黄河防御洪水方案
关键技术研究

Key Technological Issues of Designing Flood Control Schemes of the Yellow River

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Flood Control Schemes of the Upper Yellow River

Flood Control Schemes of the Middle and Lower Reaches

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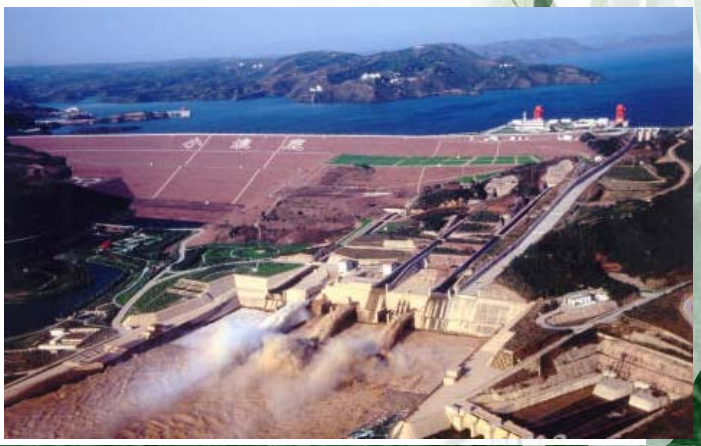
1

研究背景

Introduction

The problems of floods control and sediments management are complicated in the Yellow River catchment, and there are significantly serious flood and sediment disasters in the history. In order to reduce the flood losses, flood control projects have been built, including embankments, reservoirs, and flood storage and detention projects. How to utilize the flood control projects, and perform reservoirs and flood storage and detention projects operation scientifically, so as to reduce the flood losses, is the main target of the project.



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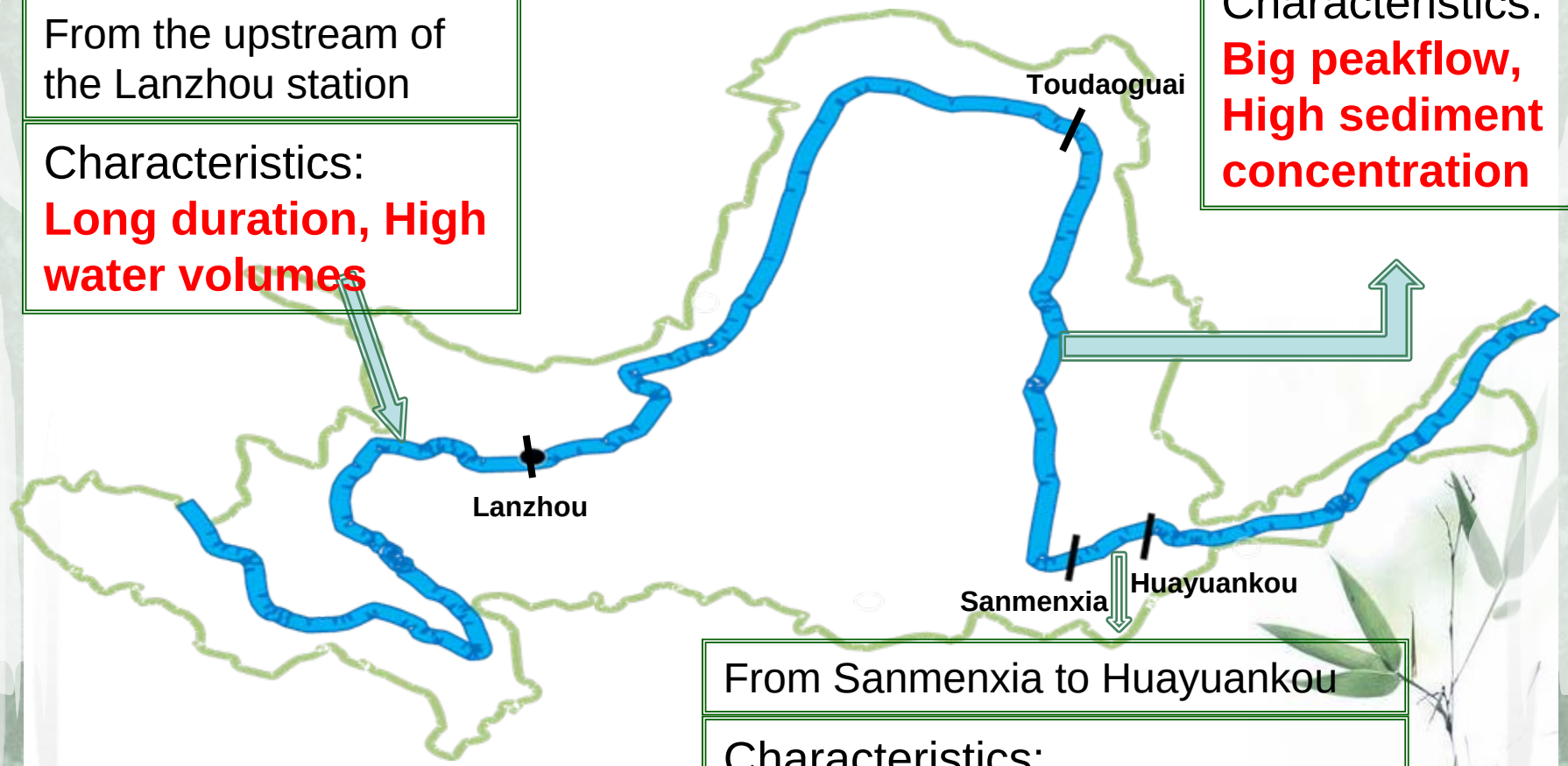
1.1 洪水来源及特点
Flood sources and characteristics

