Progress of Flood Management and Emergency Response in China

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31 Oct. 2016, Beijing

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- Impacts of flood control situation changes in China
- Shifting strategy from flood control to flood management
- Approaches to restrain the increasing flood risk
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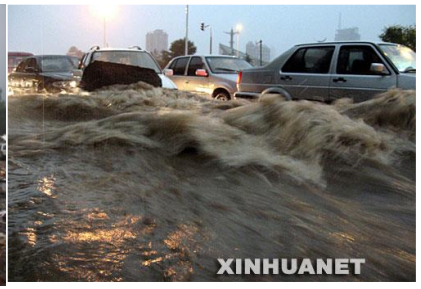
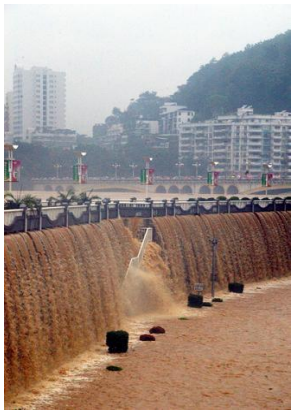
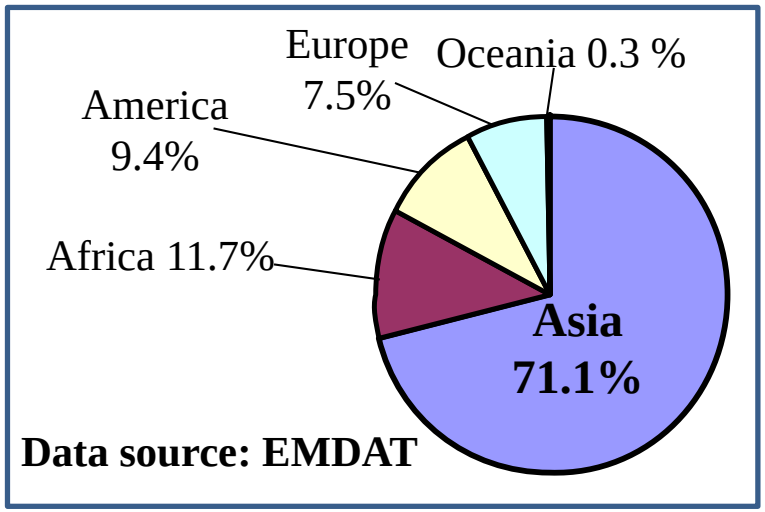


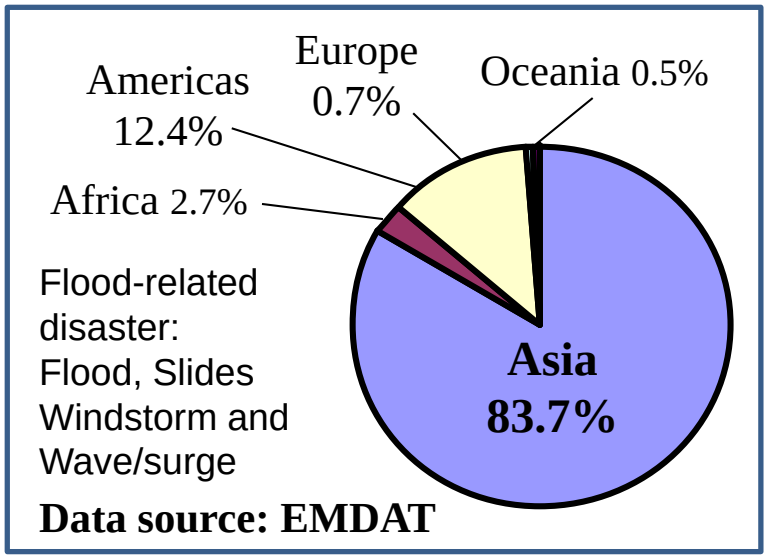


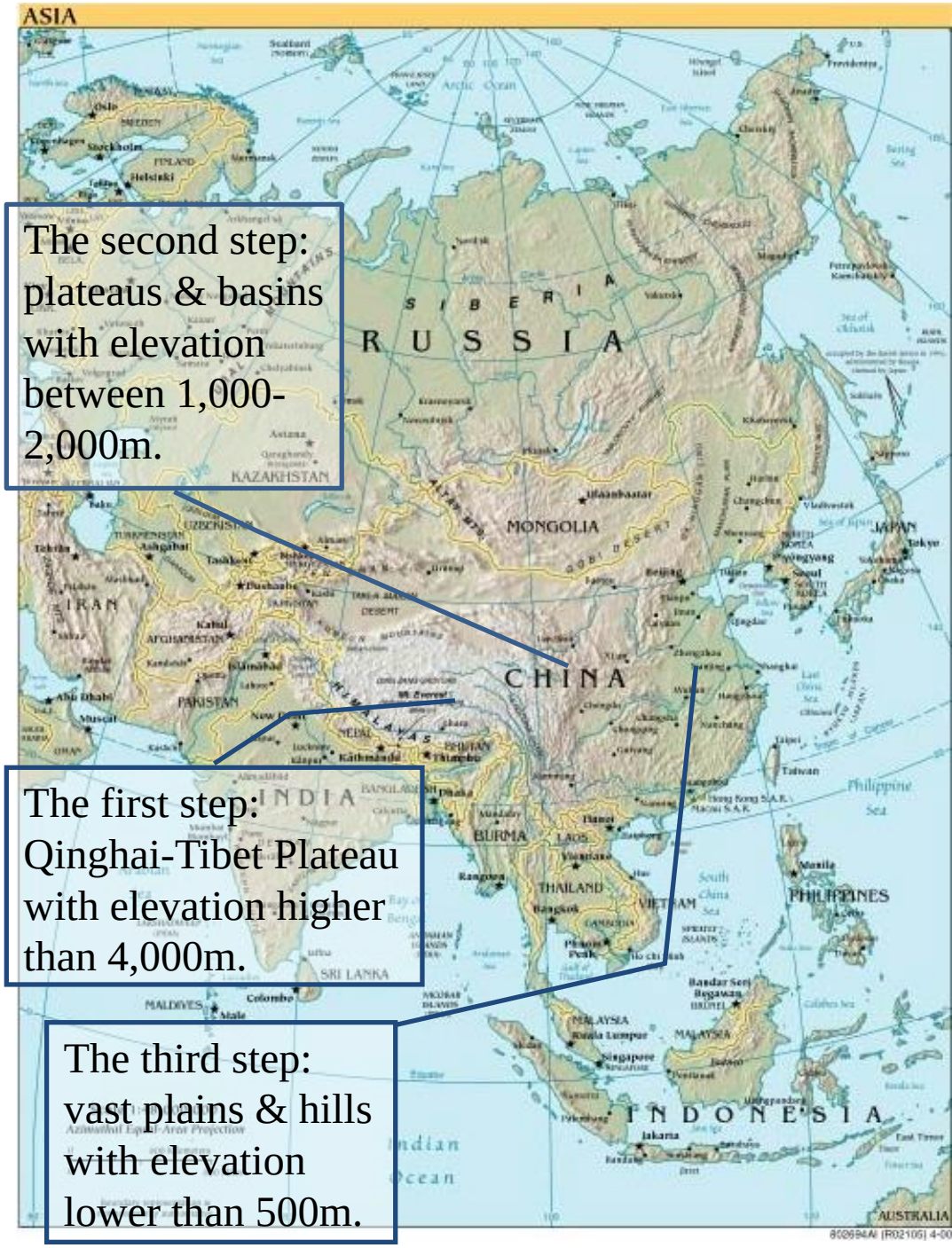
1 Introduction

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

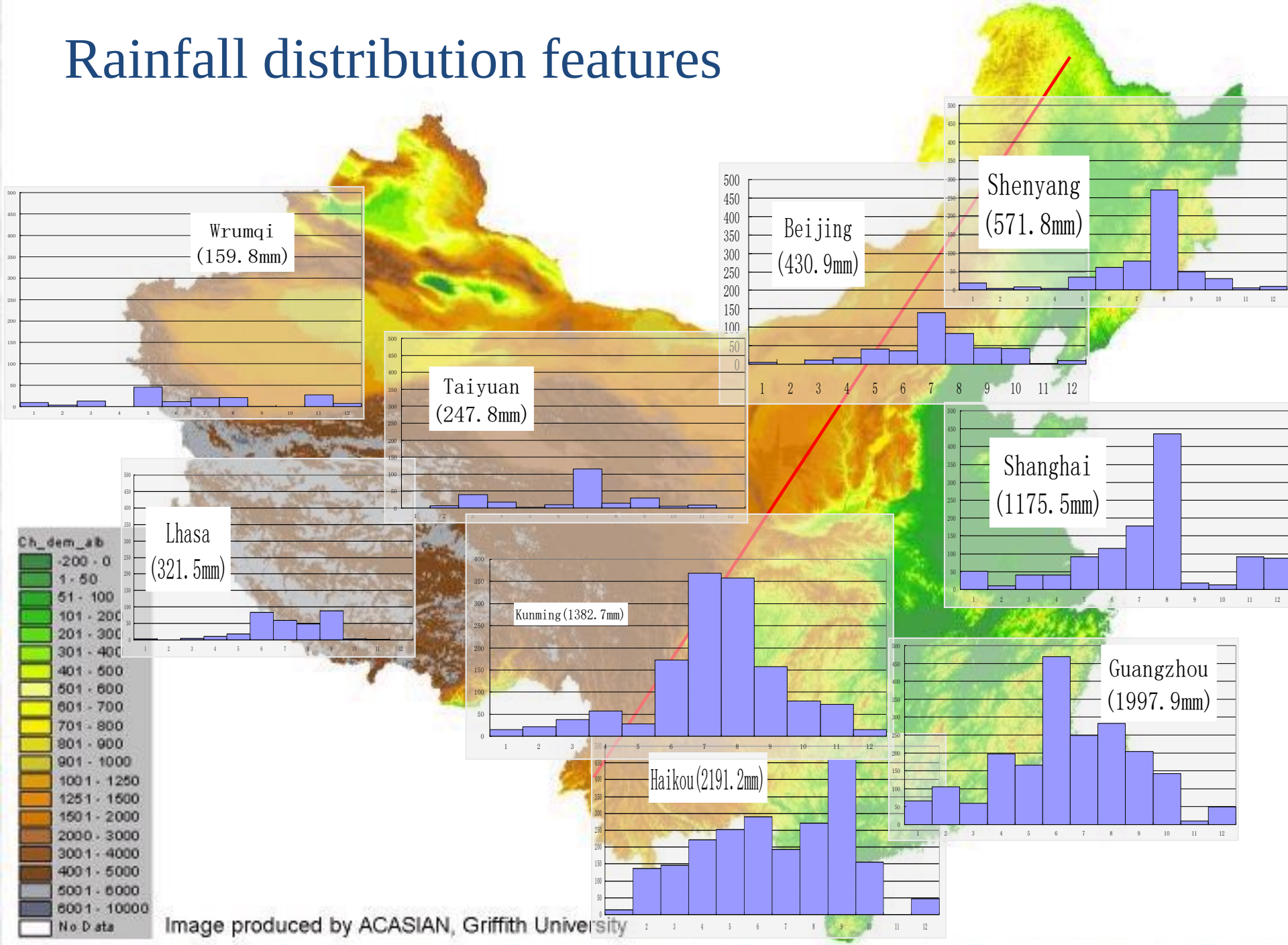


Global Total Fatalities of Flood-related Disaster from 1986 to 2006





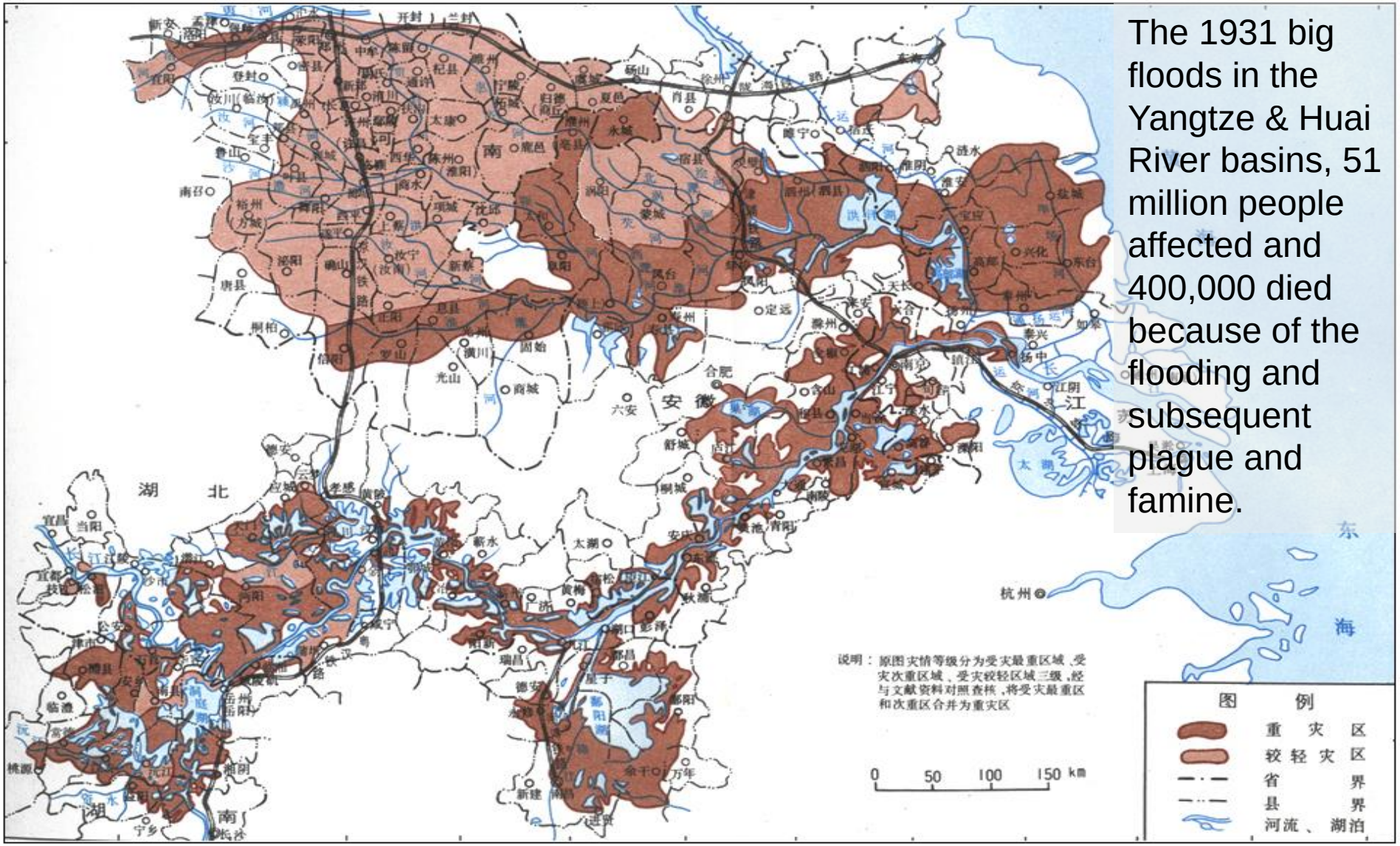
Rainfall distribution features



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

The 1931 big floods in the Yangtze and Huai river basins



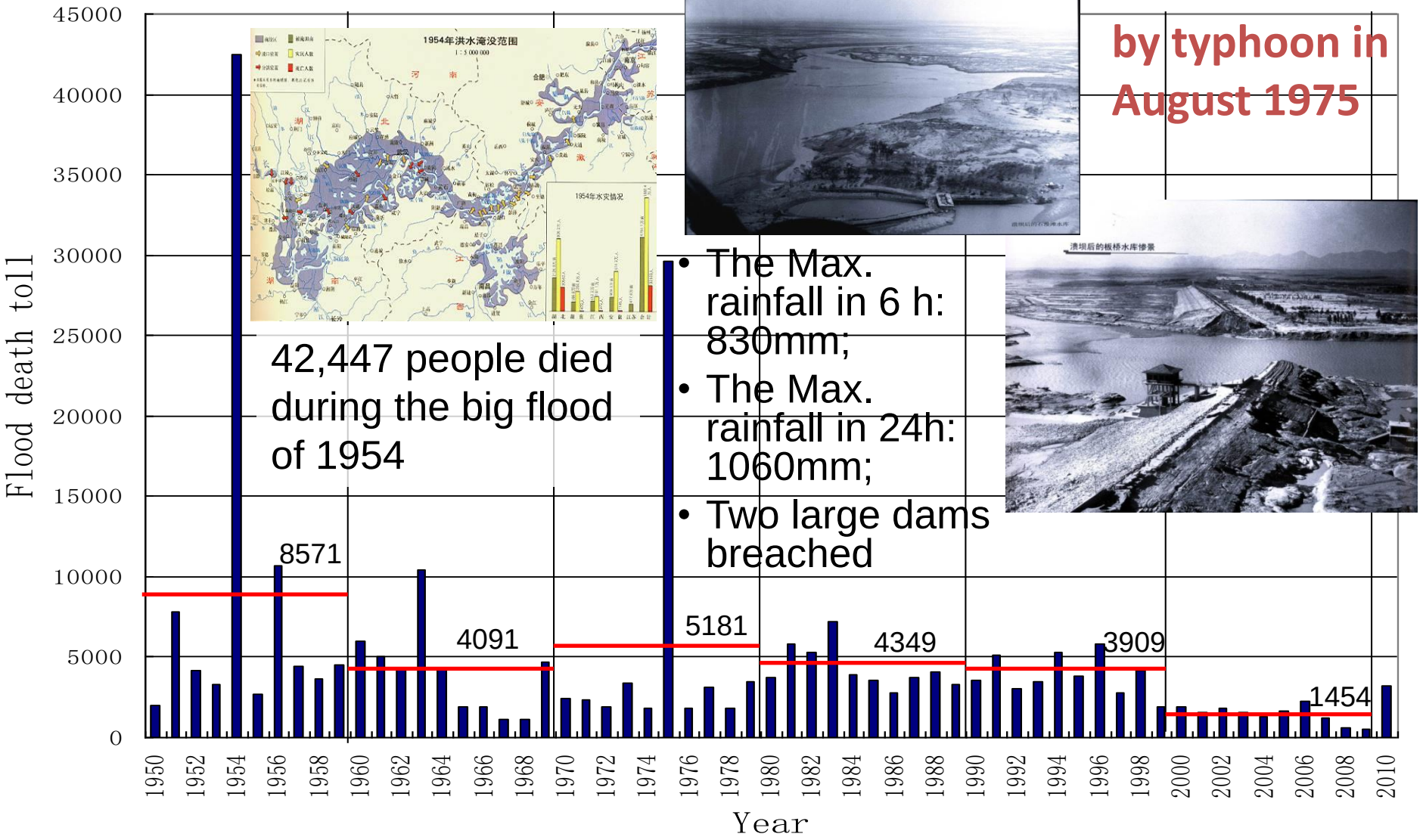
Wuhan, the capital city of the Hubei province was inundated in the 1931 flood for months

Flooding death toll in China （1950-2010）

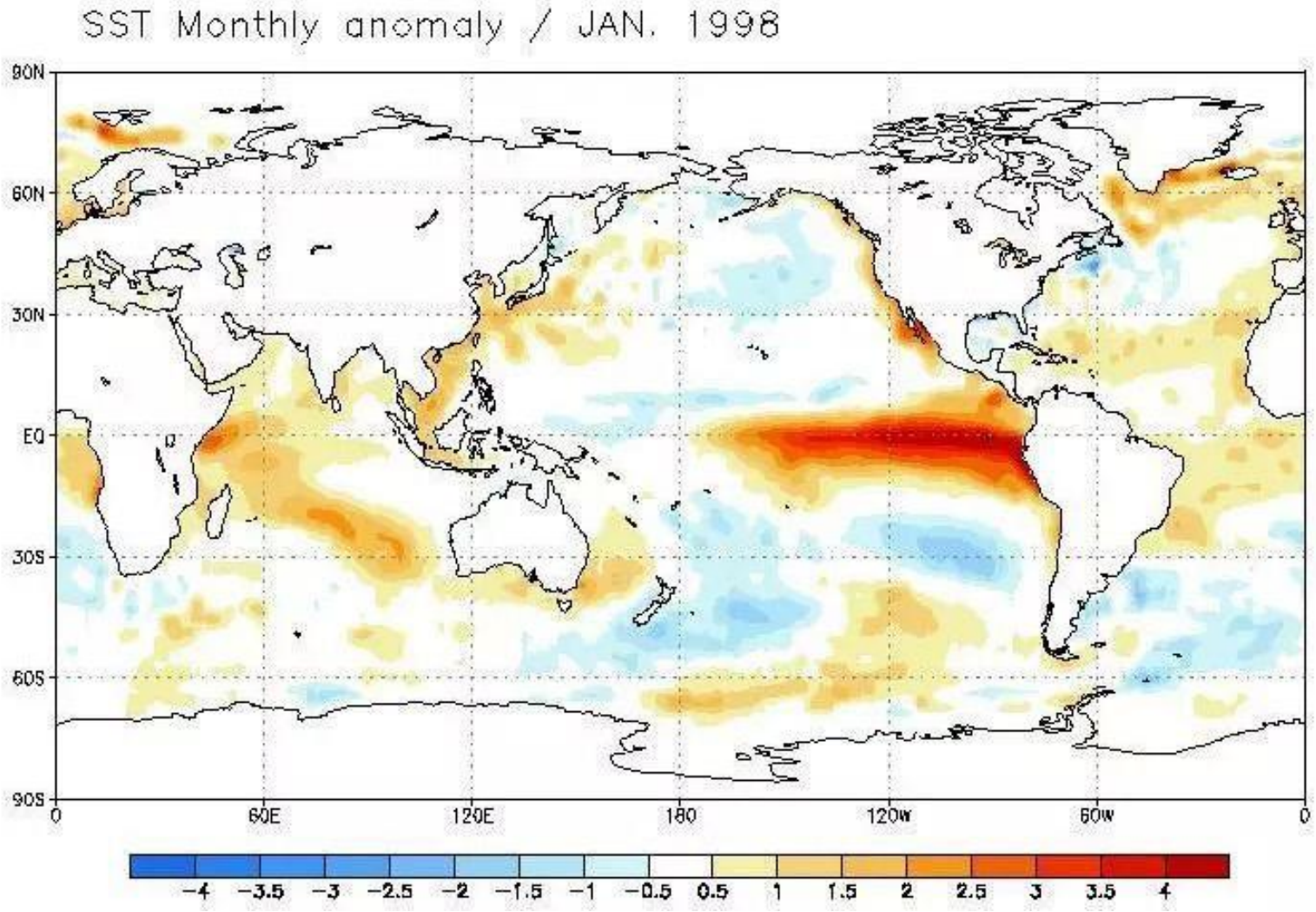
42,447 people died during the big flood of 1954

Flood caused by typhoon in August 1975

- The Max. rainfall in 6 h: 830mm;
- The Max. rainfall in 24h: 1060mm;
- Two large dams breached



Super Ei Nino phenomenon in 1997/1998



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.

