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南京水利科学研究院

XVIII World Water Congress

Regional Case Study on Flooding Risk Zoning and Prevention Zoning Methods

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OUTLINE

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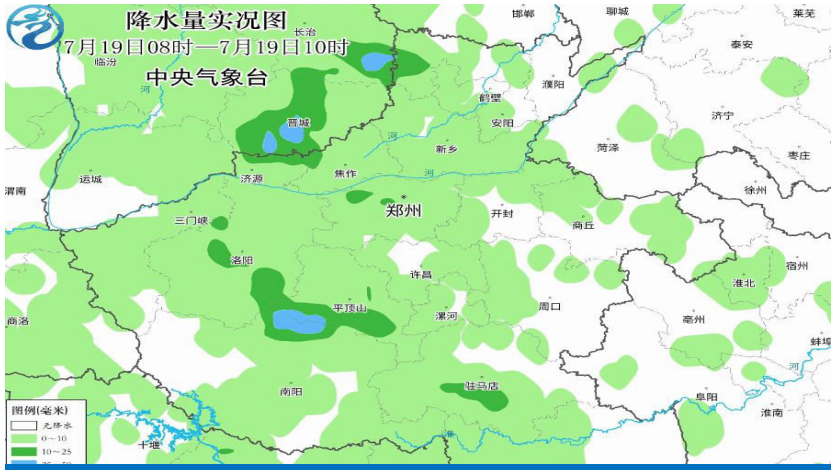
1. Background

1.1 Flood disaster in China

- Rain and heat in different periods, with more rainfall in summer and less in winter
- The territory is vast, with significant differences in flood characteristics between the north and south
- The rapid development of social economy, results in significant losses and impacts from flood disaster

2022 Qingyuan, Guangdong



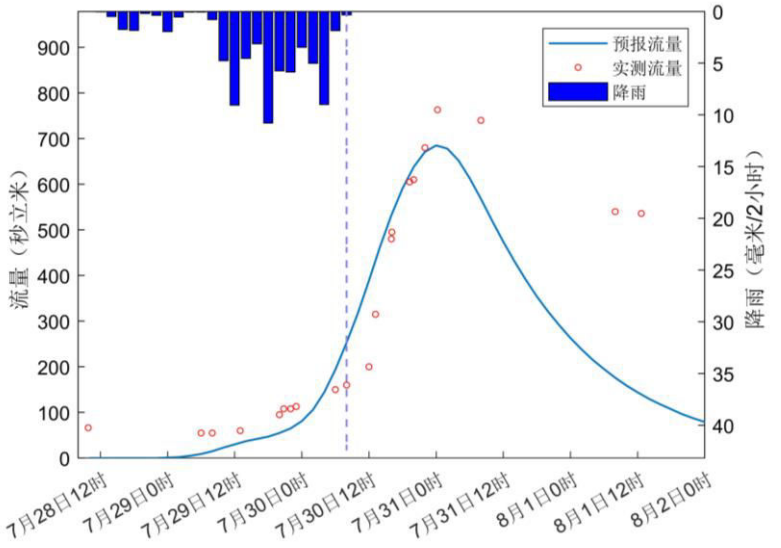
Precipitation of Zhengzhou “7•20”