From the upstream of the Lanzhou station

Characteristics:
Long duration, High water volumes

From Toudaoguai to Sanmenxia

Characteristics:
Big peakflow, High sediment concentration



From Sanmenxia to Huayuankou

Characteristics:
Big peakflow, Short forecast intervals

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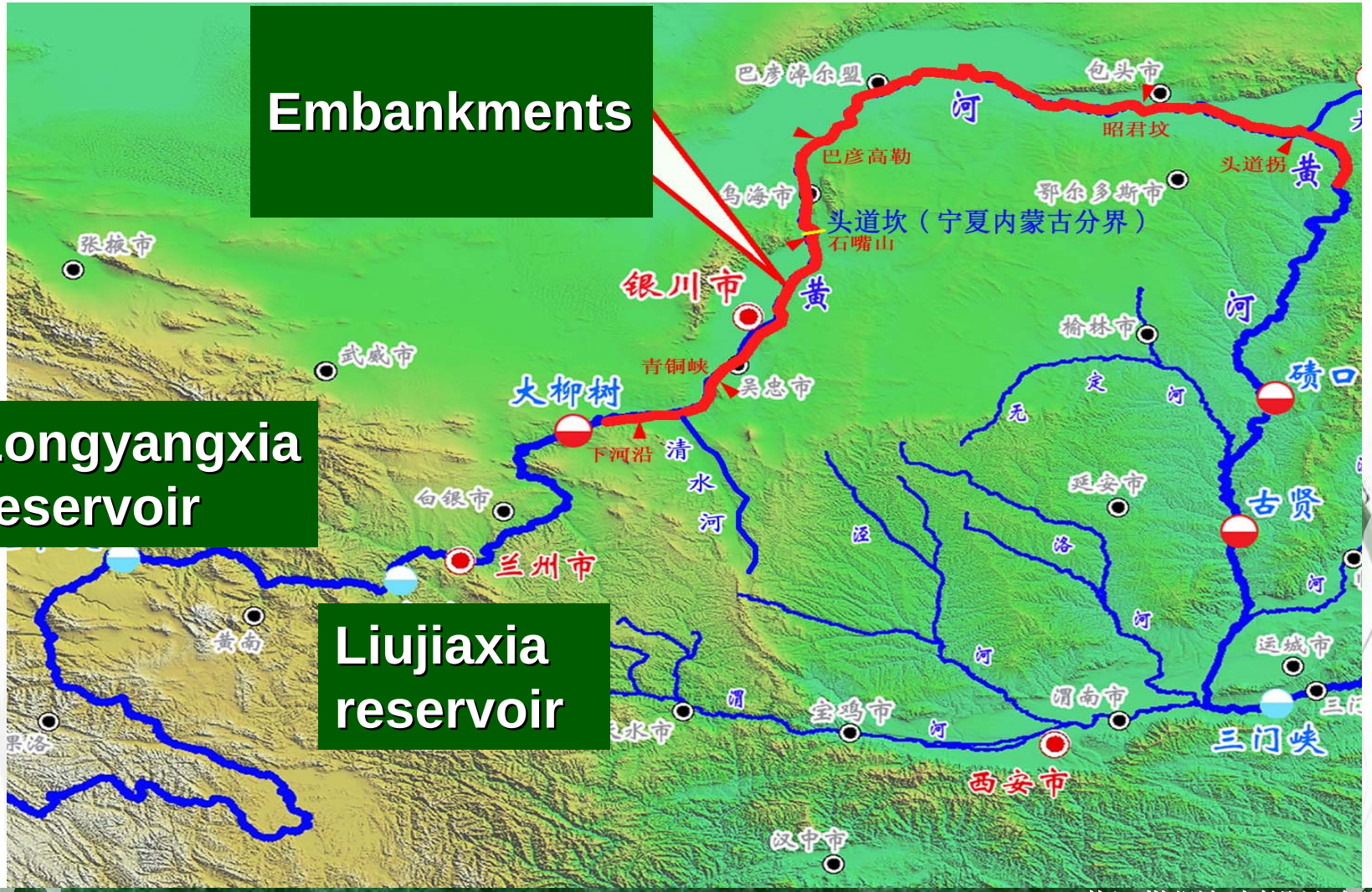
1.2 干流重点防洪河段