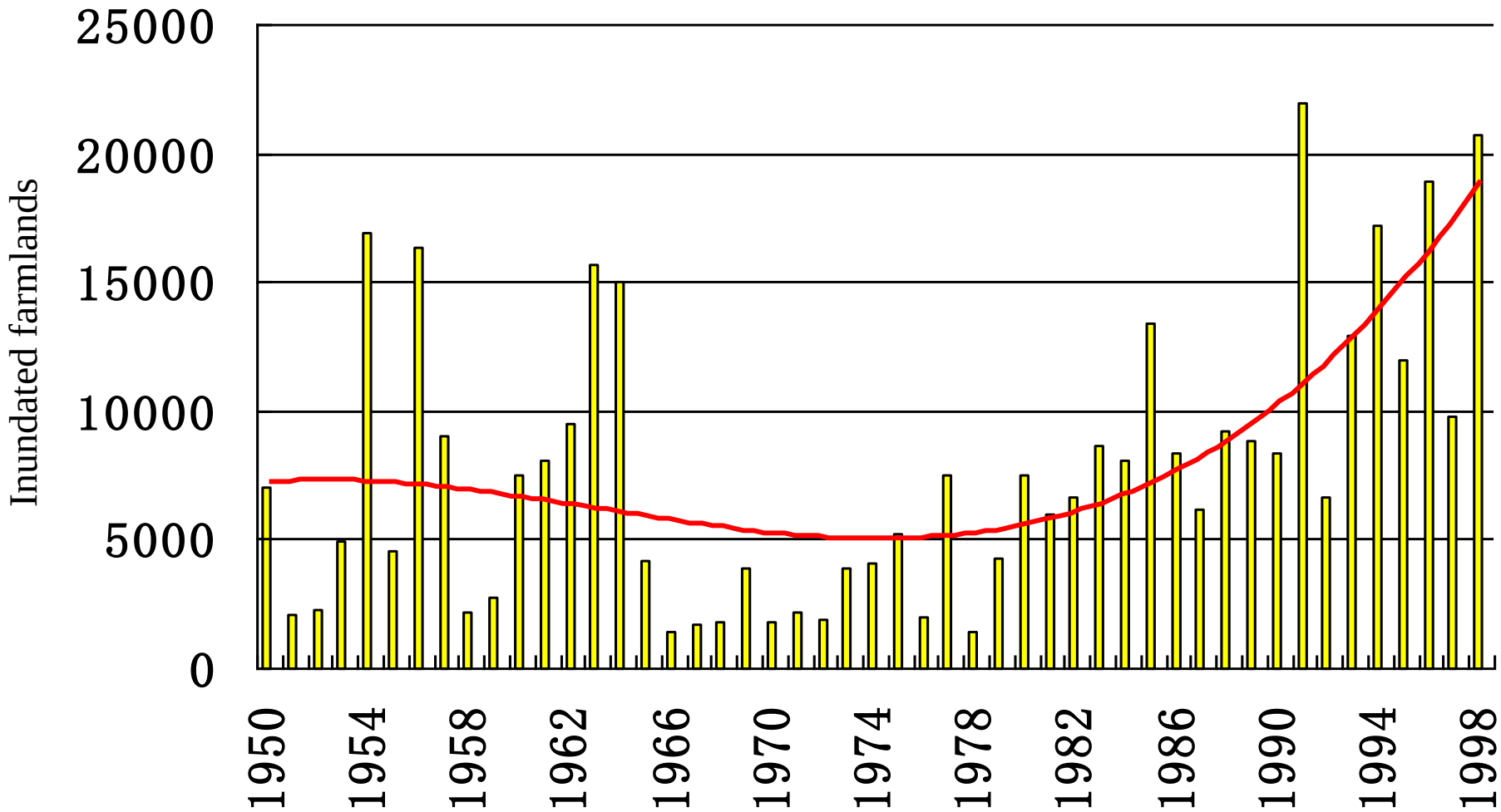
In Minjing River Basin, the biggest flood in the 20th Century occurred in Fujian province during the mid-to-end of June

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

Flood fighting in Nenjing-Songhua River during August 1998

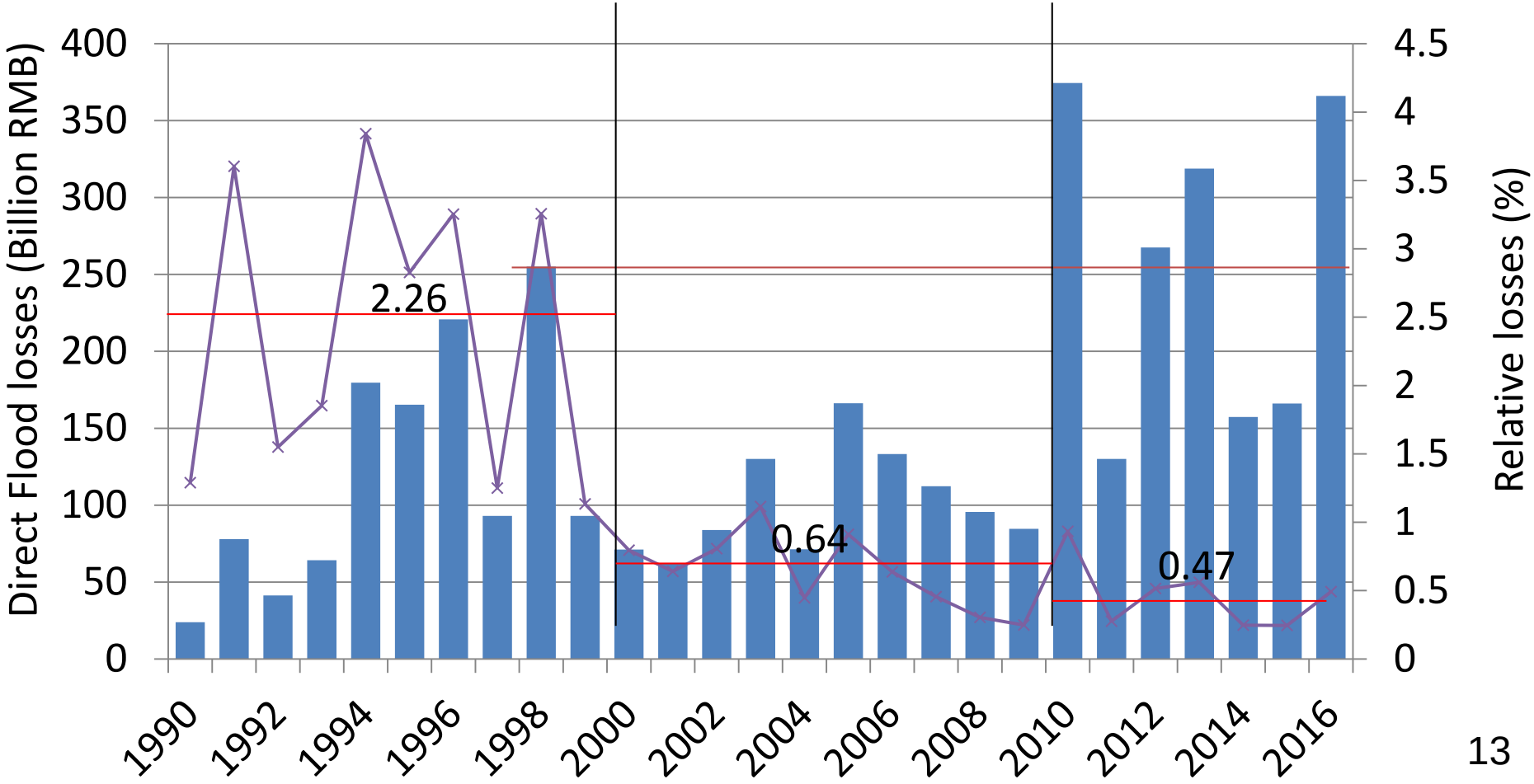
Characteristics of flood disasters

The total area of inundated farmlands keeps increasing in tendency since 1980's



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

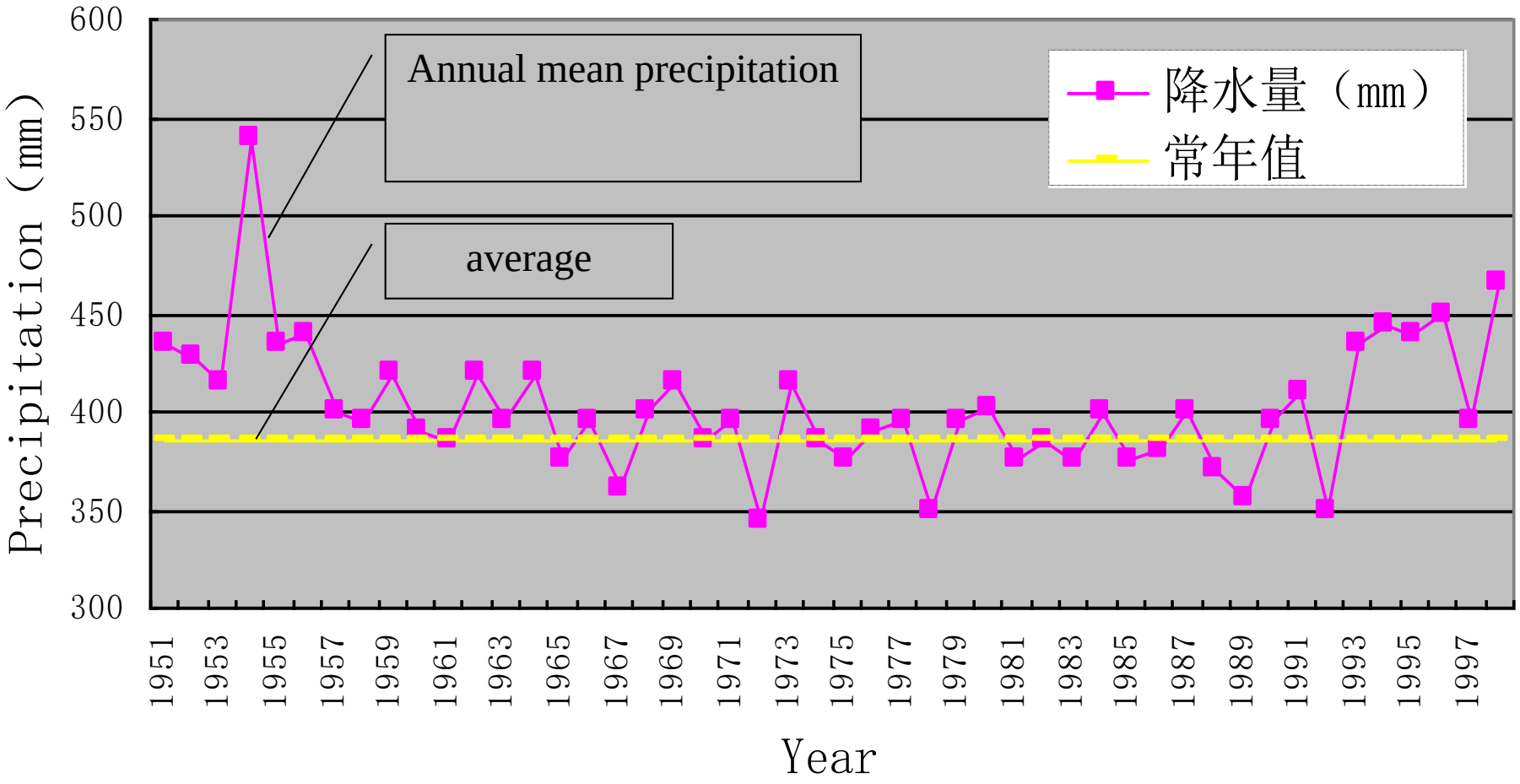


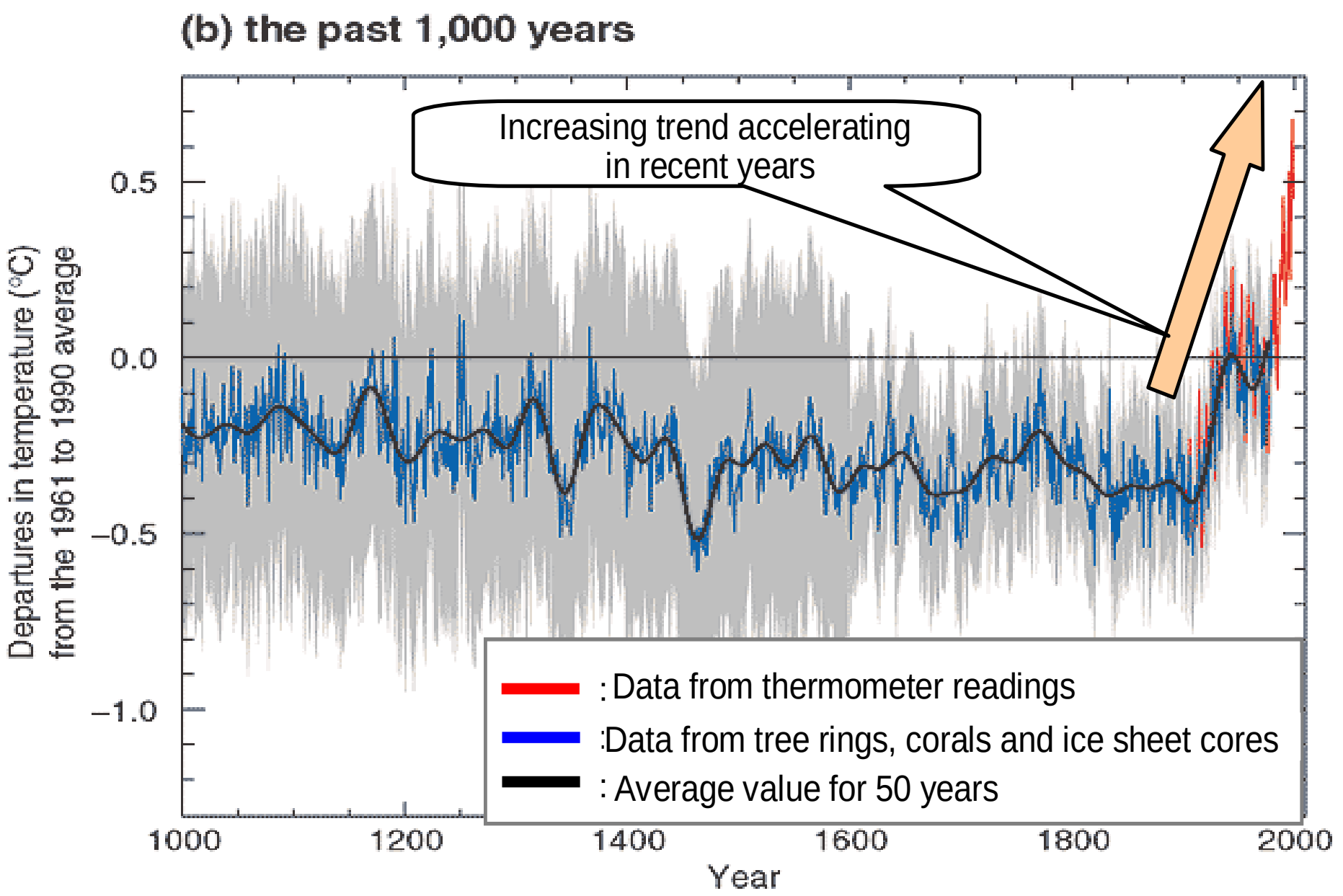
2 Impacts of Flood Control Situation Changes in China

- Impacts of climate changes
- Impacts of the high density of population
- Impacts of the flood control systems
- Impacts of the rapid economic development
- Impacts of environment changes
- Impacts of the rapid urbanization

Impacts of climate changes

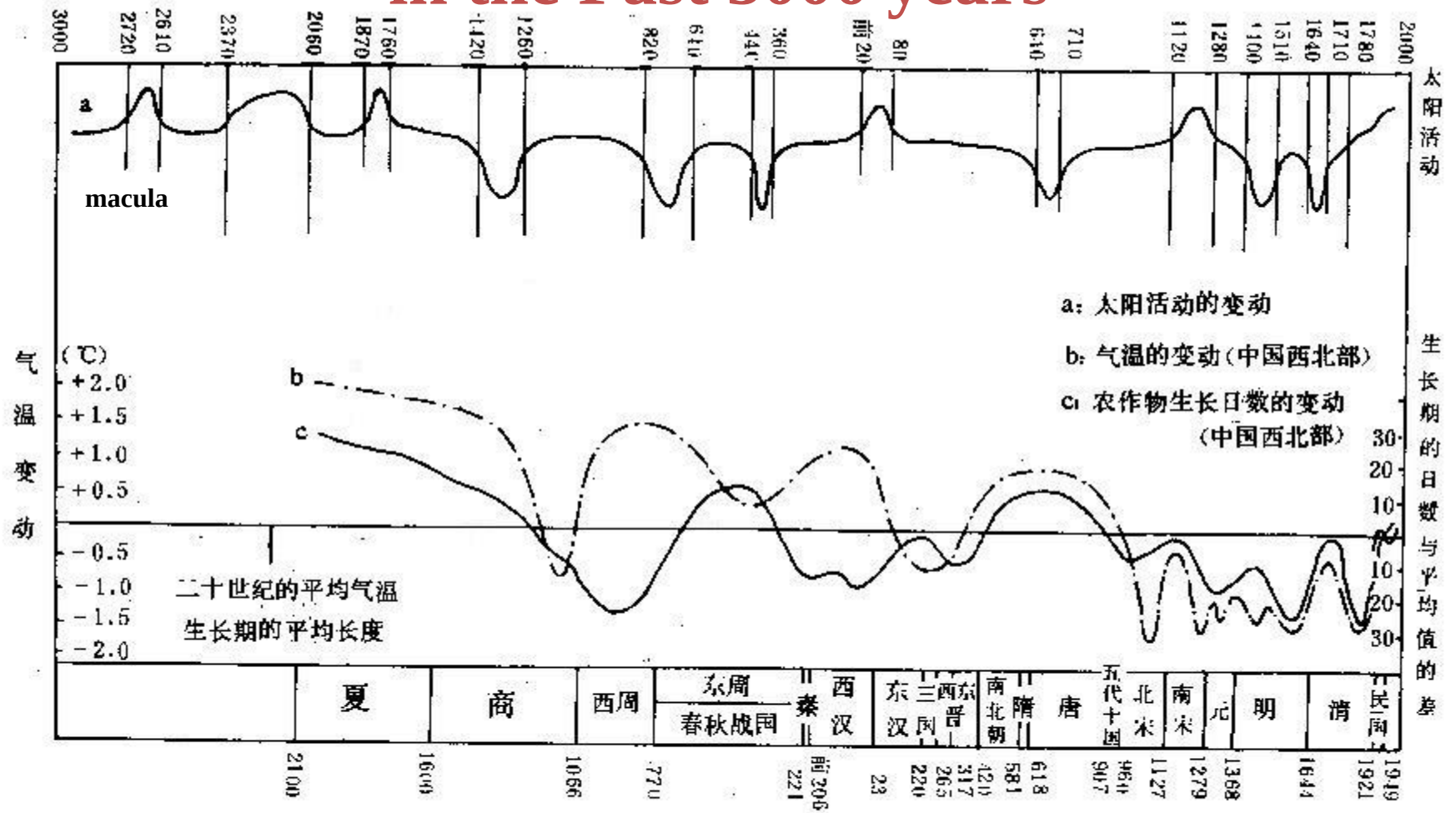
The climatic fluctuation is the natural reason that caused the frequent severe floods in 1990s in China



