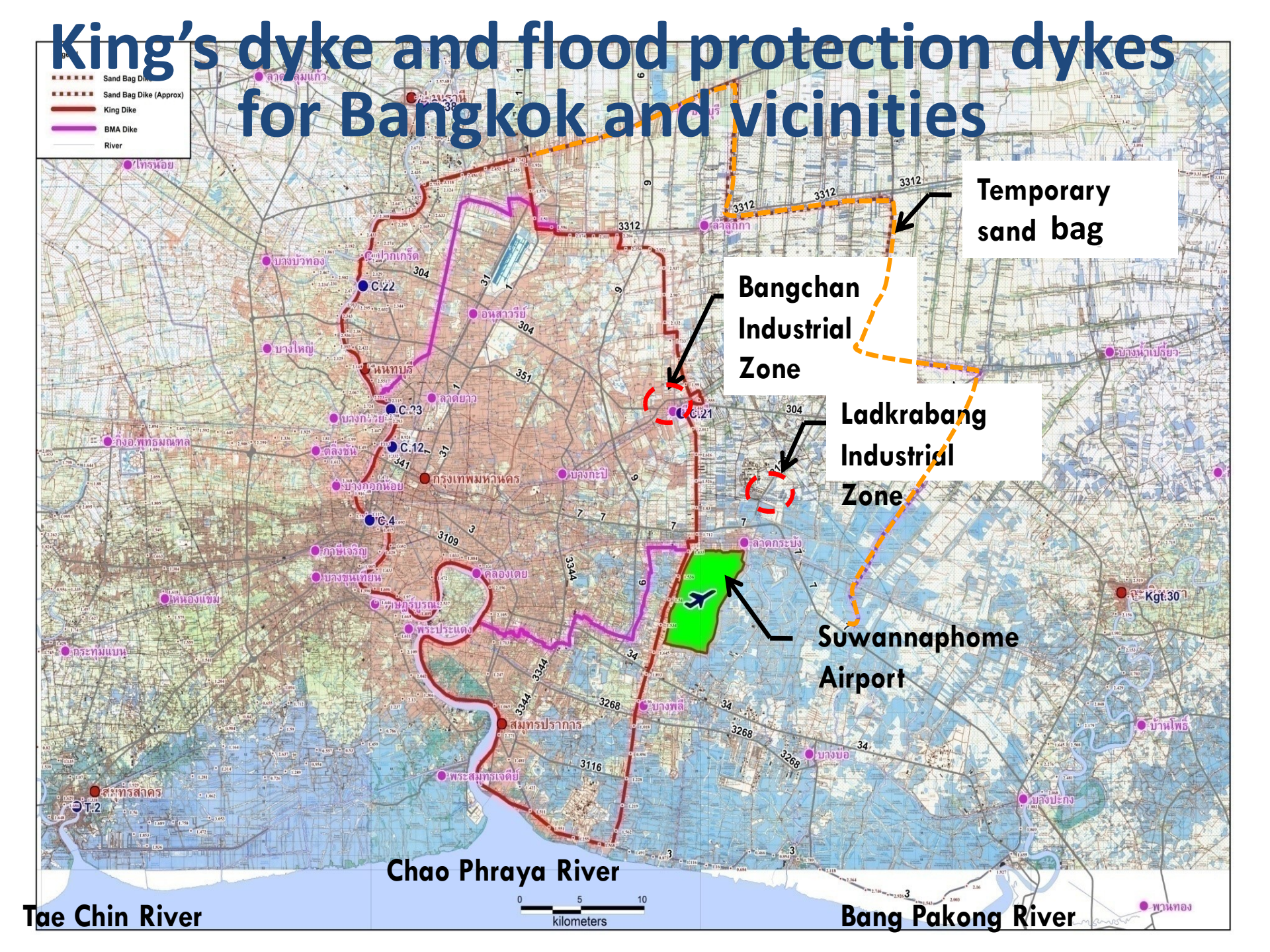


The accumulated rainfall in March and May were 277% and 45% higher than the average records, respectively.

Normally, there were only 2 or 3 tropical storms arrived, however in 2011, just within 10 days of later Sept. and early Oct., there were two tropical storms and one Typhoon occurred.


แผนที่แสดงแนวคันกั้นน้ำและระดับพื้นที่ในเขตกรุงเทพมหานครและปริมณฑล
King's dyke and flood retarding area
King's dyke
Flood way which is preserved for agricultural land
N
อ่าวไทย

King's dyke and flood protection dykes for Bangkok and vicinities



The area of cultivated land in the basin increased by five times from 7,000km^2 in the 1950s to 35,000 km^2 in the 1990s.The area of Bangkok, from 51 km^2 in the 1950s, expanded to 180 km in 1970, then soared to 528 km^2 in the 1990s, a tenfold increase.


Deforestation of Nan Watershed


Deposition of sediment in the River Downstream (Chiang Mai)

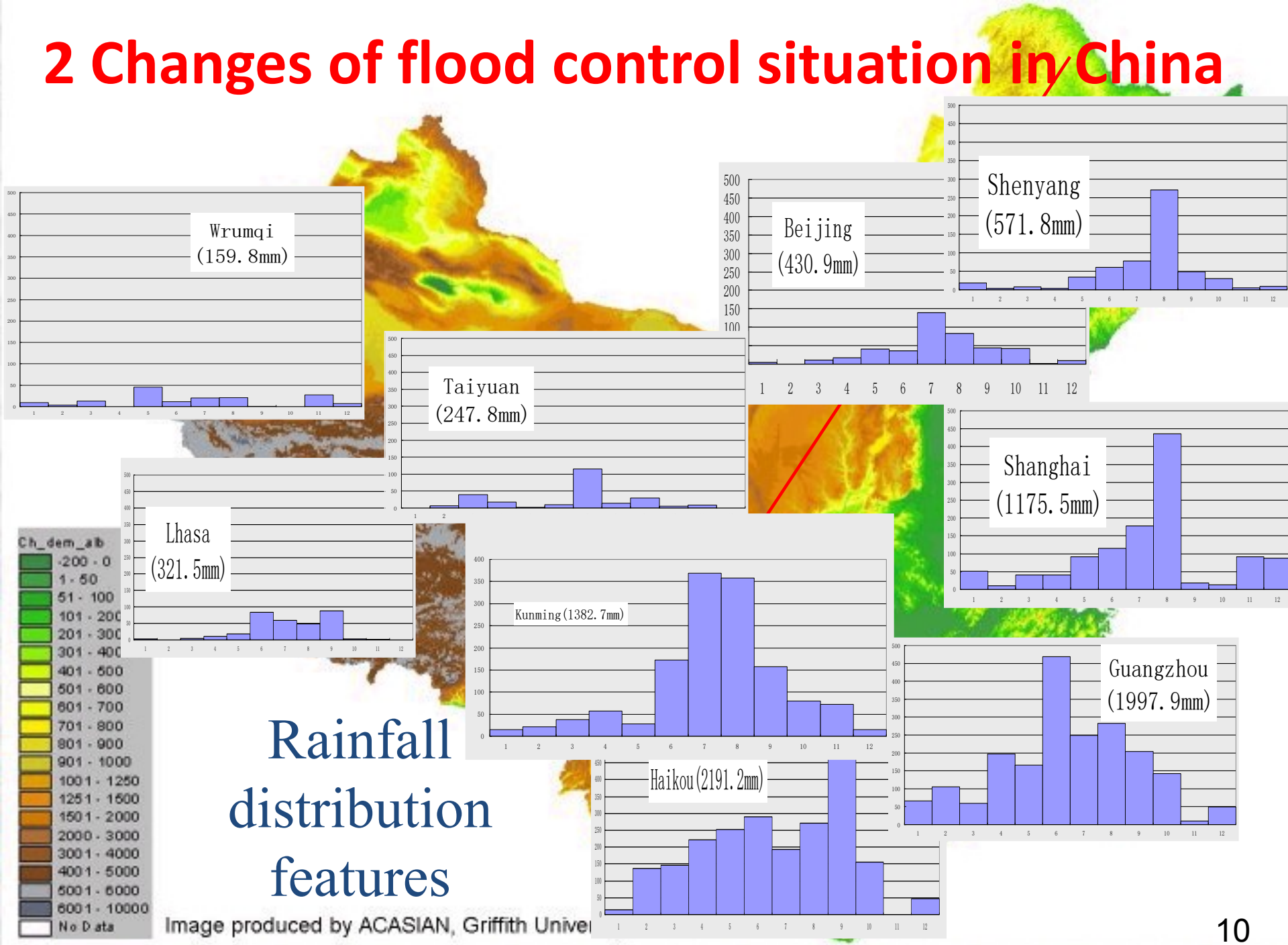
Meanwhile, the forest area in the basin was reduced from 166,000 km^2 in 1950 to 92,000 km^2 in the 1990s, down by 44.58%.

Deforestation exacerbated soil erosion, which led to the severe silting of the river.

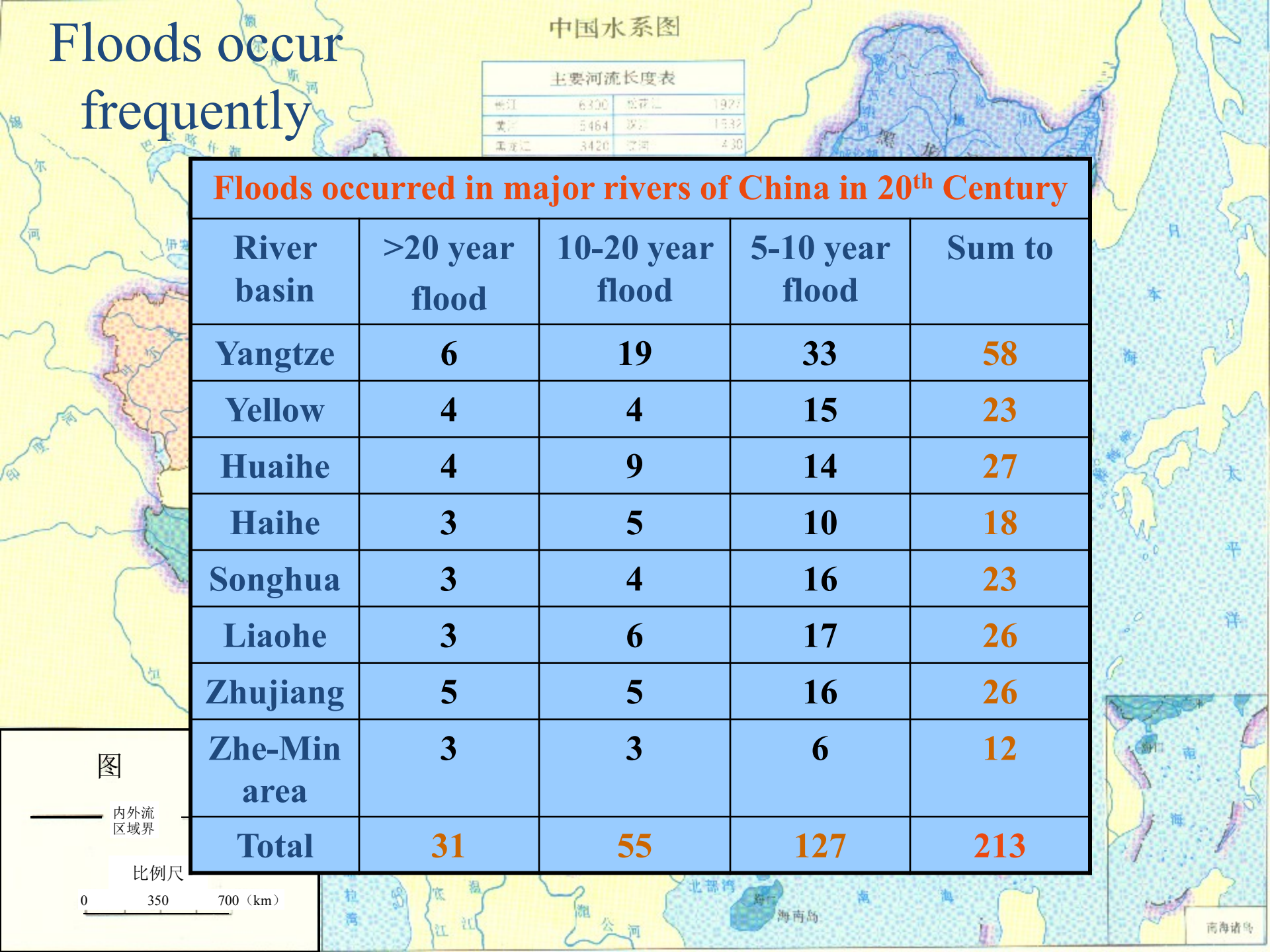
Basic understanding

- The features of the 2011 big flood in the Chao Phraya River indicates that the flood control situation in Thailand has affected obviously by global warming, rapid urbanization, dramatic land use changes and human activities.
- China is also facing such serious challenges, and we have to multiply investment in enhancing flood control system after the 1998 floods, and further, to shift the strategy from flood control to flood management since 2003.

2 Changes of flood control situation in China

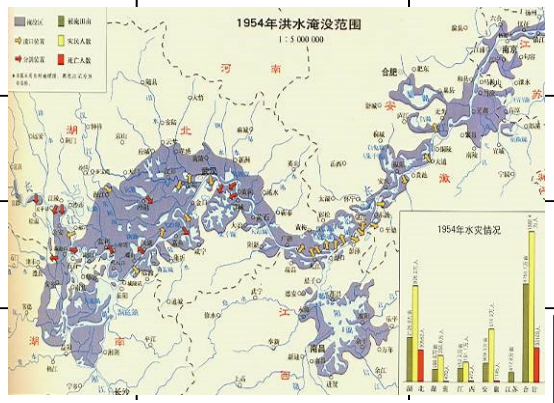


Floods occur frequently

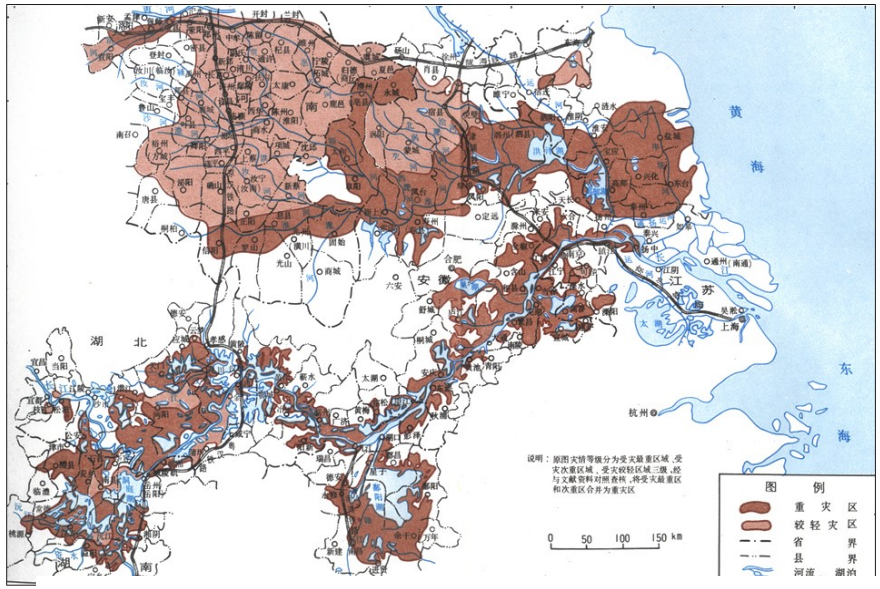


Floods occurred in major rivers of China in 20th Century				
River basin	>20 year flood	10-20 year flood	5-10 year flood	Sum to
Yangtze	6	19	33	58
Yellow	4	4	15	23
Huaihe	4	9	14	27
Haihe	3	5	10	18
Songhua	3	4	16	23
Liaohe	3	6	17	26
Zhujiang	5	5	16	26
Zhe-Min area	3	3	6	12
Total	31	55	127	213