Key sections for flood control of the mainstream

1.3 防洪工程现状
The status quo of flood control projects

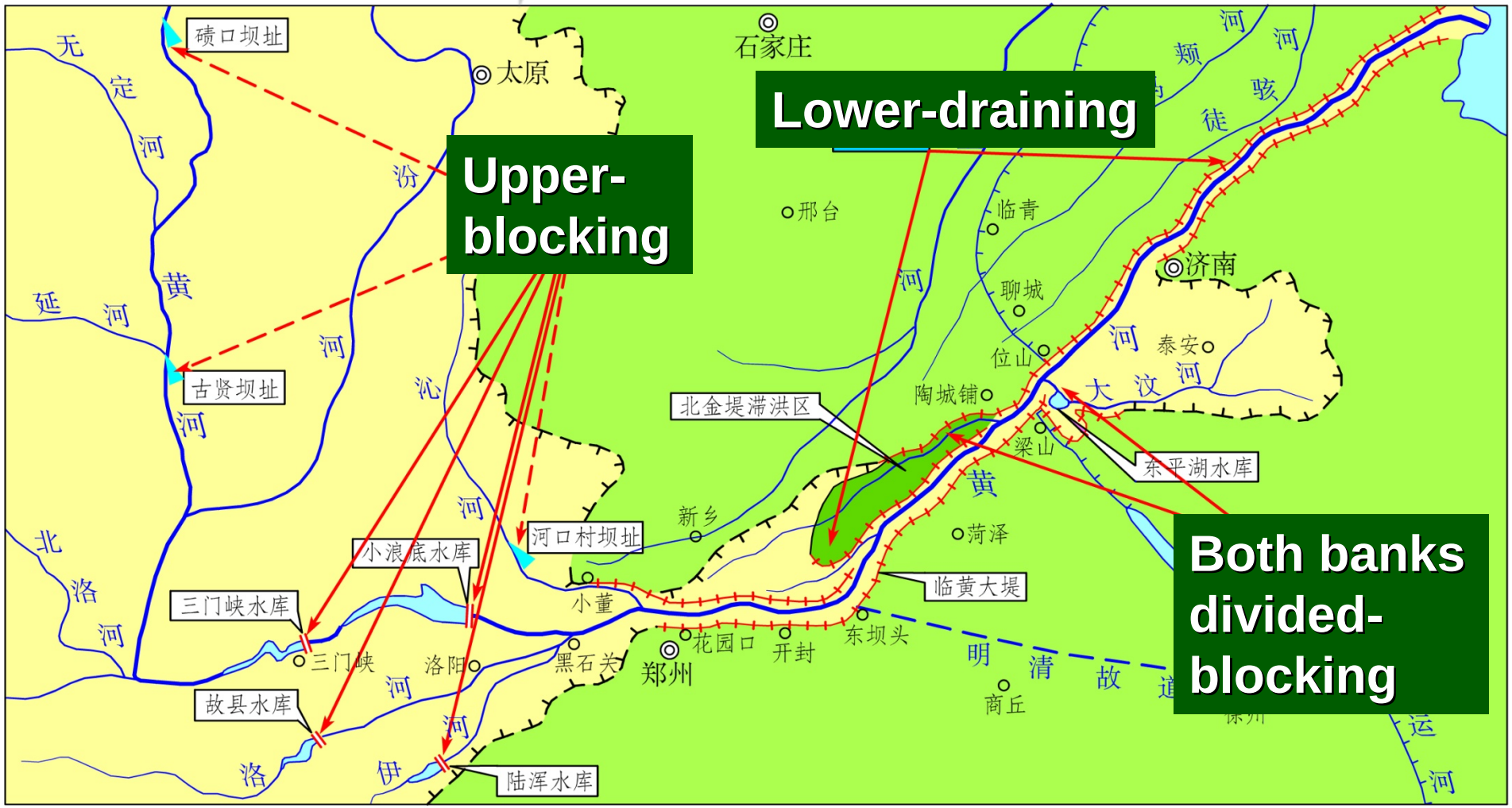
- The upper Yellow River：



The middle and lower Yellow River：

Flood control projects system

Upper-blocking, Lower-draining, Both banks divided-blocking.



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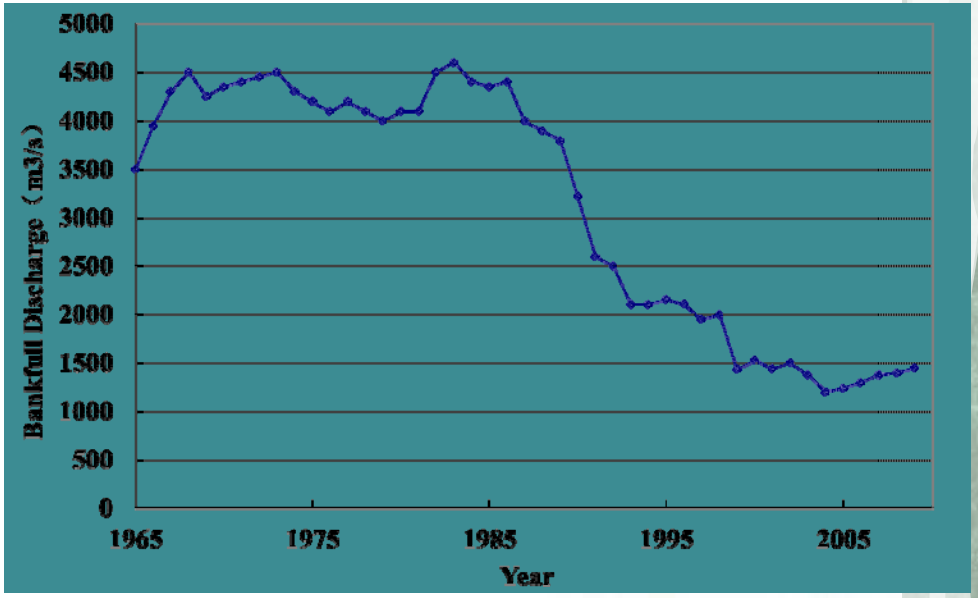
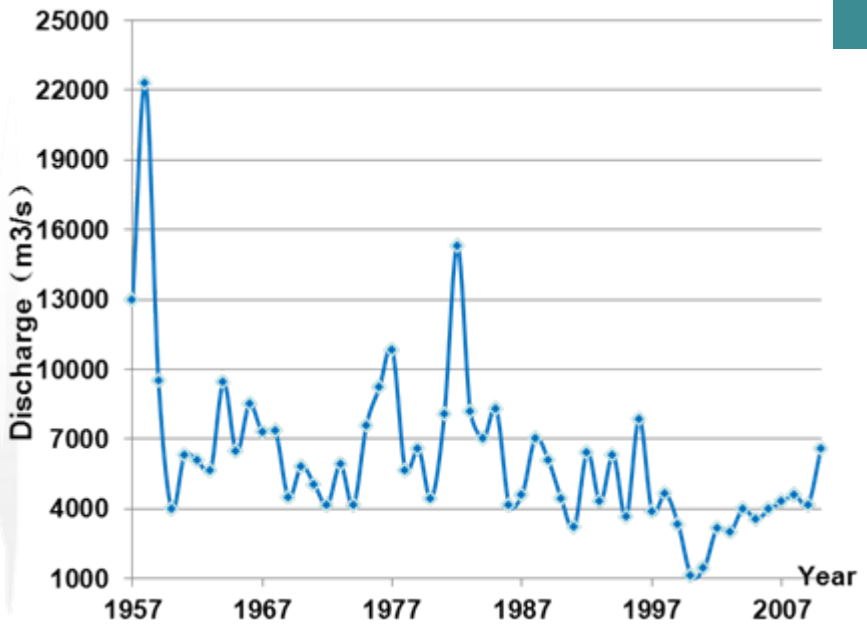
1.4 近年来防洪形势变化
The changes of flood control situation in recent years