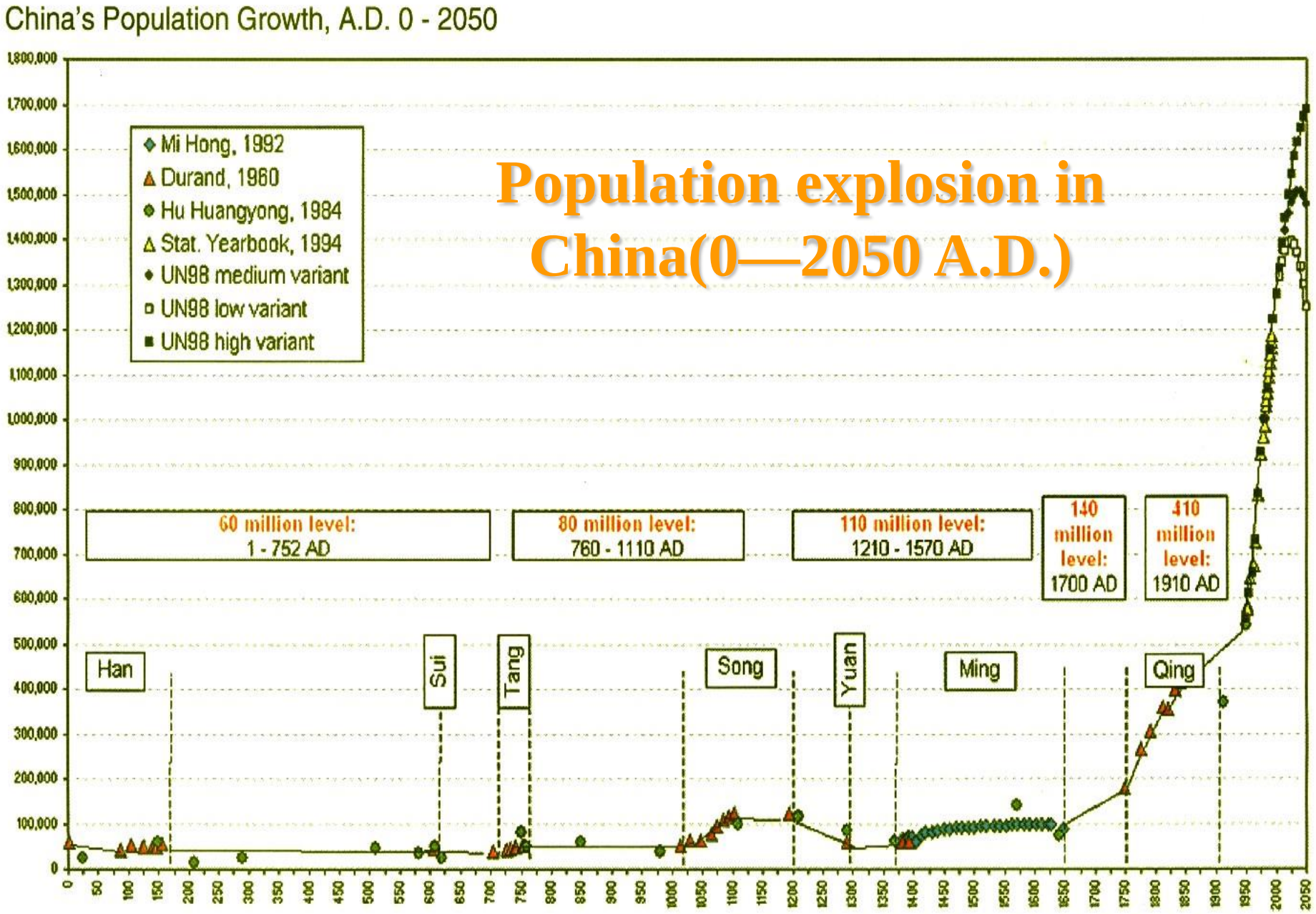


Excerpts from “Climactic Change 2001”, a Report of the First Working Group in the Third Evaluation Report of the IPCC

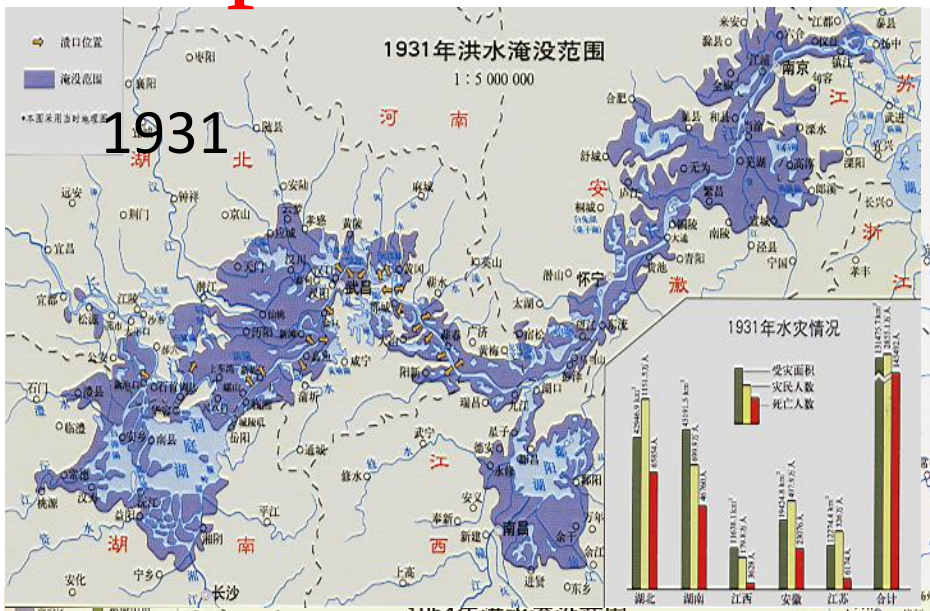
Changes of Solar Activities and Temperatures in the Past 5000 years

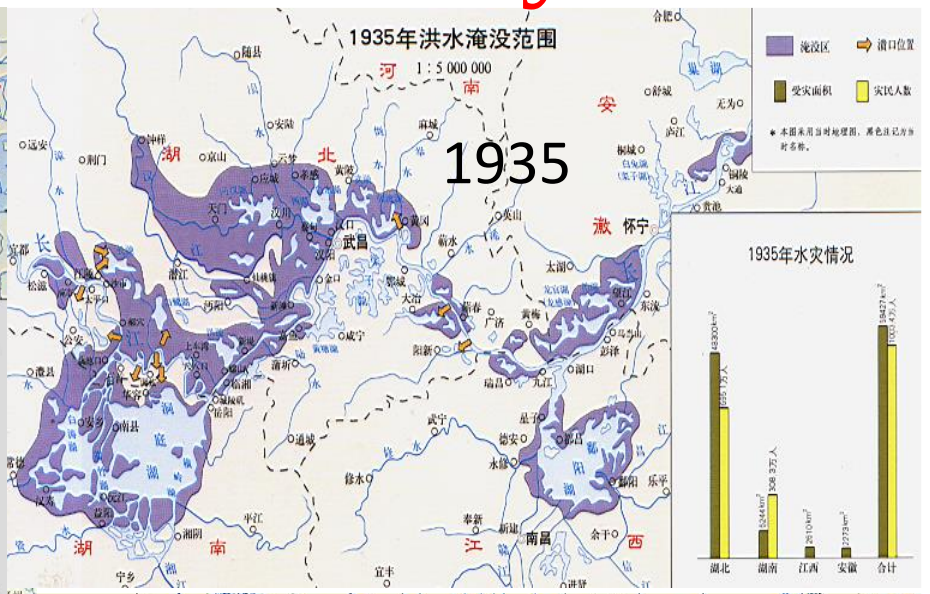


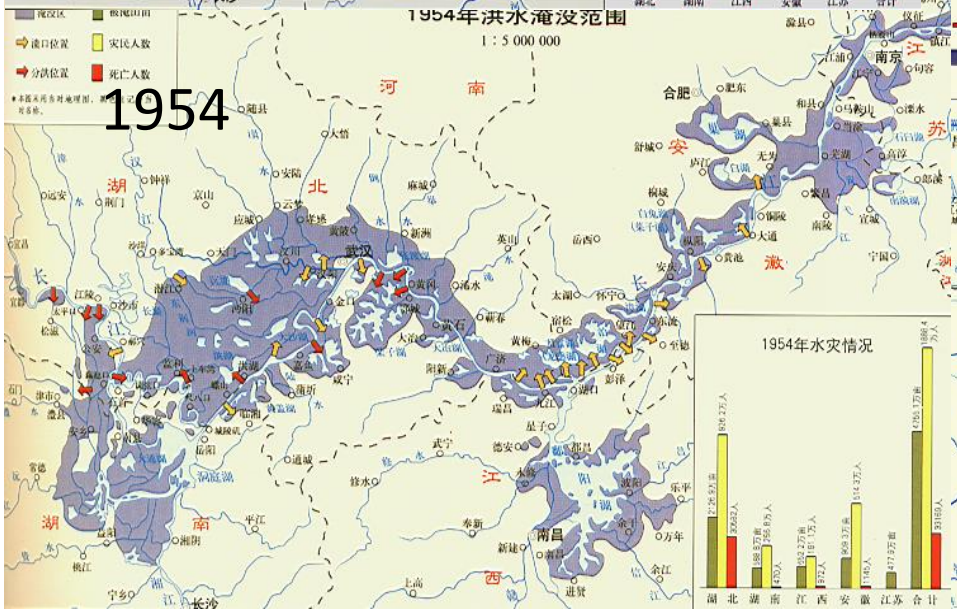
Impacts of the High density of the population

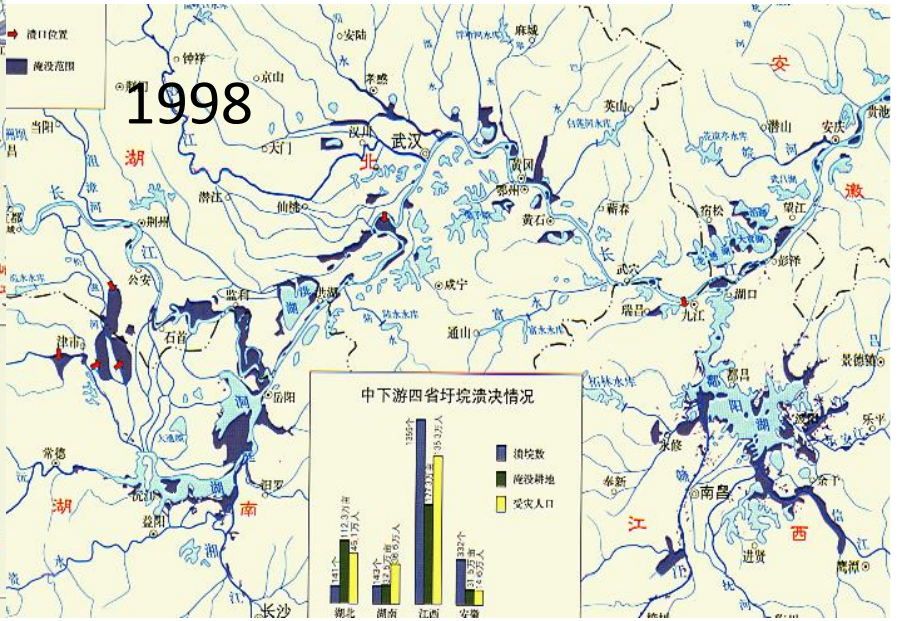


Impact of the flood control systems

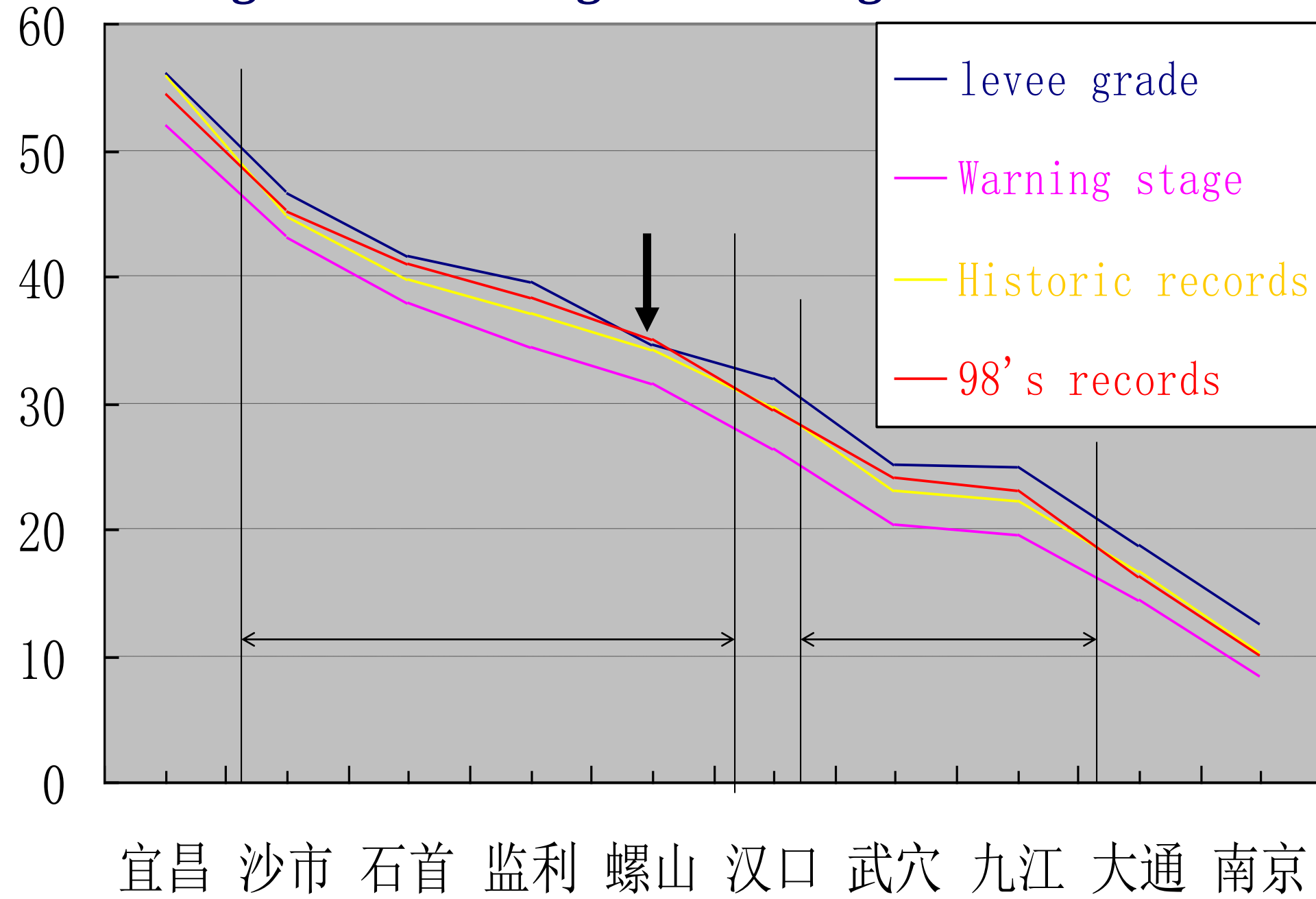






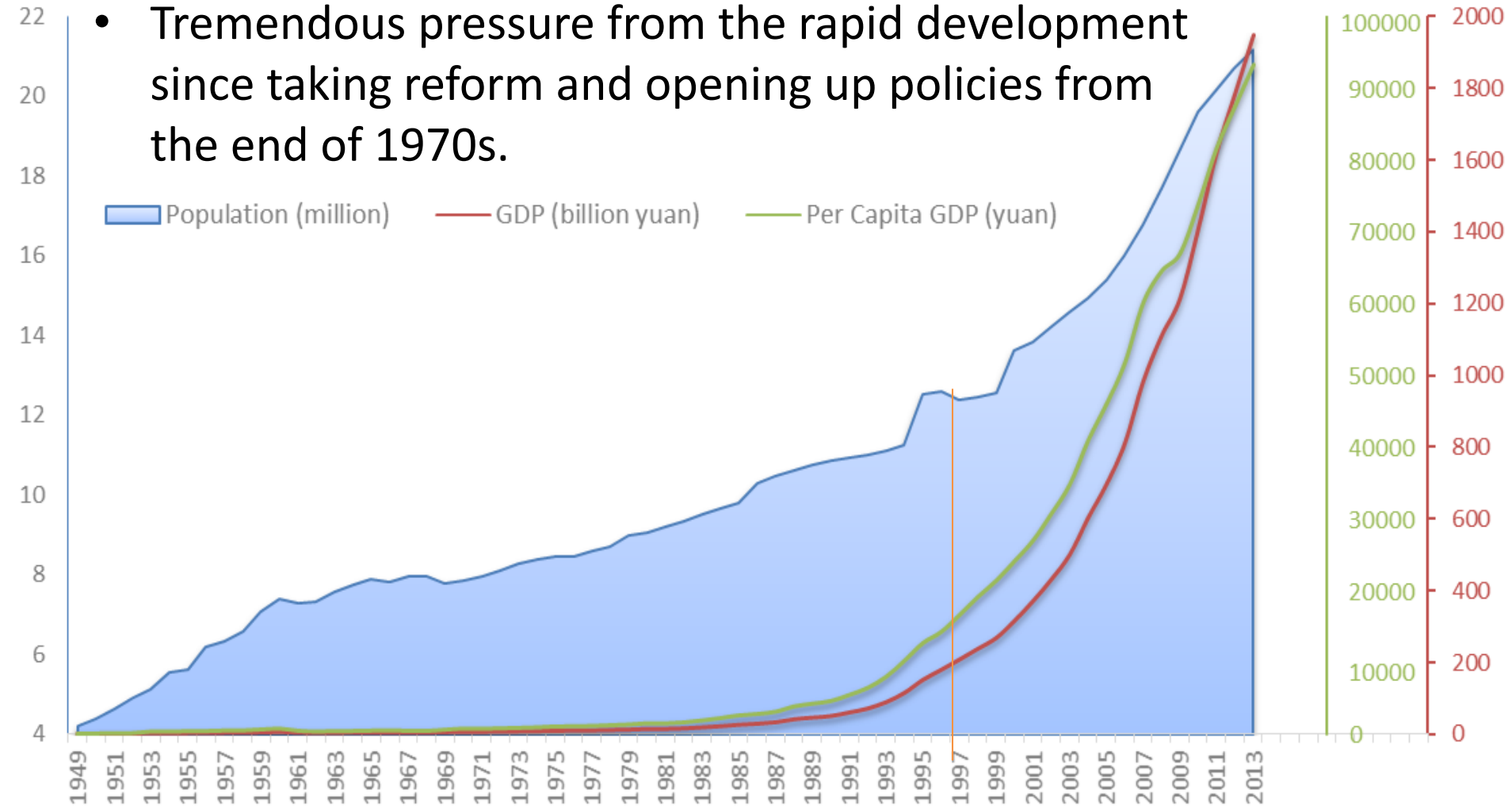


The Highest Water Stage of the Yangtze River in 1998



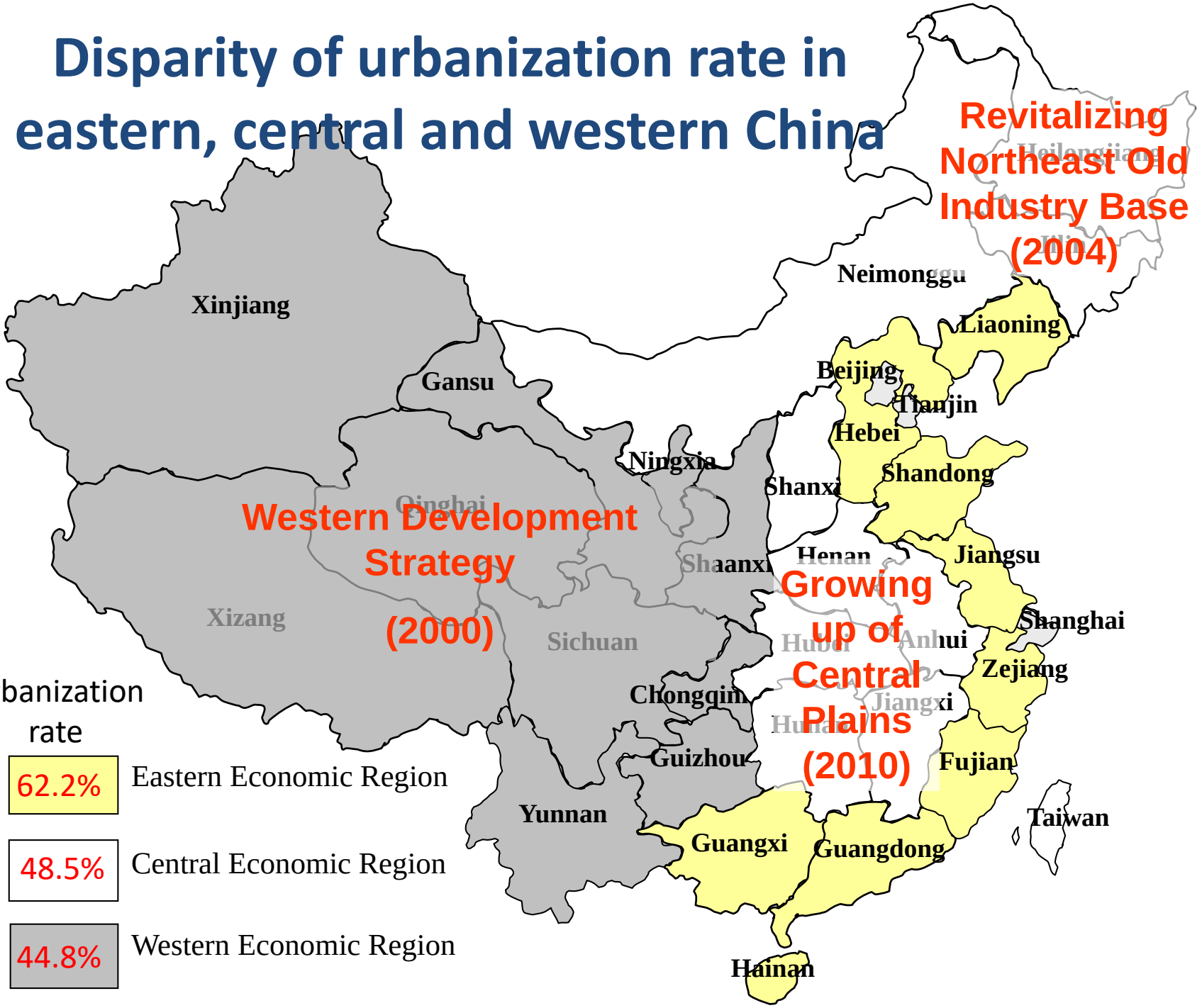
Impacts of the rapid economic development

- Tremendous pressure from the rapid development since taking reform and opening up policies from the end of 1970s.



