FLOOD CONTROL, DROUGHT RELIEF AND DISASTER MITIGATION IN CHINA

MINISTRY OF WATER RESOURCES, PEOPLE'S REPUBLIC OF CHINA

Flood Control, Drought Relief and Disaster Mitigation in China

1. Overview

1.1 Main Types of Flood Disasters in China

1.1.1 Basin-Wide Flood

Areas most prone to flood disasters are the middle and lower reaches of the seven major rivers in China, namely, the Yangtze River, Yellow River, Huai River, Hai River, Songhua River, Liao River and Pearl River, that concentrate 1/2 of the national population, 1/3 of the national arable land and 3/4 of the gross industrial and agricultural output in China. Since the founding of P. R. China in 1949, more than 50 extraordinary basin-wide floods have hit China. It is expected that, by

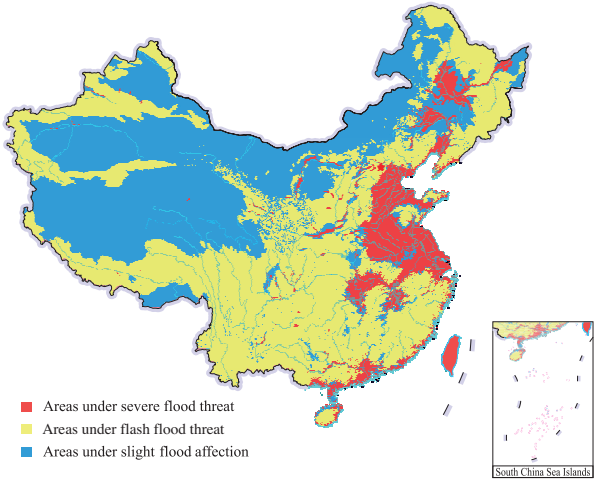


Fig.1 Sketch map of areas under flood threat

2020, the areas protected for flood control purpose in the middle and lower reaches of the major rivers will accommodate a total population of 600 million and register a combined GDP of RMB 26 trillion.

1.1.2 Flash Flood

The area in China directly threatened by debris flows and landslides that are induced by flash floods and heavy rainfalls extends 480,000 km^2 and is home to more than 76 million people. The area in need of flash flood prevention and control in China registers 4.87 million km^2 and is inhabited by 570 million people. The death toll of flash floods usually accounts for 70% of the total casualties caused by flood disasters.

1.1.3 Typhoon

China is among the few countries in the world that suffer severe impact of tropical cyclones. Each year, about 7 typhoons land in Mainland China on average, which number may rise to 12 or more in an extreme year. Once hitting the inland, typhoons bring along heavy rains and floods to southern, eastern, central, northern, northeastern, and southwestern parts of China, directly affecting an area of 477,000 km^2 and 235 million inhabitants. Ever since 1949, the overall capability to prevent and combat typhoons in China has enjoyed marked improvement, with annual death toll of typhoons decreasing from 969 in the early days of the PRC to 259 in the new century.

1.1.4 Urban Floods and Waterlogging

637 cities in China have flood control mandates. Almost all of them have prepared flood control plans, i.e., 490 have finalized their urban flood control plans, 355 completed initial design of flood control works, and 321 reached the national standards for flood control. The completion of 28,000 km urban dikes and embankments protects an urban area of 88,000 km^2. In recent years, waterlogging in urban areas has aggravated. 184, 243 and 125 cities (including county towns) in China were severely logged in 2012, 2013

Mouth of mudslide valley in Zhouqu disaster-hit area in Gansu Province

Fig.2 Division of monsoon and non-monsoon zones

and 2014 respectively, which resulted in paralyzed transportation in certain urban districts, severe impacts on normal operation of the cities, and enormous economic losses.

1.2 Drought

1.2.1 Drought as An Agricultural Hazard

Since 1949, average drought-affected area per annum in China records 20.98 million ha, whereas average annual grain loss stands at 16.33 million metric tons or even goes up to 60 million metric tons in extremely dry years. In 1997, when a catastrophic drought hit the Yellow River Basin, the Lijin section in the lower reaches of the Yellow River dried off for 13 times and 226 days, with the total length of dried-off river section extending over 700 km. In 2000 and 2001, the whole country was caught in consecutive catastrophic droughts. In 2006 Chongqing Municipality and Sichuan Province suffered a 100-year-return drought. In 2009 numerous severe droughts hit the northern part of China. In 2010 another catastrophic drought occurred in southwest China.