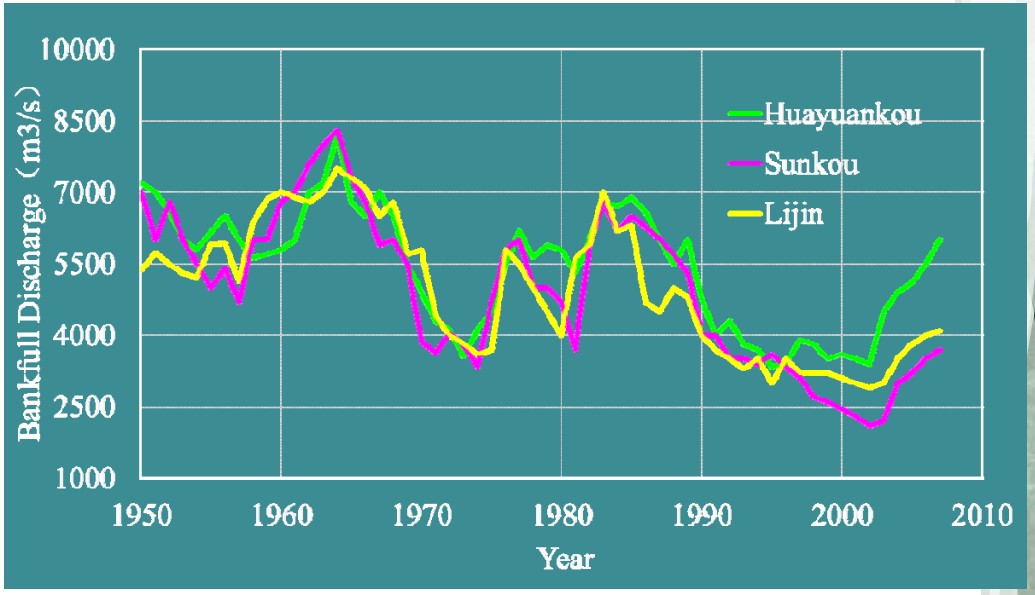
- Affected by the use of the Longyangxia and Liujiaxia reservoir, the flood decreased in Ningxia-Inner Mongolia reach, and the flow carrying capability reduced to 1500m³/s from 4000m³/s in 1980s.

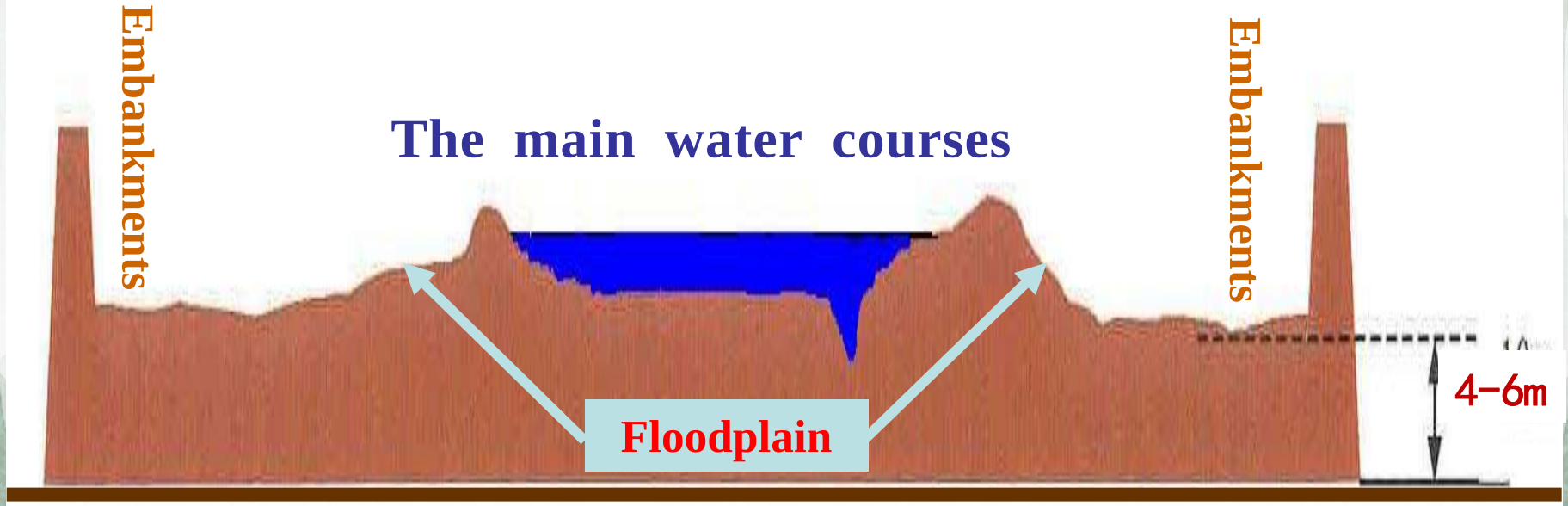




- Characteristics of floods of the middle and lower Yellow River have changed significantly recently. The changes lie in the decreases of flood frequencies, flood magnitudes, flood durations, and etc.