Population, GDP and Per Capita GDP of Beijing (1949-2013)

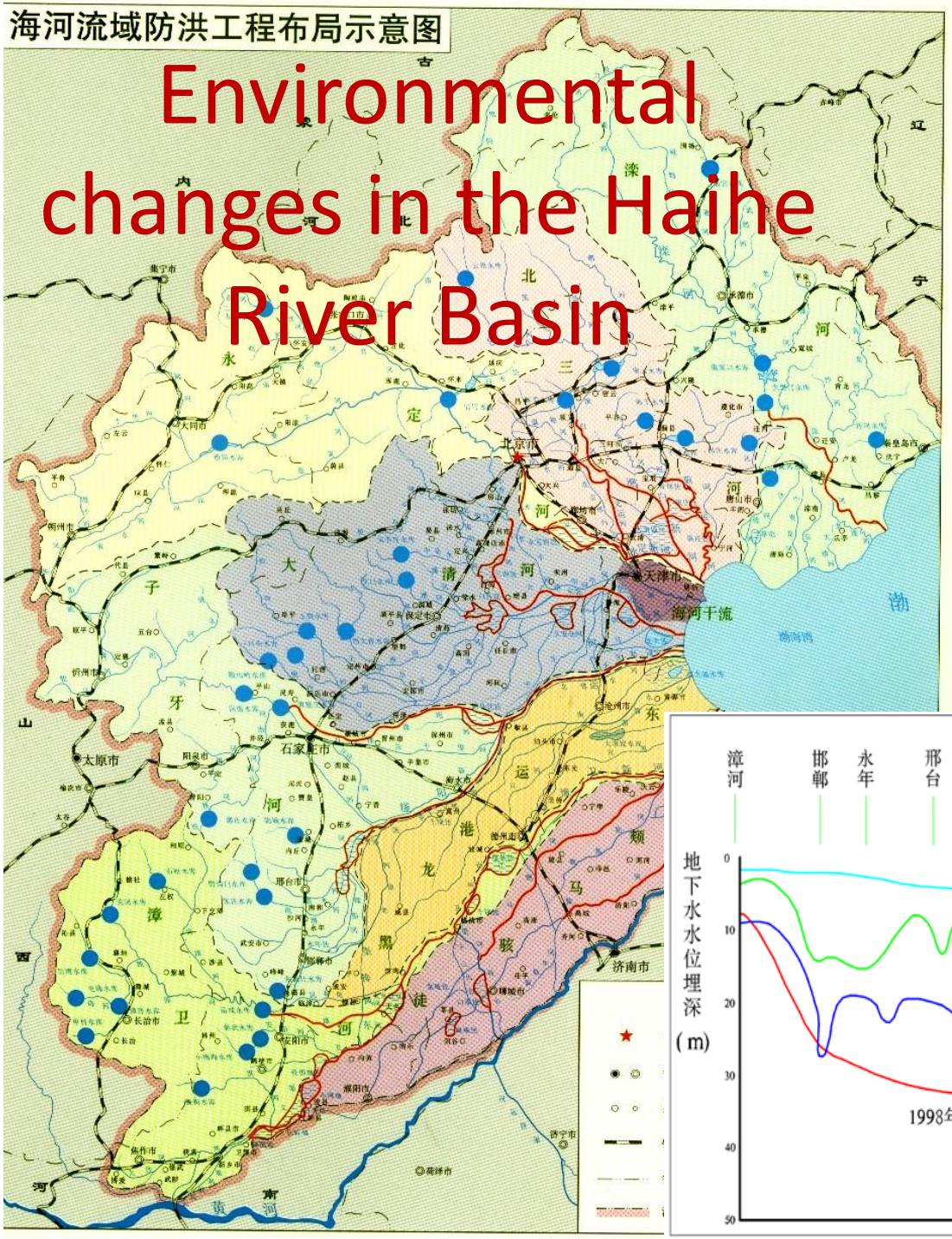
Disparity of urbanization rate in eastern, central and western China

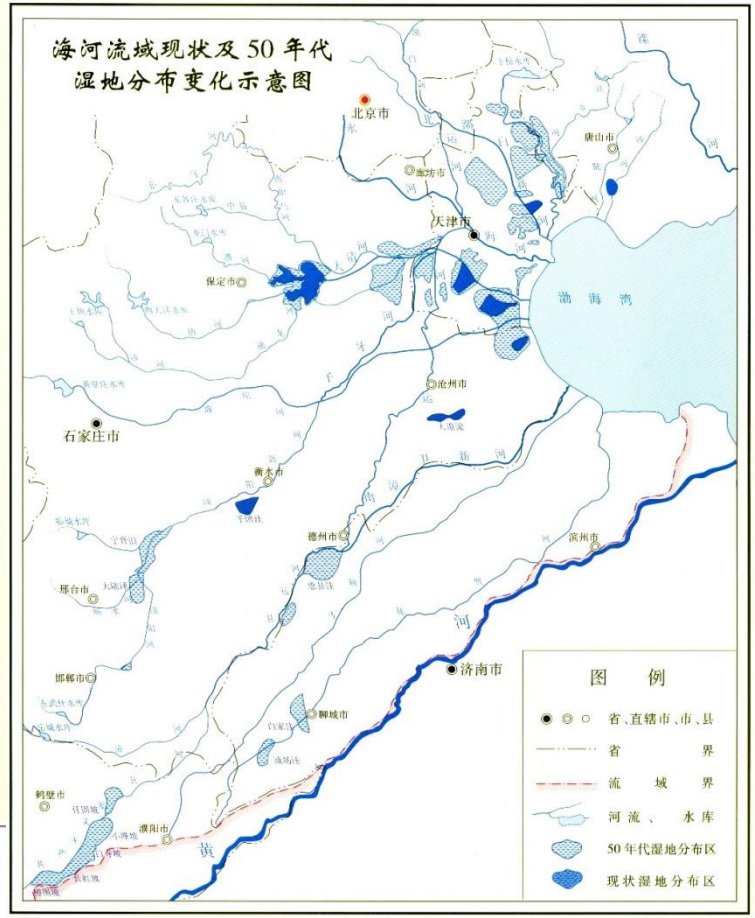


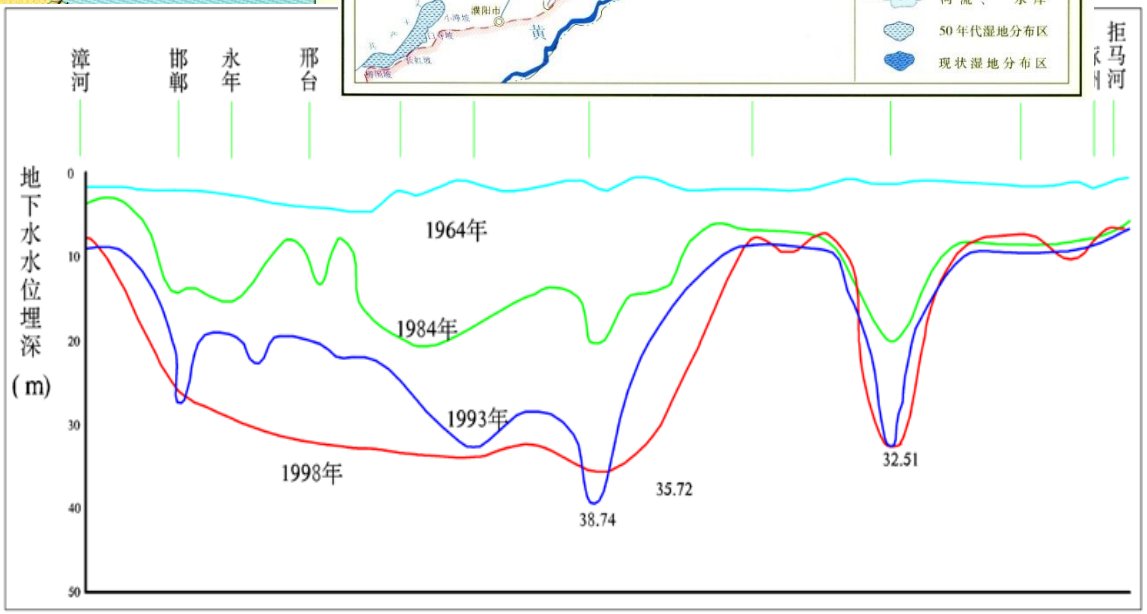
Urbanization rate

62.2%	Eastern Economic Region
48.5%	Central Economic Region
44.8%	Western Economic Region

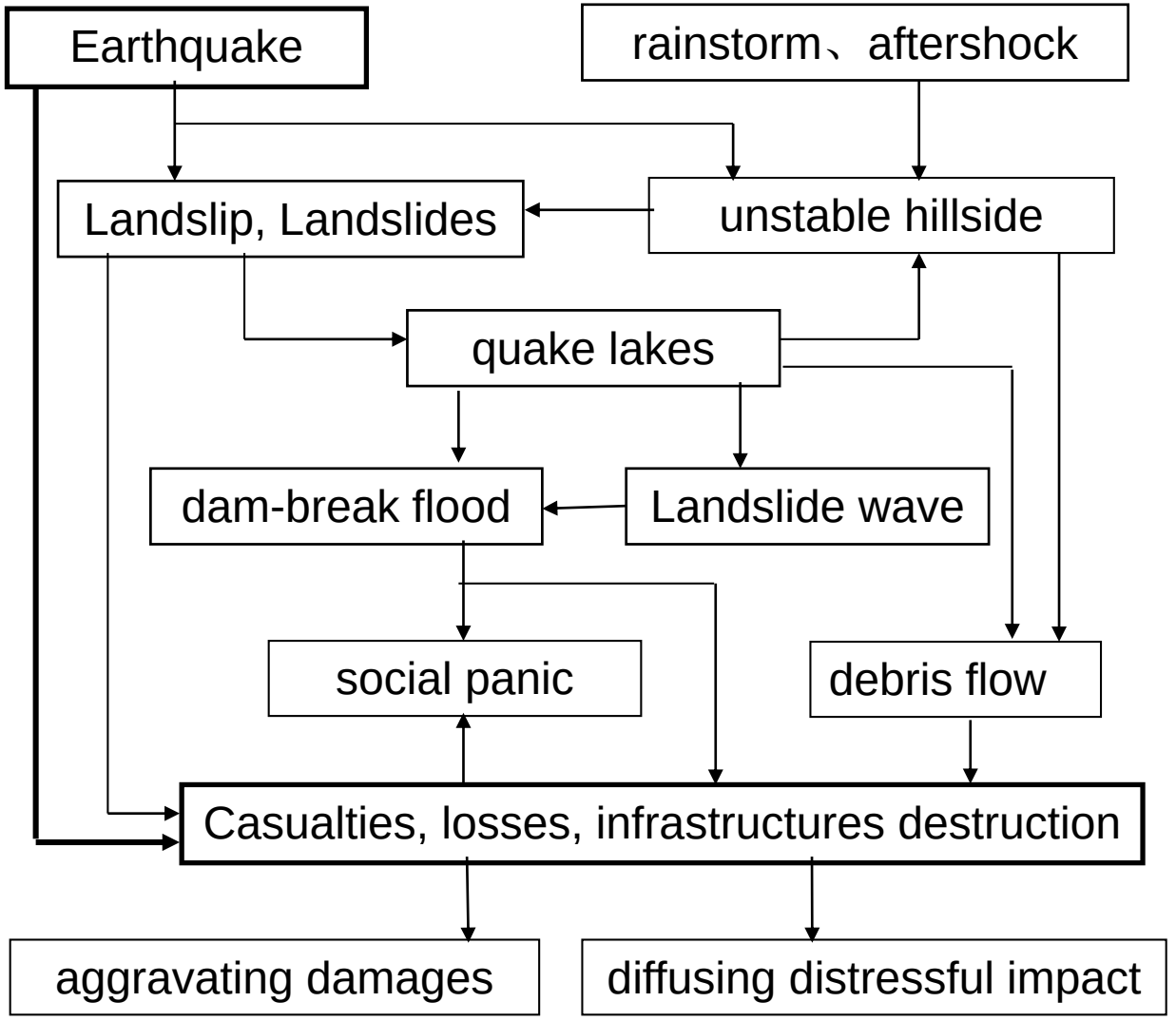
Environmental changes in the Haihe River Basin





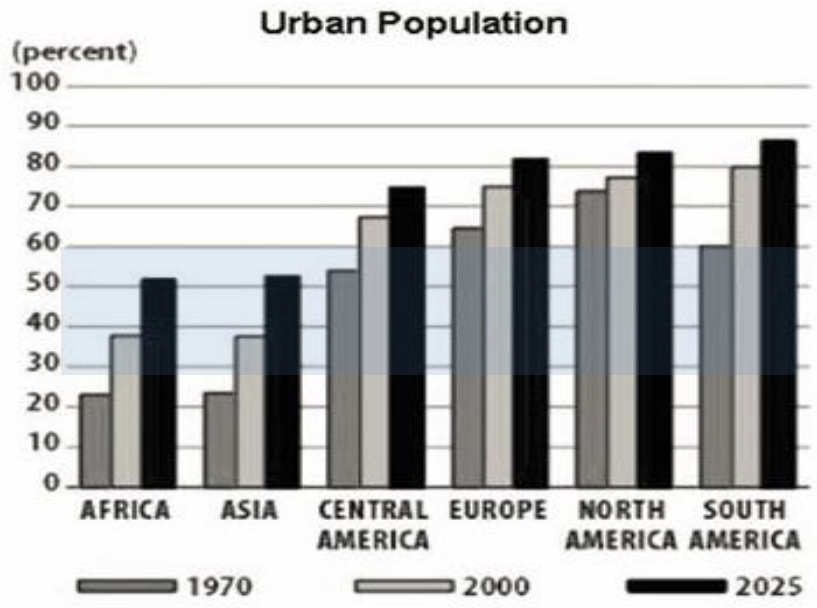


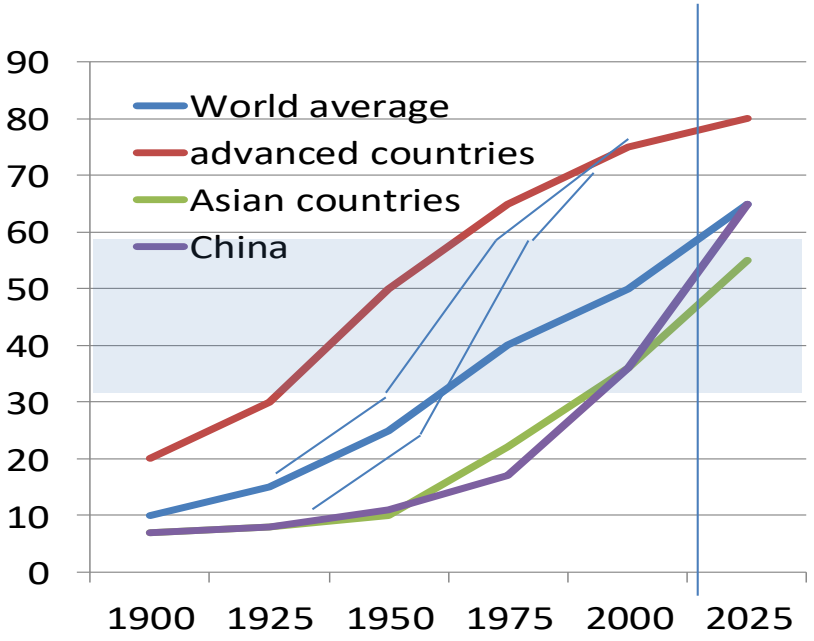
Subsequent Hazards of the Wenchuan Earthquake



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.



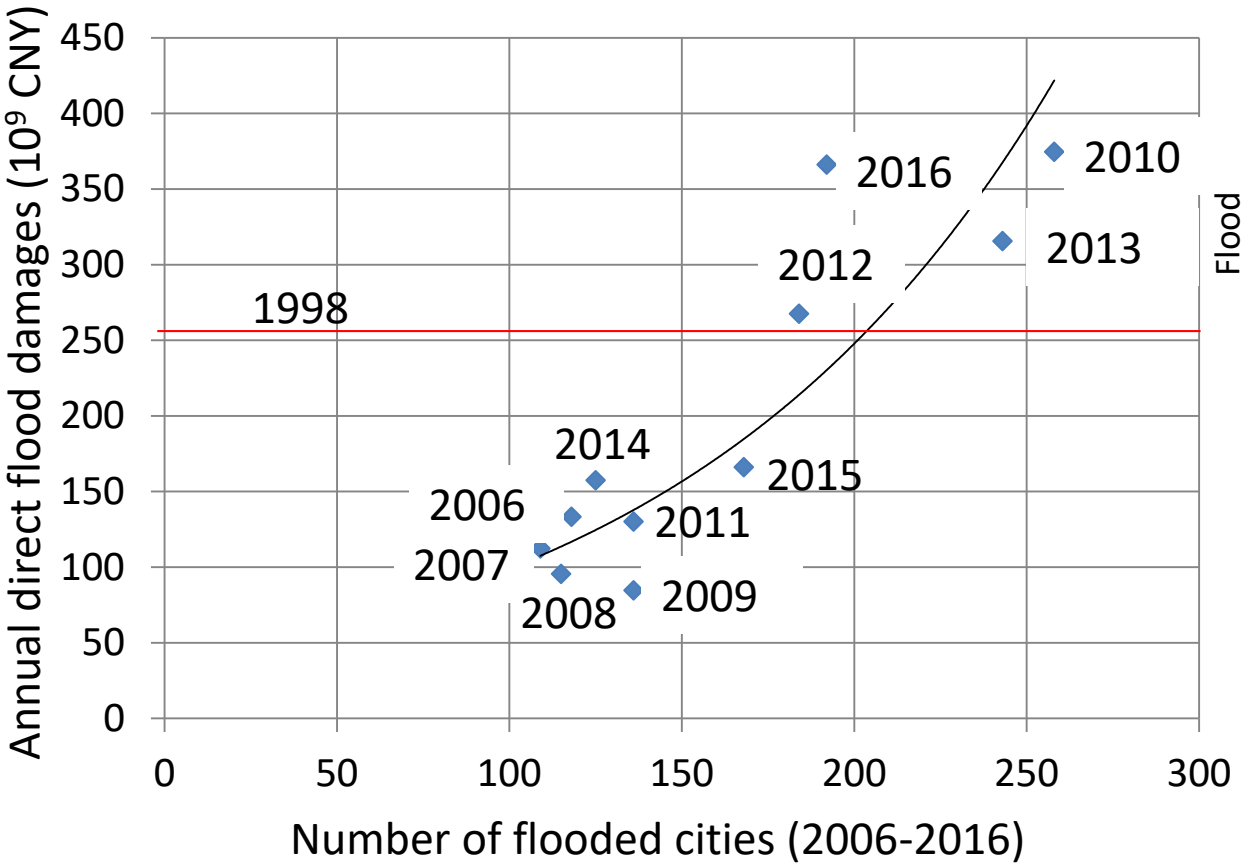


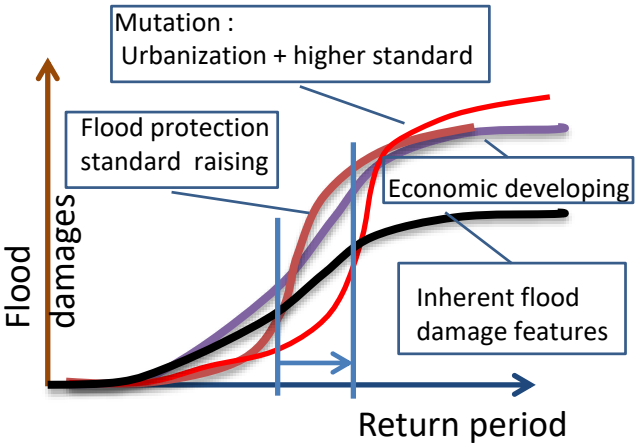
Growing urban flood disasters

- More than 130 cities flooded every year since 2008, 258 in 2010 and 234 in 2013;
- In particular, most of them suffered pluvial floods during local heavy rains.

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.