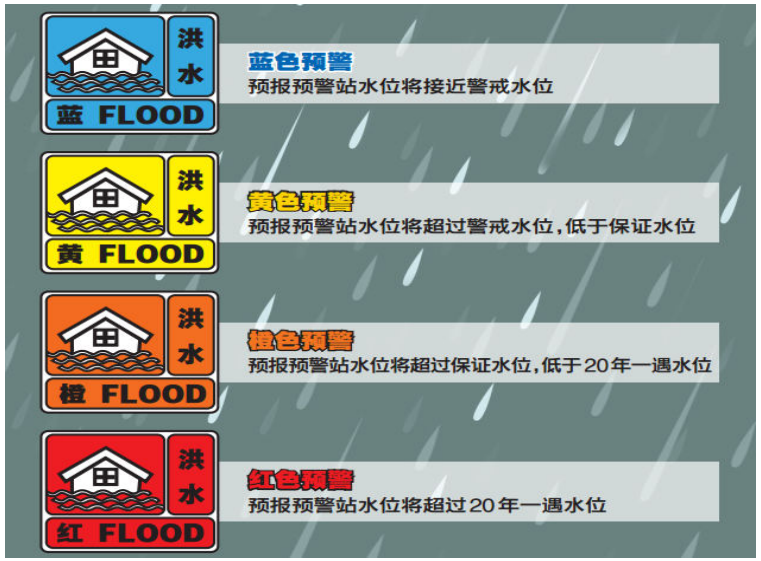
14 deaths in Metro Line 5 in Zhengzhou

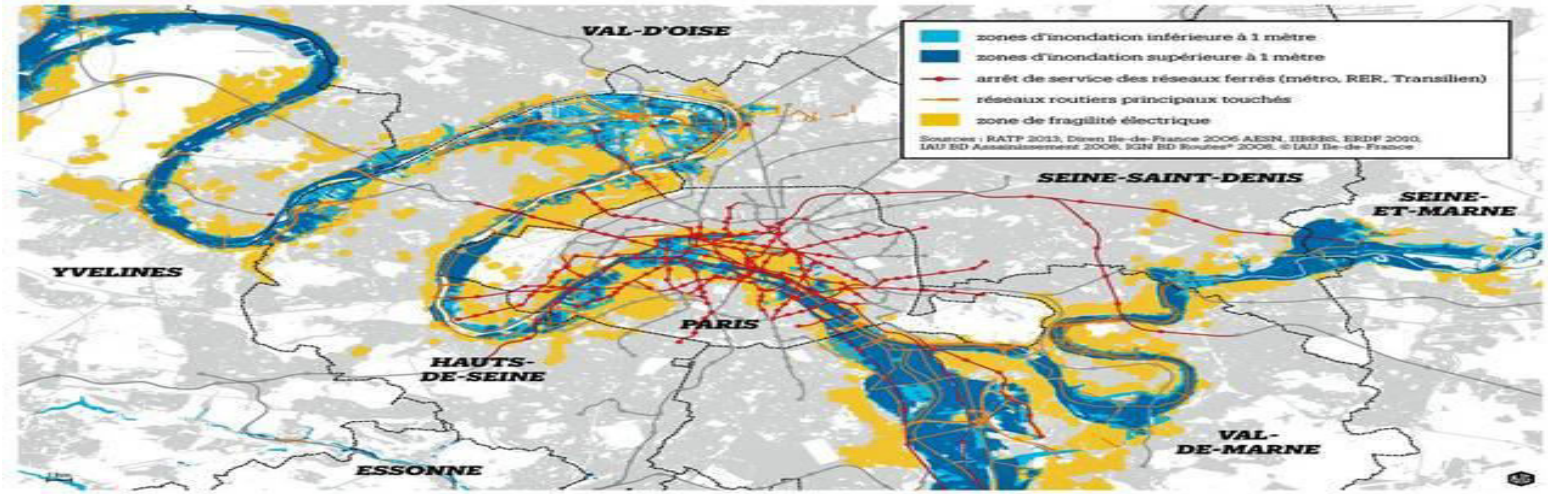
1. Background

1.2 Flood risk management

- Flood forecasting
- Flood warning
- Flood control operation
- Flooding risk maps
- Flooding risk zoning
- Flooding prevention zoning
- Flooding insurance
- etc







1. Background

1.3 Comprehensive risk survey

- **Organize**: The first national comprehensive risk survey of natural disasters from 2020 to 2022
- **Task**: Natiaonal Flood and Drought Risk Survey, The Ministry of Water Resources, and guided local water resources department
- **Stardand**: Technical requirements for flood risk zoning and prevention zoning (FXPC/SL P-01)

国务院办公厅文件

国办发〔2020〕12号

国务院办公厅关于开展
第一次全国自然灾害综合风险普查的通知

各省、自治区、直辖市人民政府，国务院各部委、各直属机构：

按照党中央、国务院决策部署，为全面掌握我国自然灾害风险隐患情况，提升全社会抵御自然灾害的综合防范能力，经国务院同意，定于2020年至2022年开展第一次全国自然灾害综合风险普查工作。现将有关事项通知如下：