- The flow carrying capability of the lower Yellow River reduced to 1800m³/s in 2002 from about 5000m³/s in 1980s. And the serious situation of the Secondary Perched River phenomenon brings serious threat to flood control .





- The floodplain areas of the lower Yellow River, where nearly 1 900 000 people live, are not only channels for flood flowing but also the homestead of these 1 900 000 people. And the floodplain areas of the lower Yellow River are planned as important flood detention and sediment deposition areas. Therefore, in order to reduce the inundation losses of the floodplain areas, control operation for common and small floods turns to be very important。




2

面临的挑战

Challenges

1

How to perform the Longyangxia and Liujiaxia reservoirs flood control operation, considering flood control of the Ningxia-Inner Mongolia reach?

2

How to perform the Xiaolangdi reservoir flood control operation for common and small floods during its sediment-retaining and sedimentation period? Considering both flood control and sediment reduction?

3

How to analyze the hydrographs and characteristics of common and small floods of Huayuankou Station under current projects condition, to provide the basis for reservoir operation?

4

What is the joint operation modes of the flood control projects system, subjecting to condition changes?

3

研究思路

Research Procedures

According to the sources of flood and distribution characteristics of flood control projects, the upper Yellow River and the middle and lower Yellow River were studied separately.

The upper Yellow River

The main study is that whether the Longyangxia and Liujiaxia reservoirs can give consideration to flood control of Ningxia-Inner Mongolia regions.

The middle and lower Yellow River

The key research is that the operation modes of Xiaolangdi reservoir to the common and small floods.

4

上游方案研究
Scheme Research of the Upper Yellow River

The flood control capacity under 2594m (design limited water level) of the Longyangxia reservoir can be used to provide the flood-control safety of the Ningxia-Inner Mongolia reaches.

In most years, the Longyangxia and Liujiaxia reservoirs can only give partial consideration to the flood-control safe of the Ningxia-Inner Mongolia reaches.

If the water level of the Longyangxia reservoir at the beginning of the flood season has been reached at 2588m , the joint operation modes of the Longyangxia and Liujiaxia reservoirs , can ensure the outflow of the Liujiaxia reservoir less than 2500m^3/s for floods with 10 years recurrence periods.

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下游方案研究
Schemes of the Middle and Lower Yellow River

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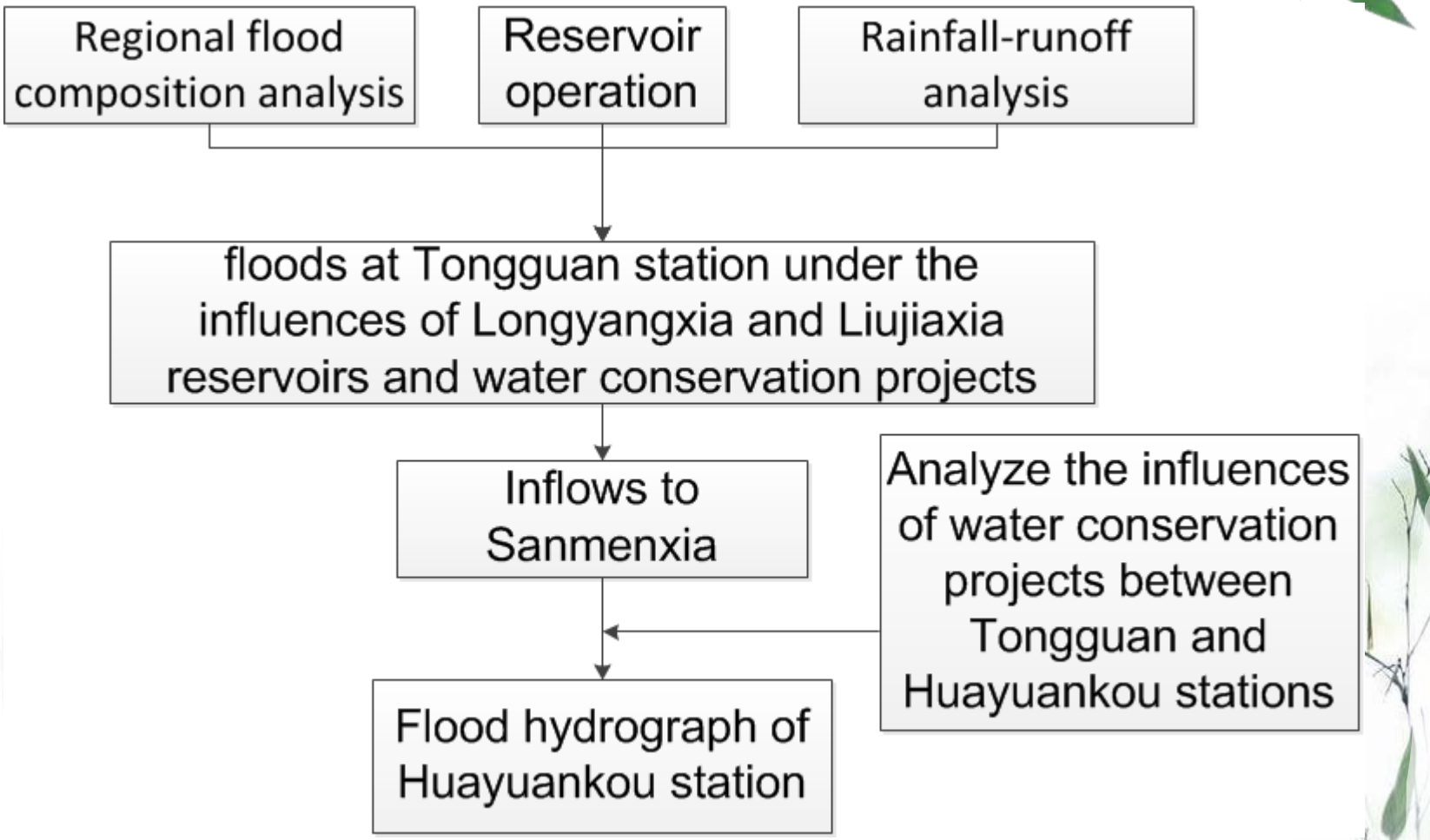
5.1 现状工程影响后花园口中小洪水特性分析