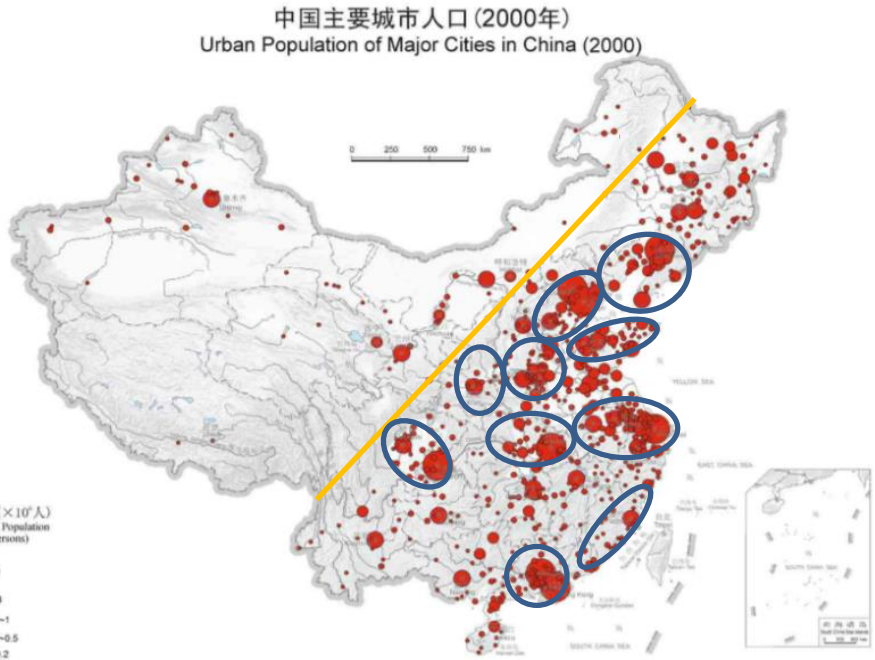


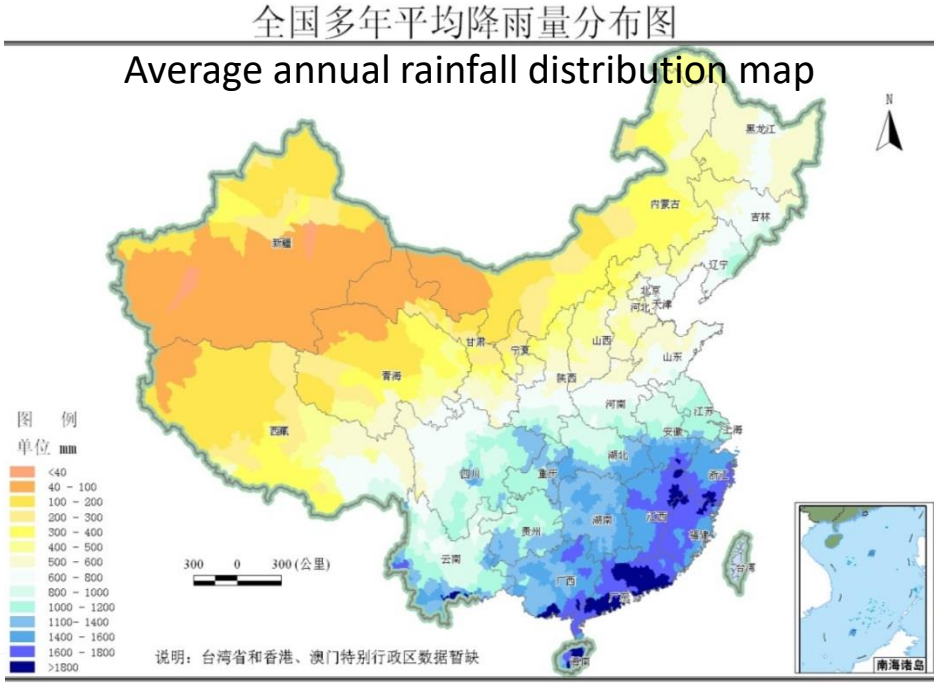
Mutability of Urban Flood Damages

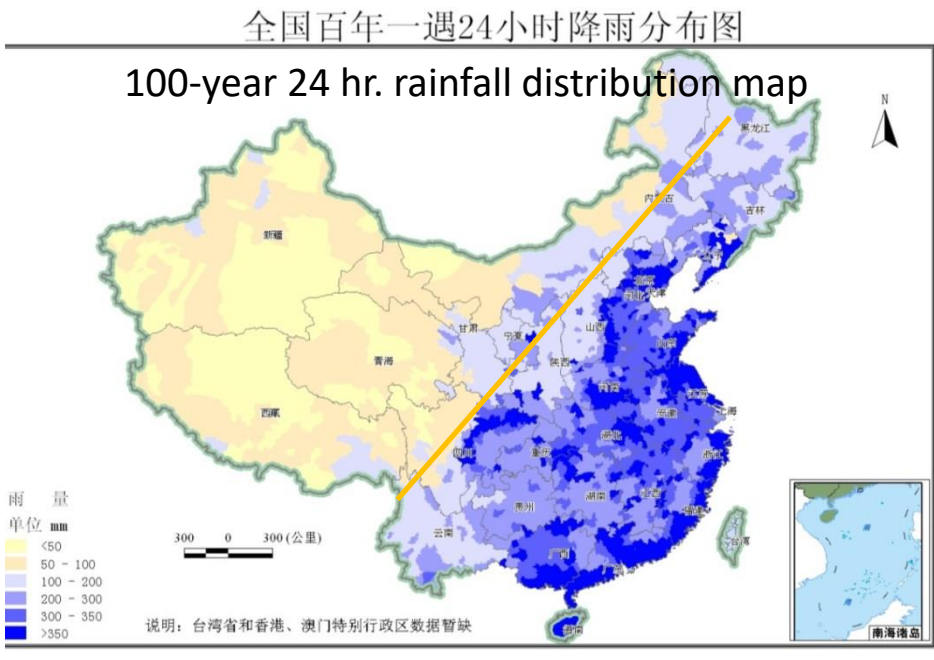
- Urbanized areas expanding to the low-lying areas
- Increasing properties and population in flooded regions
- Normal operation of the city greatly depends on the lifeline system

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%)







Pressure and Challenges on Urban Flood Prevention

- With rapid urbanization, the development of urban flood control and drainage system is important for flood prevention of cities.

- In order to strengthen the urban flood control, 25 cities closely related to large rivers were assigned as the national key cities for flood control early in 1987, and the number of such cities increased to 31 till 1998.
- Later, another 54 cities were assigned in succession as the major cities for flood control after 1998.

- In 2013,
  - urban population in China : 731.11×10^6, 53.7% of the total;
  - urbanized area : 44.5×10^3 km^2, about 6 times of that in 1981;
  - urban embankments :28×10^3 km;
  - protected area increased to 88×10^3 km^2;
  - total length of the urban drainage pipelines :43×10^3 km, about 18 times that of 1981.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Legend
Key cities(31)
Major cities(54)

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).

Flood fighting in 1998 : a great turning point in accelerating the process of flood management in China

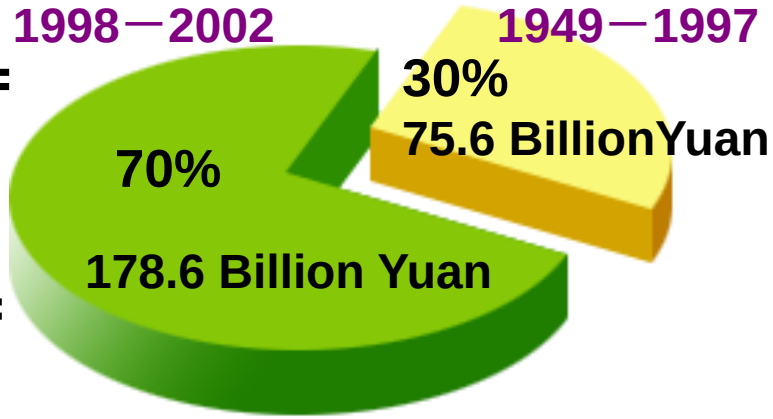
- After the 1998 flood, the investment in enhancing flood control system has been increased several fold, and people commenced to explore the flood prevention and mitigation issues in a wider field of vision on society, economy, environment, ecosystem, population, resources and public security, etc, which formed a new thinking of water governance to promote a harmonious relationship between man and nature for the sustainable development.

Investment from Central Government

$$\frac{\text{1949-1997}}{\text{1998-2002}} = \frac{1}{2.36}$$

Average Investment per year

$$\frac{\text{1991-1997}}{\text{1998-2002}} = \frac{1}{4.2}$$



Shifting from Flood Control to Flood Management

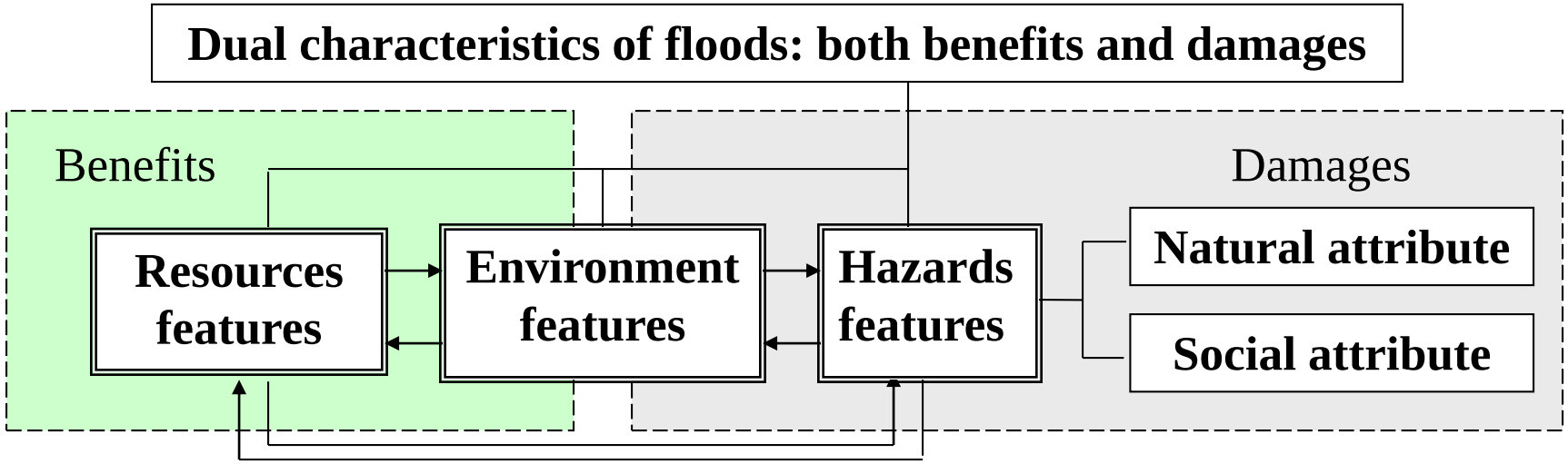
- In the beginning of 2003, the SFCDRH and MWR declared that the flood and drought disaster mitigation in China should shift "**from flood control to flood Management**" and "from simplex drought-fighting to comprehensive drought management".
- Since then, the concept and meanings of Flood and Drought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

New measures taken for the "Two transitions"

- To enhance policies and regulations
- To institute and improve flood prevention and drought relief schemes
- To initiate some specific planning
- To promote the development of information systems for flood and drought management.
- To undertake some research projects

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.**

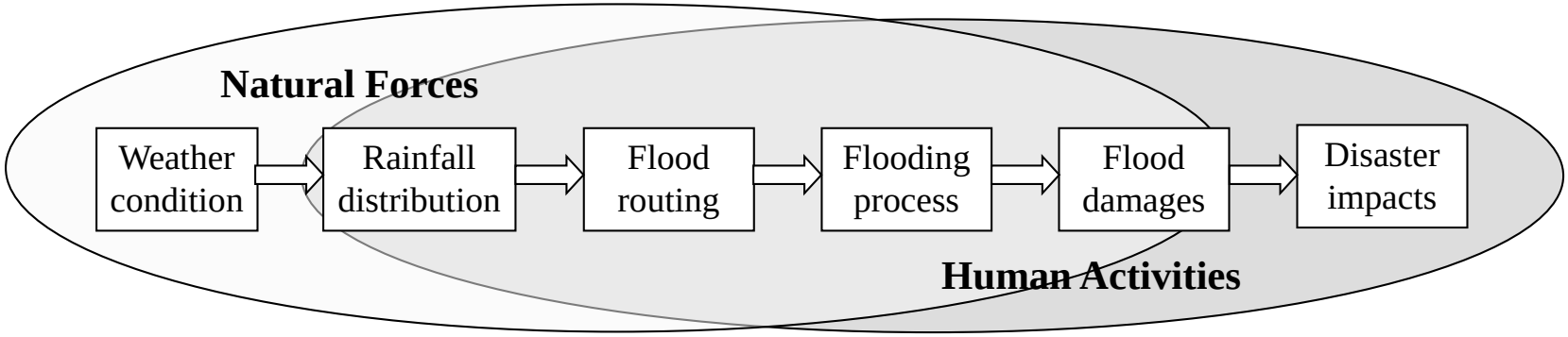


Definition

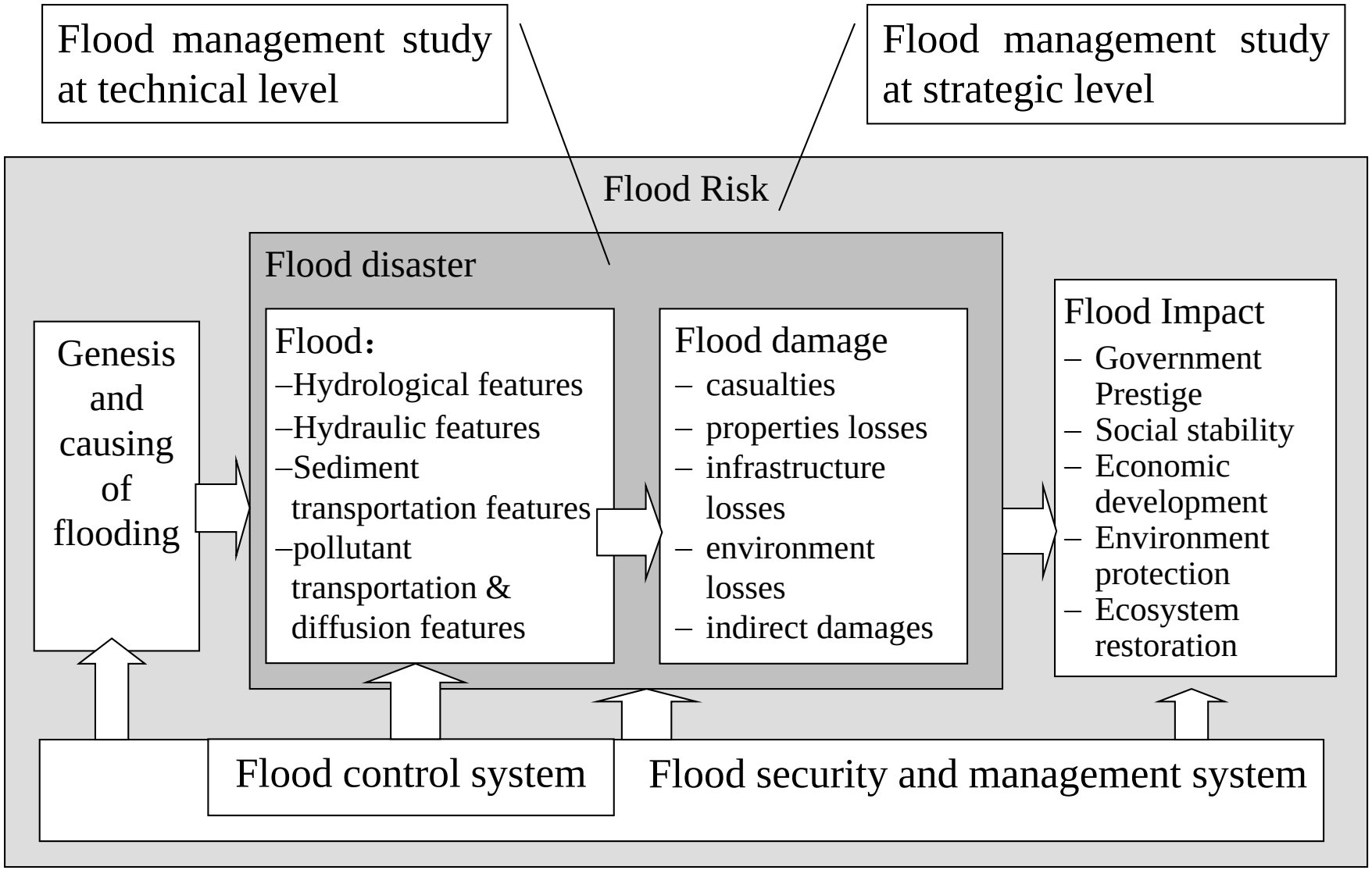
- flood management is a collective noun for a series of activities following the principle of sustainable development, aimed at the harmony between man and nature, normalizing flood control and operation activities into a rational approach, enhancing self-resilience capacities, and accepting a certain risk in moderation to utilize floodwater as a resource and help to improve the water environment (Cheng Xiaotao, 2001).

Definition of Flood Management

- Flood management is to strive for the most favorable possibility through effective improving and operating all related flood prevention and mitigation systems under a series of uncertainties.
- It should be stressed that the measures to minimize the flood damages may not always bring the best impacts in political, social, economic and ecological aspects.



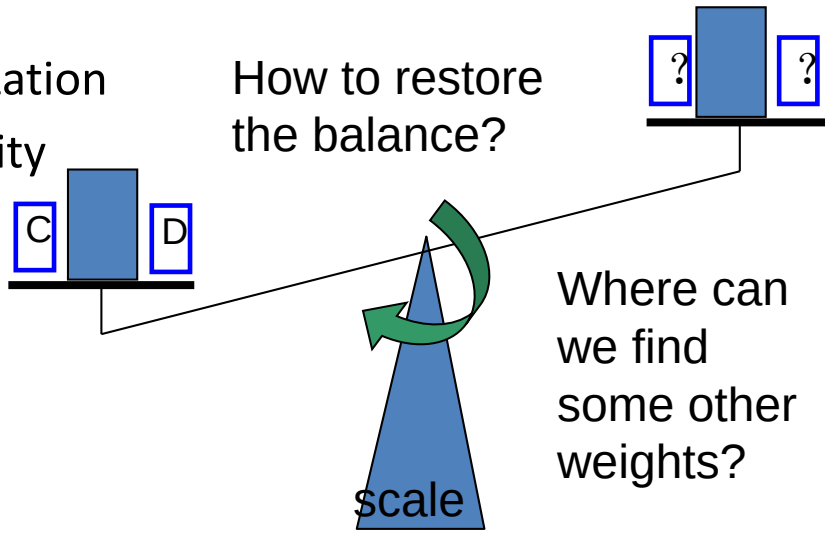
Flood management on each phase and the convertible results



The objects of the flood management strategic study

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
- ……

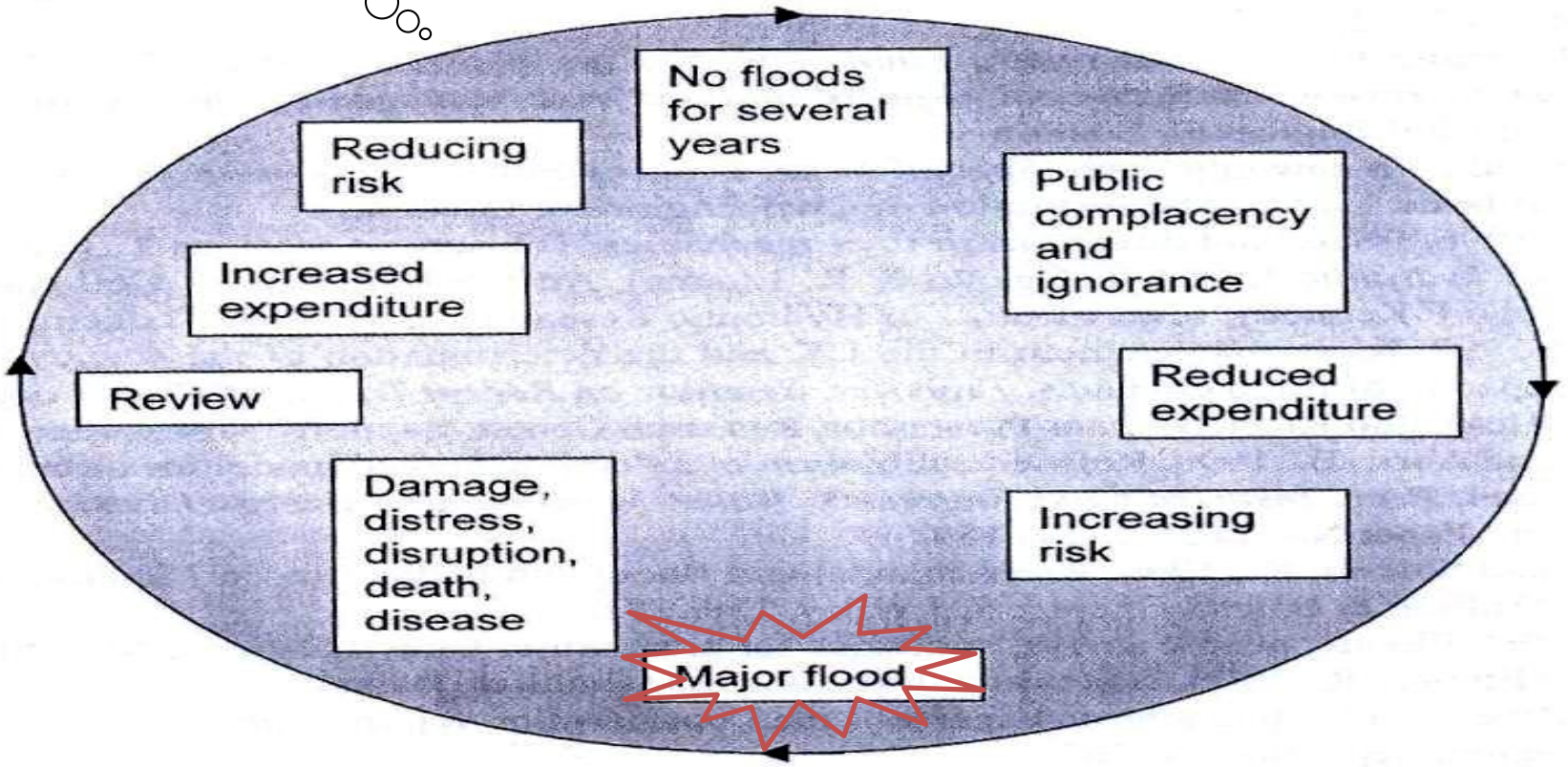
Actively explore and implement the strategic shift to flood and drought management

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.