Flooding death toll in China （1950-2010）



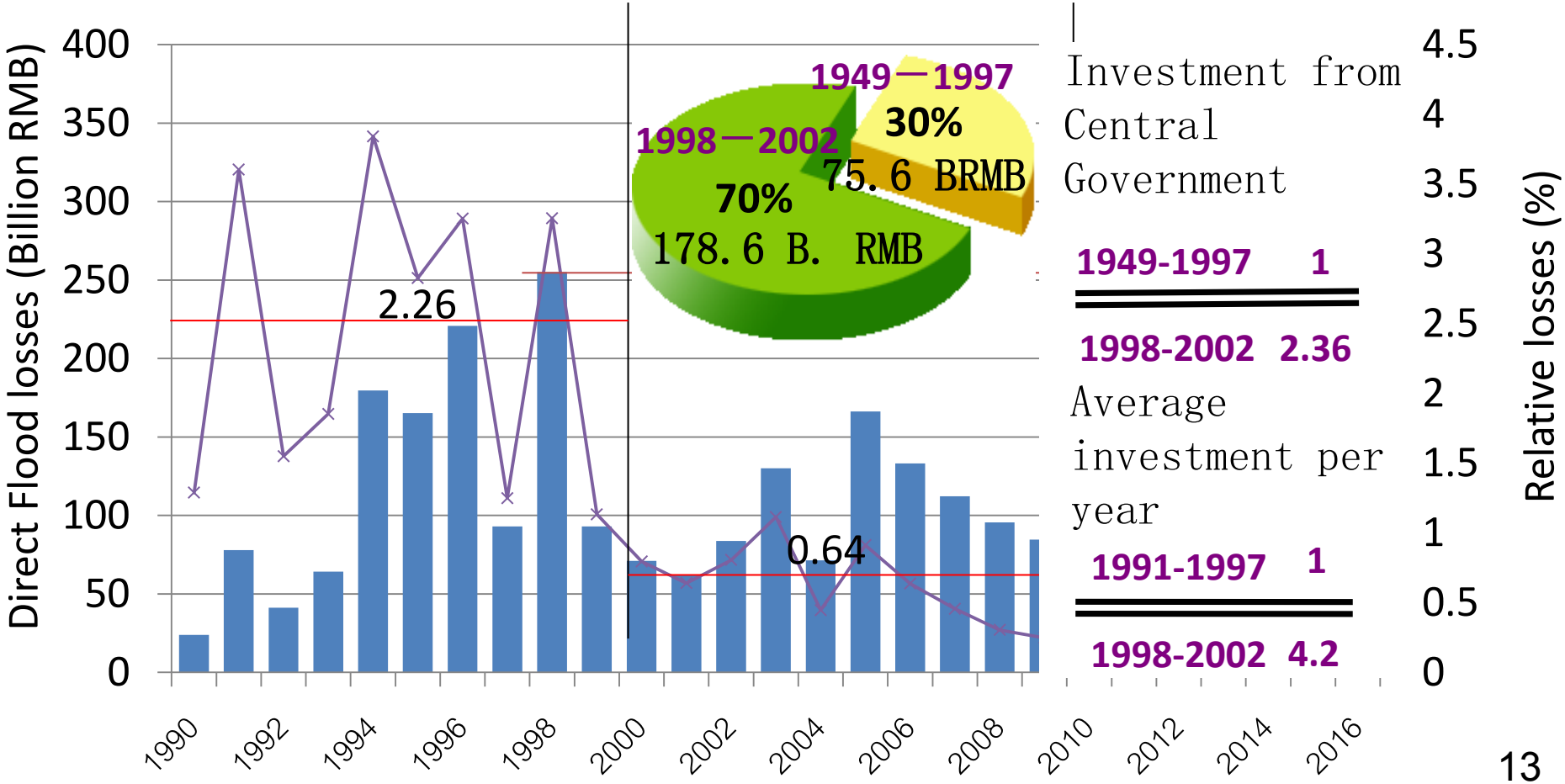
42,447 people died during the big flood of 1954



The 1931 big floods in the Yangtze & Huai River basins, 51 million people affected and 400,000 died because of the flooding and subsequent plague and famine.

The characteristics of flood losses in China (1990 – 2016)

- In the new century, the relative losses of floods in China has decreased significantly. However, over the past 7 years since 2010, there were 4 years that the total loss exceeded the flood loss in 1998



The riverine Flood-prone Areas in China

In Nenjiang River Basin:

- From Aug. 2 -- 14, 1998,
- the amount of rainfall is 2--5 times
- more than that of the same period of an average year.
- Flood frequency: 150--300 year.

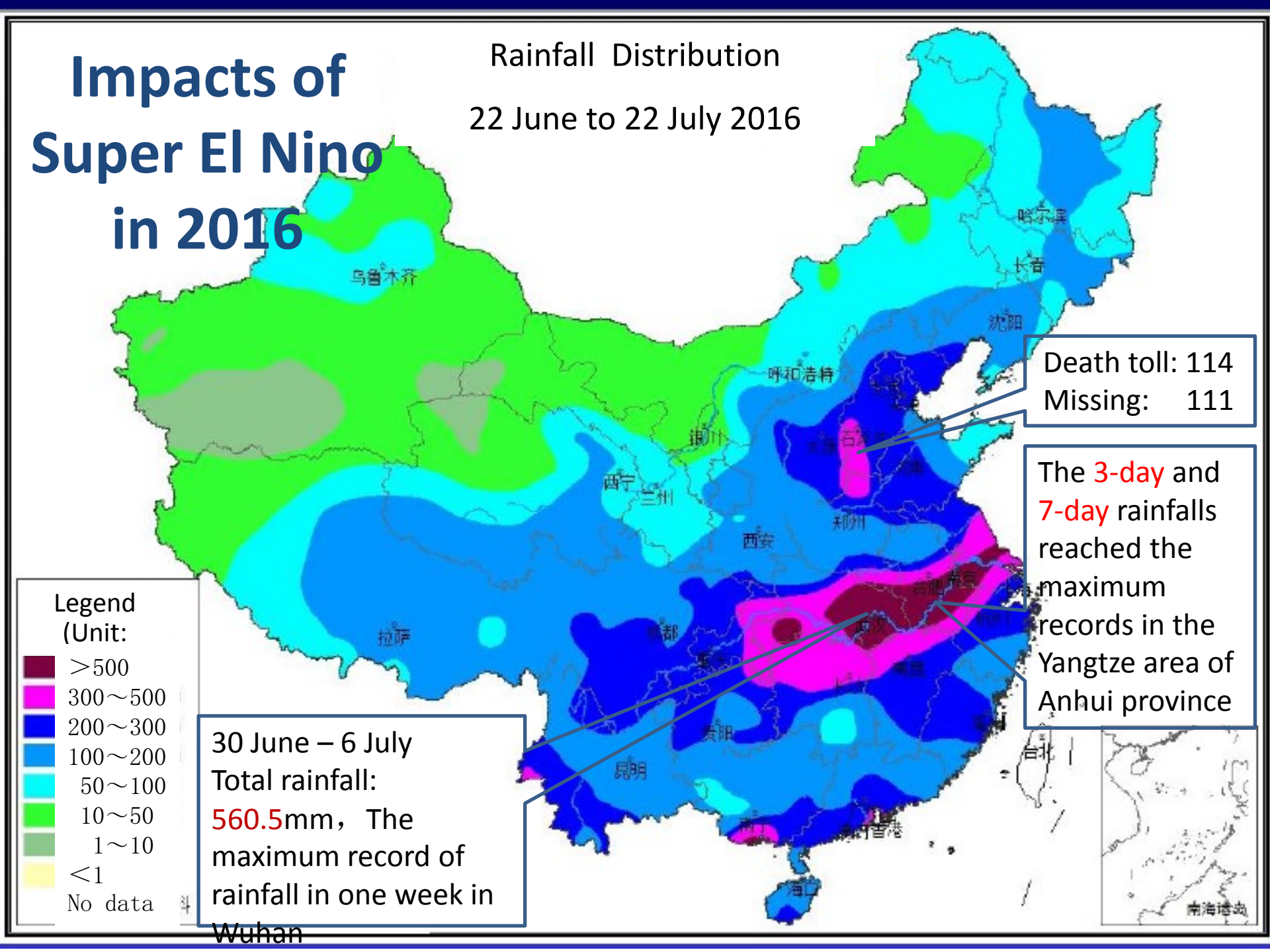
In Yangtze River Basin:

- Form June 11 --Aug. 27, 1998
- the amount of rainfall is about 1--3 times more than that of the same period of an average year,
- formed a basin type flood just less than the 1954 flood of this century.

In Minjing River Basin, the biggest flood in the 20th Century occurred in Fujian province during the mid-to-end of June

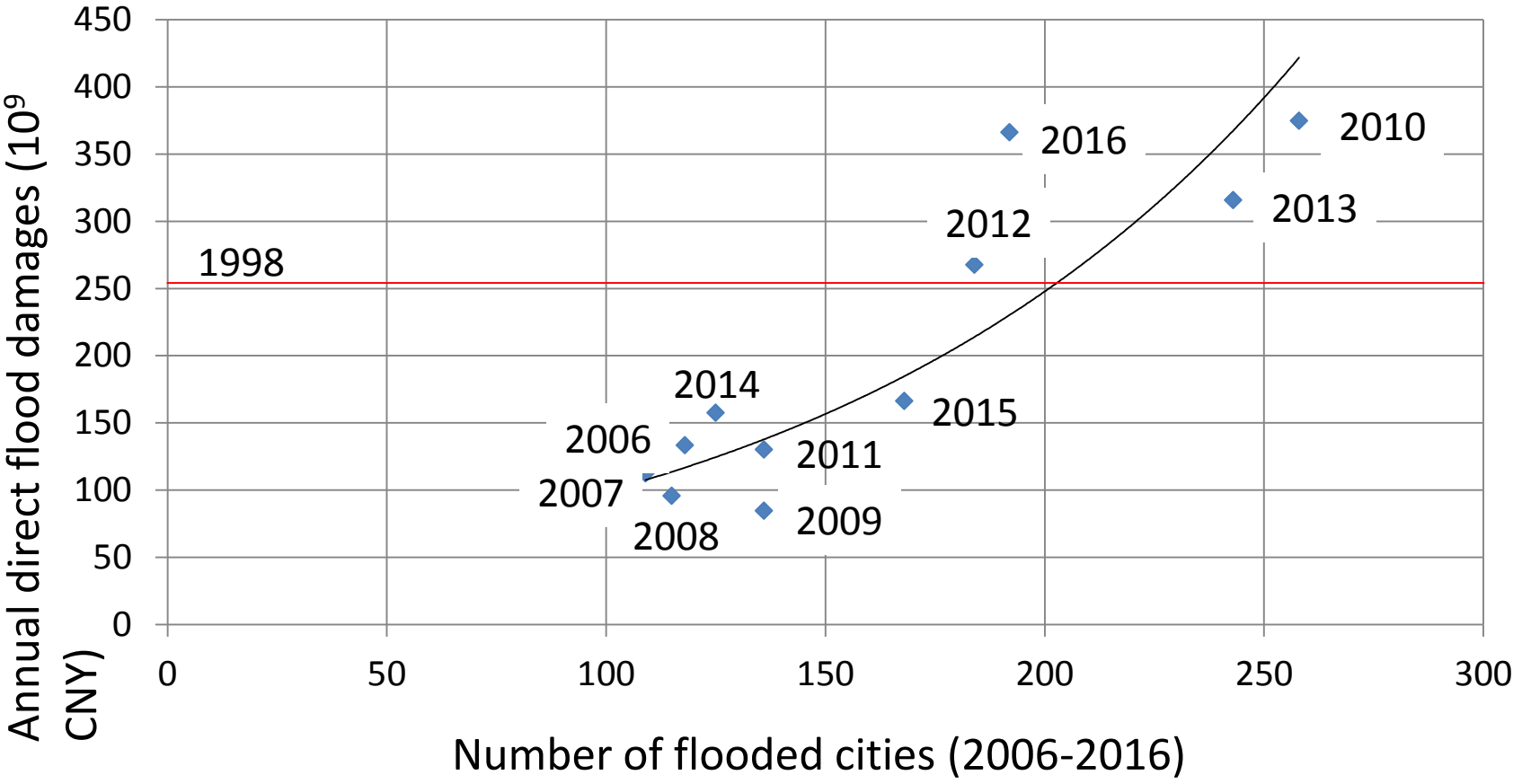
In the West tributery of the Pearl River in Guangxi, the second biggest flood in the 20th Century occurred in June.

Impacts of Super El Nino in 2016



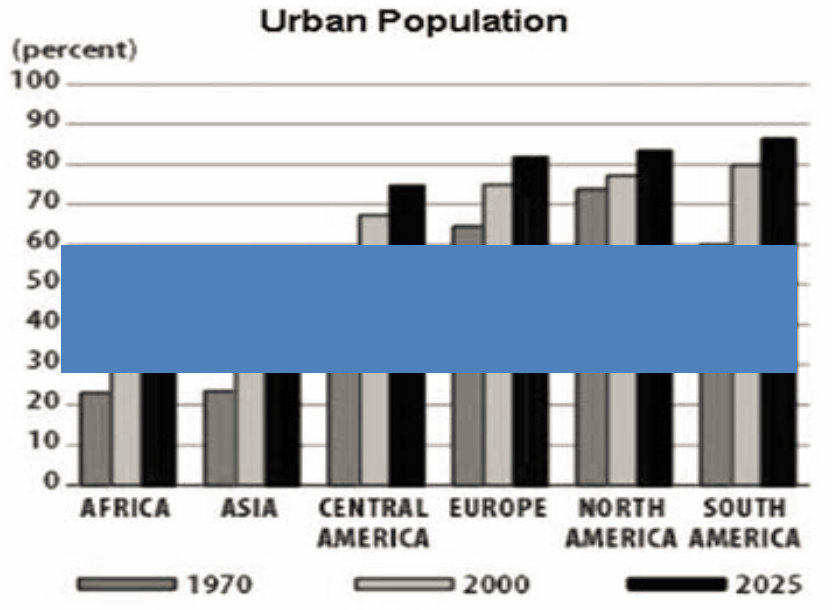
Challenges on urban flood prevention

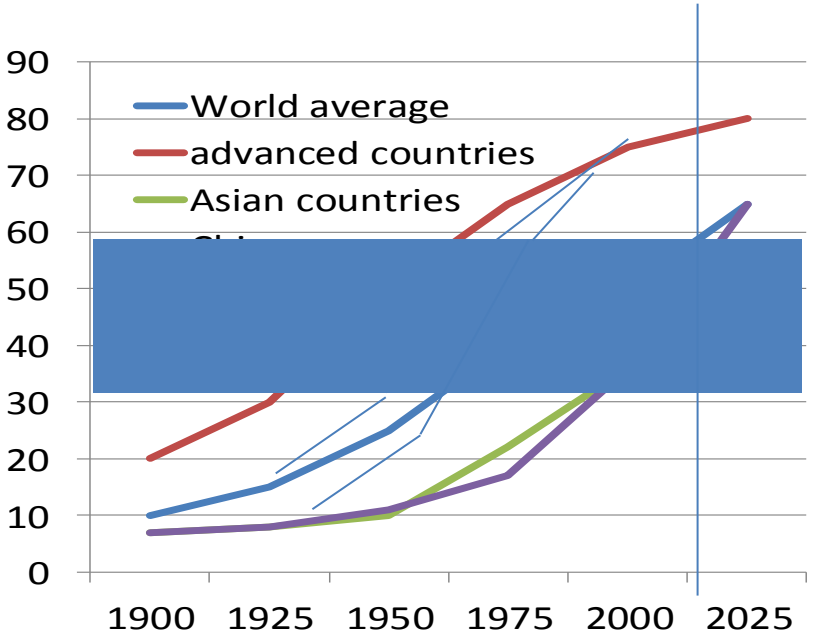
Since 2006, more than 100 cities were inundated every year, the annual total flood damages is proportional to the number of affected cities.