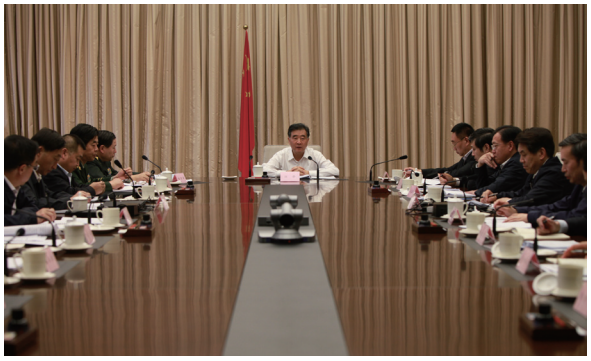
1.2.2 Water Shortage in Cities

More than 400 cities in China are short of water, of which over 100 cities suffer severe water shortage. Since 2000, due to consecutive droughts in the Hai River Basin, Tianjin Municipality was short of water supply for multiple times. During the 2000 severe drought in Yantai and Weihai in Shandong Province, available water per capita per month was capped at 1 metric ton in these cities. From the winter of 2004 onward, saltwater intrusion in the estuary of the Pearl River has threatened the safety of water supply in various cities in the Pearl River Delta, including Zhuhai and Macau, etc. Moreover, water pollution has led to frequent urban water supply crisis. Drinking water supply for nearly one million inhabitants was suspended in cities including Neijiang because of the serious pollution of Tuo River in 2004. Jilin and Harbin were both caught in a water supply crisis when the Songhua River was polluted in 2005. Likewise, the cyanobacteria bloom in Taihu Lake in 2007 led to a water supply crisis in Wuxi.

1.3 Institutional Setup and Legal Framework for Flood Control and Drought Relief

In China, the institution in charge of flood control and drought relief work nationwide is the State Flood Control and Drought Relief Headquarters, which performs its mandate under the leadership of the State Council. Its General Commander is a vice premier of the State Council and its members include relevant ministries of the central government as well as the People's Liberation Army (PLA) and the Chinese Armed Police Force (CAPF). Based in the Ministry of Water Resources, the Office of State Flood Control and Drought Relief Headquarters is responsible for daily operation of the Headquarters.

Basin flood control and drought relief headquarters are set up for major river and lake basins (the Yangtze River, Yellow River, Huai River, Hai River, Songhua River, Pearl River and Taihu Lake), and the Flood Control and Drought Relief Coordination Group is established for the Liao River basin. They lead



The plenary session of the State Flood Control and Drought Relief Headquarters

and direct flood control and drought relief efforts within their respective jurisdictions. Flood control and drought relief headquarters designated by local people's governments at and above the county level that have relevant mandates of flood control and drought relief, shall, under the dual leadership of the competent authorities at the next higher level and the corresponding people's governments, take charge of organizing and directing flood control and drought relief within their respective administrative areas. Departments, large and medium-sized enterprises and key hydraulic and hydropower works that have the mandate to prevent and control floods also establish their flood control headquarters to undertake flood control and disaster relief work of their own organizations.

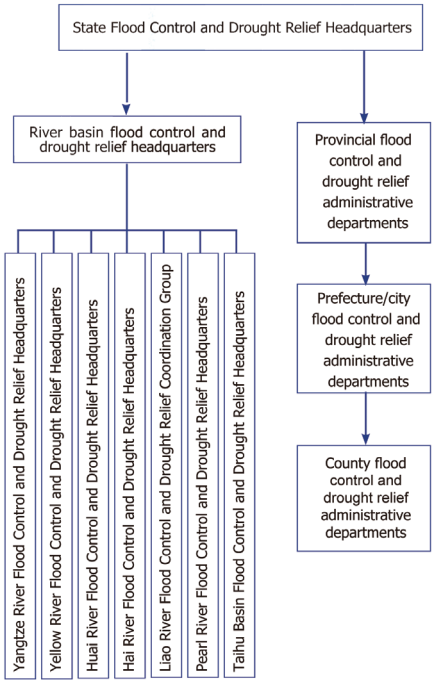
In accordance with relevant laws and regulations, the central government has formulated the *National Flood Control and Drought Relief Emergency Response Plan* as well as flood prevention plans and flood regulation plans for major rivers and their tributaries. All provinces, autonomous regions and municipalities have correspondingly promulgated and implemented the supplementary regulations and rules for flood control and drought relief. Flood control and drought relief headquarters at and above the county level and with the mandate of flood control and drought relief, have prepared their own emergency response plans for flood control and drought relief work. Flood control emergency response plans and operation plans are worked out for more than 90 thousand reservoirs or hydropower stations nationwide. Operation and evacuation plans have been developed for all the 98 national flood storage and detention areas, and flash flood emergency response plans for 2,058 counties prone to the disaster. Typhoon prevention plans are available in more than 490 coastal cities and counties. All provinces (autonomous regions and municipalities), 89% of the prefecture-level cities and 83% of the counties have completed drought relief emergency response plans.

