

**Action plan toward effective flood hazard mapping
in China**

**Concluding Report For
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1.The role of flood hazard maps to mitigate flood damages in China

1.1The flood status in China.

Geography and meteorology.

The topography of China is characterized by high west part and low east part, gradually descending in elevation from the west towards the east to form three steps. China is endowed with about 50,000 rivers, including 1,600 rivers with water basin larger than 1,000 km² each. The main river systems consist of seven major rivers, the Yangtze, Yellow, Pearl, Hai, Huai and Song Liao rivers. Most rivers, including seven major rivers, flow from west to east, directly or indirectly emptying into the Pacific Ocean. And the total annual average runoff is about 2,800 billion m³.

Table 1 Characteristics of seven main rivers in China.

River	Drainage Area (10 ⁴ km ²)	River Length (km)	Annual Average Value		
			Annual Runoff (10 ⁹ m ³)	Depth of Annual Runoff (mm)	Annual Average Discharge (m ³ /s)
Yangtze R.	180.85	6300	975.5	539	30933
Yellow R.	75.24	5464	56.3	75	1785
Huaihe R.	26.93	1000	61.1	227	1937
Haihe R.	26.36	1090	22.8	86	723
Pearl R.	45.37	2214	336.0	741	10654
Songhua R.	55.72	2308	74.2	133	2353
Liaohe R.	22.90	1390	14.8	65	469

China is subject to strong monsoon climate and most of the areas are under the impacts of the southeastern and southwestern monsoons. The average annual precipitation in China is 648 mm. About 70% of annual rainfall is concentrated in the flood season lasting from June to September in most area. The floods have the characteristic of high peak discharge and great amount of flood volume. The water volume of one large flood may account for the annual runoff of the river. The extremely uneven temporal and spatial distribution of precipitation and river runoff constitute the fundamental cause of frequent floods and waterlogging in flood season.

Floods occurred frequently in China. According to statistics, in the past two thousand years, nearly one thousand comparable large floods have occurred altogether, and one flood disaster occurred in two years in average. During the 1990s, six out of 10 years witnessed major floods taking place in the major river basins. In some areas, floods occur every year. On average, there are seven typhoons that land on the mainland of China every year. Torrential rains also cause mudflow and landslide problems. The total flood-prone areas are about 1.06 million km², nearly 11 percent of Chinese territory. In these areas there is a population of 840 million people, and GDP is about 6562.8 billion RMB. These areas are the major regions of Chinese social and economic activities. The characteristics of the seven main rivers are given below.

The flood hazard damage is serious. In various hazard, flood hazard is one of the most serious one. From 1996 to 2005, the total casualties due to flood hazard are about 24,540 persons. That means 2400 to 2500 persons died of flood hazard per year.

The average economic is also serious with an average number of 125 billion RMB per year. Damage of each year is given in the bellowed table. In 1990s, annual economic losses caused by floods accounted for 1.7% of GDP. But in developed countries the flood damage rate to GDP is less than 0.5%.

Table 2. Annual flood hazard damage from 1996 to 2005.

year	affected field	affected people	casualty	economic loss
	(10 ⁴ ha.)	(million)	(person)	(billion RMB)
1996	2039	267	5840	220
1997	1313	181	2799	93
1998	2229	186	4150	255
1999	961	130	1896	93
2000	905	129	1942	71
2001	714	110	1605	62
2002	1238	152	1819	84
2003	2037	226	1551	130
2004	778	107	1282	71
2005	1497	200	1660	166
average	1371	169	2454	125

One important thing must be illustrated here is that the flood hazard damage mentioned above include damages caused by flood of main river, land slide, mudflow and typhoon. The injury, death and property losses caused by floods, landslide and mudflow, rank the first among all natural disasters in China. Floods seriously threaten the social and economic development. As a significant strategic issue, flood control and flood security attract high attention all over the country.

1.2The outline of the present countermeasures for mitigating flood damages in China

Present countermeasures for mitigating flood damages in China can be divided into two main groups. One is to construct flood control system which is composed of structural and nonstructural measures. The other is to restrain people's action under the concepts of integrated water resources management and integrated flood risk management.

The flood control system can be summarized as follow:

Construct flood control works in main river systems. Flood control dams, reservoirs, levees, detention basins, flood division ways, flood control sluices and pumping stations are constructed in main river systems. Structural measures are aimed at releasing, detaining, confining, diverting and storing floodwater, to reduce the frequency and magnitude of flooding. Reservoirs were constructed in upstream areas to store floodwaters and cut flood peak, to reduce flood magnitude so as to relief the flood defending pressure downstream. Levees and embankments along the rivers were constructed to confine extents of inundation. Flood detention basins, for temporary storage of floodwaters to control discharge to downstream, were built up in the lower rivers. Sluices, water gates and pumping stations are used to discharge water from retarding area.