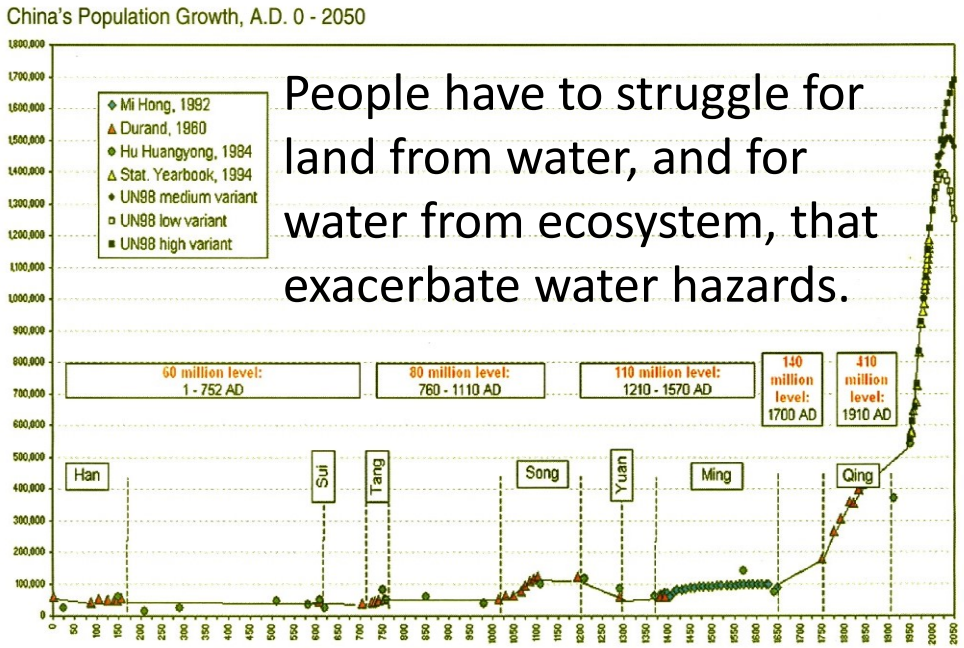


Impacts of the rapid urbanization

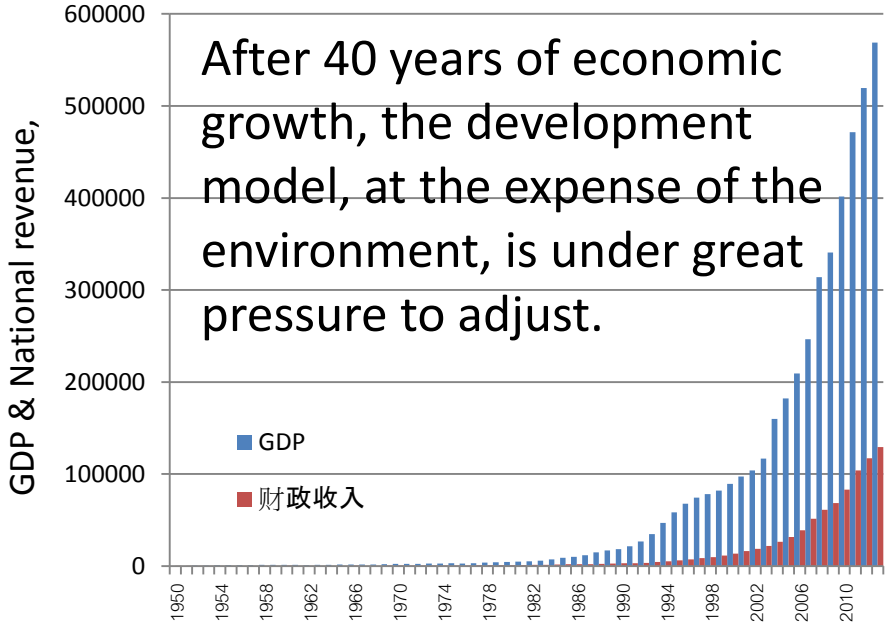
- China's urban population exceeded 30% in 1998. Since then, it increased 20.4% in 15 years.
- In the past 35 years, a net increase of urban population in China is about 564 million, more than the combined population of the 28 countries in EU.
- Of the current 26 megacities, half are in Asia and the UN(2008) projects that there will be 37 in Asia alone by 2025.





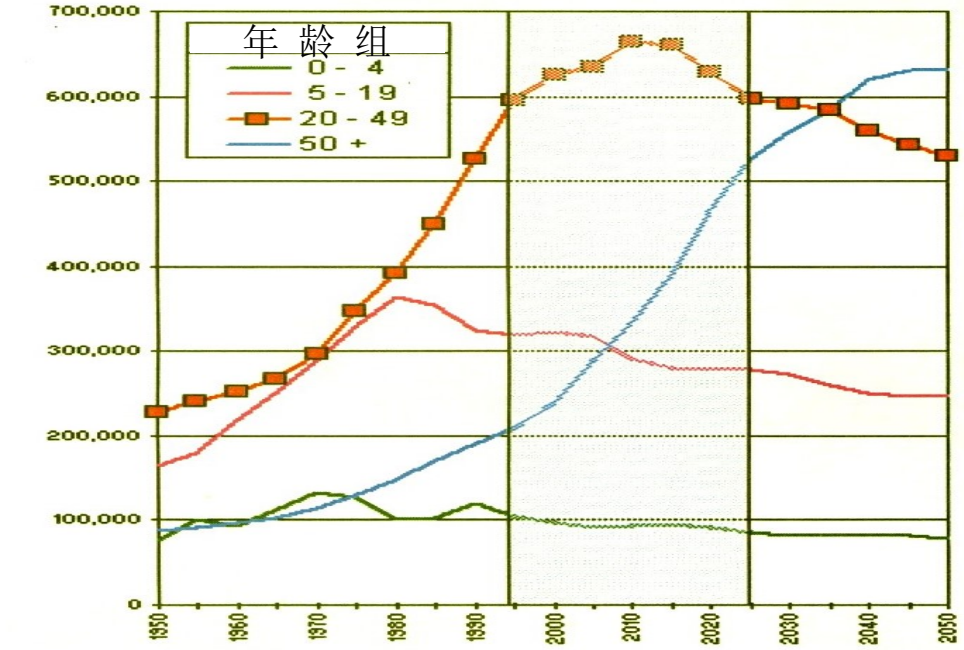


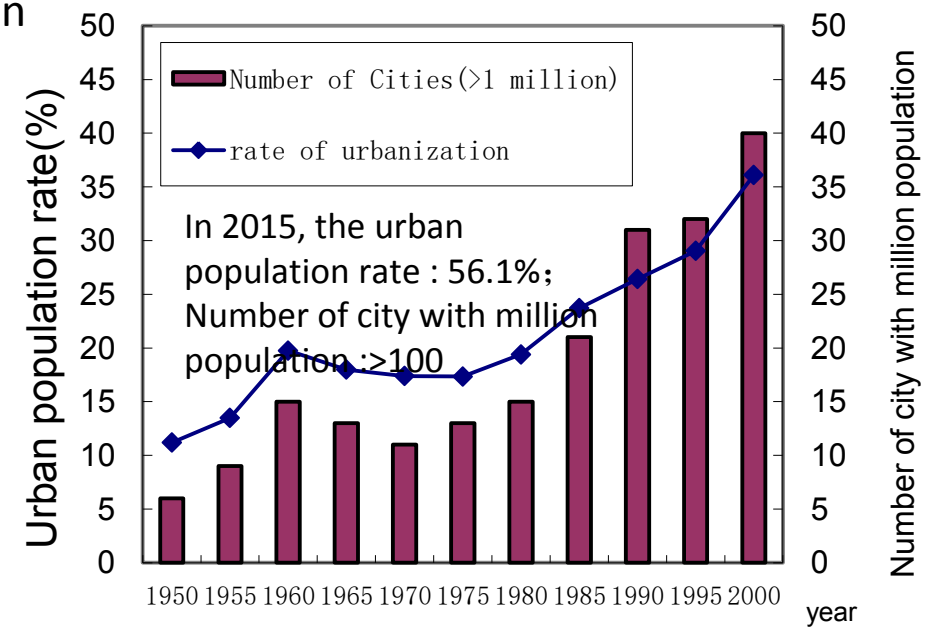
People have to struggle for land from water, and for water from ecosystem, that exacerbate water hazards.



After 40 years of economic growth, the development model, at the expense of the environment, is under great pressure to adjust.

