Flood Management in the Yellow River Basin

1. Flood Sources and Composition in the Lower Reaches

Storm floods in the lower reaches of the Yellow River mainly come from three areas: 1) Hekou Village - Longmen section (Lanzhou onwards). In this section, floods often occur in late July and August. Rainstorm here is frequent, intensive and with a short duration; 2) Longmen – Sanmenxia section. Three tributaries, namely Jing River, Luo River and Wei River flow into the Yellow River in this section where floods often occur in August and September. As most of the region has sources of loess and is covered with hills and gullies, and one part of it is consisted of rock hills, together with the three tributaries, heavy floods in this region feature high peak, huge volume and lots of sediment; 3) Sanmenxia – Huayuankou section. The Yellow River is joined by Yiluo River and Qin River in this section with a basin area of 41,615 km2, most part of which is rock hills. Floods usually occur from middle July to middle August, featuring frequent and intensive rainstorms in short notice.

![Map of main regions for generating flow](image)

Figure 1 Sketch of main regions for generating flow

2. Flood Prevention and Control

2.1. Prevention and Control of Icicle Floods

Icicle disasters and floods in winter and spring in the Yellow River may damage and ruin water projects. Therefore, prevention and control of icicle floods are one of the major tasks for water control. There are three factors in the formation of icicle or ice dam: the first is unfavorable geographical conditions such as curved and narrow river courses and jig-saw like banks; the second is driving forces, such as water storage in the water channel before the floods; the third
factor is thermal force, such as temperature differences between sections.

Therefore, engineering measures are mainly used in icicle flood control work. In the lower reaches, joint use of Sanmenxia and Xiaolangdi reservoirs may adjust water volume and temperature in order to control dynamic and thermal factors in the river course. The common practice is that delaying river-shutting and raising ice cover by increasing discharge of water from the reservoirs before river courses are frozen in the lower reaches; creating favorable conditions for river-unlocking by reducing discharge of water and hence less water storage in the river channel. In the upper reaches, in the same manner, Liujiaxia reservoir is used to defend against icicle floods from the Ningxia-Inner Mongolia section. Because reservoirs store waters all around the year and their discharges will be of higher temperature, zero-temperature fracture will be further into the lower reaches, so will the initially frozen section, and the length of frozen section will also be greatly reduced.

2.2. Rainstorm floods Prevention and Control in Summer and Autumn

1) Flood control projects

Flood control projects are mainly consisted of reservoirs, diversion-detention basins and dykes, featuring a system called “interception, discharge and detention on the both sides” which is developed in the process of water control. Proper configuration and optimizing the combination of the three components while making full use of their features and functions equip the Yellow River with a powerful defense system.

2) Hydroninformatics for flood management

Based on 3S technology and hydroninformatics, “hydroninformatics for flood management” in the Yellow River, according to the framework of “IT Yellow River”, develops an applicable system covering major flood control regions in the Yellow River basin, including rainstorm flood forecast, flood control and ice prevention, flood control organizing and directing, dynamic water and sediment modeling, and disaster mitigation, etc., in order to realize standardized and intelligentized management of all links in flood control and disaster mitigation in the Yellow River.

3. Flood Utilization

Floods could dilute water bodies, mitigate pollution, and improve water quality; floods contained and stored in rainy season can be used in dry season to mitigate drought; floods of certain standards may be utilized to recharge underground water, slow land subsistence and protect the environment. These measures are carried out in countries all over the world. In the Yellow River region, besides above-mentioned ways, small and medium floods and icicle floods are also employed and practiced in the flowing aspects:

3.1. Turn silt to land and improve farmlands

Floods in the Loess Plateau are usually rich in sediments. Small and medium floods are induced to low-lying areas, and sediments in them are utilized to form new land. Rich in organic matters, sediments are employed to improve the soil and enrich farmlands.

3.2. Wash the river course and discharge sediments
As a part of the flood prevention project, reservoirs need to release water before the flood season in order to make room for storing the flood and reducing the flood peak, which is a common practice for countries all over the world and the Yellow River is no exception. However, the Yellow River basin is short of water resources and therefore every drop of water is precious, so making full use of stored waters before the flood season will surely improve the utilization efficiency of the Yellow River water. One of the practices is utilizing the water to discharge silt, flush the river course and alleviate sediment accumulation.

4. Risk Management and Disaster Mitigation in Flood Storage and Detention Basins in the Lower Yellow River

Building flood storage and detention basins in the lower reaches of the Yellow River (including large areas of floodplain) have long been a major means of reducing flood peak, adjusting flood flow rate, and mitigating flooding risks; at the same time, as a result of vast population and limited farmland, a large number of people (current population is 1.81 million) live in these basins, which is decided by natural conditions and is the case in the past thousands of years; in addition, river diversion flooded and also reformed lots of farmland—soils rich in organic matters in the basins have nurtured numerous lands which turned out to be suitable for crop-growing. Therefore, risk management and disaster mitigation in flood storage and detention basins pay attention to both floods and is people oriented.

The public is a major force in flood prevention and disaster mitigation. In risk management, public flood-prevention awareness has been strengthened, and people are encouraged to learn about related regulations and information through publicity, which helps regulate people’s behavior; flood control facilities have been taken good care of in order to win understanding and support from the public and motivate them to engage in flood control work. The public are prepared for flood prevention both mentally and physically, so that the loss from all levels of flood can be mitigated to the largest extent.

In order to protect the lives of the residents in the floodplains and ensure the security of their asset, risk management have been carried out in populous areas in the lower reaches of the Yellow River. A policy of “no production levees, more flood shunning dykes” has been implemented. In times of flood diversion detention and inundation, residents can find settlements nearby. Standard for flood shunning dyke was 3 m2 per capita in 1974 and it was changed into 5 m2 in 1982. These dykes played a life-saving role in flood seasons in 1976 and 1982. Later, village platforms gradually took the place of dykes, whose construction standards had been 30 m2 per capita, 50 m2 per capita, and 60 m2 per capita in succession. Flood shunning building had also been adopted for the same purpose.

Roads and bridges for withdrawal in flooding time have been built and related routes have been worked out. Temporary withdrawals are actually also good measures to avoid casualties and property losses.

5. Achievements

With continuous construction of flood management projects from 1949 to 2009, floods over the years have been well under control, including 6 heavy ice floods which were deemed historically irresistible by man power, ensuring a safe period of 60 years. Now large reservoirs
have been built in the main stream and tributaries, such as Longyangxia, Liujiaxia, Sanmenxia, Luhun, and Guxian. Of these, average water storage of Longyangxia Reservoir and Liujiaxia Reservoir is around 3-4 billion m$^3$, reducing base flow of the Yellow River in flood season; reservoirs like Sanmenxia, Xiaolangdi, Guxian and Luhun greatly improve standards of flood control in the lower reaches: flow rate of a-thousand-year flood in Huayuankou has decreased from 42,300 m$^3$/s to 22,600 m$^3$/s and that of a-hundred-year flood from 29,200 m$^3$/s to 15.9 m$^3$/s. With levee constructions in the lower reaches, especially that of standardized levees, flood-prevention standards for dams in the lower reaches has been improved from once 60 years to once a-thousand-year. As a result of the construction of GIS-based risk-related decision-making system, relevant planning of safety provision in the lower reaches and water issue management in the river course and on the floodplain, security of the lives and property are guaranteed, and there is also a total of approximately 400 billion yuan worth of benefits from these flood control works.