Flood Forecasting and Warning in China

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China has been frequently hit by big floods and suffered from flood disasters. The critical issue is that about 8% of the middle and down stream of the seven major rivers are prone to floods, where is inhabited 50% of total population and contributes over 2/3 of total agricultural and industrial product value. Flood control and management of the said areas are of vital importance to China in its social and economic development. Strenuous efforts have been made in fighting against flood, however there is still long way to go. Hydrological information and forecasting, as one important non-structural measure, plays an important role in flood control and disaster relief.

1. The storm monitoring and forecasting

The vast area of the East China and most part of the South China are dominated by the Eastern Asia monsoon. As a result, rainfall period of China is highly concentrated within a year with a distinctive flood season. The main flood season in China is from May to September, when the westerly depression system and the low latitude tropical cyclone system may both cause the macroscopic rainstorm.

At present, the storm monitoring network has been initially constructed to meet the requirement of flood prevention and disaster mitigation, which consist of ground observation system, meteorological radar network and meteorological satellite data receiving and transmitting system. For the ground observation system, flood control departments and meteorological administrations at various levels maintain about 6600 rainfall-observing stations and 2300 rainfall-monitoring stations. 420 meteorological radars are installed for monitoring disastrous weather system, and 4 meteorological satellites have been successfully launched.

Timely and accurate prediction of storm occurring and moving can be done by using different techniques in China, e.g. by the **traditional techniques** based upon meteorological station and rain gage networks, by means of **meteorological radars** or **meteosat images**. Using these techniques can make the short-duration (<12 hrs), short-term (< 3 days), medium-term (4-10 days) and long-term (>10 days) weather forecasting of storms. The short-duration forecasting is to forecast rainfall up to 12 hours, which can make precise judgement according to the ground-based rainfall observations in combination with other rainfall estimation

techniques based on meteorological radar and meteosat images. The short-term forecasting is to predict rainfall up to 3 days according to the weather situation maps from the World Weather Forecasting Network, information from local meteorological stations and nephogram from meteorological satellites, which can give out reliable rainfall forecasting for flood control decision-making. The medium-term forecasting is to predict rainfall up to 10 days, which can predict storm events according to the evolvement trend of weather system. The long-term forecasting is to predict weather system over 10 days, for which there are still no very precise and reliable methods—the most practice is to conclude the results according to expertise, on the basis of the relationship between rainfall and some meteorological factors.

2.Flood information monitoring and transmitting

Hydrological information and flood forecasting are the basis of flood fighting during rainy season. As of 2000, there were 3,124 hydrological stations (measurement of rainfall, water level and discharge), 1,093 gauge stations and 14,242 rain gauges, which constitute the hydrological network as well as the flooding monitoring system over China. 7,559 stations are mandated to report/release hydrological information during flood period regarding the hydrological elements at a regular time interval as stipulated on the basis of the requirement of flood forecasting for the river system.

In China, some important hydrological stations have been equipped with advanced facilities such as satellite data transmitting system, GPS, ADCP, PC flow measuring system, rainfall solid-state storing system and water level automatic recorder. About 200 hydrological automatic telemetering systems with 2000 remote sensors have been built in some key flood control areas and large or medium-size reservoirs on larger rivers to collect hydrological data.

Hydrological information is transmitted through the telecommunication system of the country. For reporting stations in areas where the telecommunication system may not cover, special transmission line is established. In accordance with the regulations laid down by the government, hydrological information transmission during the flood period is regarded as one high priority task of telecommunication industry.

For those river reaches and water projects of special importance, short wave radio stations were established to ensure more effective information transmission. Furthermore, data collection, processing, storage, retrieval and distribution for the major rivers have been computerized for real time flood forecasting.

3. Flood forecasting and warning

Flood forecasting and warning are made by the Flood Control and Drought Relief Headquarters (FCDRHs) at various levels, i.e. the central government, the river basin commissions, the provinces/autonomous regions/municipalities under the central government

and prefectures. In case of critical situation, i.e, a given water level is surpassed, the FCDRHs will issue a warning to the public through government at different levels, all parties concerned and the media (radio, TV, news papers) to the public. The flood fighting schemes are prepared prior to the flood season, and annual meeting of FCDRHs at different levels is held to review the preparatory work. Flood forecasting is also performed for large reservoirs both completed and under construction for their own operation. In addition, about 1,000 hydrological stations also conduct flood forecasting as requested.

The Chinese hydrologists have developed empirical forecasting schemes of more than 500 forecasting points for the seven major rivers, which functions as the basis for hydrological forecasting. The modeling technique has been developed since early 1950s, on the basis of the conventional methods in runoff yield analysis and flood routing. Xinanjiang Model developed by Chinese experts has been widely used in large river basins, other models like API, SCLS, Sacramento, Tank, SMAR, Shanbei and Maskingum routing model are also used in many river basins. A computerized flood forecasting system has been established with real time adjustment leading to high precision in the flood forecasting. At present, automatic flood operational forecasting systems have been successfully developed and put into running by the river management authorities and hydrology departments at various levels. At present, a powerful and unitized flood forecasting system is under construction in China. Referring to the experience and lessons in the past, this system can develop various standard-forecasting models and adopt the available empirical methods based on a unitive real-time database in the environment of Client/Server or Browser/Server. With the functions of perfect data processing, model calibration, real time forecasting and image displaying, the system can make automatic forecasting and manual forecasting. The concrete objectives of the Chinese Flood Forecasting System are as following: 1) Being convenient to absorb advanced technical results so as to use the flood forecasting system over the country; 2) Having many models and methods; 3) Allowing users to make multiple-schemes forecasting for one site; 4) Being easy to add new models and methods to ensure the synchronous development of the forecasting technology; 5) Being able to process large quantity data and make forecasting at some hundreds of the stations and points; 6) Allowing users to control forecasting process in a flexible way (see figure 1).