（$\times 10^3$）Prime time for infrastructure construction

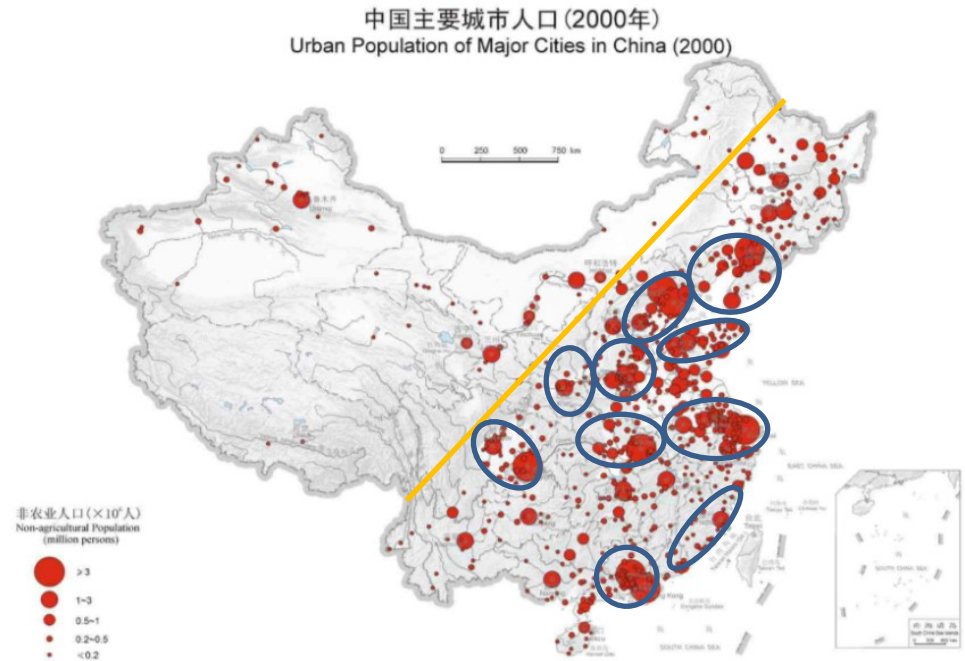


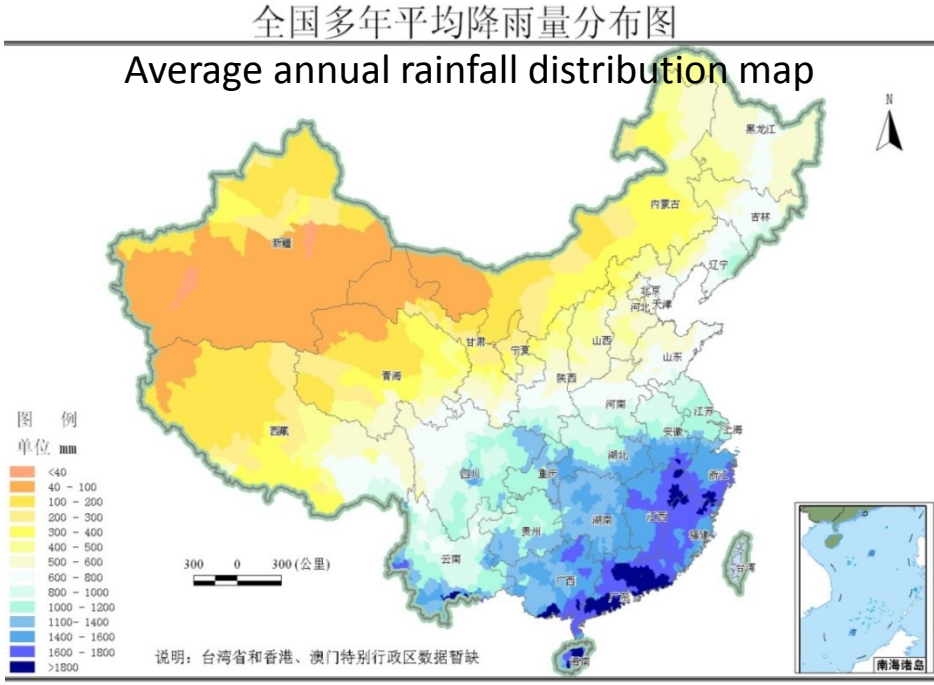


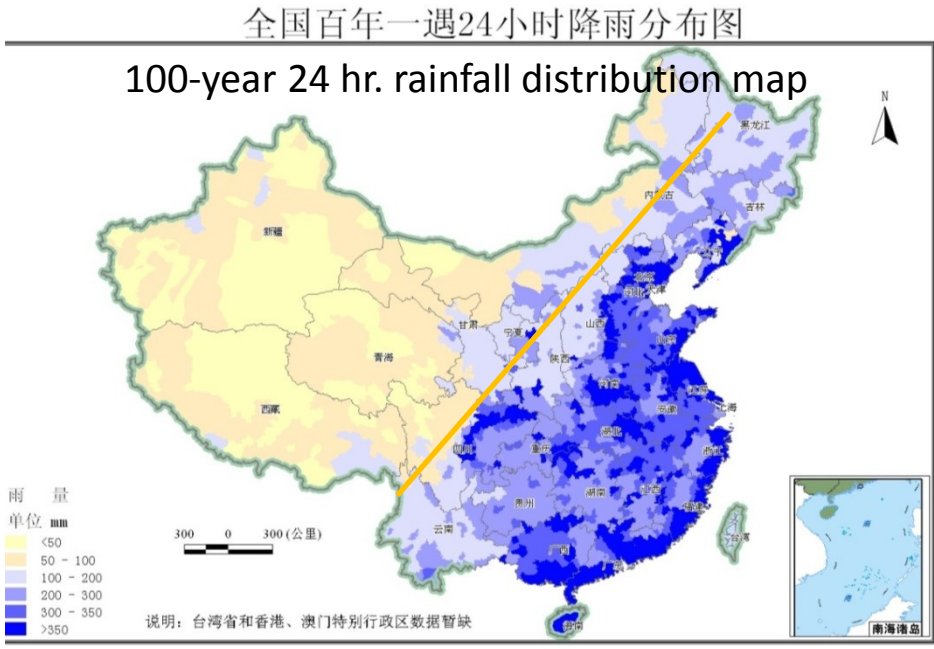
Urbanization process in China

City Distribution

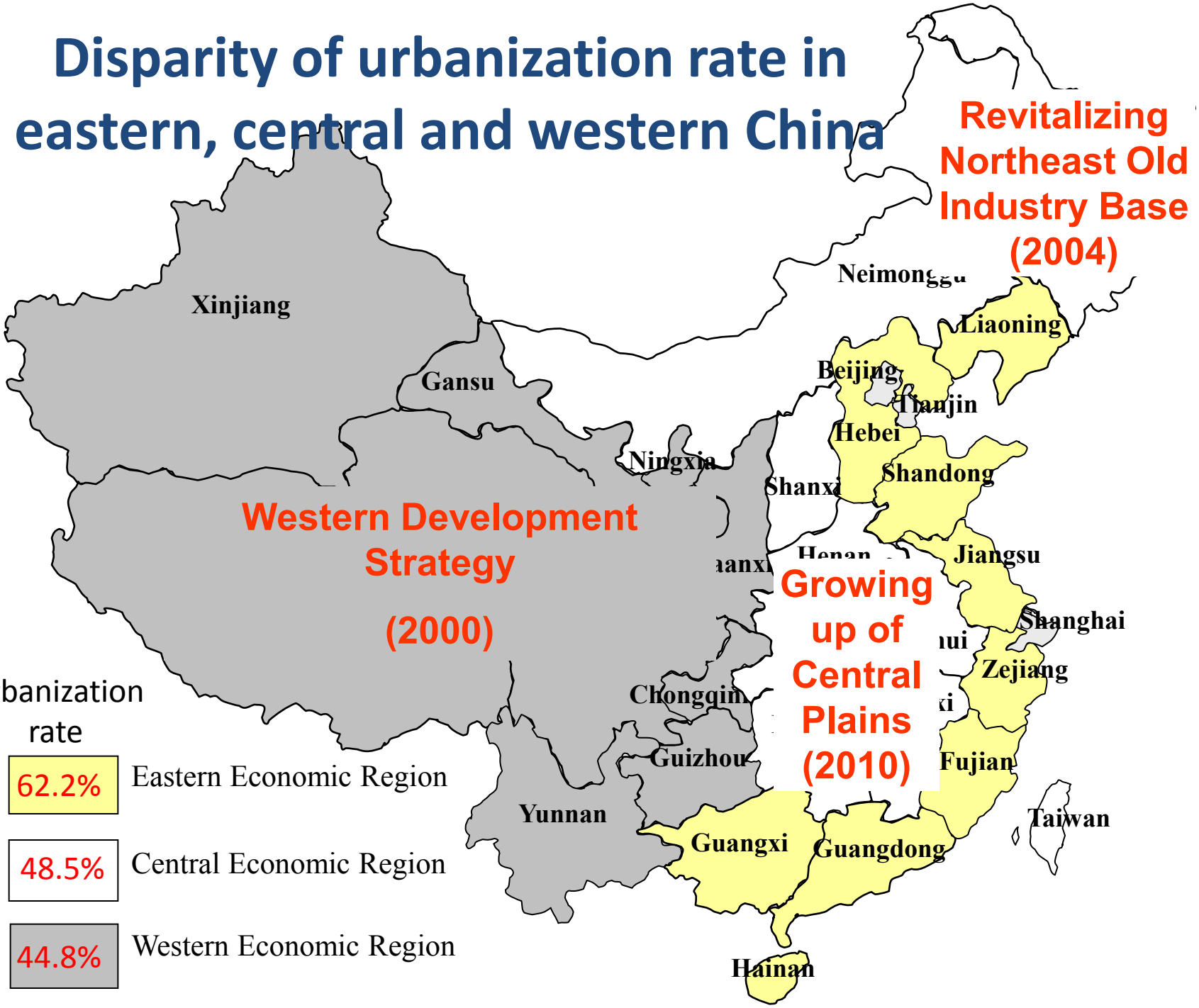
- Among the current 654 cities in mainland China, 642 of them are under threat of floods.
- Among them, there are
  - Coastal cities: 57 (8.9%)
  - Plain cities: 288 (44.8%)
  - Hilly cities: 297(46.3%)







Disparity of urbanization rate in eastern, central and western China




Legend
Key cities(31)
Major cities(54)
南海诸岛
1:24 000 000

A huge task to build a perfect urban drainage and flood control system

- For the 642 cities with flood prevention tasks, only 321 of them (51%) have reached the national flood prevention standards.

	total	up-to-standard	rate
Key cities	31	10	32%
Major cities	54	16	30%

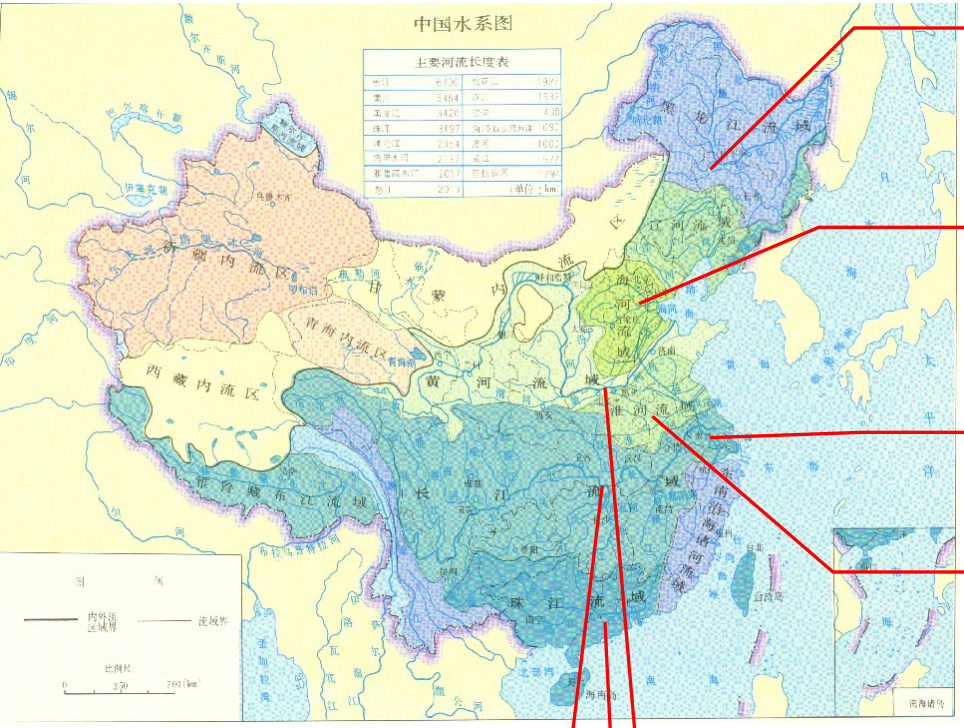
- Six national key cities and 20 major cities for flood control, as well as 258 other cities have not completed plan formulation or modification due to the rapid changes of situation.
- It should be noted that, the total number of such cities was 170 in 2006, while 7 years later, instead of decreasing, the number increased to 284 cities.

Grade	Importance	Non-agricultural population (thousand people)	Flood control standard [Return period (year)]
I	Very important cities	> 1500	>200
II	Important cities	1500 ~500	200 ~100
III	Medium- sized cities	500~200	100 ~50
IV	Small cities	<200	50 ~20

3. Shifting Strategy from Flood Control to Flood Management

- “During the transformation from an agricultural society to a modern society, the conventional mode that is aimed at controlling floods should be raised to a higher level of flood management to meet the demands of ensuring sustainable development”(Cheng Xiaotao, ISFD2, Beijing 2002).

Seven River Basin Water Resources Commissions, MWR



Song-Liao River Water Resources Commission, 1982

Haihe River Water Resources Commission, 1979

Taihu Basin Authority, 1984

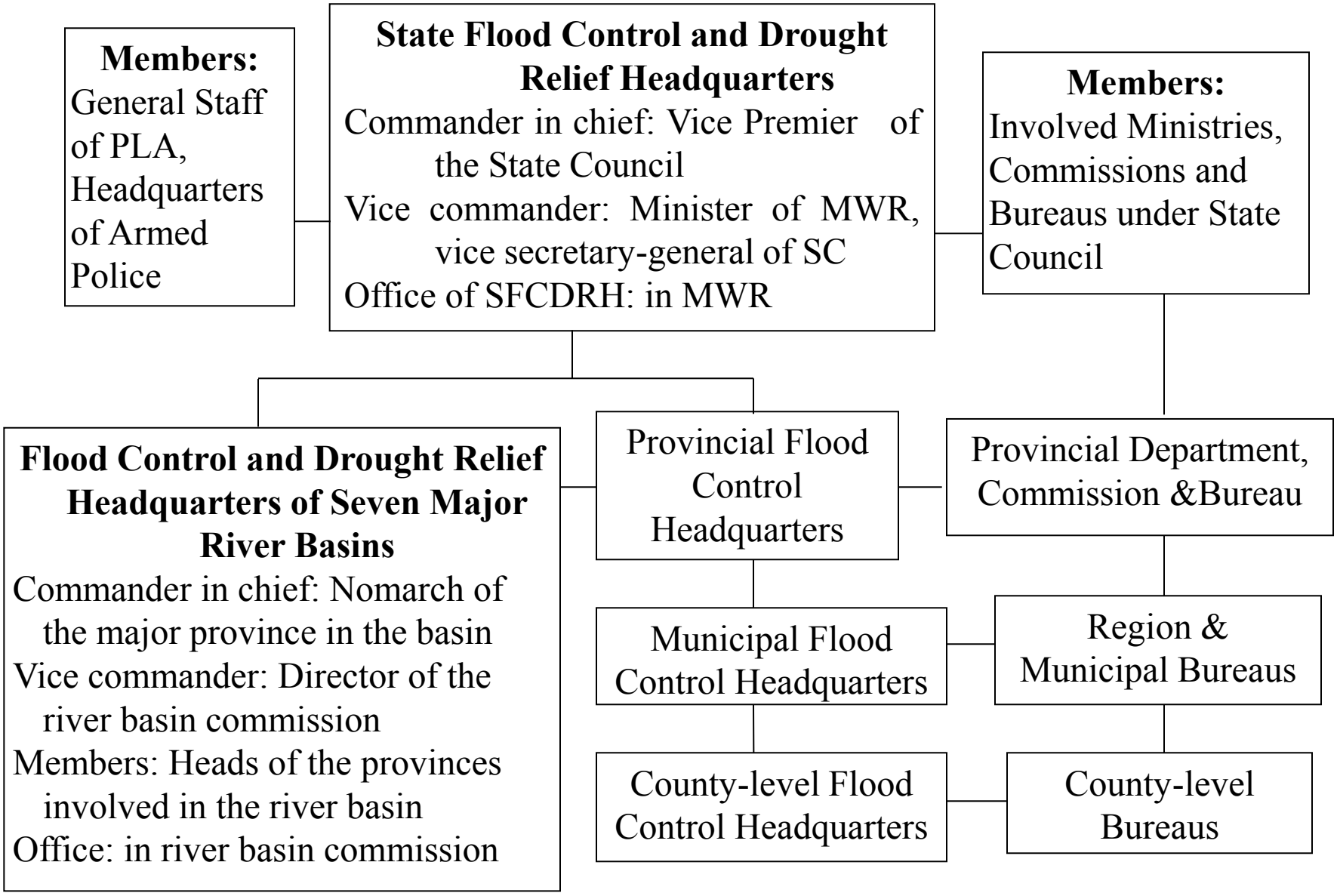
Huaihe River Water Resources Commission, 1950