一、普查目的和意义

全国自然灾害综合风险普查是一项重大的国情国力调查，是提升自然灾害防治能力的基础性工作。通过开展普查，摸清全国

第一次全国自然灾害综合风险普查技术规范（FXPC/SL P-01）

洪水风险区划及防治区划编制
技术要求

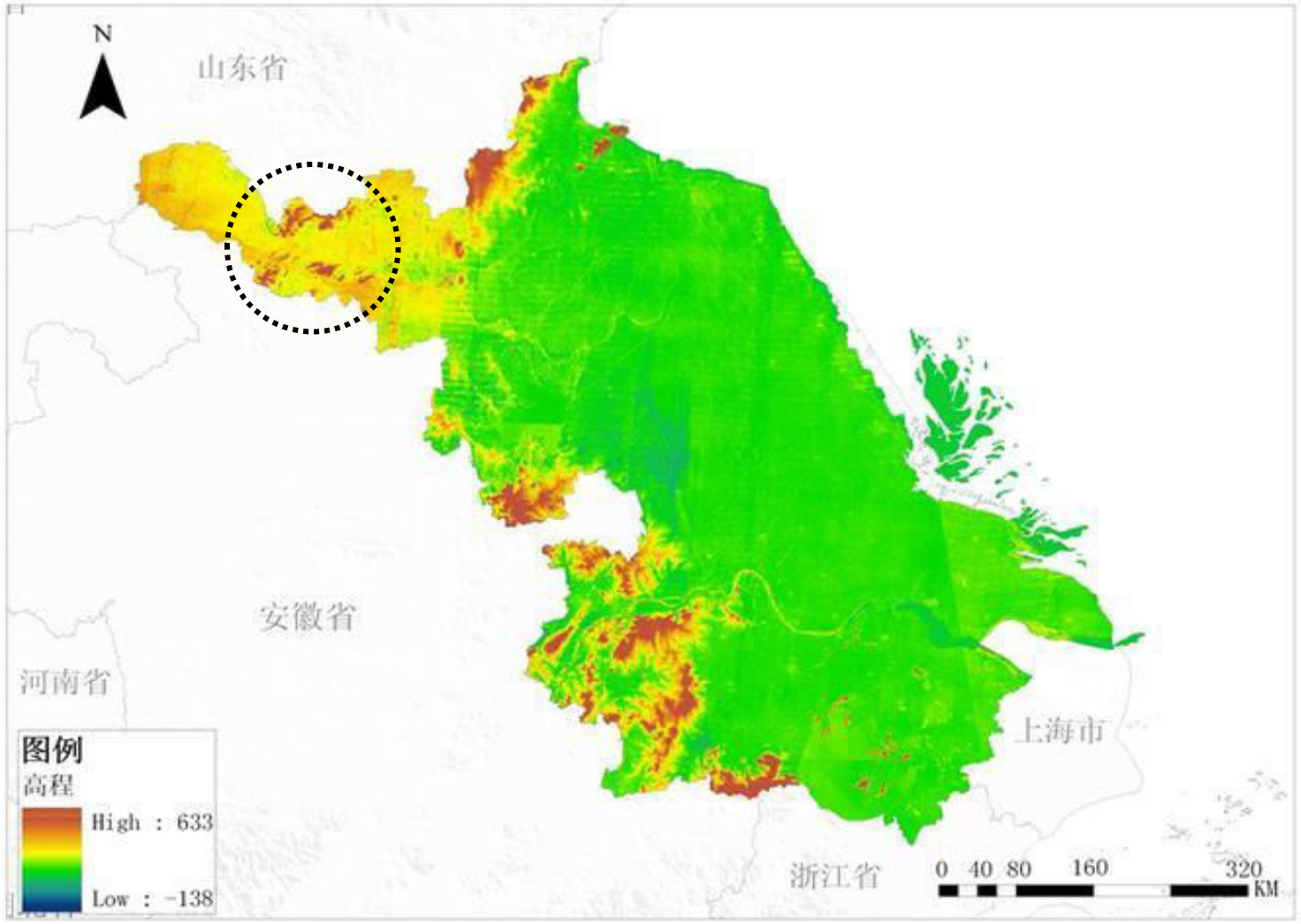
How universal is the standard ?