The “Guide of Hydrological Information Dissemination and Forecasting” was approved and issued by the Ministry of Water Resources and Electric Power in 1985 on the basis of long-term practice since late 1950s. To ensure the accuracy of flood forecasting, various means are used to synthesize, analyze and consulate. When rainstorms occur, hydrological units at central and regional levels undertake operational forecasting according to their work requirement. Then they hold a consultation, select reasonable forecasting values and possible limits and adjust forecasting results according to the regulation of water conservancy projects. At crucial times of flood control, possible weather system and possible rainstorm process with

different quantities and different temporal-spatial distribution are assumed. Actual regulation of water projects is also considered for predicting and simulating flood hydrographs (peak and volume of flood) in important regions or on important river segments. This enables policy makers to be conscious of possible situation in the future, make preparation for emergencies and take initiative in flood controlling.

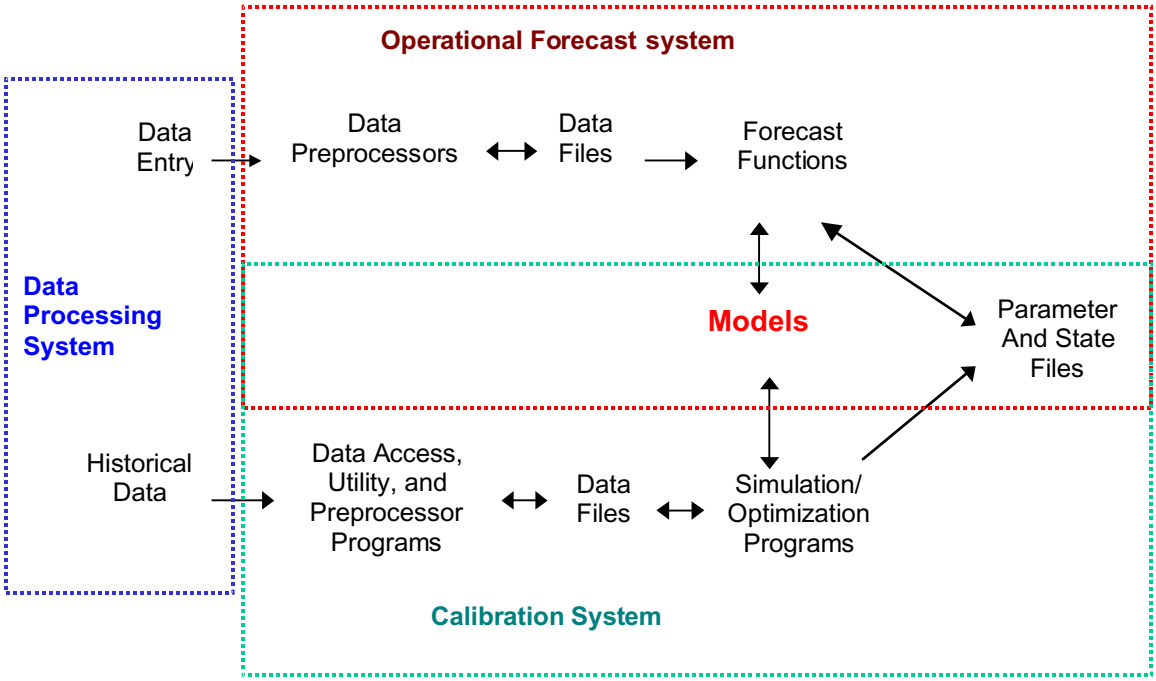

Fig. 1 Flood Forecast Components

The flood forecasting and warning system have played an important role in flood fighting, especially at the critical moment of extraordinary floods. In the past the decision on diversion of floodwater into flood storage and retardation basins is in many cases contingent upon timely and accurate flood forecasting and warning. In 1954, a big flood hit the Yangtze River. Jing Jiang Flood Diversion Gate opened three times on the basis of the flood forecasting so that the water level of that section dropped 1 meter and the Jing Jiang Levee was safeguarded and Wuhan City protected. In 1958, the Yellow River experienced an extraordinary. The State Council adopted the suggestion of the Ministry of Water Resources and decided to resist the flood by protecting the BeiJin Dike and not to use the flood-retarding basin so that 1.25 million people in that basin were refrained from flooding.

4. The National Flood Control Command System

After strenuous efforts made in the past 50 years, general floods for large rivers could be controlled. In order to ensure the sustainable development of China's national economy, a

nation wide flood control and management as well as flood disaster reduction system need to be established. Therefore, the Chinese Government has decided to design the National Flood Control Commanding System.

The system can be divided into 4 sub-systems: information collecting, telecommunication, computer network and decision-making support. The target and strategy of the NFCCS are to be:

- A capacity of monitoring observed maximum historic floods shall be built for the hydrological stations that are mandated to report/release hydrological information to the SFCDRH.
- Hydrological information shall be transmitted from local stations to the SFCDRH within 30 minutes.
- Information collection for flood, drought and flood-control water projects shall be carried out on the basis of standardization, normalization, and digitization.
- Real-time or close to real-time monitoring hydrological, engineering and disaster information on the key river stretches of 7 major rivers and for the key flood control areas, shall improve the precision and accuracy in predicting floods or droughts, which provides scientific basis and technical support for decision-making and flood commanding.