Yellow River Conservancy Commission, 1950

Chang Jiang Water Resources Commission, established in 1950

Pearl River Water Resources Commission, 1979

Flood emergency response system in China

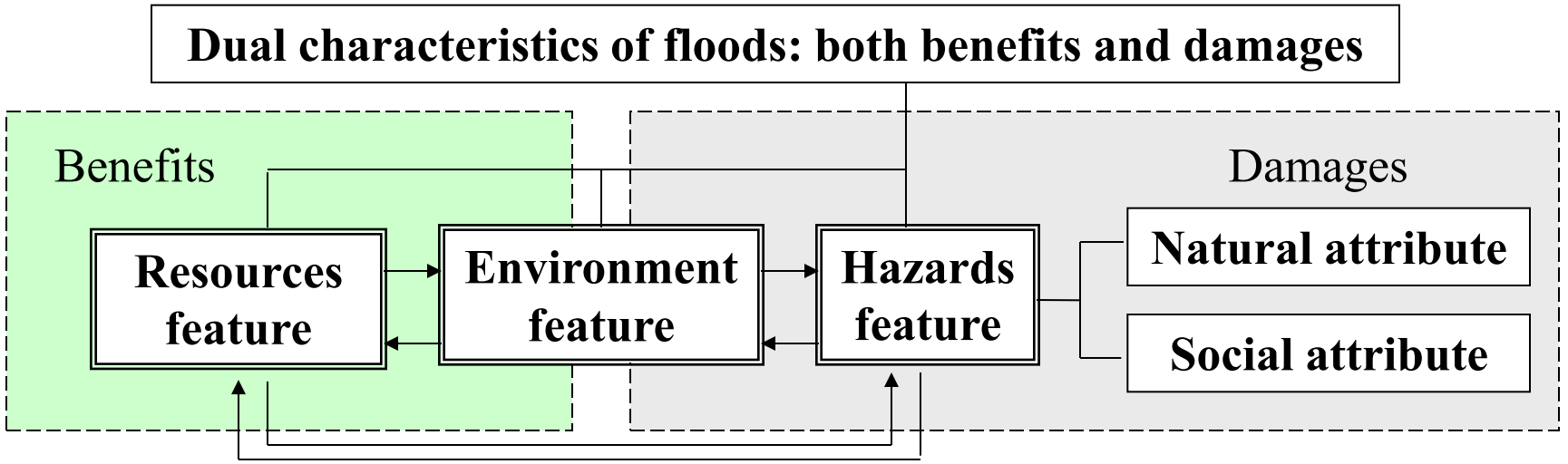


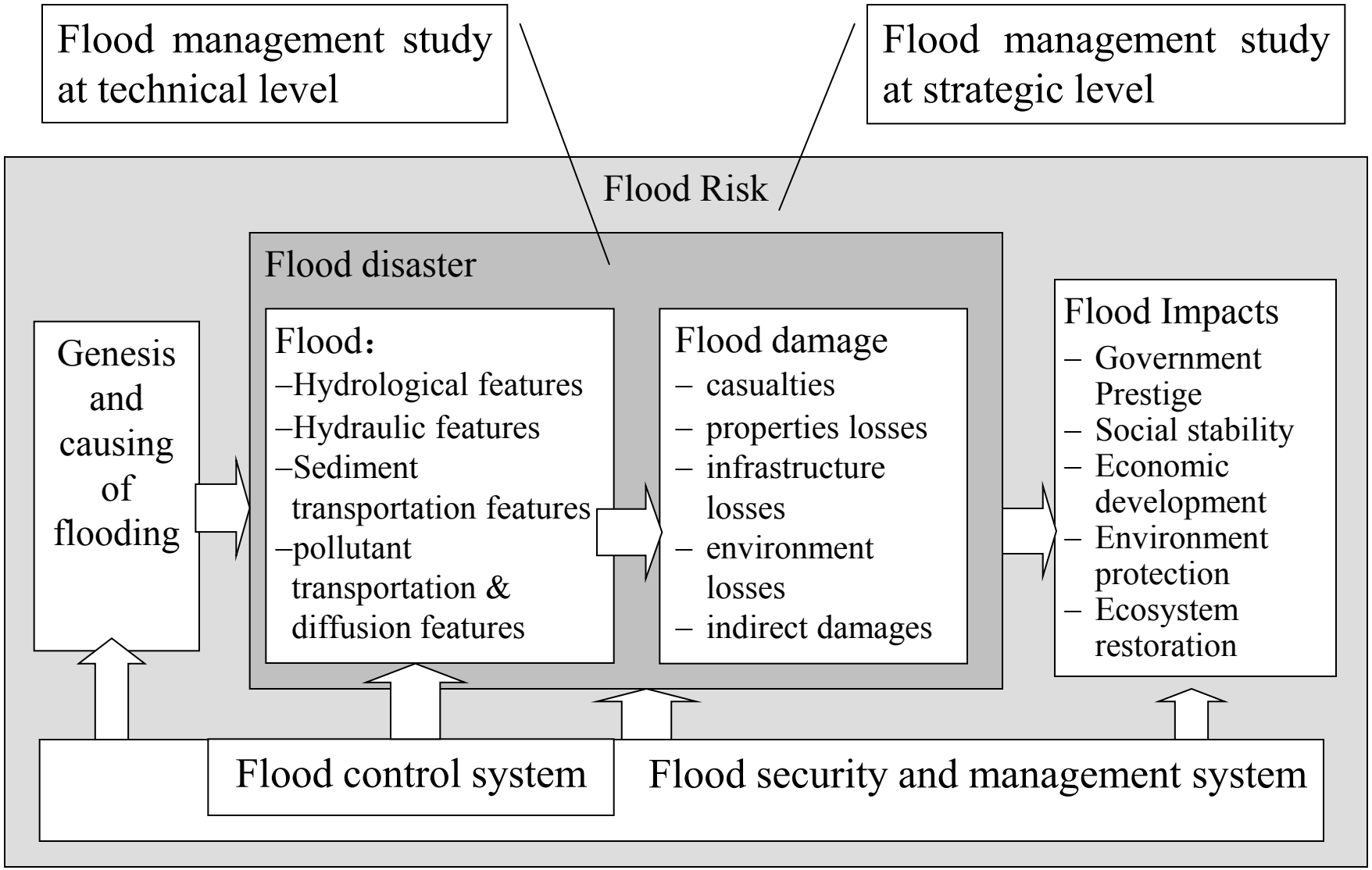
Shifting from Flood Control to Flood Management

- In the beginning of 2003, the SFCDRH and MWR declared that the flood and drought disaster mitigation in China should shift "**from flood control to flood Management**" and "from simplex drought-fighting to comprehensive drought management".
- Since then, the concept and meanings of Flood and Drought Management have been widely discussed and a series of new measures have been taken for the "Two transitions" in China.

Definition and its meaning of the flood management in China

- Floods present not only a hazard, but also opportunities and benefits for natural resource and the environment.
- There are complicated relationships, interactions and transformations among them.

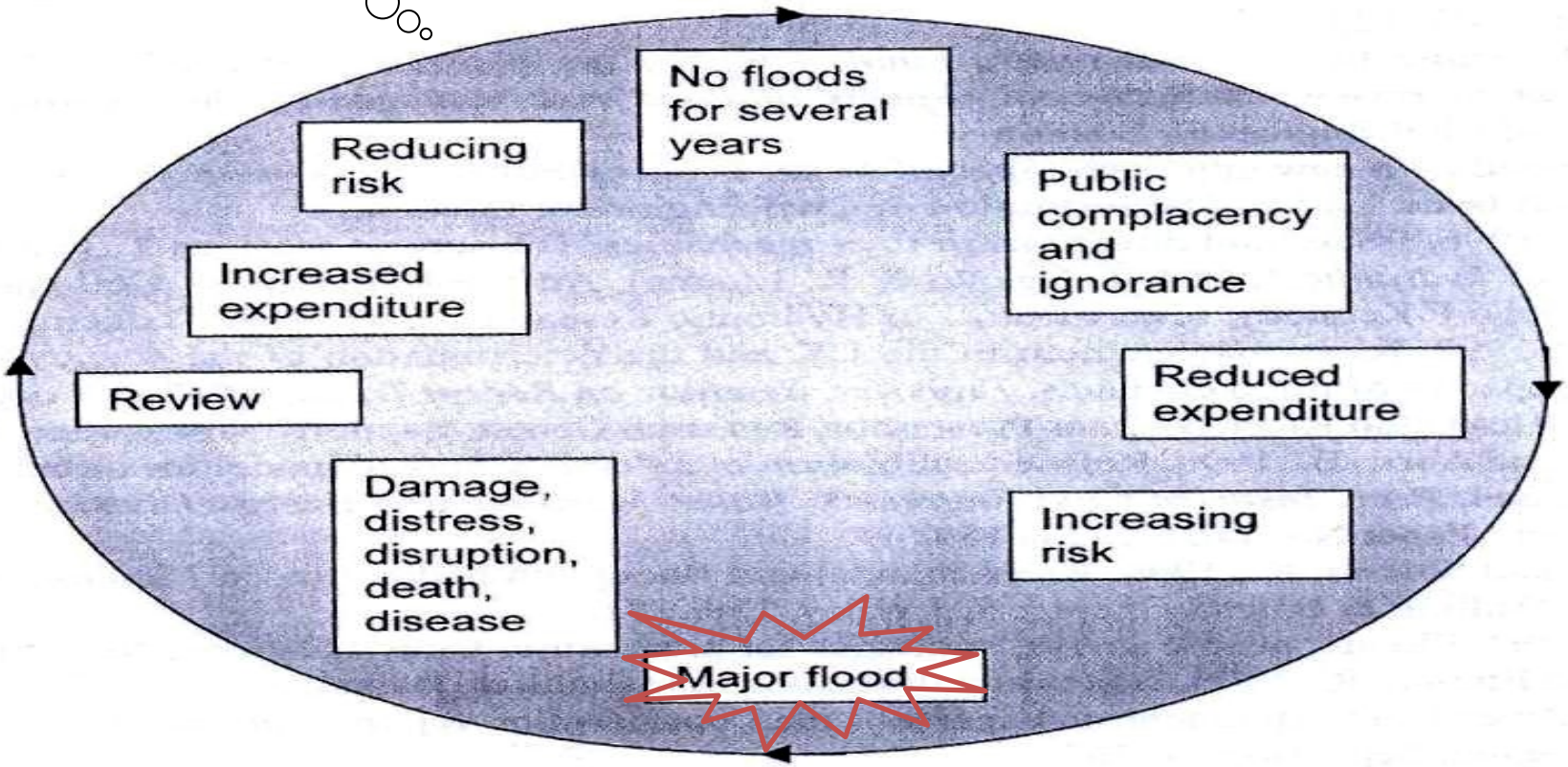




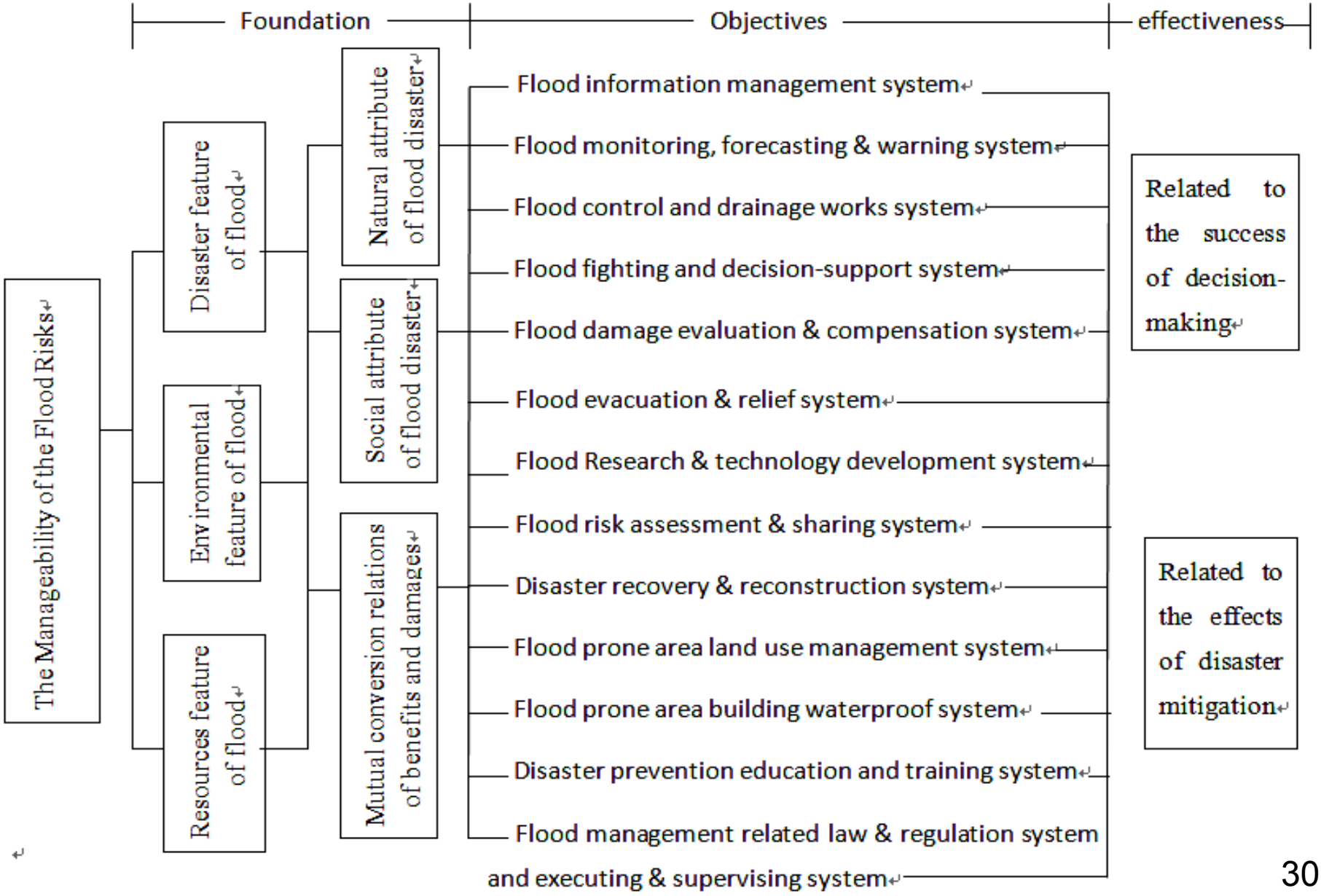
The objects of the flood management strategic study

What should be stressed in the developing countries

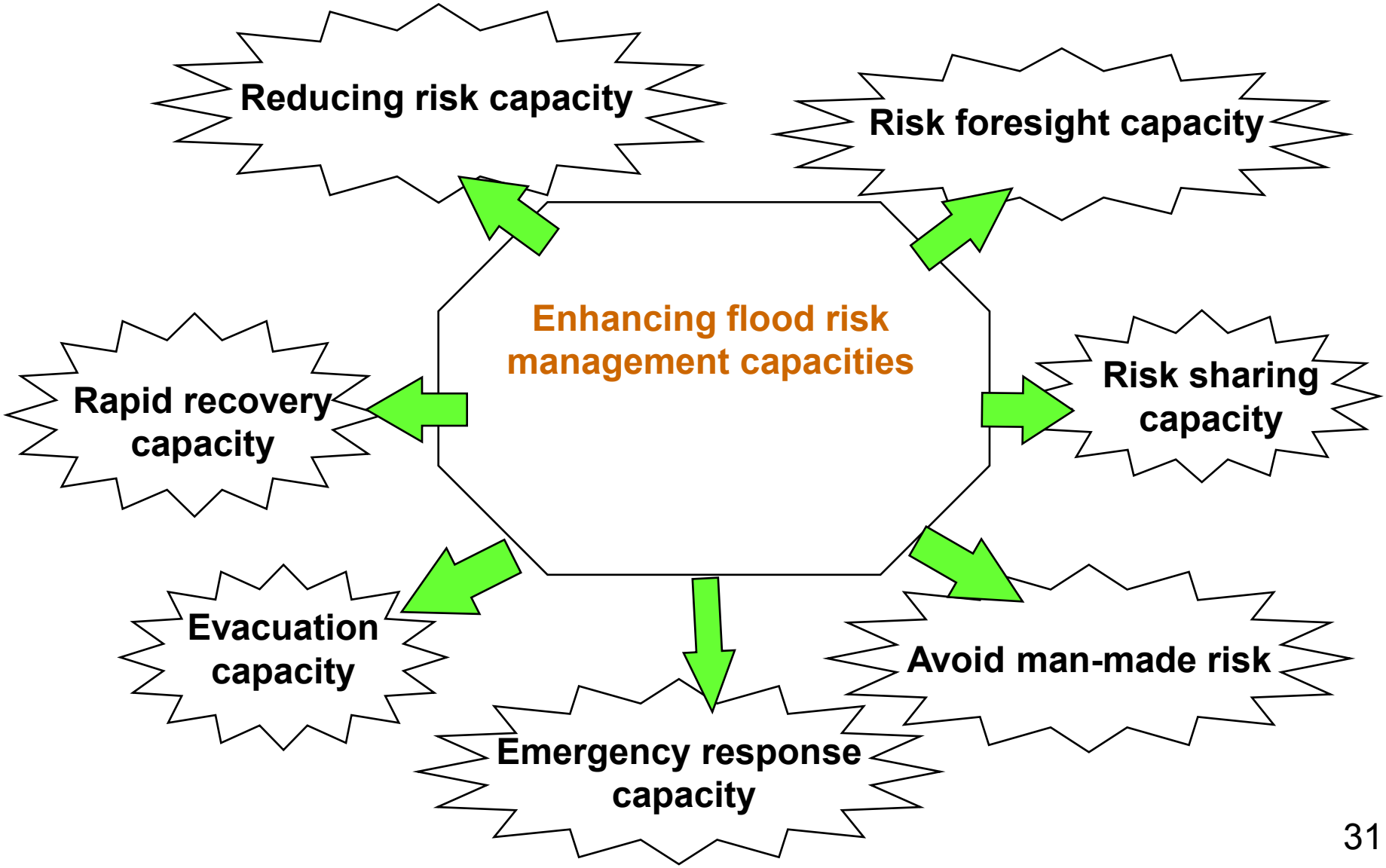
How to break away from a whacky circle?