2. Major Achievements and Challenges

2.1 Major Achievements

At present, main sections of major rivers in China are by and large capable of withstanding the most catastrophic flood since 1949. With the combined use of dykes, embankments and reservoirs plus flood storage and detention areas, both the Jinjiang section of Yangtze River and main sections of Huai River that are

Organizational Chart of Flood Control and Drought Relief System in China



most prone to flood disasters, could survive 100-year-return floods; the sections on the middle and lower reaches of the Yellow River are capable of preventing 1,000-year-return floods; the rivers in the northern part of the Hai River basin can defend floods similar to the 1939 one, while the main sections of rivers in the southern part could combat 1963-type floods; and main sections of Songhua River, Liao River, Pearl River and Taihu Lake are basically capable of guarding against the most catastrophic flood since 1949. The dykes along the key coastal areas that used to sustain 5~10-year-return typhoons are now able to defend 50-year-return typhoons. Medium and small rivers are capable of withstanding ordinary floods. Moderately dry years will not expose industrial and agricultural production or ecological systems in certain regions to serious adverse impacts as the latter can secure the safety of water supply in both urban and rural areas.

China has not only enhanced the construction of flood control and drought relief works, but also adopted various non-engineering measures across the country. For flood fighting and emergency rescue work, China has mobilized 19 national teams with the PLA and the Armed Police Hydropower Troops as the main task force, 25 backup teams that are attached to river basin authorities, 1,389 local teams and more than 13,000 grassroots volunteer service groups. The State Flood Control and Drought Relief Headquarters and local flood control and drought relief headquarters at various levels have reserved relevant materials with a total value of nearly RMB 12 billion. 34,000 hydrological stations and more than 8,600 flood forecasting stations spread all over the country. Intelligent monitoring and forecasting systems and flood regulation systems have been installed at more than 1,100 large and medium reservoirs that are critical to flood prevention and control. Flood warning and forecasting systems are applied in main river sections of major rivers. Phase 1 of the national flood control and drought relief commanding system is completed. A full set of non-engineering measures have been applied for controlling and preventing flash floods in 2,058 counties. Various scientific and technological products, such as remote digital monitoring and electronic detection of dangers, have been widely used in flood control and drought relief work. As such, China continues to press ahead with IT development in the area of flood control and drought relief.

Thanks to gradual improvement of structural and non-structural systems, and with extensive participation of the whole society, flood control and drought relief in China has achieved enormous social benefits and economic returns.

2.1.1 Assurance of Flood Control Security

Accumulated direct economic benefit obtained from flood control in China since 1949 amounts to RMB 4.62 trillion; reduction of flood-inundated arable land totals 182 million ha, a yearly average reduction of 2.81 million ha; and reduction of grain loss based on flood control stands at 760 million metric tons, a yearly average of 11.65 million metric tons. In recent years, China managed to handle several extraordinary floods, and successfully combated super typhoons, strong typhoons, tropical storms and severe local flash floods.

2.1.2 Assurance of Water Supply Security

From 1990s onward, irrigation of drought-affected land extends an area of 29.86 million ha per annum on average, which reduces grain loss by 39.36 million metric tons, and enables 24.92 million people and 18.91 million livestock temporary access to drinking water. For multiple times in a roll, in response to emergency draught-relief requirements, the Chinese government diverted water from the Yellow River to the City of Tianjin, and replenished fresh water to suppress salt water intrusion in the Pearl River basin, which ensured safety of water supply and ecosystems in Tianjin and cites in the Pearl River Delta including Guangzhou, Zhuhai, Zhongshan and Macau Special Administrative Region.