Characteristics analysis of common and small floods at Huayuankou station under influences of current projects

5.1.1 现状工程对花园口洪水影响研究

Influences of current projects on floods at Huayuankou station



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5.1.2 花园口中小洪水量级确定
Magnitudes definition of common and small floods at Huayuankou station

Magnitudes of common and small floods was defined as between 4000m^3/s and 10000m^3/s at Huayuankou station.

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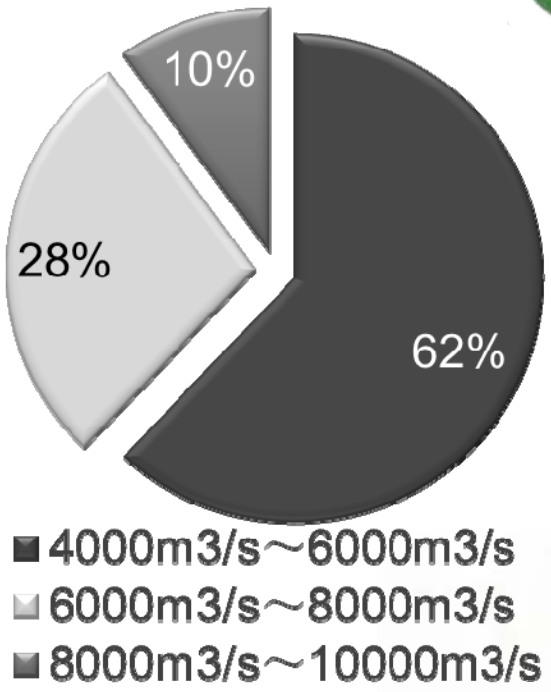
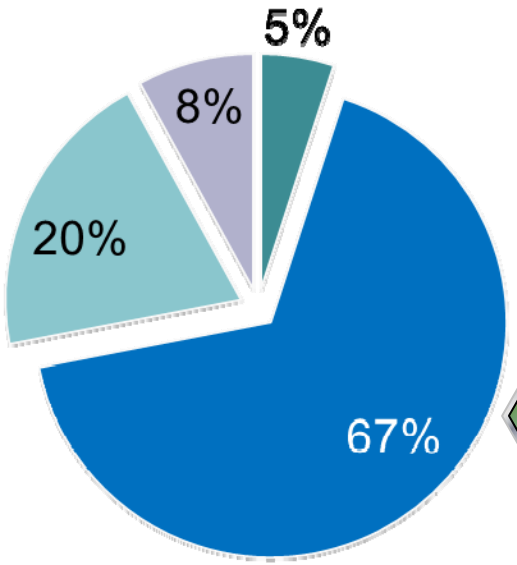
5.1.3 中小洪水特性分析
Characteristics of common and small floods

1 The occurring probability of common and small floods is about twice a year.





2 Floods with peak flow magnitudes between 8000 m^3/s and 10000m^3/s mainly occur in July or August. Peak flow magnitudes of floods occurring in September or October are usually lower than 8000 m^3/s.

3 About 80% of main peak flow water volumes of common and small floods are sourced from basins upstream of Tongguan station.

4 The peak flows within Xiaolangdi-Huayuankou interval of floods sourced mainly from Sanmenxia-Huayuankou interval, are usually higher than 4000m^3/s.

5 The flood magnitudes at Tongguan station decrease and the proportion of hyperconcentrated floods increase. Almost all of the larger floods are sediment hyperconcentrated.