With so many years' efforts, a comparable integrated flood prevention system has been constructed. From statistics, about 246-thousand kilometers levees and embankments, more than 860-thousand reservoirs with a total storage capacity more than 475.1-billion cubic meters, 97 national specified flood detention basins with total capacity near 100-billion cubic meters have already been accomplished. With the present flood prevention system, normal flood can be defended in seven main river basins. According to incompleteness statistics, the flood prevention system that has been built has reduced losses of 1,500 billion RMB from floods.

Set up non-structural measure system.

Outline on legal and institutional system. Law and institutional system has been set up to guarantee flood mitigation activities being carried out. As have been introduced in country report, China has set up a series of flood control laws and regulations.

- ✚ The water law (1998)
- ✚ The law of flood control (1997). Flood Control Law was adopted on August. 29 1997, and came into force on January.1 1998.
- ✚ Flood fighting regulation of PRC (1991, revised in 2005)
- ✚ Regulation on dam safety management (1991)
- ✚ Provisional compensation regulation for use of flood detention basins (2000)
- ✚ The guide to safety building of flood storage and detention basins
- ✚ Regulation of river course management

Framework of normal flood management and emergency management. The Ministry of Water Resources (MWR) is the ministry of the State Council that is responsible for water administration. One of main responsibilities of MWR is in charge of planning, construction and management of flood control measures. Office of State Flood Control and Drought Relief Headquarters (OSFCDRH) is the special department in charge of national flood affairs in MWR, and also take the daily work for its Headquarters. Bureau of Hydrology (BOH) is another department of MWR, which provides hydrological, precipitation information and technical support for OSFCDRH.

In China, seven major rivers flow different provinces, in order to coordinate and conduct water-related affairs, River Basin Water Resources Commissions (RBWRC) for the Yellow River, Yangtze River, Hai River, Huai River, Pearl River, SongLiao River and Taihu Lake, have been established. Specific functions for water management and flood protection, such as drafting out flood control planning for major rivers, are implemented through these commissions. For the convenient flood management of river basins, the Yangtze, Yellow, Huaihe and Songhua River have separately established a basin-wide flood control organization, which is under the leadership of SFCDRH. Flood Control and Drought Relief Headquarters at local levels are in charge of flood emergency response affairs at the river basin or the local level.

Hydrology and meteorology monitoring and reporting stations are constructed to get data in time. Hydrological information system can collect and disseminate

hydrological information promptly, and make hydrological forecasting. The real-time rainfall and flood information of the national hydrological stations can be collected within 30 minutes, and forecasting results can be obtained within 1 hour. The hydrological information is the most important data for flood-decision. Research is ongoing to maintain and improve technical capabilities.

Flood forecasting is another non-structure measure widely used in China. Modern technologies such as radars and satellites are used on weather and flood monitoring, forecasting and assessment. However, modern technologies are not almighty. In some cases, traditional tools are more convenient and practical than radars and satellites. In the whole procedure of flood reduction, we use radars and satellites for flood monitoring and forecasting, use television, telephone, mobile phone, newspaper, broadcasting and internet for flood alerts. Cooperation between the Bureau of Meteorology of China and the CCTV has been set up to broadcast landslide and mudflow defending warning information whenever it is necessary. In some remote areas where all modern measures are not available, even firecrackers and alarm gongs are used to make flood alerts.

Flood defending plans in central, provincial and local levels are made for flood preparedness and defending.

Under the concept of integrated flood risk management, more efforts are made. Flood issue is considered with the context of water resources and land resources. Giving flood water more space and do not occupy river or lake spaces which means recovery of floodplain storage in river systems has been carried out since 1998. Other methods such like taking good use of flood water to relief the shortage of water resources, using flood water to clean river system in some areas like the downstream of the Huai river so as to relief the issue of water pollution also are conducted. All those methods are taken under the concept of integrated flood risk management. After 1998 flood of Yangtze River, farmlands around the Poyang Lake and Dongting Lake, the two largest lakes in middle stream of Yangtze river, are returned to recover lakes and rivers, 2.42 million affected populations were resettled to nearby places, water area of 2900 km² was recovered and flood storage capacity of 13 billion cubic kilometers was increased.

1.3 Do you think flood hazard maps will be useful in China? Why?

Flood hazard maps are sure to be useful for flood hazard mitigation in China.

Firstly, compared with structural constructions, our non structural methods are still weak and not so effective. After long period of construction on flood control works, we need an effective method for more effective flood disaster mitigation. Flood hazard map is a foundation and a useful tool for disaster mitigation. Maybe it can be taken as a breakthrough toward more effective flood disaster mitigation.