Table 1 Floods Successfully Controlled in China in Recent Years

Year	River/Basin	Scale/Severity of floods
1998	Yangtze River	Basin-wide extraordinary flood
	Songhua River	Basin-wide extraordinary flood
1999	Taihu Lake	Extraordinary flood
2003	Huai River	Basin-wide extraordinary flood
	Han River, Jialing River, Wei River	Serious autumn flood
2005	Xi River (Pearl River basin)	≥100-year-return extraordinary flood
	Liao River basin	The most extraordinary flood in recent 20 years
	Han River, Jialing River, Wei River	Severe autumn flood
2007	Wei River	Basin-wide extraordinary flood
2011	Han River, Jialing River, Wei River	Severe autumn flood
2013	The lower reach of Heilongjiang River	≥100-year-return extraordinary flood
	Songhua River basin	The most extraordinary basin-wide flood since 1998
	The upper reach of Hun River (Liao River basin)	≥50-year-return extraordinary flood

2.1.3 Reduction in Death Toll

Along with enhanced management of the society, and improvement to the flood control system, the death toll caused by flood disasters has decreased continuously year by year. In the 1950s, the number of deaths caused by flood hazards in China was 8,976 per annum while the corresponding figures in the 1980s and 1990s stood at 4,338 and 3,744 respectively. For the first 15 years of the 21st century, the death toll is reduced to 1,347.

2.1.4 Assurance of Ecological Safety

In recent years, the Chinese government has adopted a series of ecological regulation measures and scored impressive results thereby.

2.2 Challenges Ahead

For the future 50 to 100 years, global climate change may further increase the probability of flood and drought disasters in China, which will result in the trend of sudden, more frequent and concurrent occurrence of local extreme weather events, such as rain storms, extreme heat or droughts and super typhoons, etc.

3. Guiding Principles and Main Measures

3.1 Guiding Principles for Flood Control and Drought Relief in the New Era

The guiding principles for flood control and drought relief in the new era is as follows: attaching equal importance to both flood control and drought

Table 2 China's Practice of Water Ecology Conservation and Restoration in Recent Years

Project / Measure	Effects
Emergency Recharge of Water for Ecological Safety to Weishan Lake, Zhaoyang Lake, Dushan Lake and Nanyang Lake	Rescued and restored the local ecosystems endangered by droughts
Diversion of Water from the Yangtze River to Taihu Lake	
Diversion of Water from Yuecheng Reservoir to Baiyangdian Lake	
Diversion of Water from Chaersen Reservoir to Xianghai Wetland	
Diversion of Water from the Yellow River to Baiyangdian Lake	
Water Recharge to Zhalong Wetland	
Emergency Supply of Water for Ecological Safety to the lower reaches of Hei River and Tarim River	
Integrated Water Regulation along the Yellow River	Ensured no dry-off of the Yellow River and restored the wetland in the Yellow River Delta
Integrated Water Regulation along the Hei River	Achieved the expected target of ecological control and restoration, and brought Dongjuyan Lake, dried up for 10 years, back to life by impoundment
Diversion of Water to Tarim River (10 times)	Restored Tarim River which had dried up for nearly 30 years, increased natural vegetation in its lower reach, reduced the area of sands and enlarged the area of Taitema Lake in the lower reach of Tarim River
Water Recharge to Zhalong Wetland	Alleviated the severe draught-induced ecological crisis in Zhalong Wetland, enlarged the water area of the wetland and greatly improved the local eco-environment and weather conditions

relief, transforming from flood control to flood management and from single-purpose drought relief to comprehensive drought relief, and thereby safeguarding all-round, coordinated and sustainable development of the Chinese economy and society.

To realize the transformation from flood control to flood management, we need to achieve the following two targets: first, to pursue harmony between man and nature as well as harmony between human beings by abiding by the principle of co-existence of humans and rivers; and second, to meet, with utmost efforts, the needs of national economic development, social progress and ecological safety by following the principle of safeguarding development with flood management.