What should be stressed in the developing countries (1)

How to break away from a whacky circle?



What should be stressed in the developing countries (2)

Principles that should be followed:

- Making overall plans and stressing the key points (aim)
- Making progress step by step and pursuing practical results (objects)
- Integrating strengths and coordinating with operations (mechanism)
- Fitting with local conditions and making the best use of the circumstances (approach)

What should be stressed in the developing countries (3)

Demands of FRM in the developing countries

- Expanding the scope of protection
- Improving protection standards

} Structural measures

- Enhancing maintenance and management level of flood control and drainage systems
- Wise operation of the flood control system
- Improving emergency response capacities
- Development of Meteorological and hydrological monitoring system
- Development of flood forecasting and warning system
- Development of information management and decision support systems

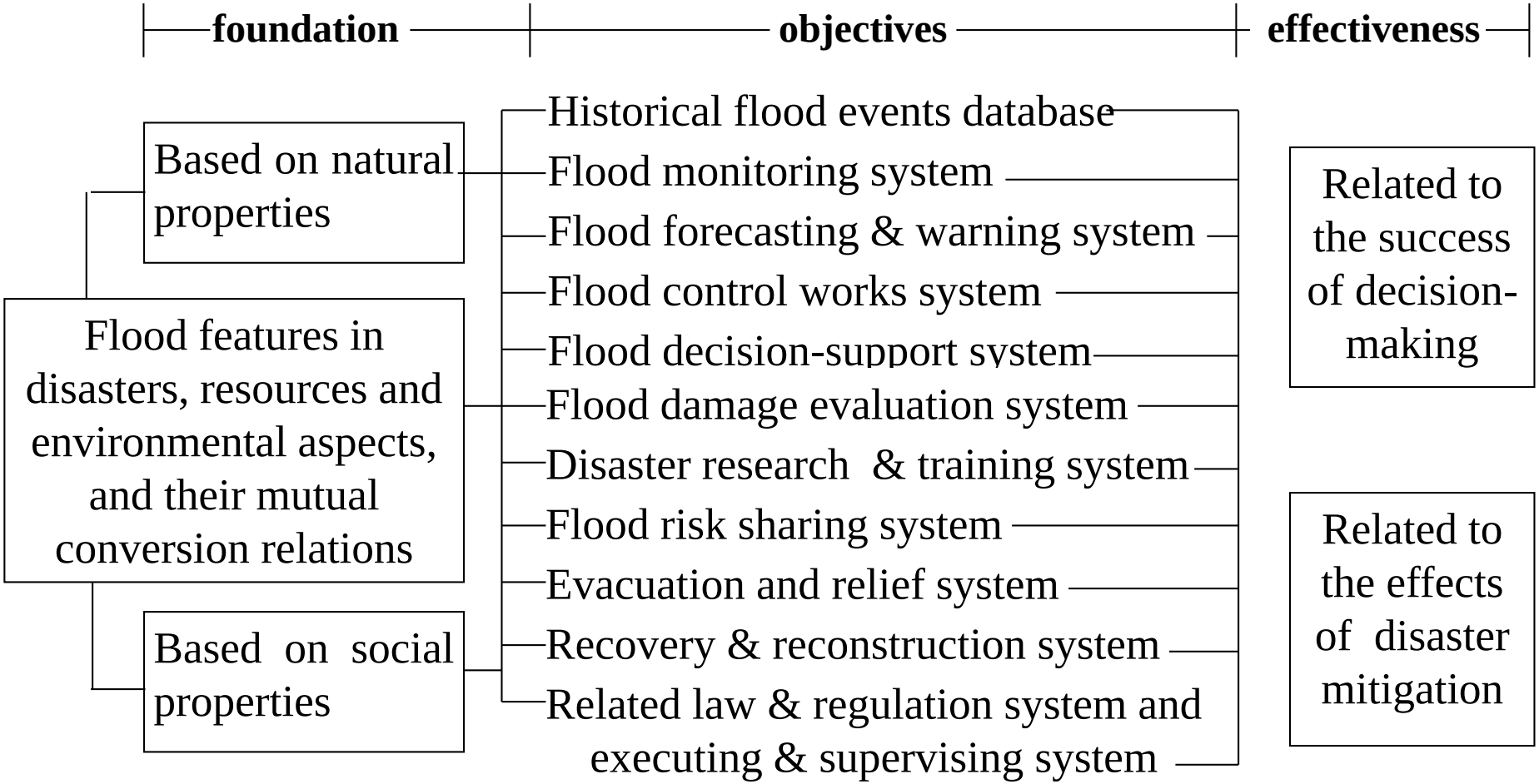
What should be stressed in the developing countries (4)

Problems analysis: To meet the demands of development and security, what are the problems to be solved ?

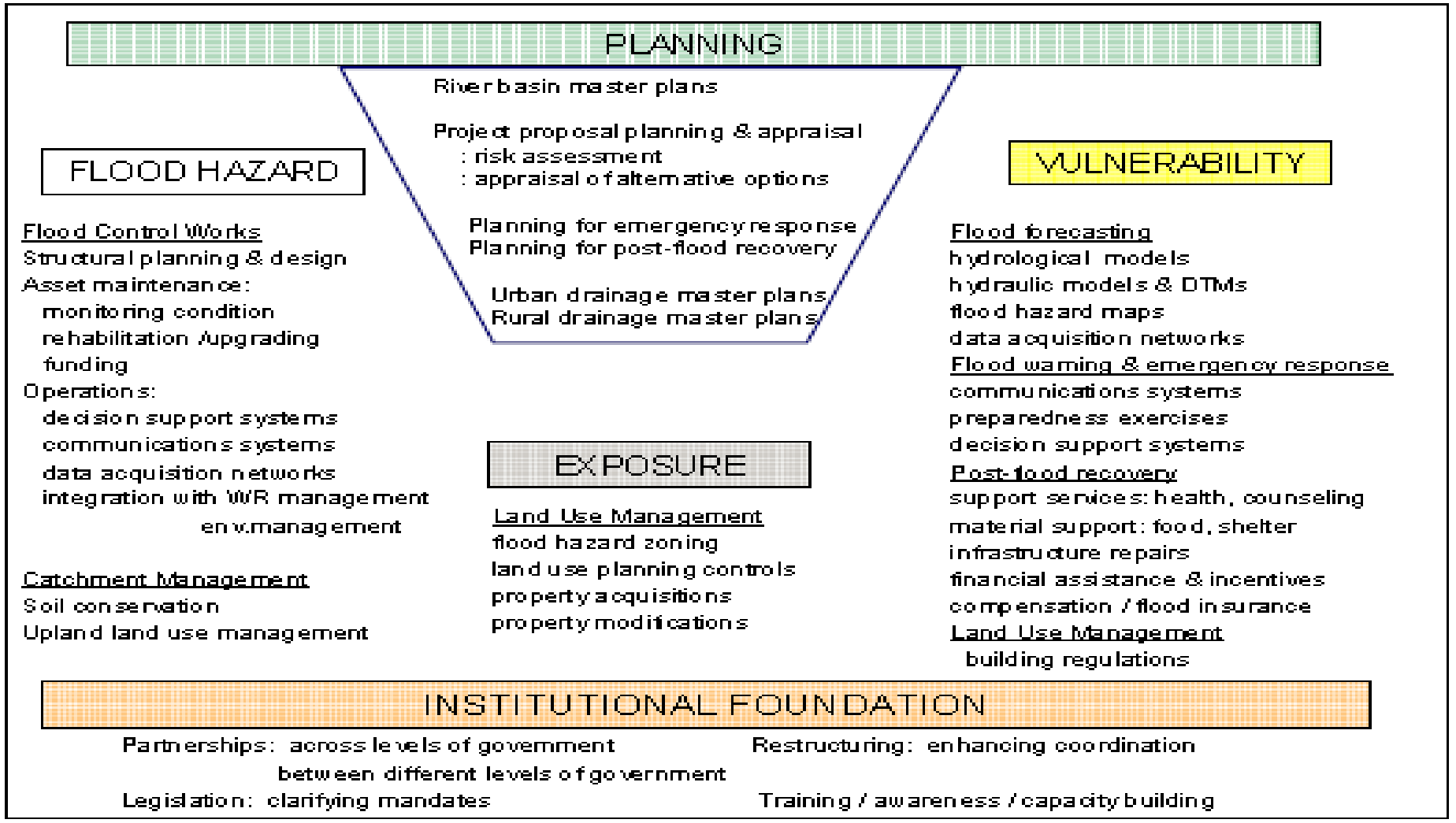
- Due to the limitations in technology, economy and management capacities, it is impossible to solve all the problems in a short term. What are the most urgent and key problems?
- Analysis of the problems urgency: problem sorting
- Analysis of the restricting factors: choose target
- Analysis of the causes for problems: prescribing the right medicine.

What should be stressed in the developing countries (5)

The Manageability of the Flood Risks



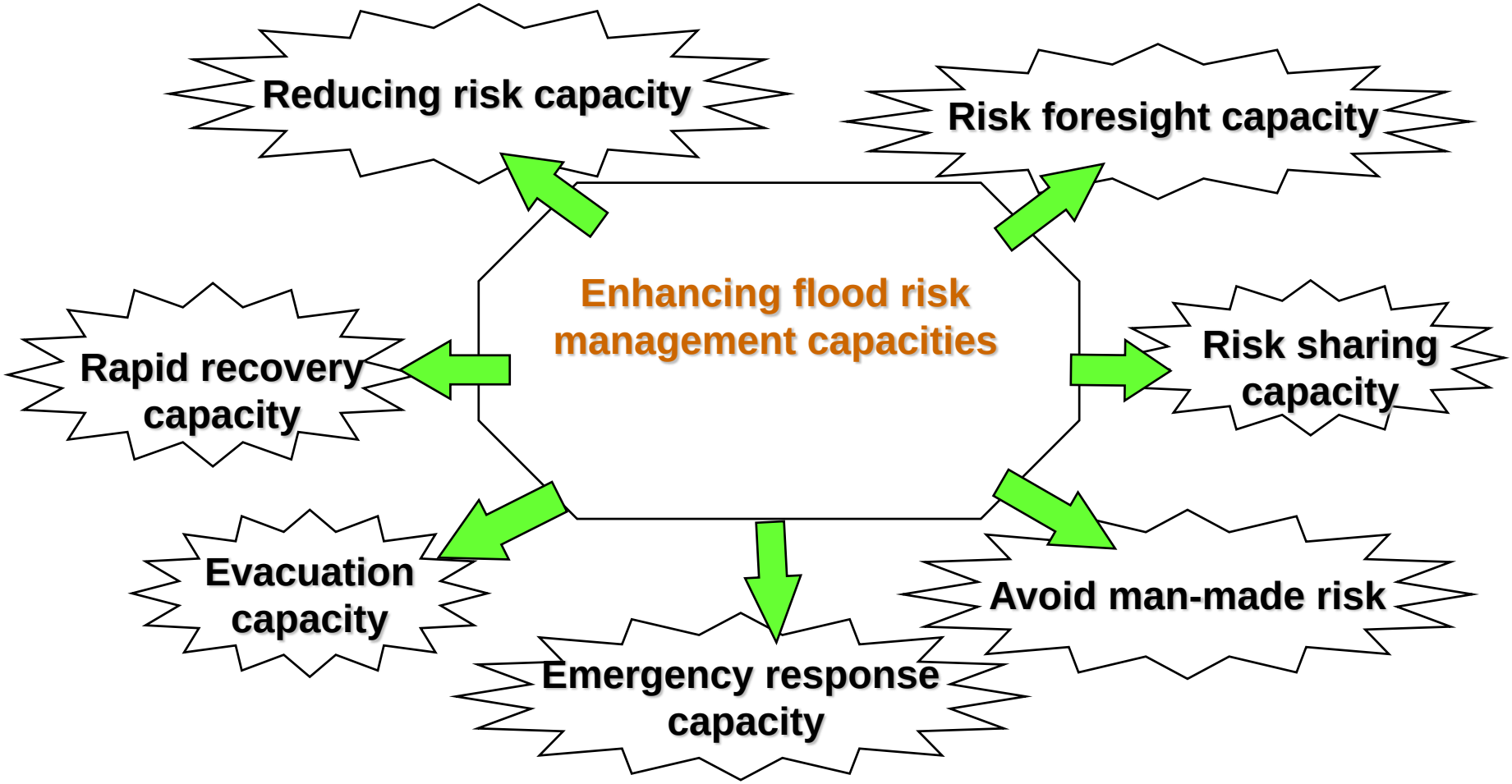
Strategic Framework for Integrated Flood Risk Management



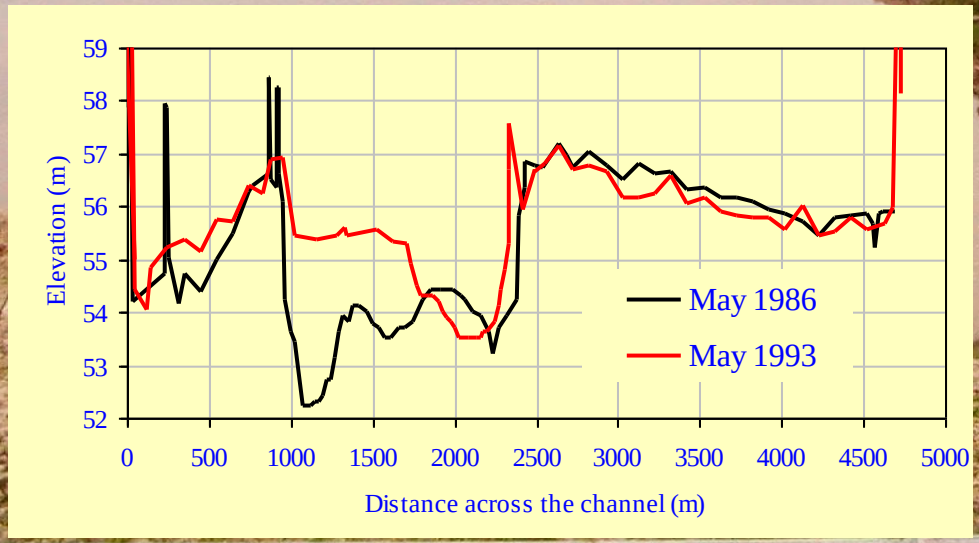
Source: Study on Flood Management Strategy for China, ADB Technical Assistance Project Report, 2005

What should be stressed in the developing countries (6)

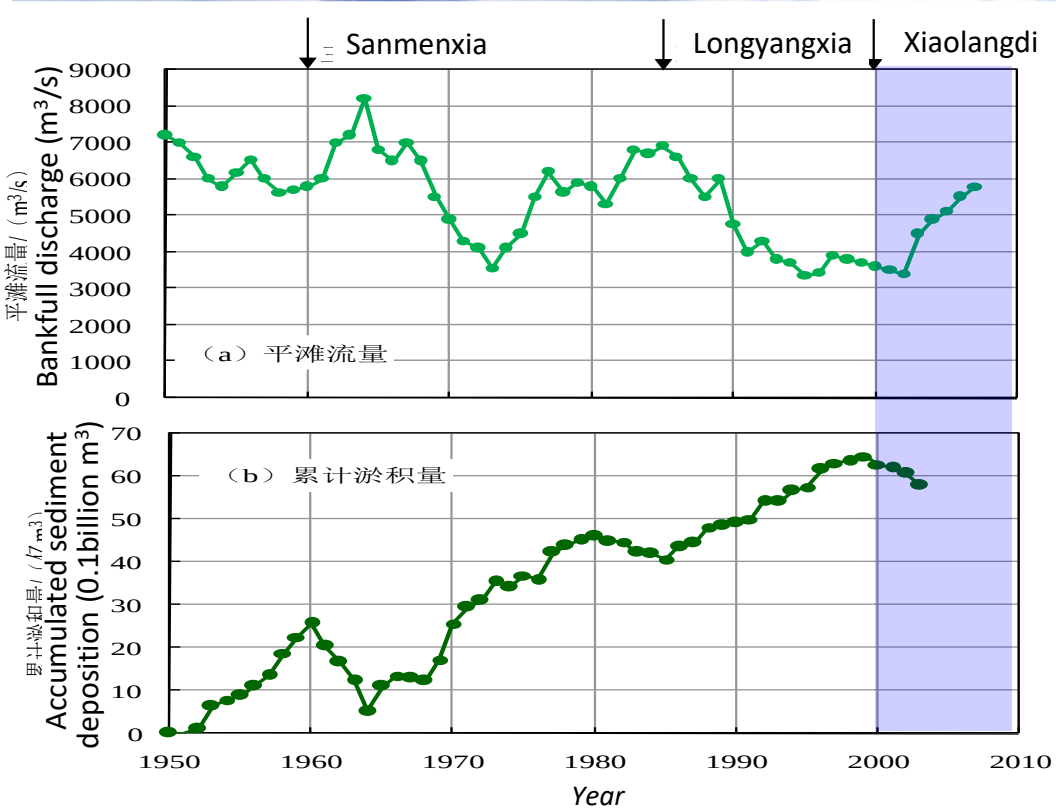
- **What kind of capacities we need?**



Changes of flood control situations of the lower Yellow River



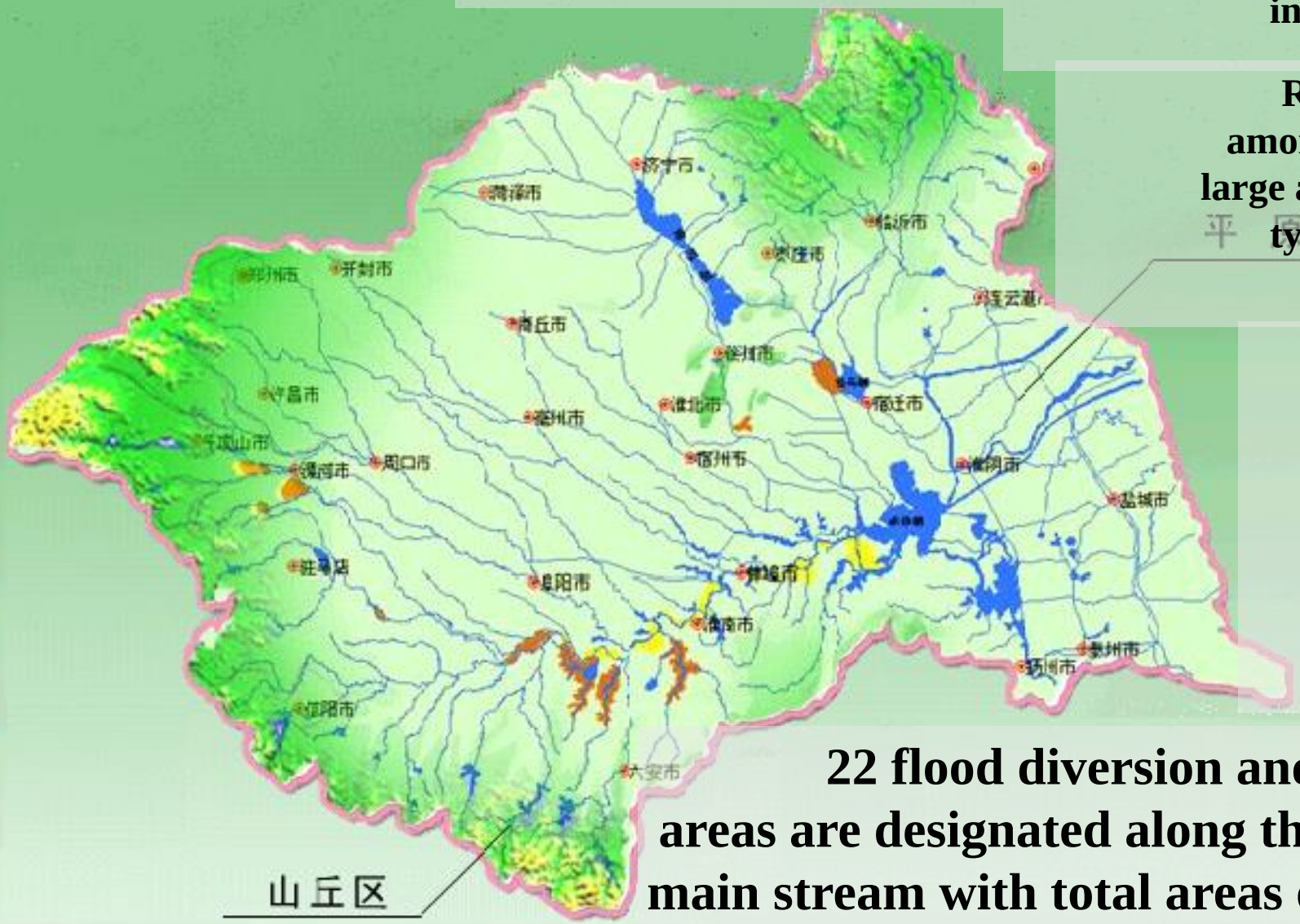
The water-sediment regulation by dams to create an artificial flood is one of the effective measures to solve the sediment problems of the Yellow River.



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.

Flood control system

Since 1950s, more than 5,700 dams have been built in the Huaihe River basin, among them 36 large and middle type of dams with flood control storages over 5.2 billion m^3



22 flood diversion and storage areas are designated along the middle main stream with total areas of 3105.7 km^2 and population of 1.32 million.