2021－09

水利部水旱灾害风险普查项目组　编制

1. Background

1.4 Research Idea and purpose



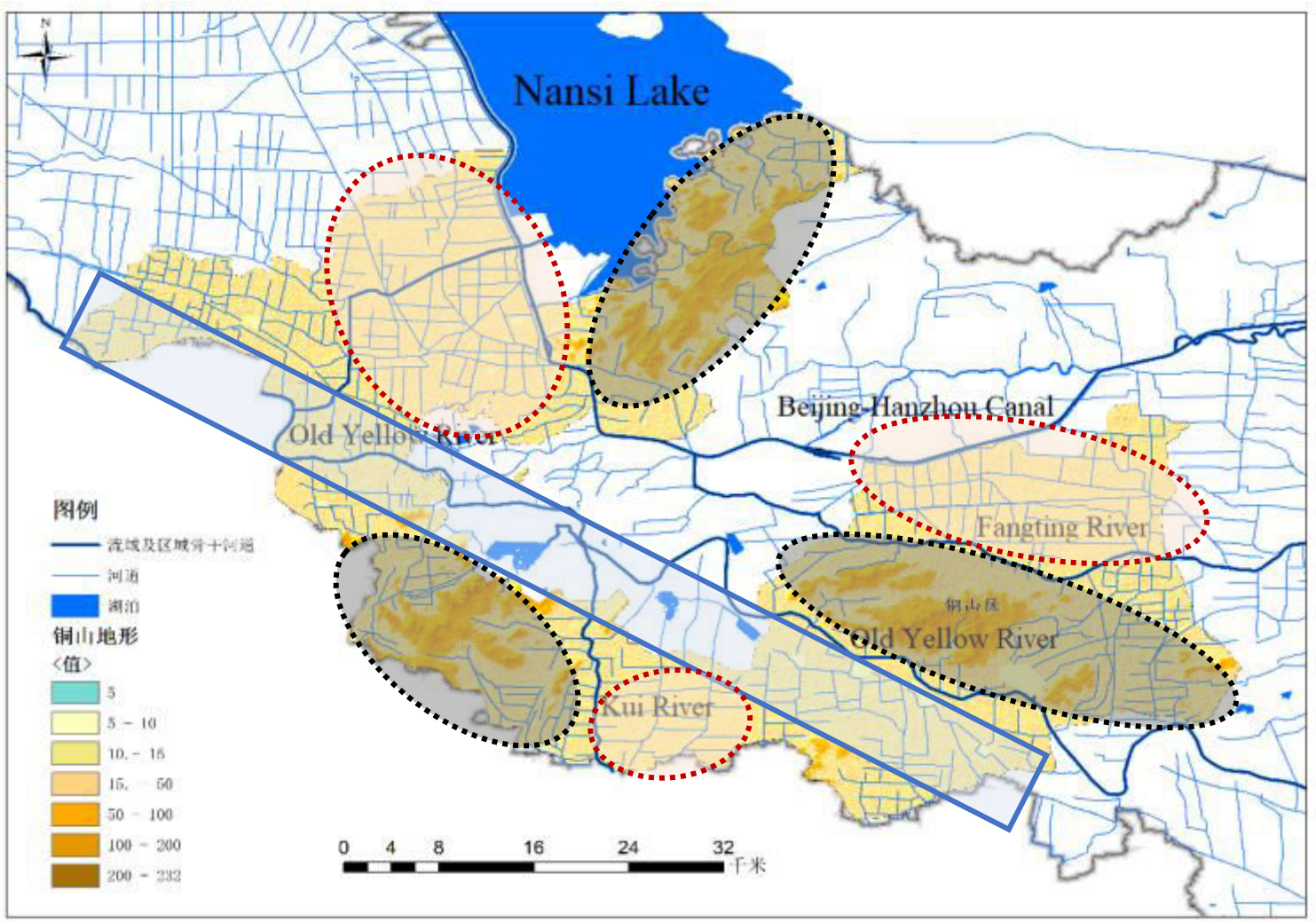
- **Idea**: adopts the technical requirements, selects a county-level administrative region in Jiangsu Province, China, studies the feasibility and applicability of technology method