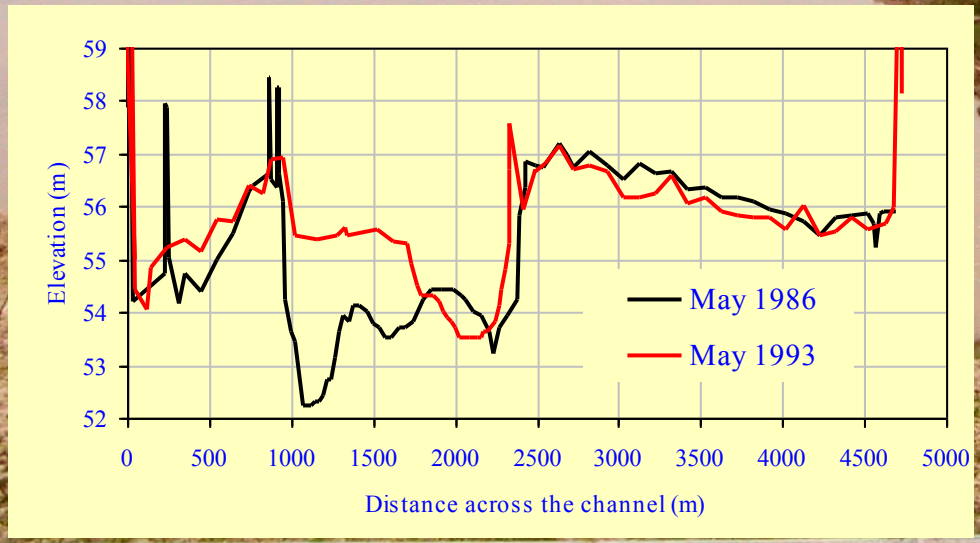
The Manageability of the Flood Risks



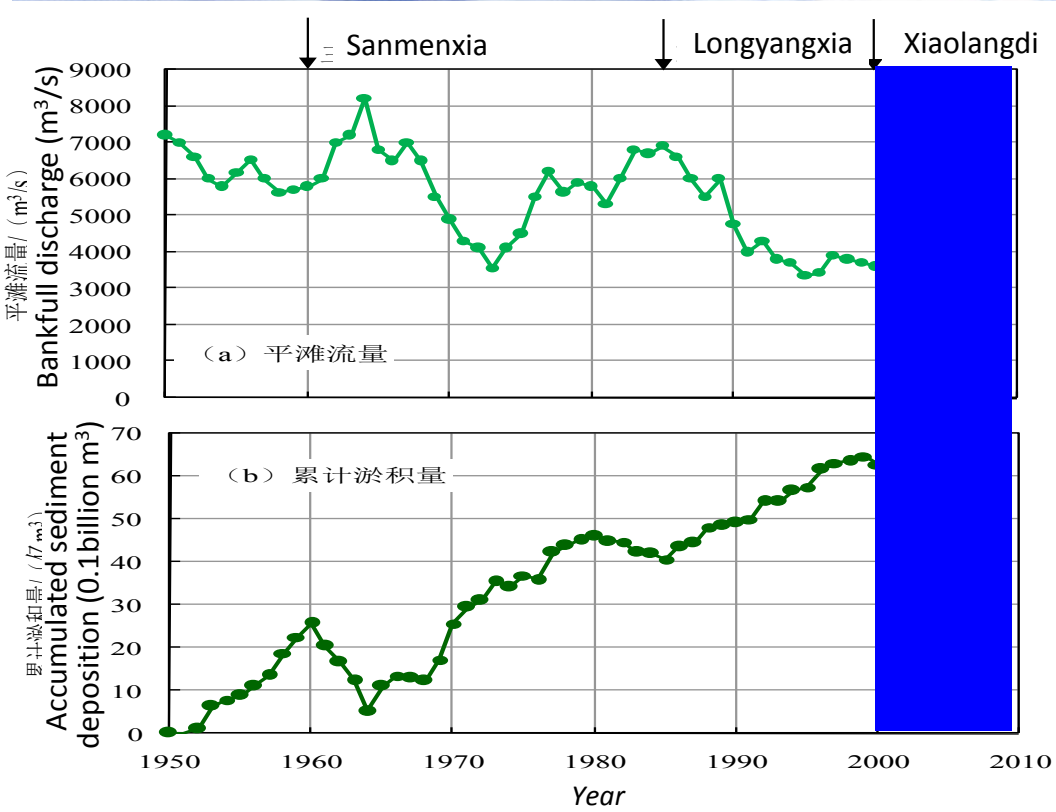
What kind of capacities we need?



Changes of flood control situations of the lower Yellow River



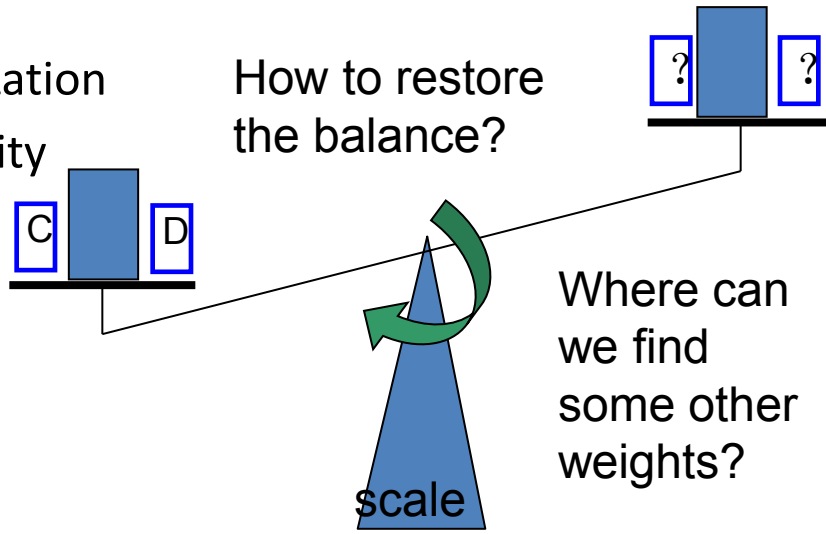
The water-sediment regulation by dams to create an artificial flood is one of the effective measures to solve the sediment problems of the Yellow River.



Dam construction is to satisfy the growing fundamental demands for human development, and to rebuild a new balance that the nature itself has not been able to provide.

Considering impacts of development stages

- Rapid progress of urbanization and industrialization
- Increasing demands on food and energy security
- The gap between rich and poor
- More uncertainties in climate change
- ……



How to meet the basic needs of survival?

Lower demands in security

Flood control system developed in a whacky circle

Lower technical ability

Low level of urbanization

How to enhance or create new balance step by step to meet the demands of rapid and smooth development?

How to keep or restore the existing balance?

How to cope with the challenges coming in the future?

High level of management, with strong economic and technical capacities, environmentally sound

Undeveloped stage

Developing stage

Sustainable development stage

To Strengthen the water hazards management has become an inevitable trend for water governance

Advanced countries

- Climate warming
- Globe economy
- Ageing population
- ……

Propel integrated water resources management and risk management

Take comprehensive measures, and promote data sharing and public participation.

To solve the increasingly complex water issues for sustainable development, and to establish a stronger security system for actively responding to the challenges of global change and the potential risks.

Developing countries

- Water shortages
- Water pollution
- Increasing damages of flood and drought
- ……

Actively explore and implement the strategic shift to flood and drought management

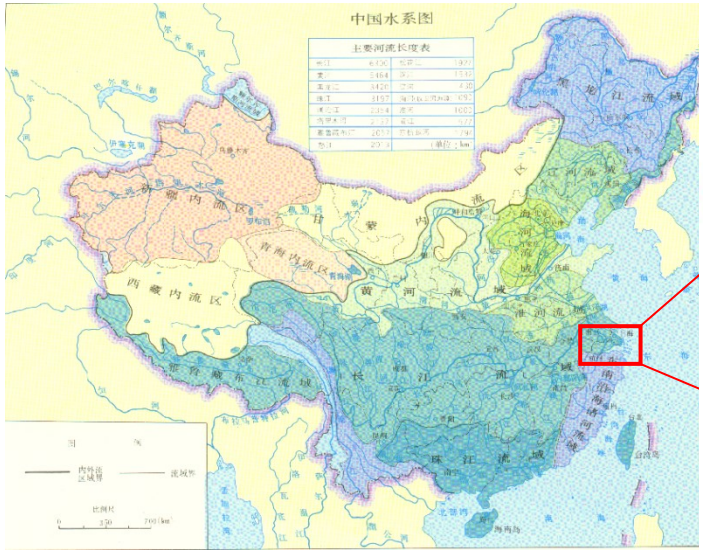
Strengthen the con-struction of governing system, mechanism and capacity building

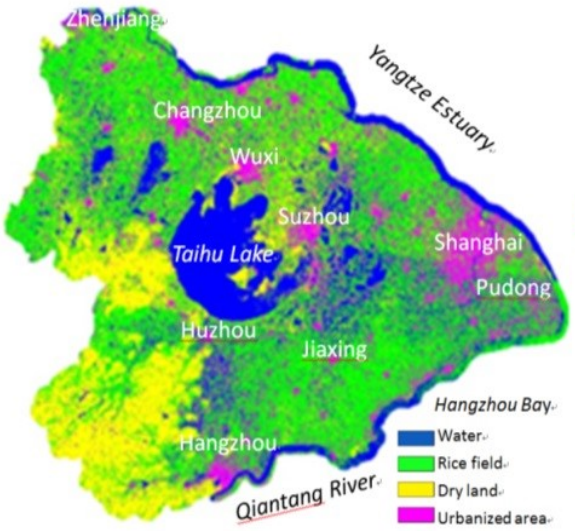
To restrain the growing trend of water hazards losses, and to effectively reap benefits of resources and environment from floods, and to create necessary conditions for sustaining rapid and coordinated development of social and economy.

4. Approaches to restrain the increasing flood risk: taking Taihu Basin as an example

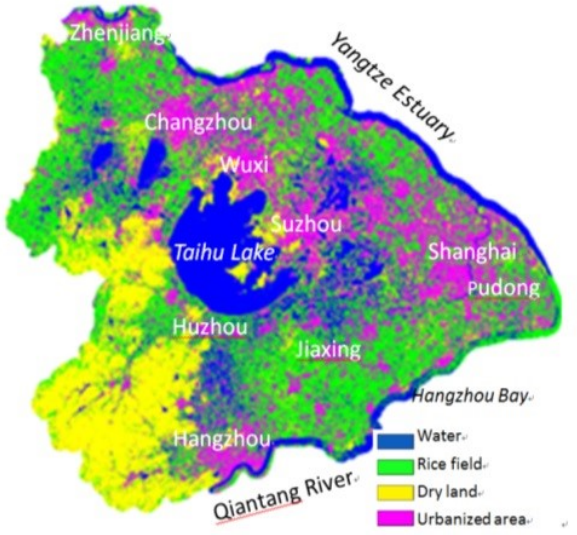
- Taihu Basin: one of the most important economic regions in China.
- Serious flood disasters caused by plum rains, typhoon and storm surge.
- In the course of rapid urbanization.
- Features of flood risk : very sensitive to both global warming and rapid urbanization.

Land use change in the Taihu Basin		
	Urbanized area /km^2	Cultivated area/km^2
1995	2,206.8	22,468
2010	9,476.4	12,999
	+ 329.4%	- 42%



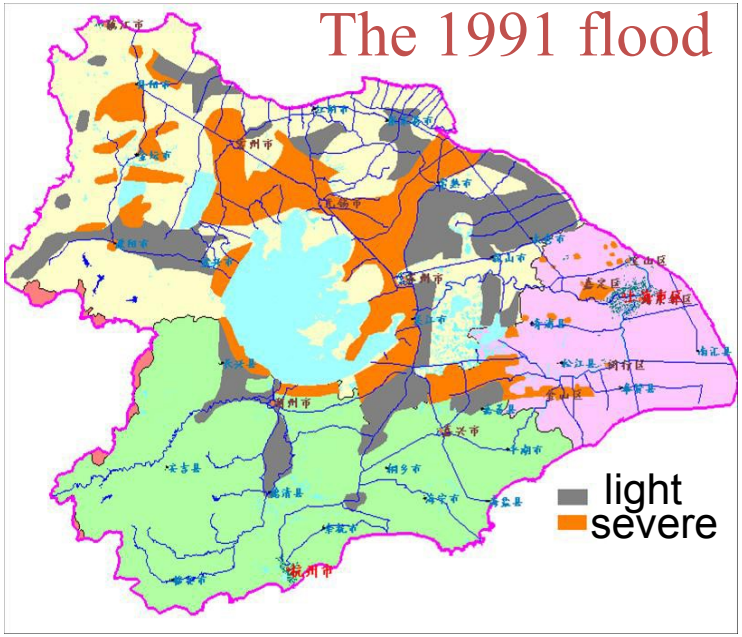


a. Land use in 2000/2001

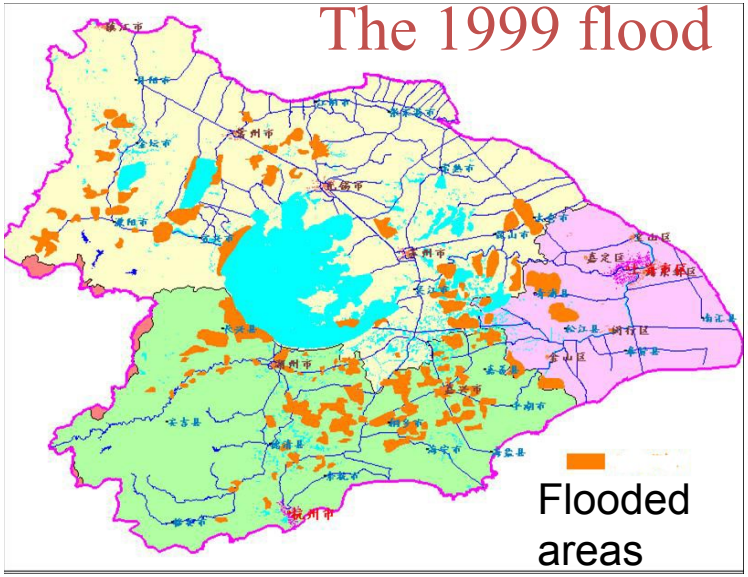


b. Land use in 2009/2010

Changes of Flood situation in the Taihu Basin



Rain island effects: Due to the urbanization process, rainstorm days in urbanized areas increased significantly higher than those in the suburbs. Comparing the rainstorm days during1981-2010 with that in 1961-1980 in the urbanized area and suburban of Suzhou city, which increased by 30.0% and 18.0%, respectively; and in Nanjing were 22.5% and 11.0%; and in Ningbo were 32.0% and 2.0%, respectively.