Secondly, public awareness on flood risk is not so strong. Their abilities of self-helping in hazards need to be enhanced greatly.

Thirdly, land use in flood prone area lack guidance according to flood risk. Land use plan and construction don't take flood risk into consideration, hence increased the vulnerability to flood risk. Statistics show that, the economic losses due to flood hazard are increasing.

Finally, flood hazard map plays an important role in flood hazard mitigation. Community based flood hazard mapping involves residents' participants. Their needs, their opinions are considered with other final users. In the process of user need investigation, making and dissemination, local residents' awareness on flood hazard are increased greatly. The flood hazard map also provides useful information on inundation and evacuation. By good understanding and using of flood hazard map, local resident can take proper method or carry out self-save on the first time when flood occur. The vulnerability to flood hazard can be decreased sharply. To the sector of land use planning and management, flood hazard map help them to make the decision by providing related flood inundation information.

The purpose of making flood hazard in China may be the following:

- ✚ serve for the flood control and flood fighting decision-making at all levels of FCH;
- ✚ enhance the consciousness of flood hazard mitigation of the nation;
- ✚ direct the constructions of the safety facilities for the flood detention areas, and to chose reasonable way and place for evacuating people in emergency;
- ✚ offer basic data for assessing flood losses, and so on.

On the other hand, flood hazard maps are not almighty. It is a supplementary method for flood hazard mitigation. So other methods must be considered in addition to flood hazard map. Flood forecasting and warning mechanisms are most crucial. In coastal areas and mountain areas multi-hazards map should be made for more effective hazard mitigation. For better understand and usage of flood hazard map, propaganda to the public and education to school students are necessary.

2.The allocation plan of making flood hazard maps in China

2.1Which organization should hold the main responsibility for making a fundamental map such as an anticipated inundation area map?

According to the framework of water resources and flood mitigation management, the ministry of water resources will be in charge of the flood hazard mapping. The office of state flood control and drought relief headquarters will make the needed guideline and criterion. The bureau of hydrological will be responsible for providing hydrological data. The institution of water resources and hydropower research are supposed to give technical support. Fundamental map such as anticipated inundation area map will be made by the IWHR.

The follow framework shows the responsibilities of each unit in flood hazard mapping.

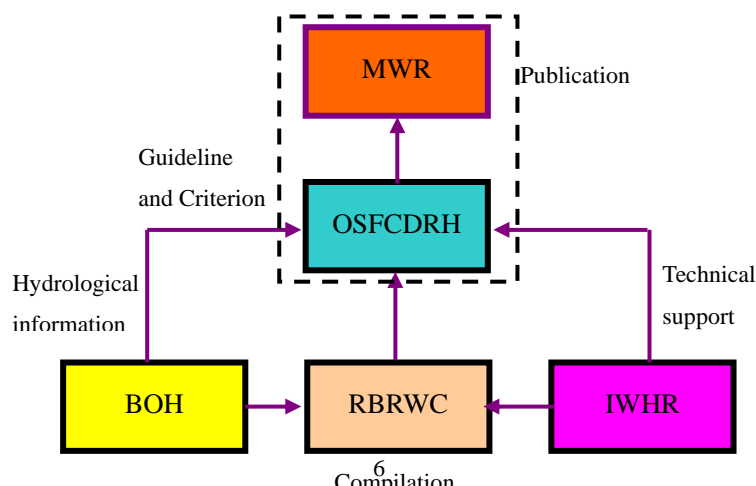


Figure 1. Flowchart of making flood hazard maps

MWR — Ministry of Water Resources

OSFCDRH — Office of State Flood Control and Drought Relief Headquarters

RBWRC — River Basin Water Resources Commission

BOH — **Bureau of Hydrology**

IWHR — China Institute of Water Resources and Hydropower Research

2.2 Which organization should hold the main responsibility for making and disseminating flood hazard maps?

The framework of SFCH. The office of state flood control and drought relief headquarters (the OSFCDRH for short) is a key organization that is responsible for the management of emergency response on flood and drought hazards. The main responsibilities will be described as to organize nationwide activities of flood control and drought relief, undertake the day-to-day work of the State Flood Control and Drought Relief Headquarters and carry out unified control of water volume from water conservancy and hydropower facilities all over the country following the directives of the Headquarters.

Under a new ongoing action plan, the main purpose is to decrease the vulnerability and the exposure to flood hazard. Flood here is specified as including flash flooding, dam-break floods, main river flooding, urban floods, debris flows and coastal flooding. The OSFCDRH has the object to make flood hazard map in seven main river systems. This will be a joint work with related ministries as the ministry of civil affairs, ministry of construction, ministry of land resources and so on. As an important foundation and a basic tool, flood hazard map are expected to play an important role. So the need to make flood hazard map is pressing. The ministry of water resources will be the administration to promote the task and the OSFCDRH will be in charge of making and disseminating flood hazard maps.