- **Purpose**: To provide corresponding opinions & suggestions

2. Methodology

2.1 Regional overview: Tongshan District

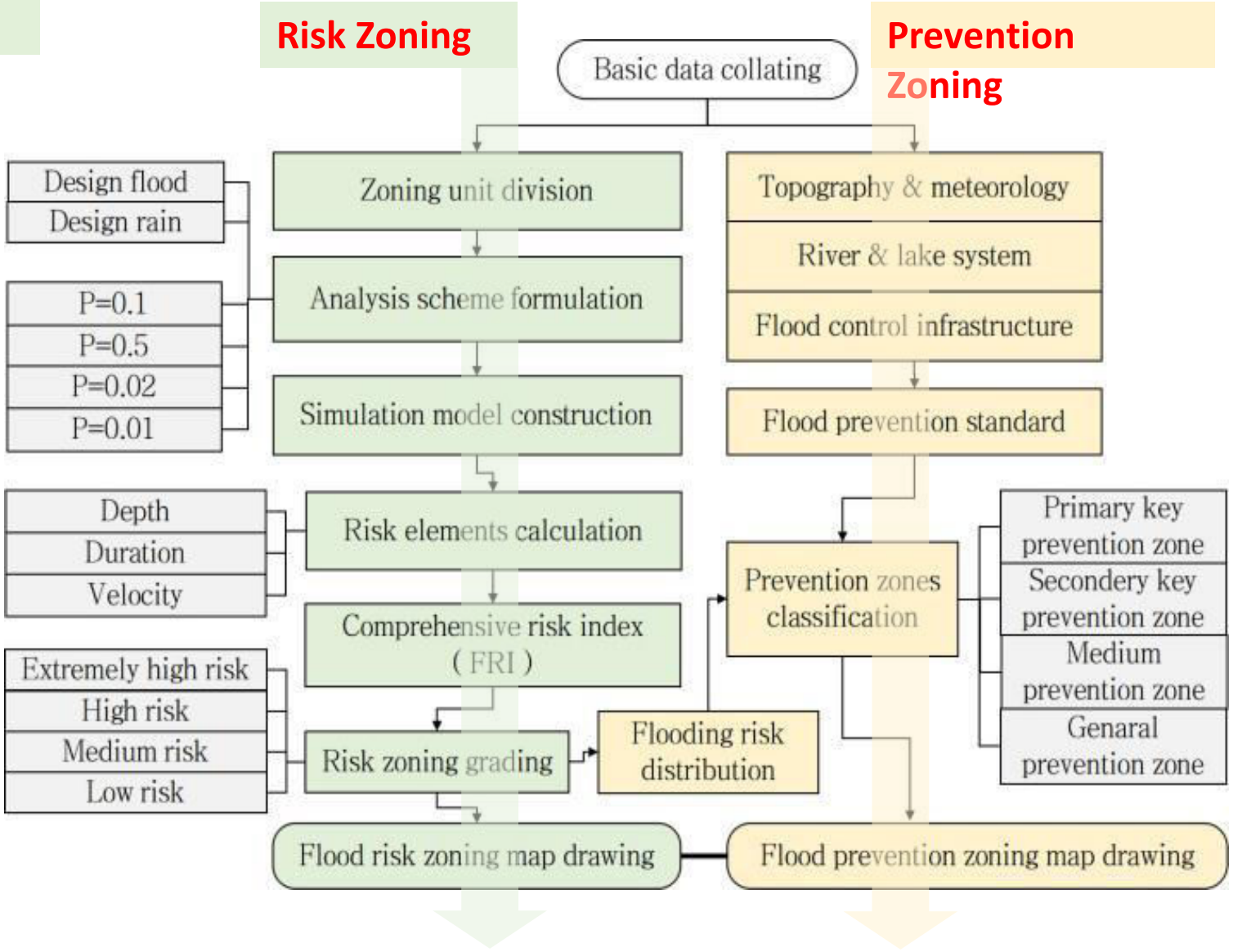
- Northwest of Jiangsu Province, a total area of 1900 km^2 and a population of 1228500
- **"three plains, three mountains, and the old Yellow River channel, a high ground"**
- Old Yellow River, Beijing-Hangzhou Canal, Kui River, Fangting river...