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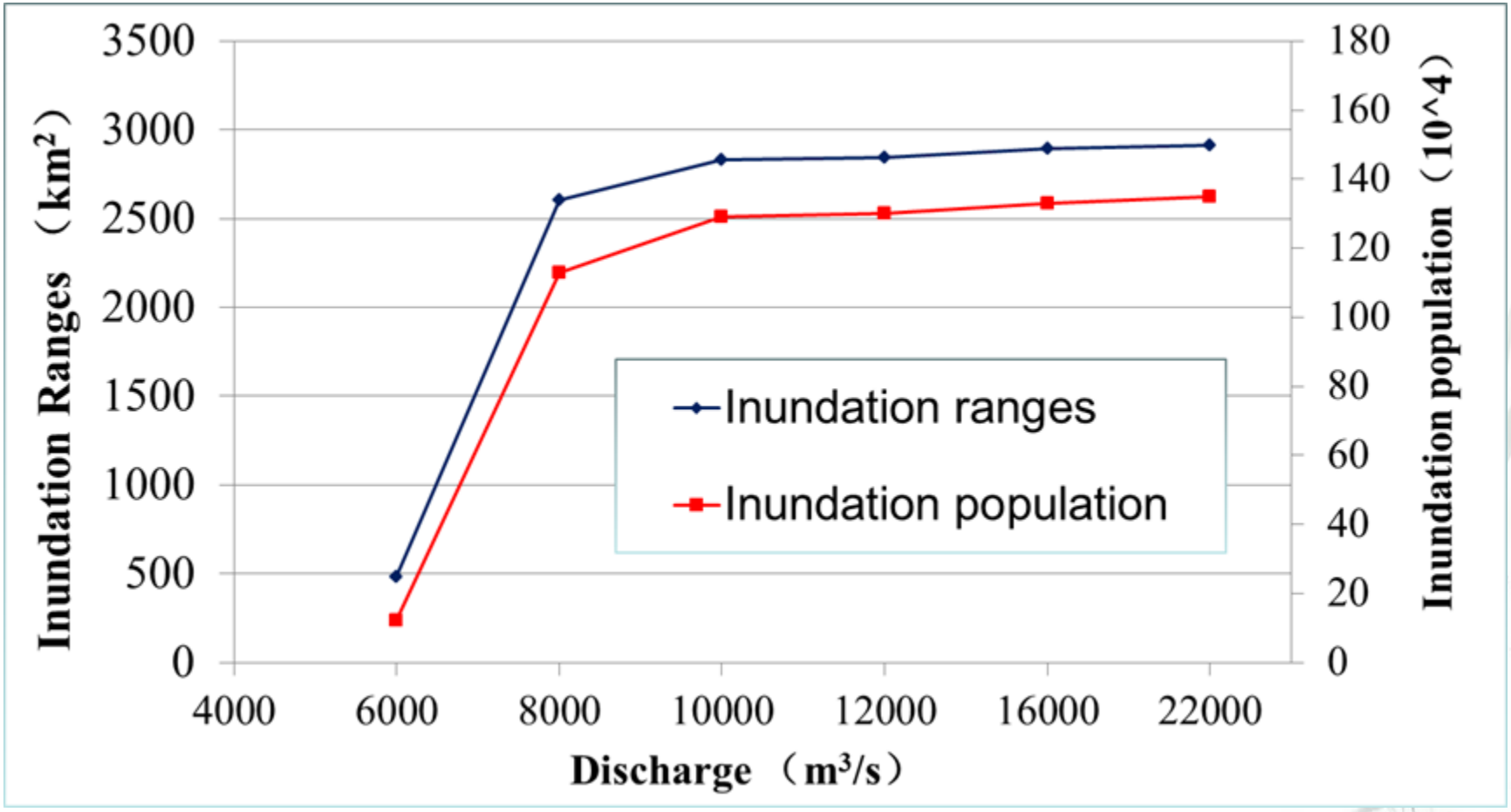
5.2 滩区淹没分析

Inundation loss analysis of floodplain areas

inundation loss of floodplain areas is lowest with peak flows of Huayuankou station smaller than 6000m³/s, and increase sharply along with peak flows increase from 6000m³/s to 8000m³/s. But the increased proportion is few with peak flows increase from 8000m³/s to 22000m³/s.



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5.3 中小洪水防洪运用方式研究
Flood control operation modes for common and small floods

5.3.1 小浪底水库防洪运用阶段划分
Phases division of flood control operation

Based on sedimentation amount and flood control storage capacity below 254m, the flood control operation period of Xiaolangdi can be divided into three phases:

Period	Sedimentation amount （10^8m^3）	Flood control storage capacity below 254m （10^8m^3）
The first	22～42	⩾20
The second	42～60	7～20
The third	60～75.5	0～7

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5.3.2 中小洪水防洪运用指标分析

Index analysis of control operation for common and small floods

- Requirement analysis of control storage capacities for common and small floods

The flood control storage capacities of Xiaolangdi reservoir to control different magnitudes of floods were obtained 10^8 m^3

Peak flow of floods at Huayuankou station	Control the peak flows to be at Huayuankou station		
	4000m^3/s	5000m^3/s	6000m^3/s
10000m^3/s	18	8.7	6
8000m^3/s	10	5.5	3.2
7000m^3/s	5.7	3.3	2.4

Results show that :
the bigger the magnitudes of common and small floods at Huayuankou station are, the smaller the peak flows should to be controlled and the bigger the required flood control storage capacities should be.

- Control discharge for common and small floods

The flood control discharges at Huayuankou station should be adjusted as the sedimentation amount varies. In the three phases of flood control operation, the flood control discharges should be 4000m^3/s, 5000m^3/s or 6000m^3/s respectively.