- Huai River -

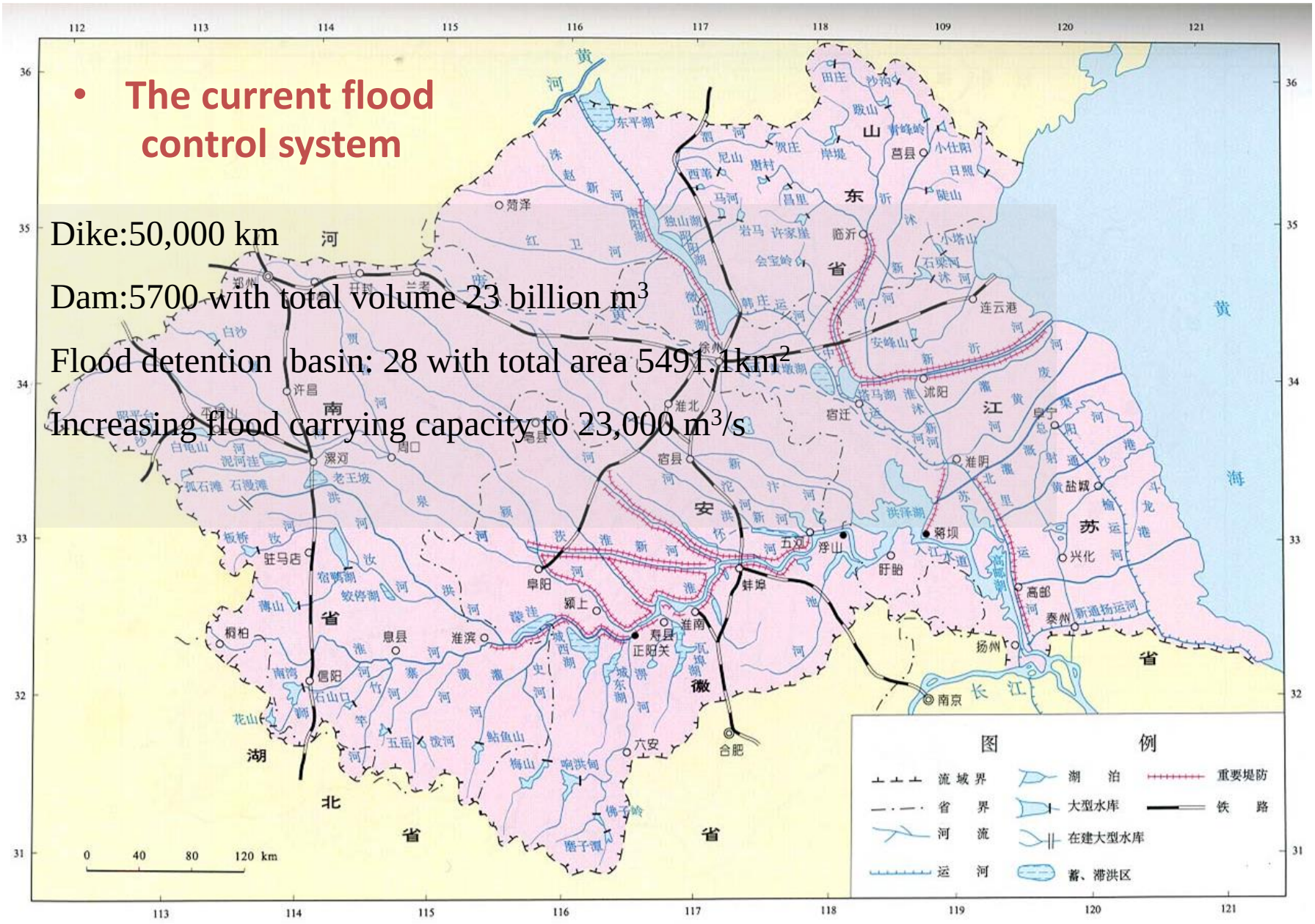
- **The current flood control system**

Dike:50,000 km

Dam:5700 with total volume 23 billion m^3

Flood detention basin: 28 with total area 5491.1km^2

Increasing flood carrying capacity to 23,000 m^3/s



The 19 key projects

- Following the floods in 2003, the Ministry of Water Resources (MWR) formulated an Accelerated Emergency Program (AEP) to enhance flood protection and improve the drainage system. This program is being implemented over the period 2003-2007 at an estimated cost of US$5.5 billion (RMB 44.7 billion) to complete 19 key projects initiated in succession after the 1991 flood.
- It aims to rehabilitate or construct the main flood control works along the Huai River and main tributaries, and upgrade the flood control standards from the current once in less than 5-50 years to once in 20-100 years.
- By the end of 2007, the 19 key flood control and water treatment projects for the river, set by the State Council in 1991 are expected to complete.

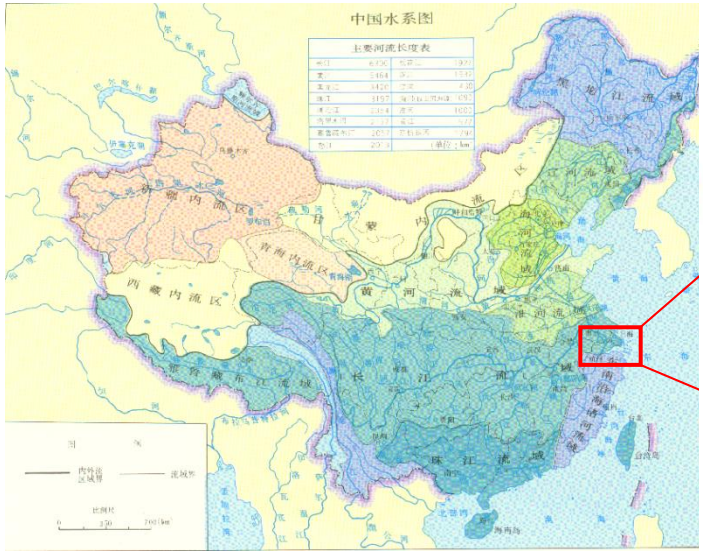
Flood Control planning to 2020

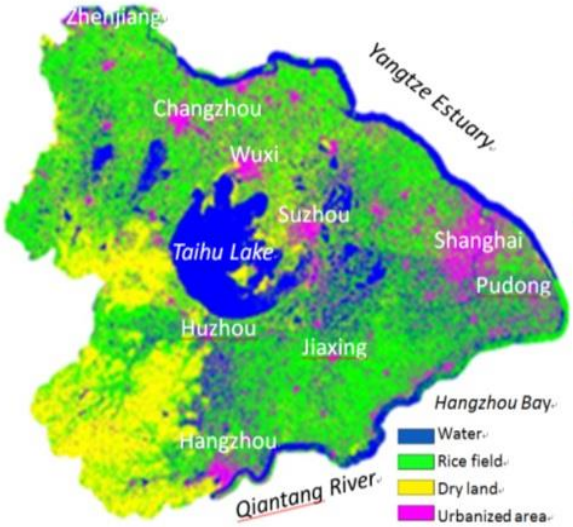
- According to a newly finished Flood Control Plan for the Huai River, the central government will invest US$ 19 billion (RMB 155.4 billion) before 2020 to enhance flood control on the Huai River. More reservoirs will be built in the upper reaches of the river to control flood. Water and soil preservation will also be carried out in those areas. The plan also includes treatment of watercourse and banks in the middle reaches and enhancement of flood discharge capacity in the lower reaches of the river.
- The new plan will enable the major flood protection areas along the middle reach of the Huai River to meet a 100-year flood from the current less than 50-year standard, and the surrounding areas of the Hongze Lake and the flood protection areas along the lower reach to meet a 300-year flood from the current 50- to 70-year standard. The flood protection standard of the main stream of the Yi-Shu-Si Rivers will be raised from 20-year to 50-year.

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

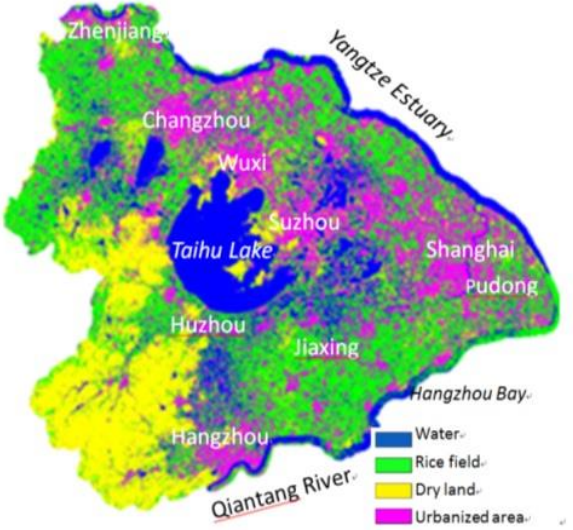
- Taihu Basin: one of the most important economic regions in China.
- Serious flood disasters caused by plum rains, typhoon and storm surge.
- In the course of rapid urbanization.
- Features of flood risk : very sensitive to both global warming and rapid urbanization.

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%



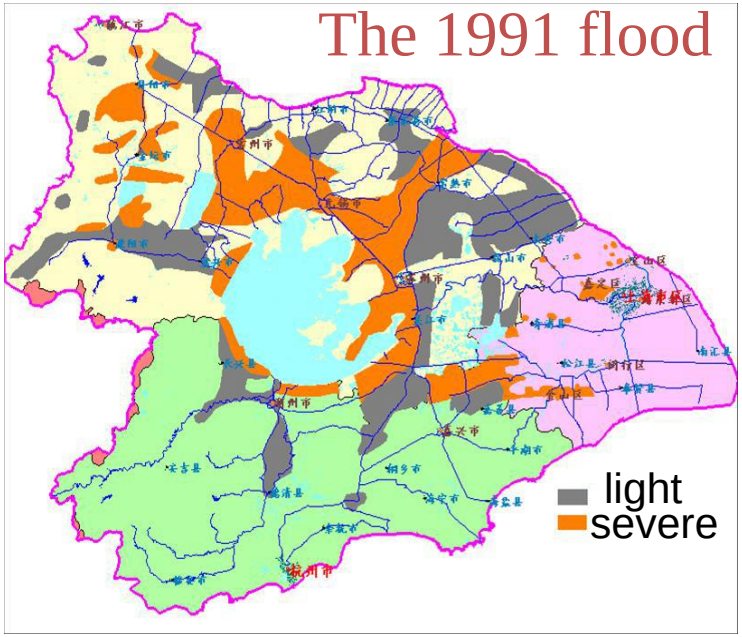


a. Land use in 2000/2001

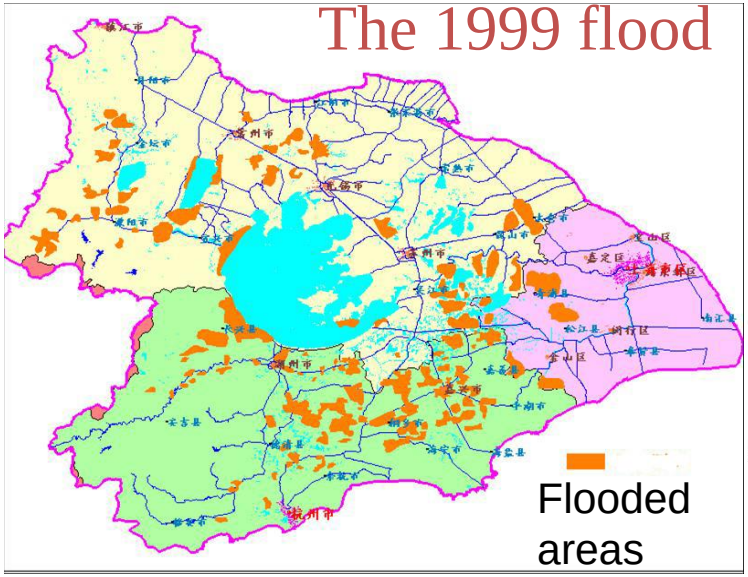


b. Land use in 2009/2010

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.



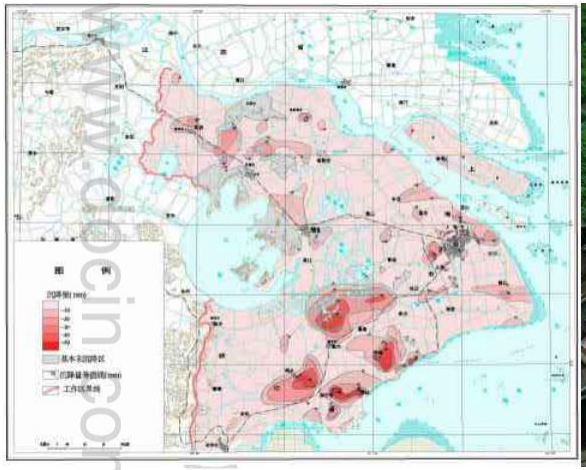


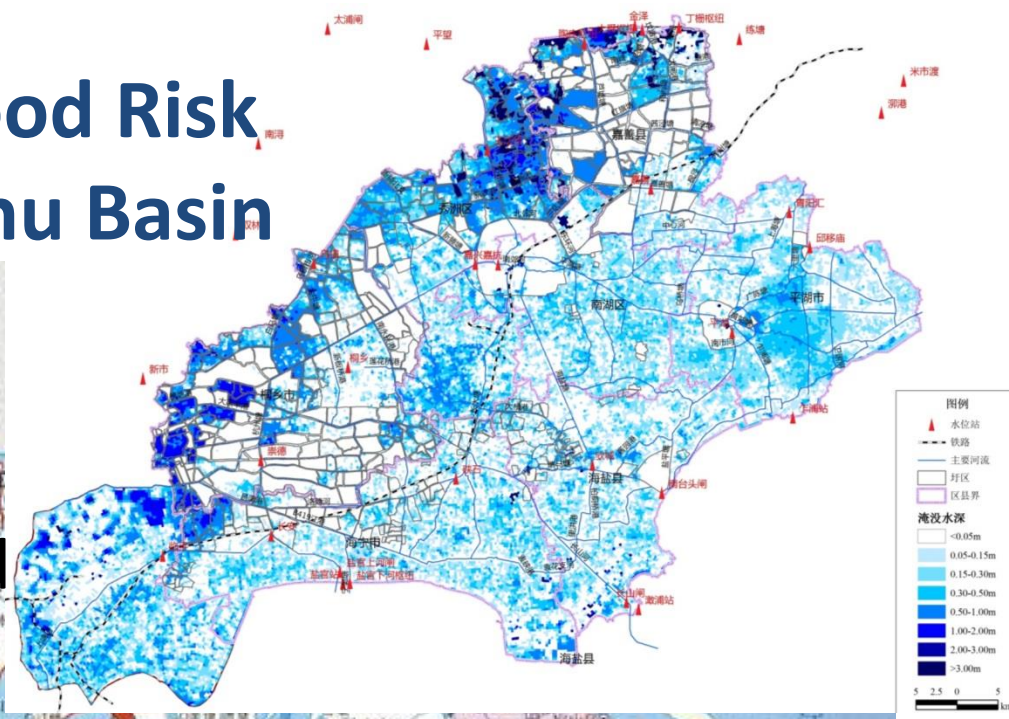
图 14 长江三角洲地区地面沉降等值线图（2004 年度）

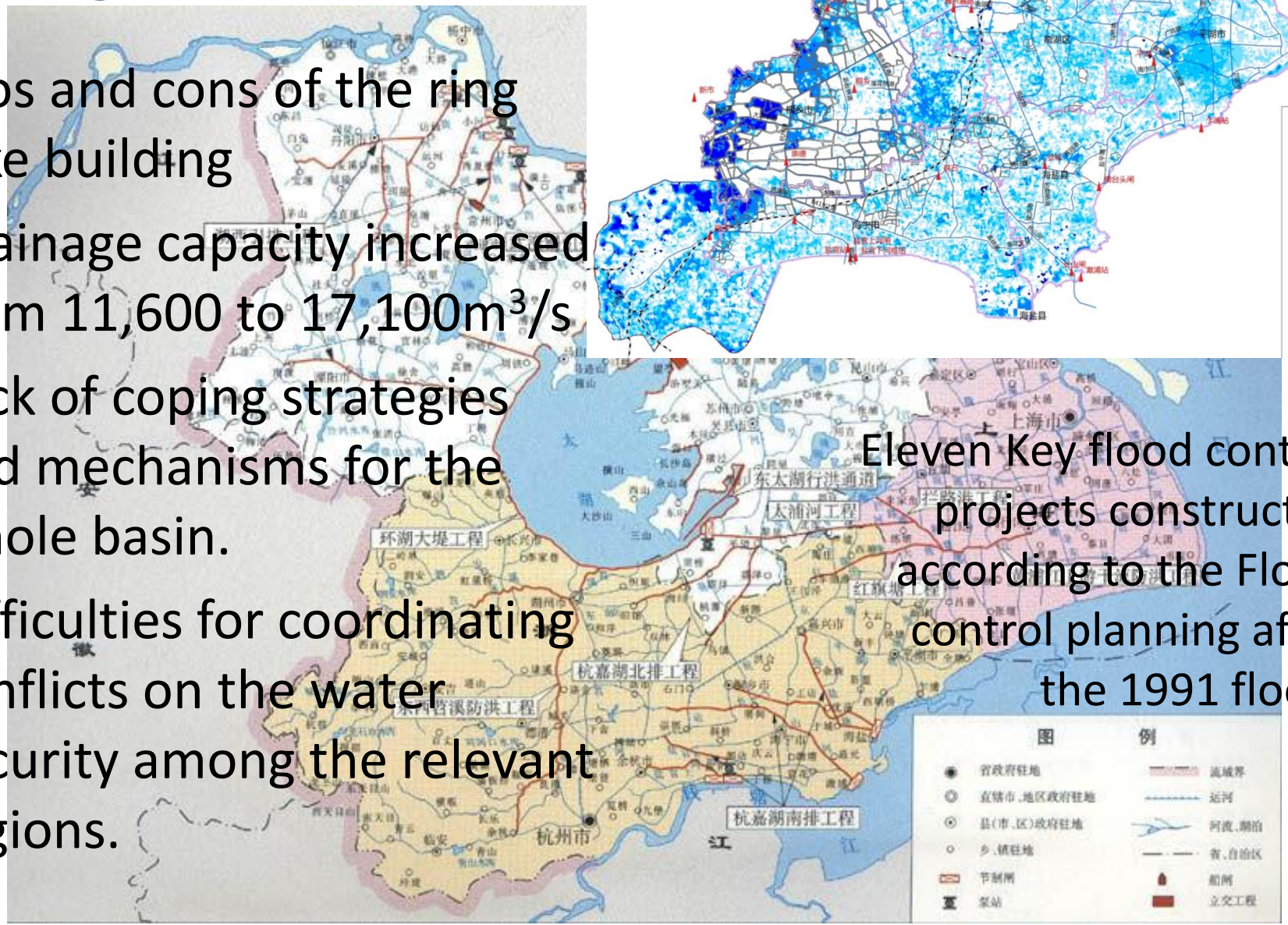
Land subsidence

Severe water pollution

Main Challenges for Flood Risk Management in the Taihu Basin

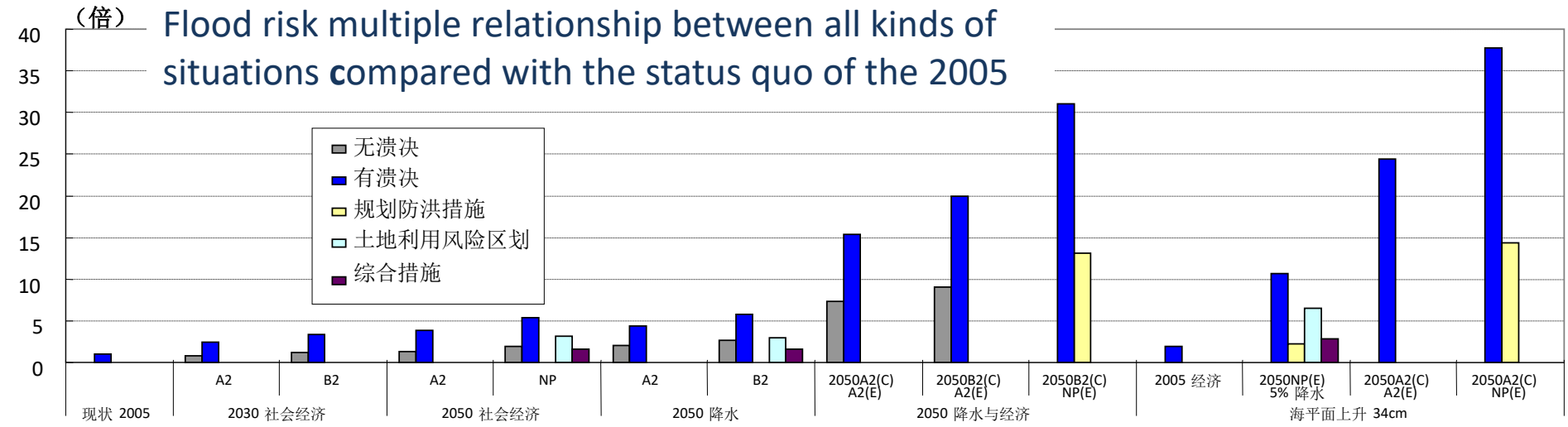
- Pros and cons of the ring dike building
- Drainage capacity increased from 11,600 to 17,100m³/s
- Lack of coping strategies and mechanisms for the whole basin.
- Difficulties for coordinating conflicts on the water security among the relevant regions.