2. Methodology

2.2 Technology roadmap

- WRM, SL483-2017, 2017
- WRM, Trail, 2019
- WRM, FXPC/SL P-01, 2021
- Flooding risk zoning framework
- Flood disaster prevention zoning framework



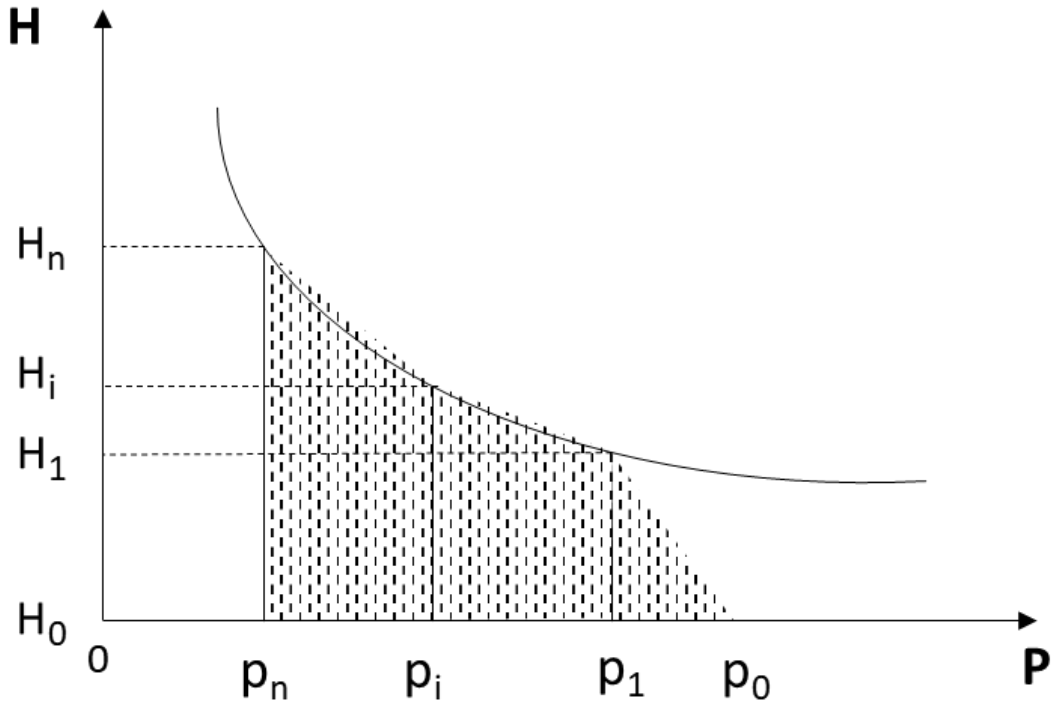
2. Methodology

2.3 flooding risk level classification standard

Flooding Comprehensive Risk Index (FRI)

$$FRI = \sum_{i=0}^{n} (P_i - P_{i+1})\left(\frac{H_i + H_{i+1}}{2}\right)$$

- when FRI<0.15 is "low risk"
- when 0.15≤FRI<0.5 is "medium risk"
- when 0.5≤FRI<1 is "high risk"
- when FRI≥1 is "extremely high risk"