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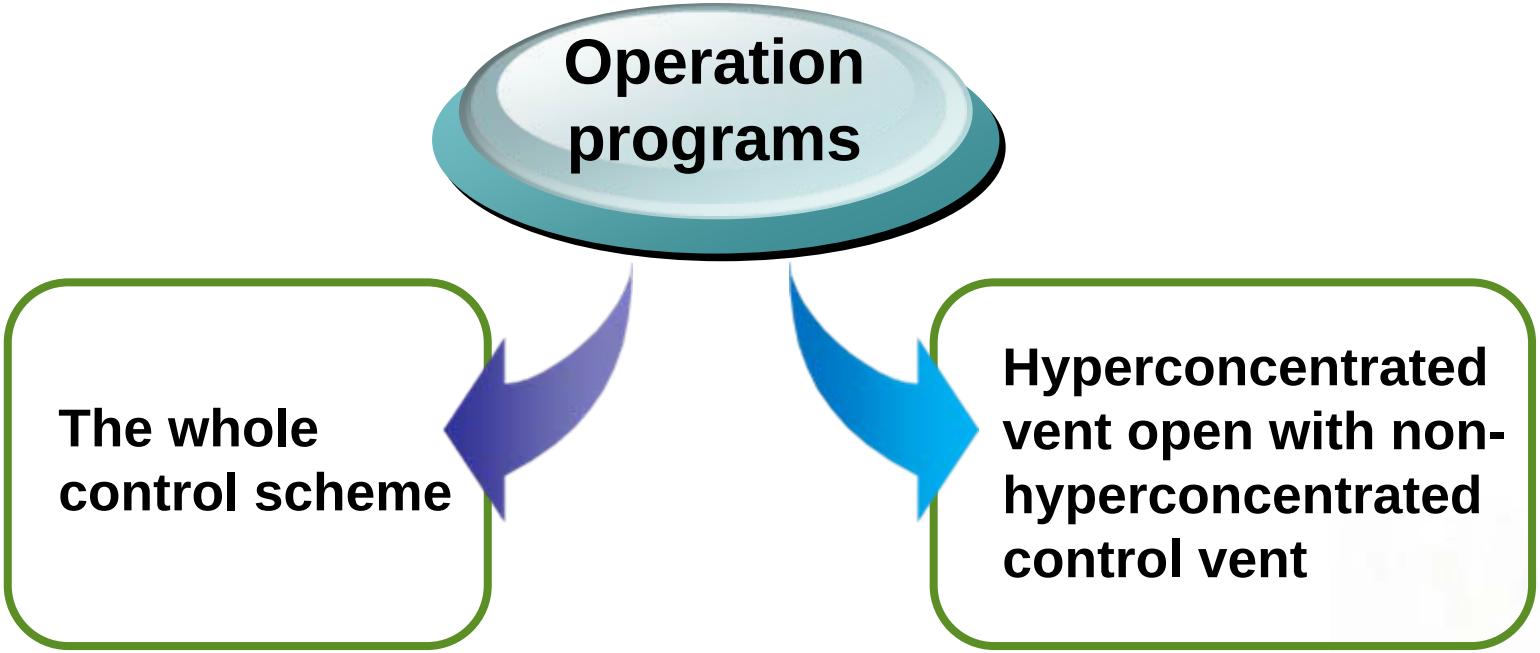
5.3.3 中小洪水防洪运用方式研究

Control operation study for common and small floods



After the comprehensive comparison of the two operation programs, the final recommendation is the open vent of high sediment concentration flood as often flood operation.

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5.4 下游防洪工程体系联合运用方式研究
Joint operation of flood control projects system

Major floods in the upstream of the Sanmenxia reservoir

The characteristics:

- **Big peakflow**
- **High sediment concentration**

The free discharging first and controlling discharging later operation mode of the Sanmenxia reservoir should be used when the recurrence of floods reaches or exceeds the standard of 50 years recurrence.

Firstly，following the flood control operation modes; when the water level of the reservoir is about to 254m, to control the discharge of Huayuankou less than 10000m³/s; when the water level of the reservoir is about to 263m～266.6m, increase the outflow of the reservoir.

when Xiaolangdi reservoir increase the outflow, the Dongpinghu flood detention project is put into operation, the operation probability of which is about of 100～200 recurrence periods.

Major floods in the downstream of the Sanmenxia reservoir

The characteristics:

Short forecast intervals

Low sediment concentration

Xiaolangdi reservoir should take control operation modes for common and small floods firstly; once the reservoir storage reaches the flood control storage capacity or the discharge of the xiaolangdi-Huayuankou interval is more than or equal to 9000m^3/s, Xiaolangdi reservoir should decrease the outflow to the hydropower discharge.

When the water level of the Xiaolangdi reservoir is about to 263m～269.3m, the outflow of the Sanmenxia reservoir is control the same as the outflow of the Xiaolangdi reservoir, the operation probability of which is about of about 100～200 recurrence periods.

Luhun, Guxian and Hekoucun reservoirs will turn into flood control modes for the lower Yellow River when the forecasted peak flows reach 12000m³/s at Huayuankou station.

When the discharge of Sunkou is more than 10000m³/s, the Dongpinghu flood detention project is put into operation, the operation probability of which is about of 20~30 recurrence periods.

When the flood is out of flood control standard, the Beijindi flood detention project is put into operation.

6

结论
Conclusions

1 In most years, the Longyangxia and Liujiaxia reservoirs can only give partial consideration to the flood-contronl safe of the Ningxia-Inner Mongolia reaches.

2 Under the influences of current projects, the magnitude of normal and small flood at Huayuankou station is about 4000m^3/s～10000m^3/s.

3 Inundation loss of floodplain areas is lowest with peak flows of Huayuankou station smaller than 6000m^3/s.

4 As the increase of the sedimentation amount of the Xiaolangdi reservoir, the flood control discharge of common and small floods switch from 4000m^3/s to 5000m^3/s~6000m^3/s. Hyperconcentrated vent open with non-hyperconcentrated control vent is recommended.

5

Joint operation mode of downstream flood controlling system is as follows.

- **For flood mainly coming from upper-streams**, Sanmenxia is taken firstly,then Xiaolangdi reservoir operate, and the Dongpinghu detention project divide the flood when the discharge at Sunkou station is more than 10000 m^3/s.
- **For flood mainly comes from downer-streams,** Xiaolangdi reservoir is put into controlling operation firstly. And then Sanmenxia, Luhun, Guxian and Hekoucun reservoirs are taken. When the discharge of Sunkou is more than 10000m^3/s, the Dongpinghu flood detention project is put into operation; and when the flood is out of flood control standard, the Beijindi flood detention project is put into operation.

Thank you!