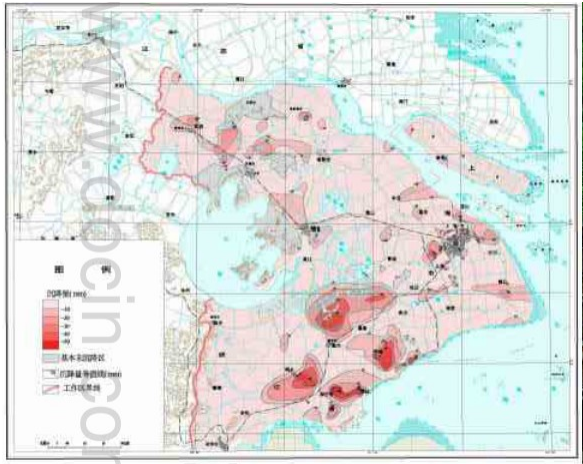


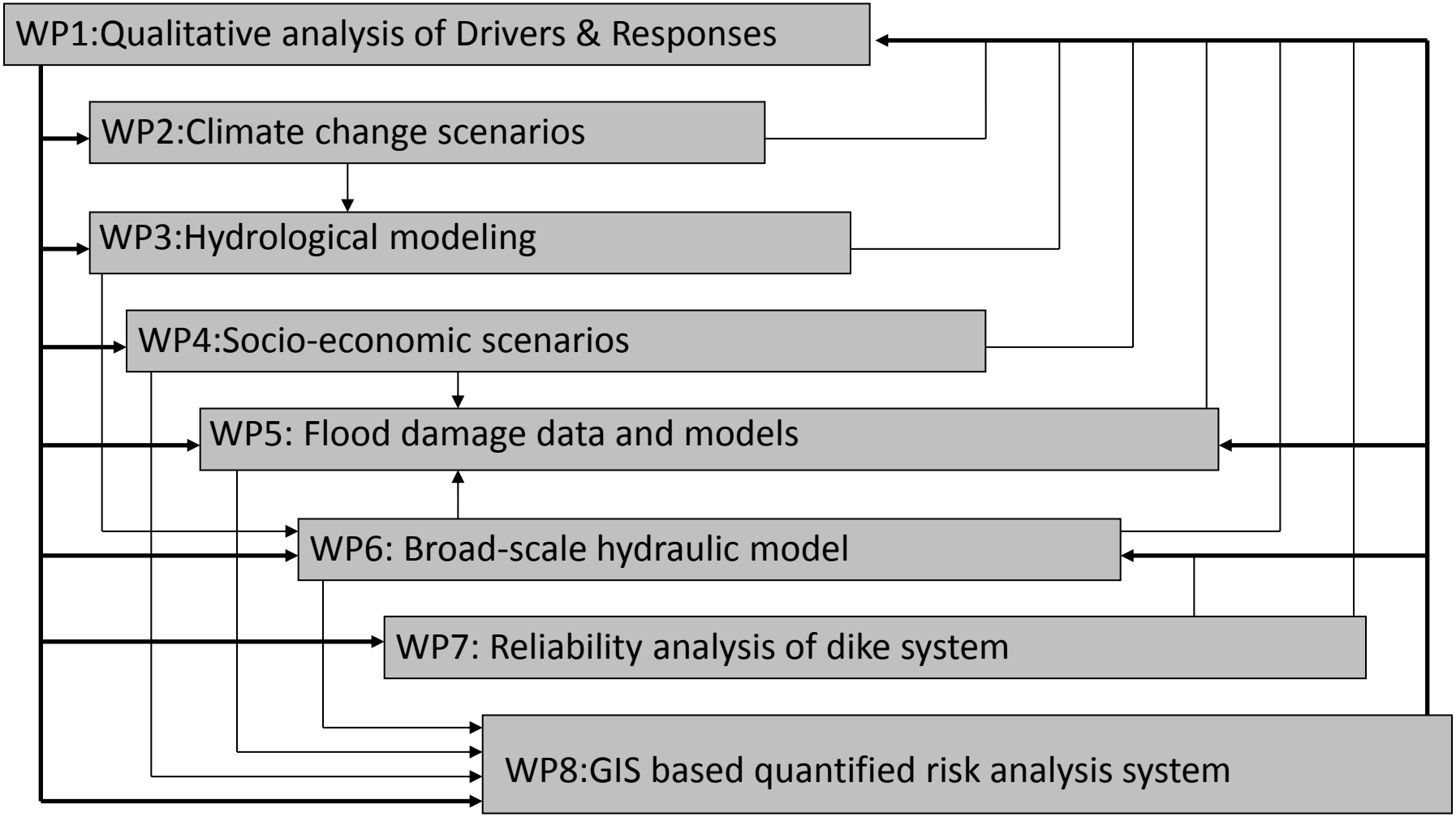
图 14 长江三角洲地区地面沉降等值线图（2004 年度）

Land subsidence

Severe water pollution

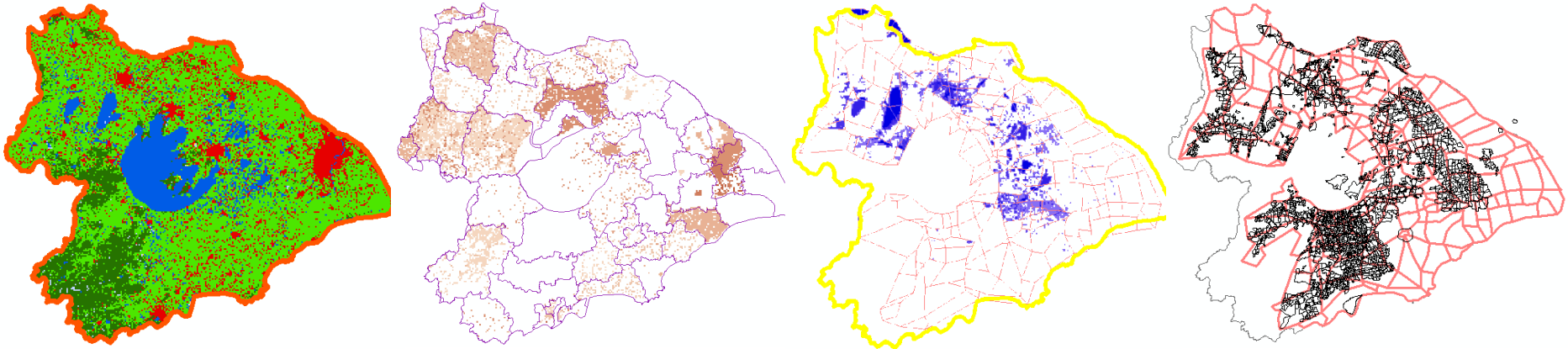
China/UK scientific cooperation project Scenario Analysis Technology for River Basin Flood Risk Management in the Taihu Basin

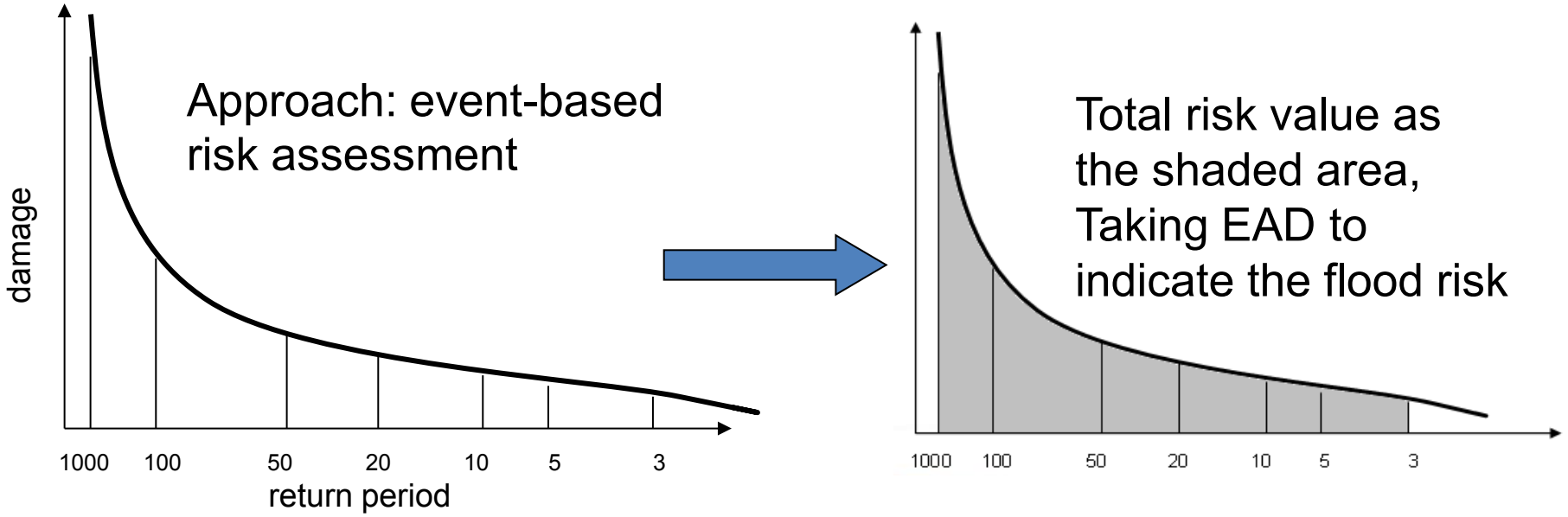
- Framework of the Project (8 Work Packages)



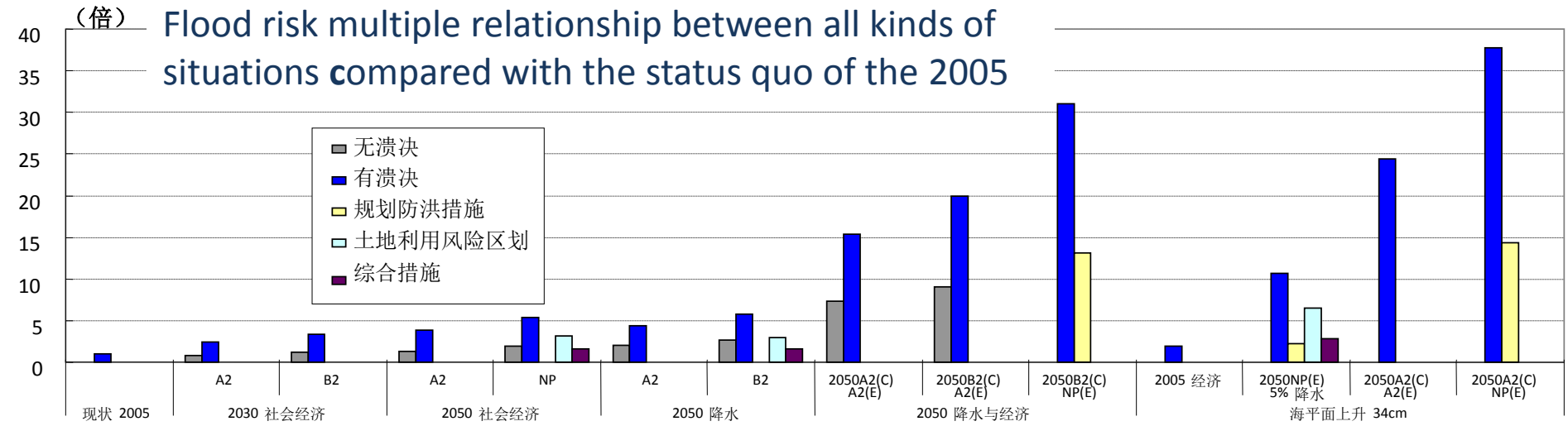
WP8:Quantified risk analysis system

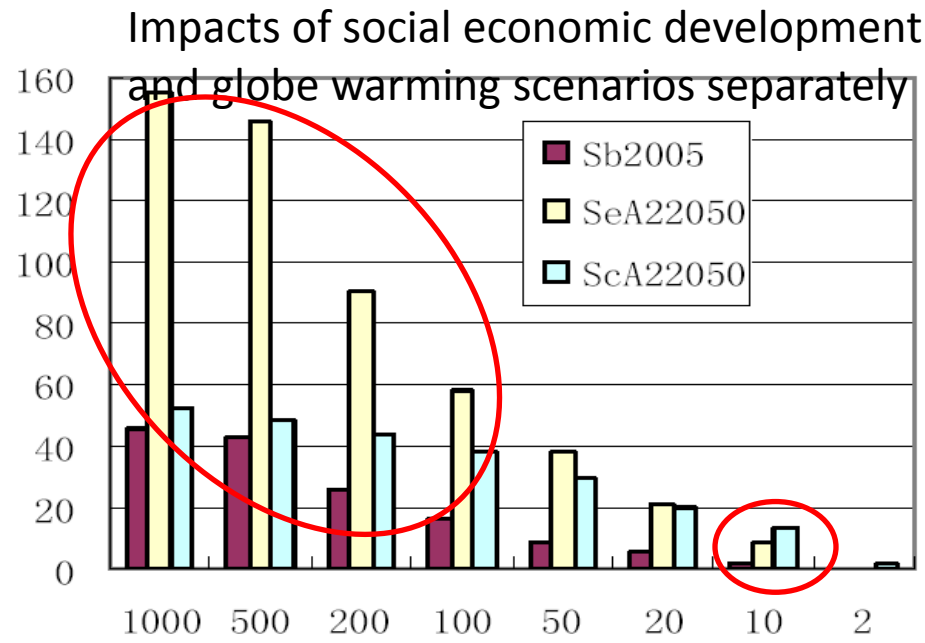
——A GIS-based flood risk analysis system has been primarily developed

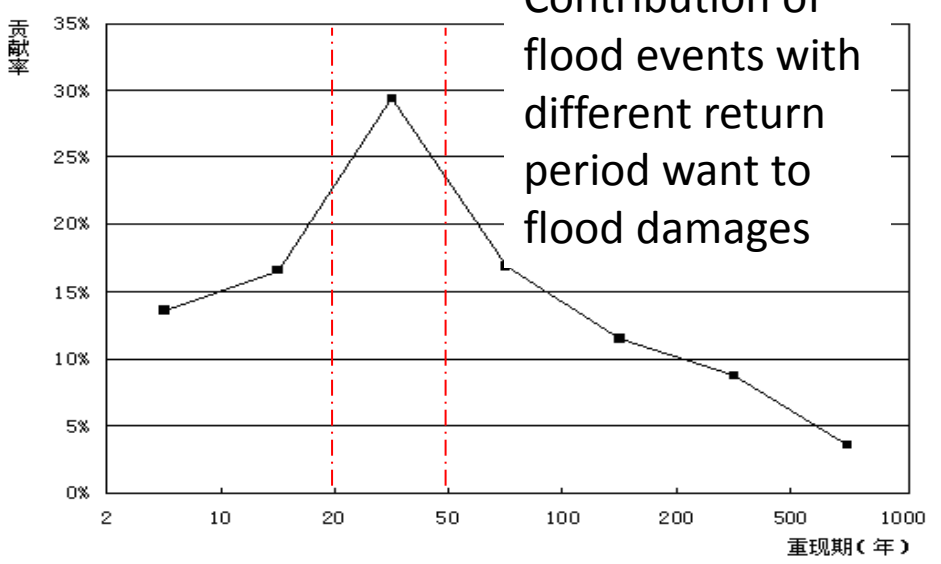




Scenario analysis results







Outcomes of the Project

- What are the impacts of
  - rapid urbanization and economic development
  - development of flood control system
  - Climate changes

on

- the features of future flood and flood damages in the Taihu Basin?
- the features of flood and ecosystem?
- the future flood control situation in the Taihu Basin?