In fact, the OSFCDRH has already done much work on flood hazard mapping. So far, pilot researches in seven main rivers including 36 experimental points have been carried out. A guideline for flood hazard mapping was also issued last year. The management system for digital flood hazard maps is under research. The project plan has been made by the IWHR under the guide of the OSFCDRH. But much work should be done to promote the developing and plan committee making the decision since there are so many public affairs need financial support.

3. The action plan of making flood hazard maps in China

According to the project plan, in the next five years flood hazard mapping in some target areas will be carried out as schedule. The planned target areas are sure to include some important cities which have flood defending tasks and 97 flood detention areas.

3.1 Which area do you choose for the target river basin area? Why?

In my opinion, the middle and down-stream areas of Huai river basin should be chosen as the target area. The Huai river basin is an important agricultural base with big cities along main river and counties along several important tributaries. The area

now produces 18 percent of the country's food grain and 15 percent of coal. From 11 century, Huai River was disturbed by Yellow river for about 600 years, and several hundred billion tons of soil and sand have taken into Huai River. The river courses were disturbed, and the serious influences were very difficult to be eliminated. So the flood discharge capacity is not adequate and flood and water logging hazard frequently occur. In recent years, it has a trend that the flood in this river occur frequently. In 2003, 2005 and 2006, severe flood disasters and water logging disasters occurred in both urban and rural areas. In 2003, about 6 flood detention basins were used for storage flood water.

3.2 What do you think is necessary to make flood hazard maps in the chosen area? Do you have data, maps, budgets that is necessary for making flood hazard maps?

Firstly, flood hazard in this area occur frequently. As has been introduced above, the Huai river is notorious for its frequent floods, endangering the local people in the river basin. And also, in this area people's awareness on flood hazard are weak, when floods occur they don't want to evacuate because they are familiar with this river hence increase the exposure to flood in another way.

Secondly, exposure to flood hazard in this area is high. Along the Huai river, from upstream to down stream, are Henan, Anhui, Jiangsu and Shandong provinces. These provinces are large in population. Henan ranks the top one among all provinces in China with a population of up to 100 million. The high density of population in this area increases the exposure to flood hazard.

Thirdly, the flood control system is not so perfect compared with that of other main rivers like the Yangzi river. Which means the vulnerability in Huai river the also high. The Huai river system is complex especially in the middle and down stream. The heavy flood along the Huai River in the summer of year 2003 caused 18.17 billion yuan (2.2 billion US dollars) of direct economic losses in Anhui, Jiangsu and Henan provinces. The flood prompted harness of Huai River from 2003. Although the large scale harness of Huai river is being carried out people living there still face the high risk of flood hazard since the construction is time taking.

Based the above reasons, I choose the Huai river area to be the target areas for flood hazard mapping. Since the river system is large, complex it is necessary to divide the system into several sub-areas according to its main tributaries. Fortunately, the Huai river is in the flood hazard mapping plan. If the project is approved, there will be abundant fund. The hydrology data are supposed to be provided by the Bureau of Hydrology.

3.3 Propose your own action plan within the next five years.

- ✚ Dec 3,2006 ~ Dec 31,2006: report to my organization about what I have learned from this traing course; set up a network among those people who have participated in flood hazard mapping in the past 3 years.
- ✚ January ,2007 ~ May,2007: conclude the flood hazard pilot researches; help with the affairs of flood hazard mapping project.
- ✚ June, 2007 ~Dec, 2007: survey in Huai river, prepare and participant in flood hazard mapping in this areas; if possible, carry out training course for

management staff in flood hazard mapping.

✚ January 2008 ~ Dec, 2010: carry out the flood hazard mapping project in target areas.

3.4 What seems a problem in making flood hazard maps in China?

According to the training course, there are four basic elements to make a flood hazard map, the technique standard, basic maps, hydraulic data and models like run-off model and overflow simulation. Besides these, financial fun is another crucial element for effective flood hazard mapping. As far as I know, problems will occur in the following aspects:

✚ Lack of large scale basic map. Large scale, simple and easy to understand designed, necessary information compose an effective flood hazard map. But in China, large scale maps are expensive. Sometime, it is not available for security reason.

✚ Lack of DEM.

✚ Lack of enough hydrology data. The hydrology and meteorology stations are far from enough. Can't get rainfall and hydrology data for every hour.

✚ Lack of budget. Compared with developed countries, China still need much more investments on both public works and public services. Budget should be planned on each level of governments to supplied much more and better public services including flood hazard mitigation.

4. My own flood hazard map on Ise city.

Flood hazard map in Ise city