2. Methodology

2.4 Prevention level classification standard

Standard \ Risk	P1 ⩾0.3 or P2 ⩾0.5	P1 ⩾0.2 or P2 ⩾0.4	P1 ⩾0.1 or P2 ⩾0.3	Other
High & higher standard	Primary key prevention	Secondary key prevention	Medium prevention	General prevention
General & low standard	Secondary key prevention	Medium prevention	General prevention	General prevention

$$P1 = \frac{A_{eh}+A_{hi}}{A_{to}} \times 100\%$$

$$P2 = \frac{A_{eh}+A_{hi}+A_{me}}{A_{to}} \times 100\%$$

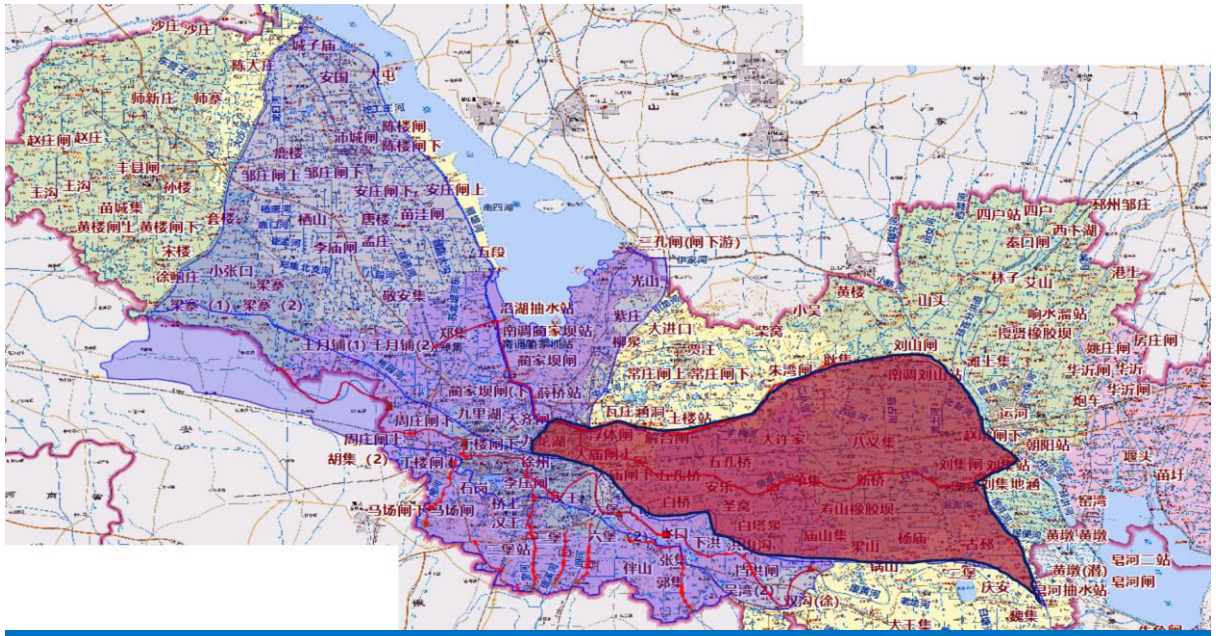
- A_{to} refers to the total area of the flood protection zone in a prevention zoning unit
- A_{eh}, A_{hi}, A_{me} are respectively extremely high, high, medium risk area of the flood risk zone in a prevention zoning unit

2. Methodology

2.5 Flooding simulation

- build a hydrodynamic model,adopts one-dimensional and two-dimensional coupling hydraulic calculation methods.
- One-dimensional unsteady flow simulation of river channel is based on Saint-Venant Equation, and the model construction is mainly to create river cross-section, hydraulic engineering facilities and their regulation rules
- Two-dimensional flood flow simulation is based on the shallow water assumption

- Continuity equation: $\frac{\partial A}{\partial t}+\frac{\partial Q}{\partial x}=q$
- Momentum equation: $\frac{\partial Q}{\partial t}+\frac{\partial}{\partial x}\left(\alpha\frac{Q^2}{A}\right)+gA\left(\frac{\partial y}{\partial x}\right)+gAS_f-u\cdot q=0$