A framework for long-term scenario analysis in the Taihu Basin, China

X.T. Cheng[1], E.P. Evans[2,*], H.Y. Wu[3], C.R. Thorne[4], S. Han[1], J.D. Simm[5], J.W. Hall[6]

Article first published online: 5 FEB 2013

DOI: 10.1111/jfr3.12024

Issue

Journal of Flood Risk Management

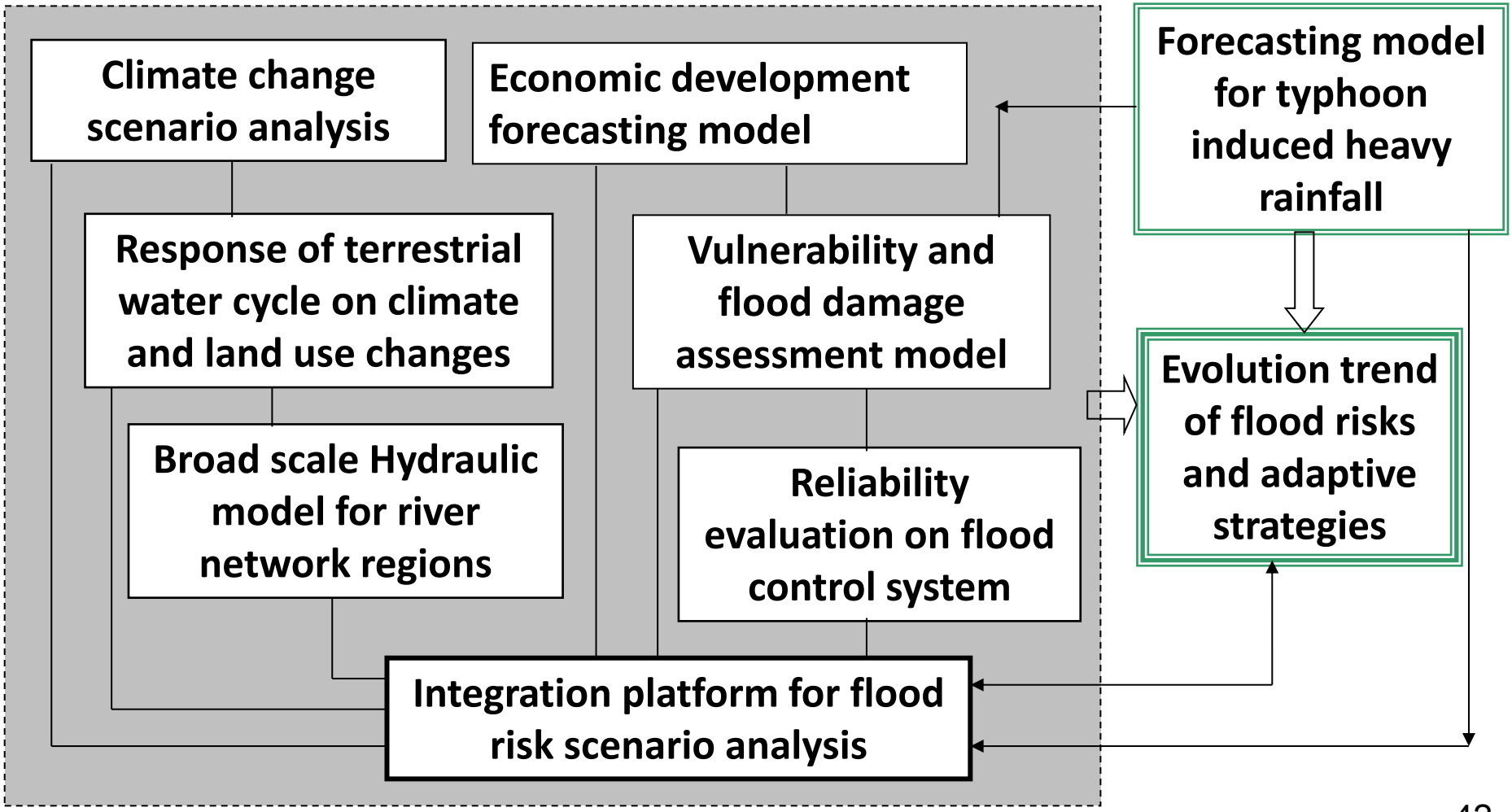
Taihu Basin Foresight Project Special Issue

Volume 6, Issue 1, pages 3–13, March 2013

Flood risk evolution and adaptive measures

- supported by the Key research project of the 12th 5-year planning

The framework of the project



Assessment of the impacts of climate change and human activities on water resources in the Taihu Basin

Evaluation by the double accumulated curve method

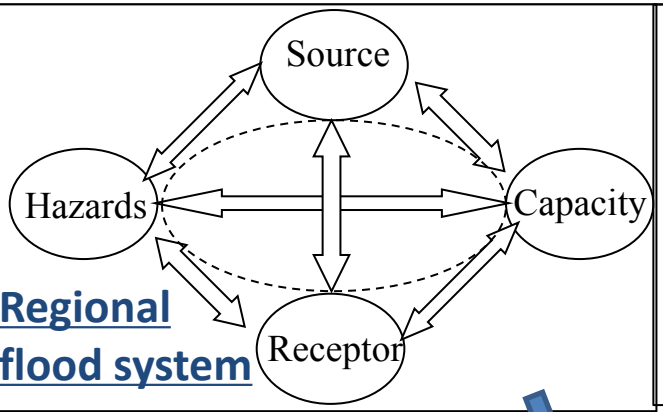
	Measured runoff /mm	Simulated runoff /mm	Total variation of runoff /mm	Variation of human activities /mm	Contribution of human activities /%	Variation of climate changes /mm	Contribution of climate changes /%
1956-1981	405.9	398.6	46.7	33.0	70.6	13.7	29.4
1982-2008	452.6	412.3					

Evaluation by the sensitivity coefficient method

	Rainfall /mm	potential evapotranspiration /mm	Runoff /mm	Variation of climate changes /mm	Contribution of climate changes /%	Variation of human activities /mm	Contribution of human activities /%
1964-1979	1173.3	815.9	405.9	17.1	36.6	29.6	63.4
1980-2008	1224.8	922.8	452.6				
variation	51.4	106.9	46.7				
β/γ	0.76	-0.53	--				

- Contributions of the impacts of climate change and human activities on the evolution of flows in the Taihu basin are 29%~37% and 63%~71%, the influence of human activity is the main factor.

Basic concept for exploring Flood risk evolution and adaptive measures in the Taihu Basin



Regional flood system

Foresight: theory+ technology

Global observation,
Remote sensing, simulation,
Scenario analysis,
evaluation models, GIS, DB,
system integration, etc.

- Rapid urbanization and land use change;
- Flood-prone area with regional conflicts ;
- Impacts of economic development modes on the features of flood risk ;
- Sustainable development depends greatly on water management system;
- Sensitive to globe warming and sea level rising.

Regulate & control strategies

- strategic direction
- watershed planning
- catchment management
- coordination

Resilience strategies

危险性 (Hazard)

承灾体易损性 (Vulnerability)

风险 (Risk)

承灾体暴露性 (Exposure)

Capacity building

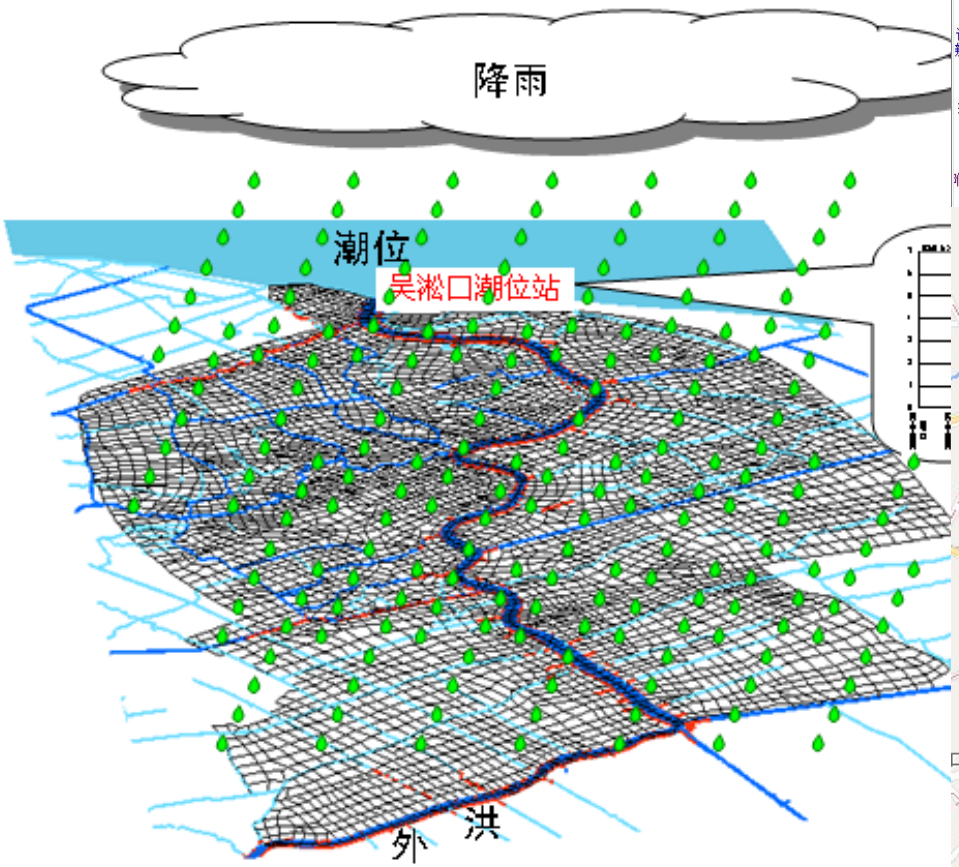
Adaptation strategies

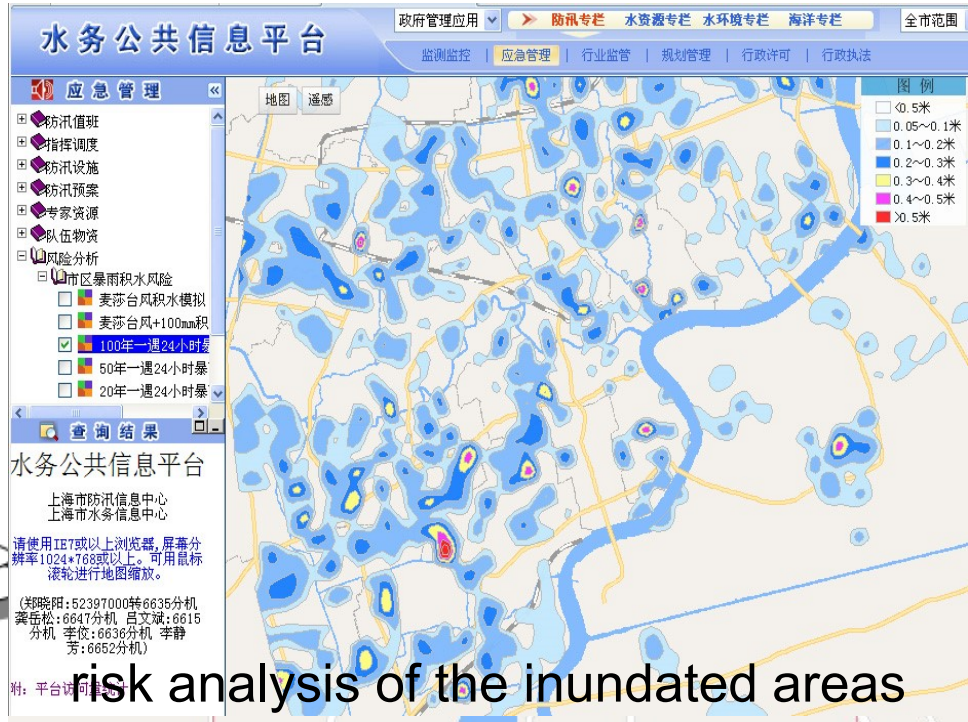
Flood risk analysis and assessment

Crichton, David. The Risk Triangle. Natural Disaster Management. London: Tudor Rose,1999

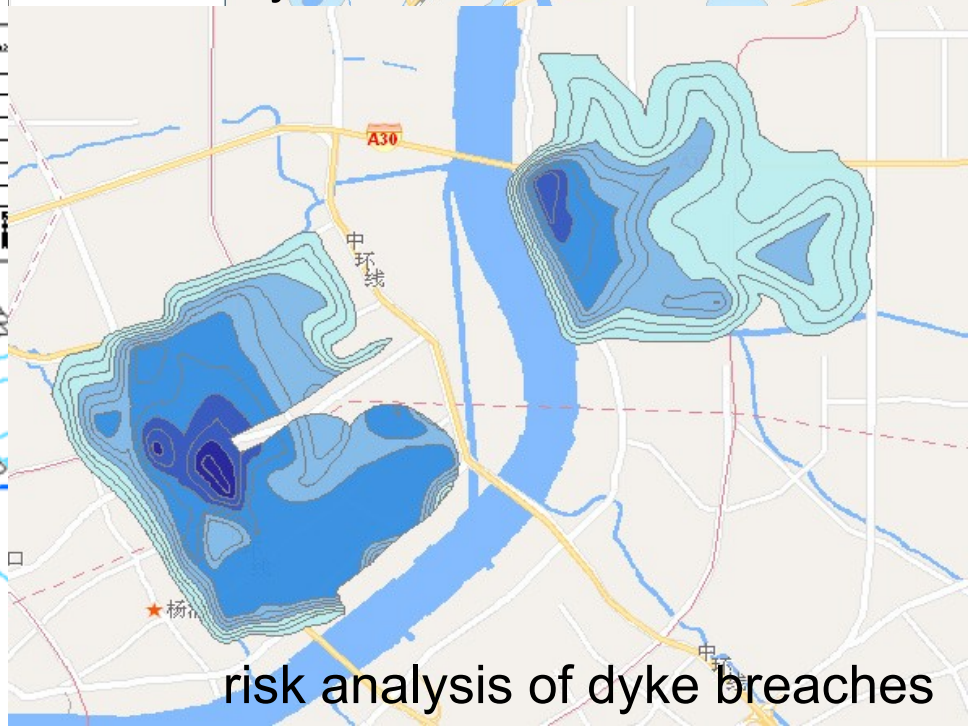
Flood Risk Mapping System for Shanghai

- Shanghai model





risk analysis of the inundated areas



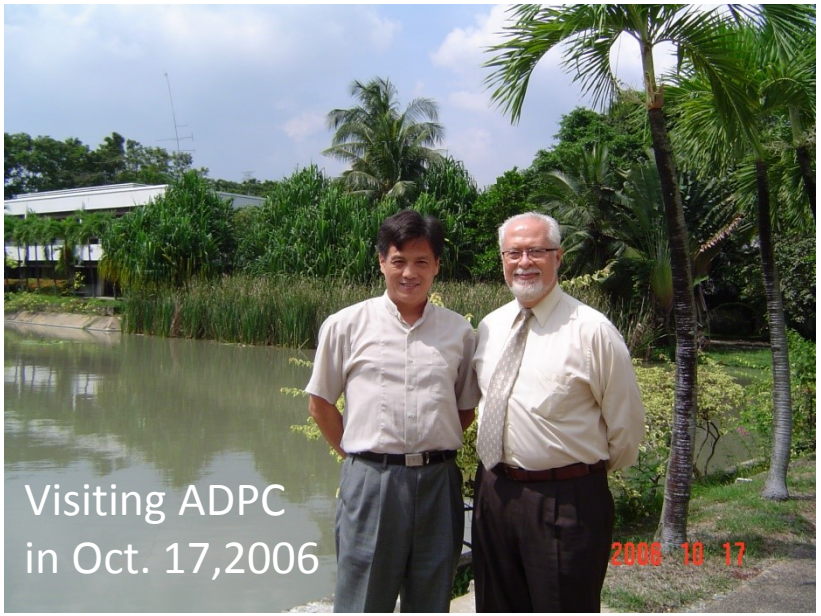
risk analysis of dyke breaches

5 Conclusions

- Flood control situations have been and will be changed greatly in the context of rapid urbanization and global warming, which will hinder the rapid and smooth development without stronger coping strategies.
- Integrated flood management will play an important role to restrain the increasing trend of flood risk both in urbanized areas and rural areas.
- We have to learn experiences from advance countries, and meanwhile , we must fully consider the difference in natural conditions and the impact of different stages of development, to choose a proper flood management strategy and enhance capacity building that can really meet the demands of water security of our own.

Thank you for your attention!

chengxt@iwhr.com



Attending International Knowledge Sharing Forum on Flood Management, 19-20 Jan. 2012, Bangkok