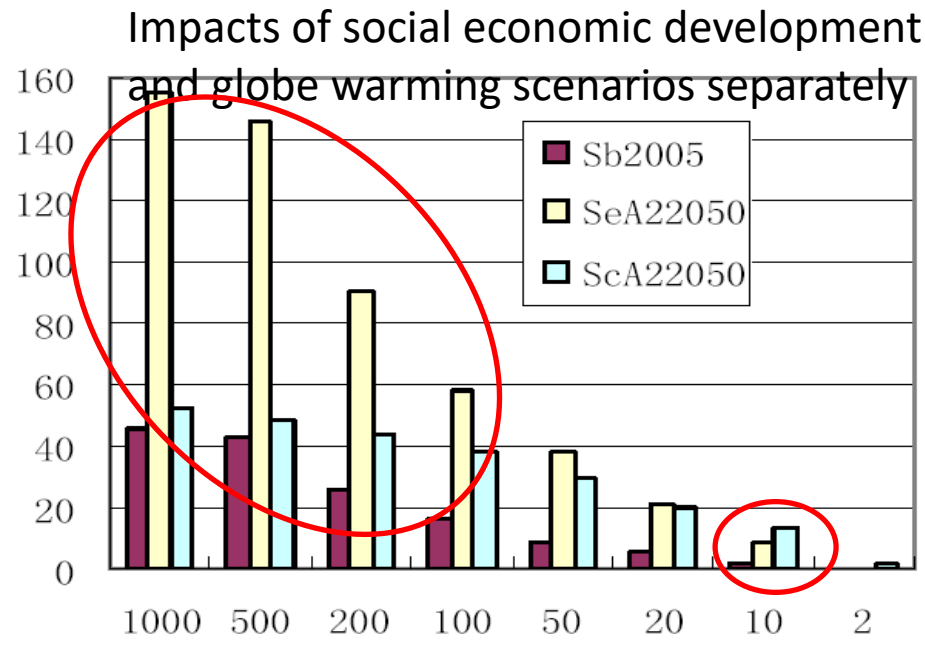


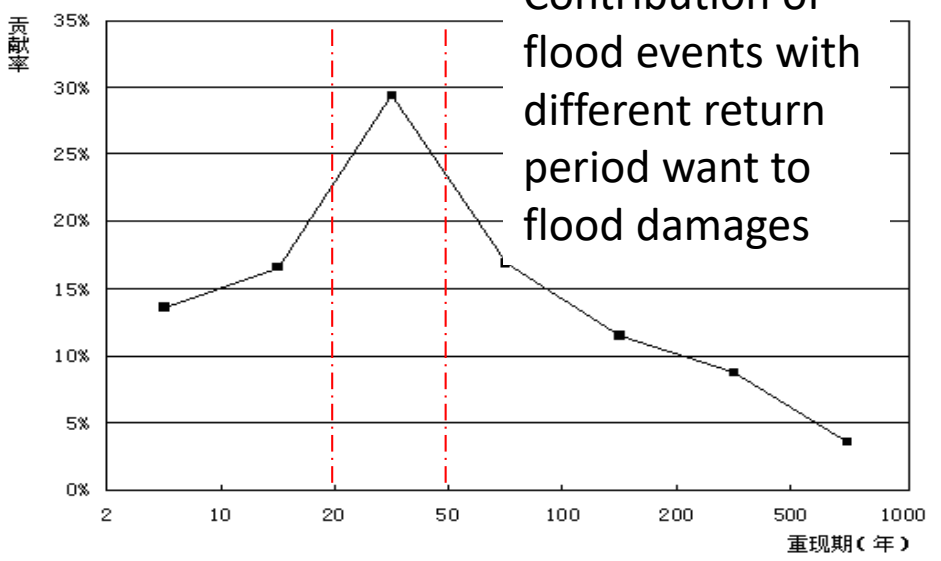


Eleven Key flood control projects constructed according to the Flood control planning after the 1991 flood.

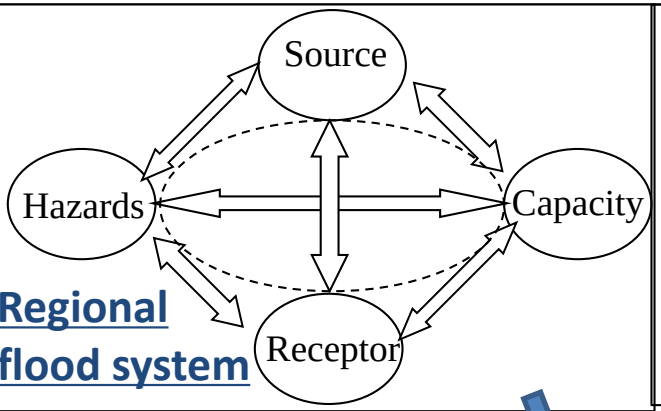
Scenario analysis results







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)

风险 (Risk)

承灾体易损性 (Vulnerability)

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 Control System for Shanghai City

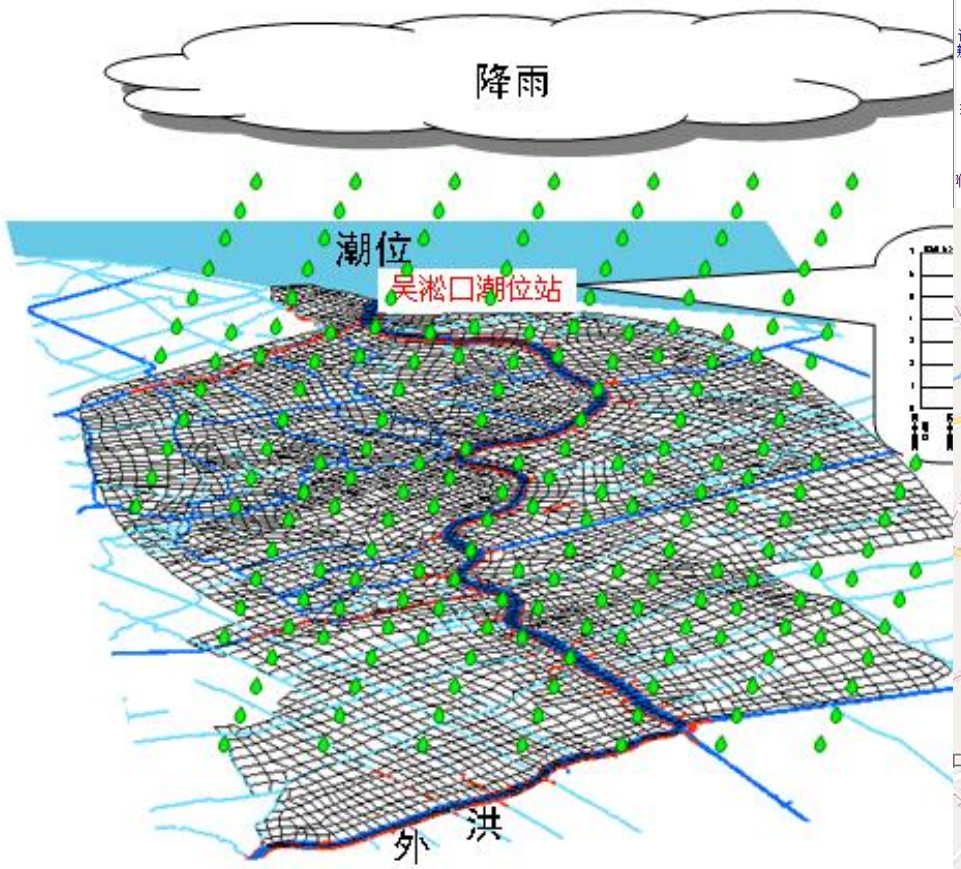
Flood control system

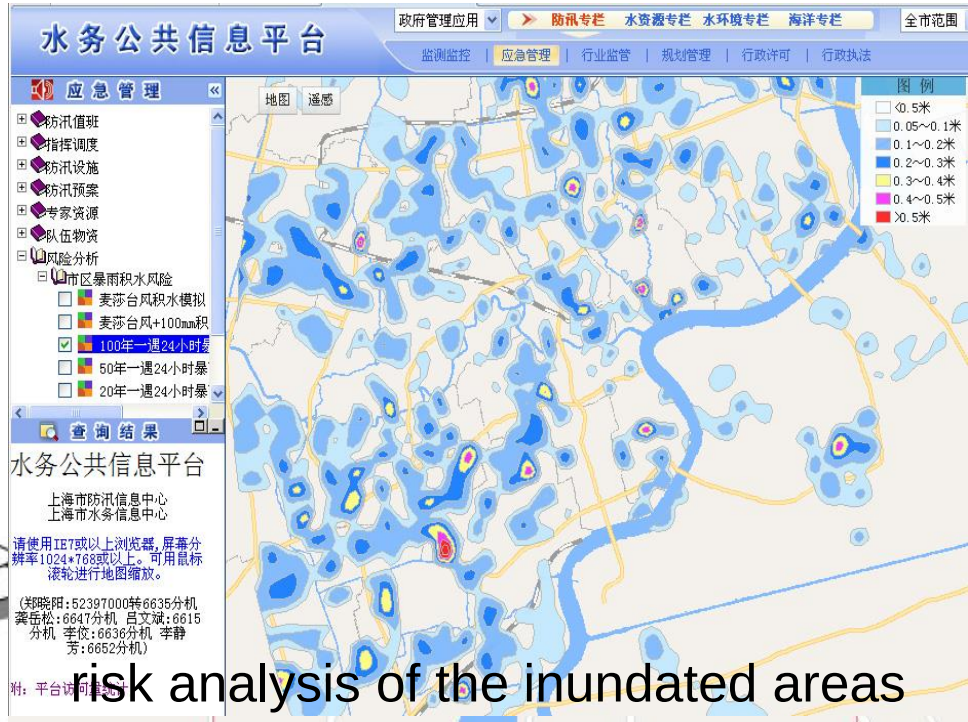
- Flood control Standard
  - Dike: 1000 year flood
  - Sea wall: 100 year storm surge + 12 grade typhoon
  - Drainage system:36mm/hr

1-h precipitation exceeds 117 mm on Aug.25,2008

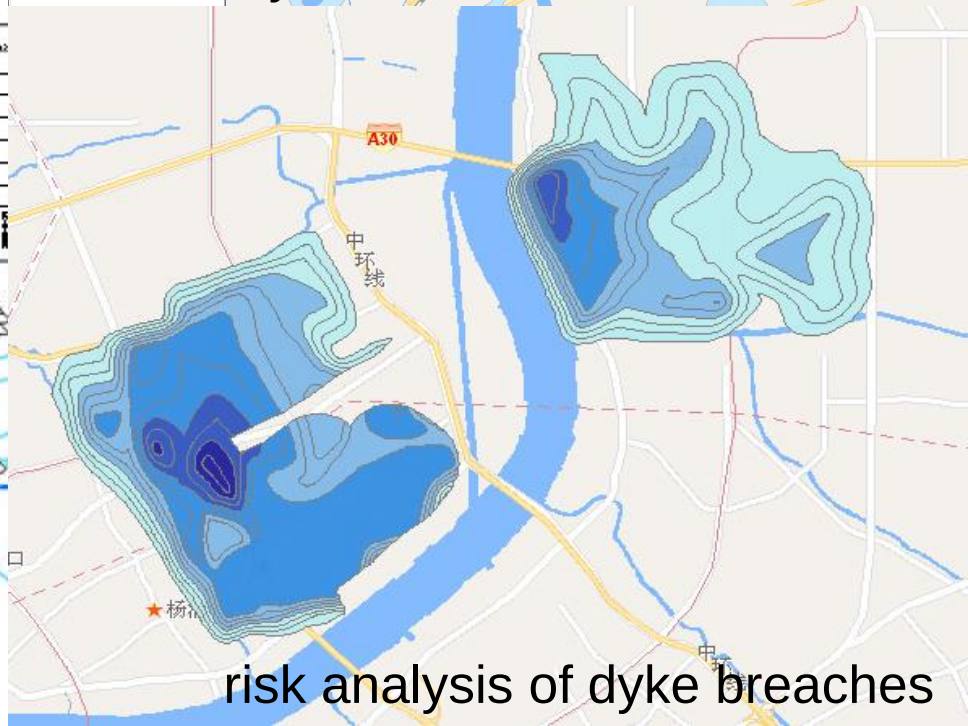
Flood Risk Mapping System for Shanghai

- Shanghai model



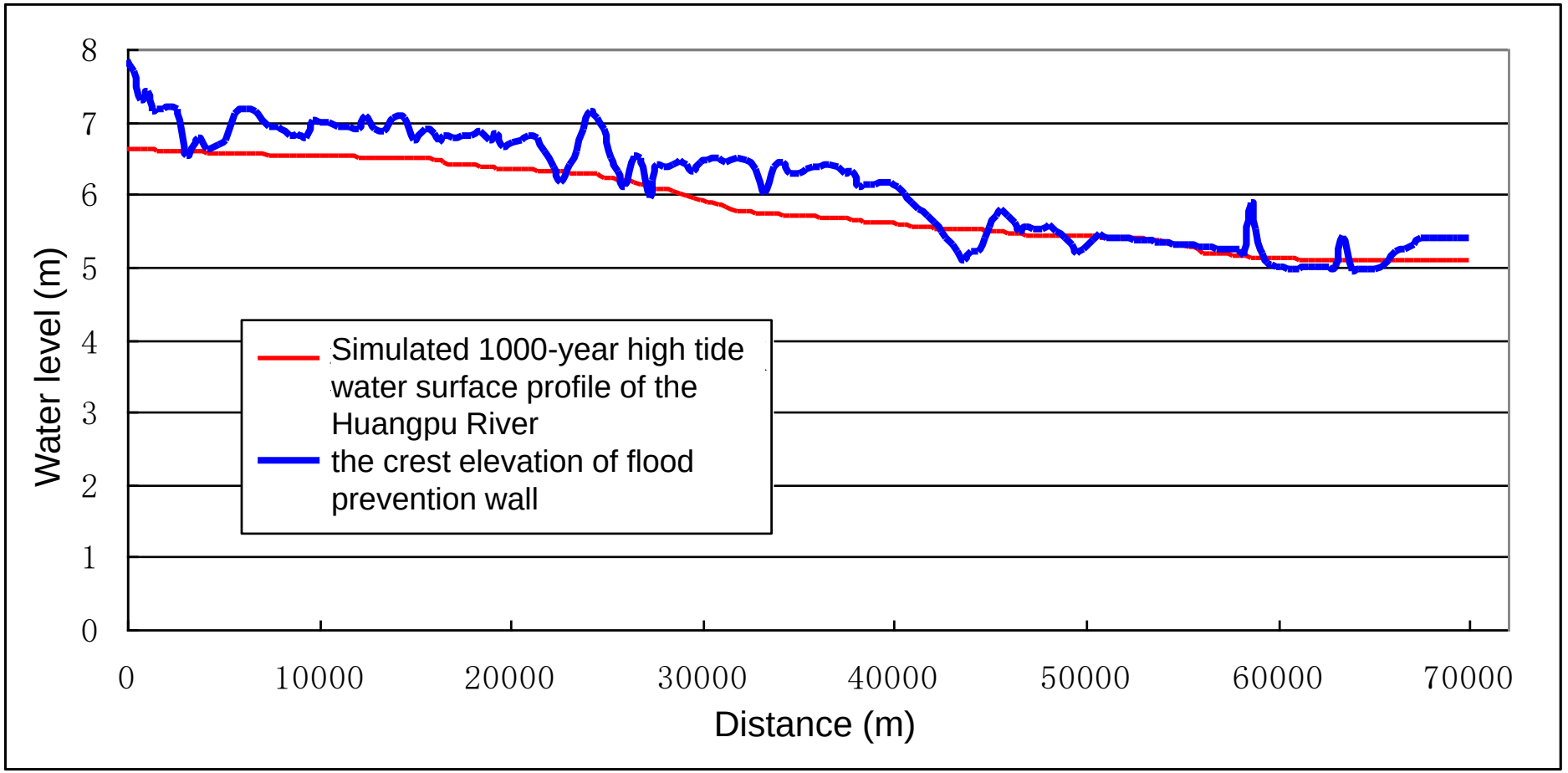


risk analysis of the inundated areas

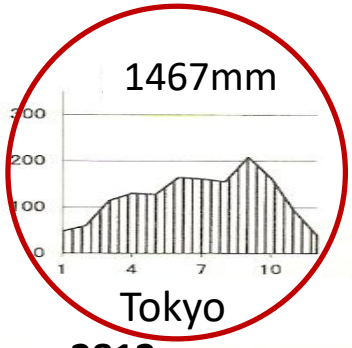


risk analysis of dyke breaches

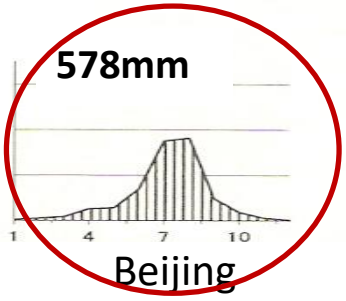
Water profile and dike elevation



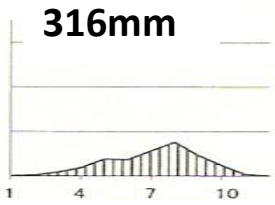
Difference of the total annual rainfall and distribution over the world



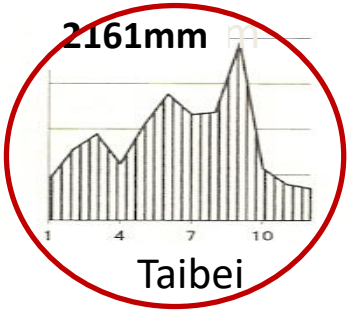
Tokyo



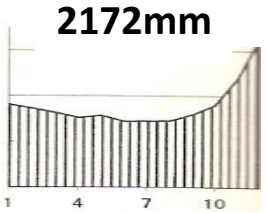
Beijing



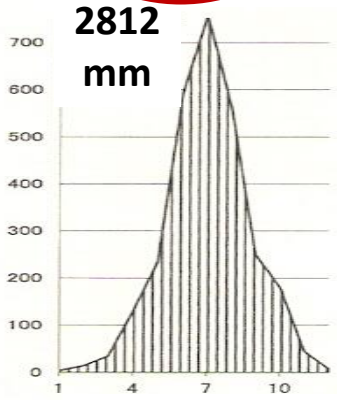
Gansu



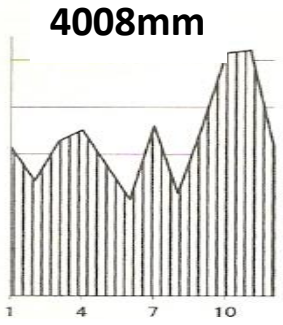
Taibei



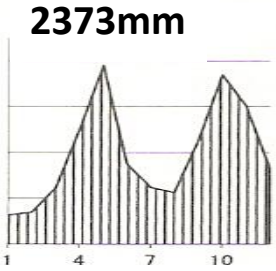
Singapore



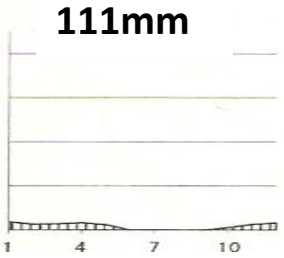
Bangladesh



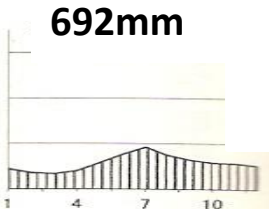
Indonesia



Sri Lanka

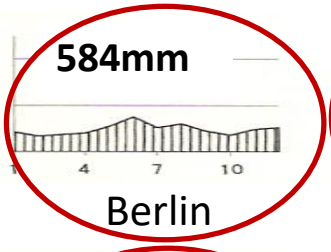


Iran

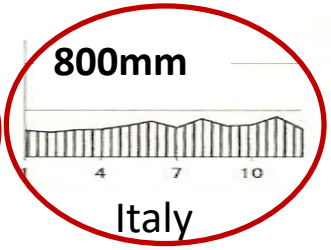


Moscow

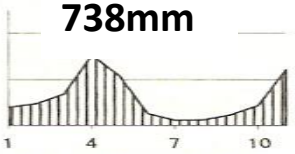
London



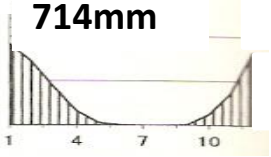
Berlin



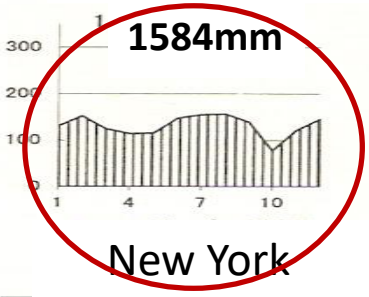
Italy



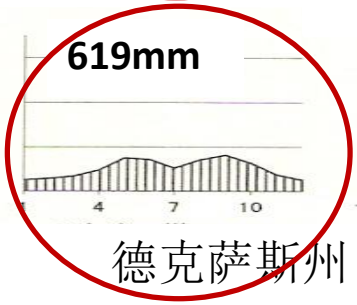
Kenya



Zambia

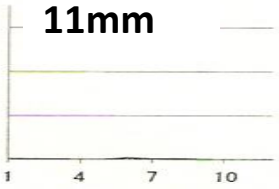


New York

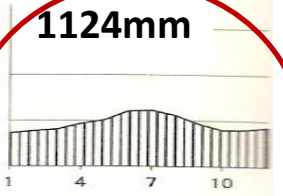


德克萨斯州

France



Peru



New Zealand

Urgent work： urban drainage planning at three scales

- Formulation and modification of flood control and urban drainage planning is an urgent work, which includes planning at three scales, river basin, municipality and community.

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 that can really meet the demands of water security of our own.

Thank you for your attention!

chengxt@iwhr.com

India,2008

The Philippines, 2010

Pakistan, 2010

Vietnam, 2010