The essence of flood management lies in the following three aspects: first, exercise risk management, which means effective risk prevention, bearing and sharing via the construction of flood control works, institutional innovation, and development of a legal framework; second, regulate human activities, i.e., deploy legal and other means to regulate economic and social activities of human beings while preventing humans from water hazards, so that human activities will adapt to the natural rules of floods, avoid or decrease the causal relation between floods and human activities, and finally achieve harmony between humans and nature; and third, regard flood as a resource and try all possible means to make the best use of floods with the premise of guaranteeing control of the flood hazard.

The essence of comprehensive drought relief also covers three aspects: first, broaden target areas of drought relief, i.e. extend from agriculture to all walks of life, from rural to urban, and from production and life to ecosystem; second, diversify the means of drought relief, i.e., when threatened by drought and shortage of water, we will adopt all available means including legal, administrative, economic, engineering and technological measures to address water-related issues; and third, turn drought relief from passive response to proactive action, which means the adoption of comprehensive countermeasures including but not limited to more forward-looking and proactive efforts, higher operability of emergency plans, and full preparedness for the future.

3.2 Main Measures

- Construct a framework of disaster relief works that features appropriate standards and rational functions;
- Set up a scientific well-regulated management system;
- Establish an effective social security system;
- Establish and enhance the policy and legal framework;
- Build up an advanced technology support system.

4. International Cooperation and Exchanges

China attaches great importance to international exchanges and cooperation in the areas of flood control, drought relief and disaster reduction. In recent years, five consecutive Sino-Swiss seminars

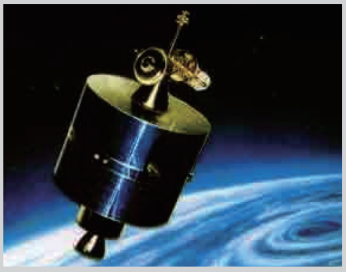
Linhuaigang Flood Control Works in Anhui Province

China's team of flood control experts working in Thailand

on Flood Control and Disaster Reduction have been jointly held by China and Switzerland. China also hosted a technical workshop on the project of urban flood risk management sponsored by the World Bank, two training courses of the World Bank, and the Fifth Training Course on Regional Flood Risk Management. In addition, China has taken an active part in international exchanges, seminars and meetings. In October 2011, at the invitation of the Thai Government, China dispatched a team of flood control experts to Thailand for provision of consulting services on flood control, disaster rescue and relief work. In June 2012, China sent another team of 23 experts to Thailand who advised on flood control and submitted the Consulting Report on Flood Control in the Chao Phraya River Basin in Thailand. In 2013, China and Russia joined hands to combat the flood in the Heilongjiang River basin. In 2014, the Ministry of Water Resources of China and the Emergency Department of the Russian Federation signed the MOU on flood control and hosted the first meeting of the Sino-Russian Working Group on Flood Control Cooperation. In addition, China also actively carries out joint international research projects. In cooperation with the World Bank, Asian Development Bank and International Council for Science, China has completed multiple projects such as Research on Major Technical Problems in Flood Control and Disaster Relief (as a sub-project of the Project on Reinforcement of Dykes in the Yangtze River), Regional Consulting Meeting on Poverty and Floods, Research on Flood Management Strategy, and Research on Drought Management Strategy in China, etc.

MWR delegation visiting Russian Emergency Department

Non-structural flood control and drought relief measures

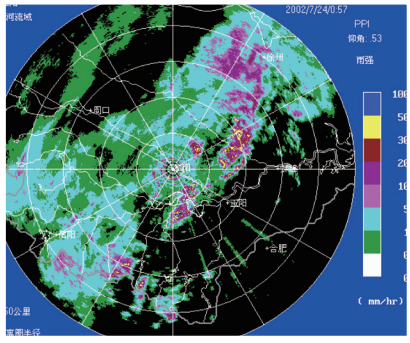


Meteorological satellite

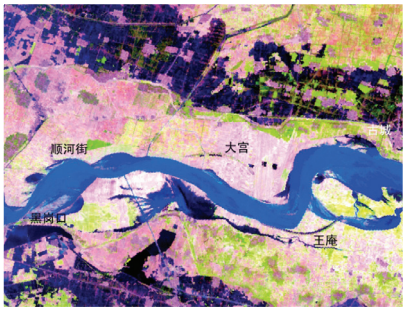
Hydrological station

Meteorological observing station

MWR Information Center for monitoring the operation of the National Water Information Net



Radar map



Remote sensing image from Heigangkou to Jiahetang in the Yellow River

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