Model calculation scope

2. Methodology

2.6 Flood analysis scheme

- **Flood sources**

  Nansi, Kui, Old Yellow...
- **Flood magnitude**

  50 years, 100 years
- **Collapse object**

  L & R Embankments
- **Parameter settings**

  Height, width...
- **Boundary condition**

  Flow process, design level

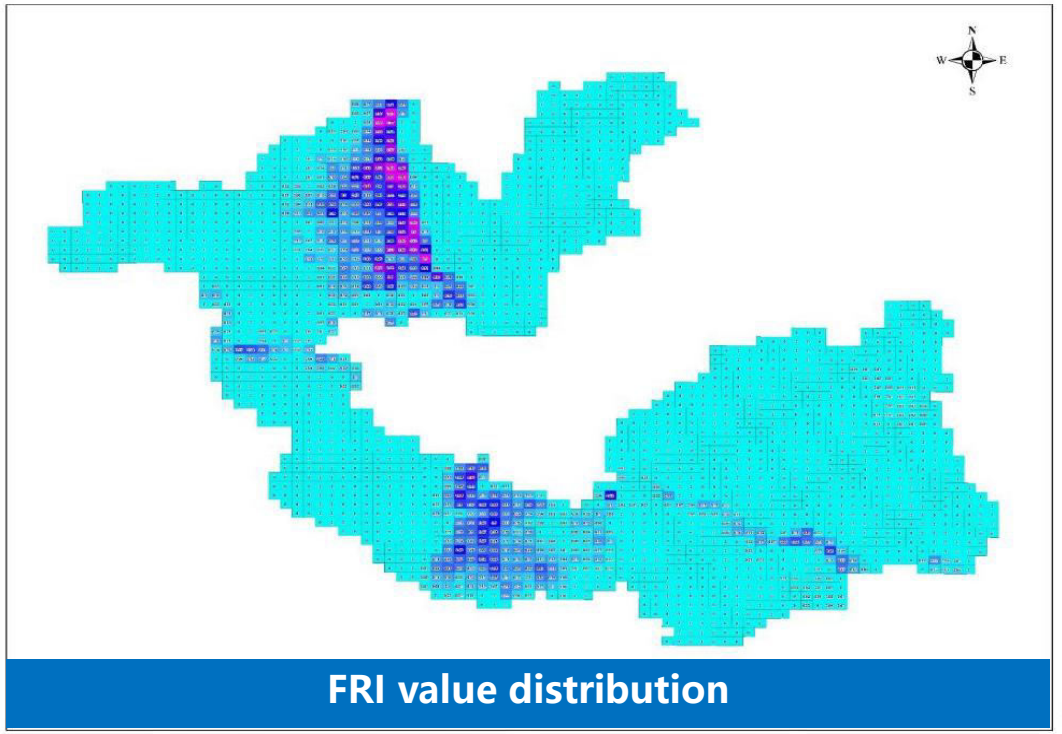
序号	洪水量级		洪水来源	溃决对象	溃口位置	溃口参数	计算边界条件
1	50年一遇与100年一遇设计洪水	外洪	南四湖	湖西大堤	五段闸	180 m	溃口流量过程
2			南四湖	湖西大堤	蔺家坝闸	180 m	溃口流量过程
3			南四湖	郑集河左堤	回水段	150 m	溃口流量过程
4			南四湖	郑集河右堤	回水段	150 m	溃口流量过程
5			中运河	右堤	胡家险工	100 m	溃口流量过程
6			中运河	右堤	三岔河险工	100 m	溃口流量过程
7		内洪	废黄河	左、右堤	全线	/	超设计水位漫滩
8			奎 河	左、右堤	全线	/	超设计水位漫滩

3. Results & Discussion

3.1 Overall flooding situation

- Statistics could be conducted according to **four zones**
- 50 years design flood: 399.59 km^2 (>0.01m) and 208.97 km^2 (>1.00m)
- 100 years design flood: 491.75 km^2 (>0.01m) and 255.1 km^2 (>1.00m)

序号	单元名称	50年一遇洪水淹没面积（km^2）			100年一遇洪水淹没面积（km^2）		
		1~2m	2~3m	>3m	1~2m	2~3m	>3m
	合计	129.45	58.35	21.17	149.58	71.05	34.47
1	南四湖湖西区	66.39	36.56	15.19	73.25	40.92	19.93
2	中运河南片区	0.00	0.00	0.00	2.10	0.31	0.09
3	废黄河区	18.95	8.70	4.34	27.31	13.95	12.34
4	奎河区	44.11	13.09	1.63	46.92	15.87	2.11



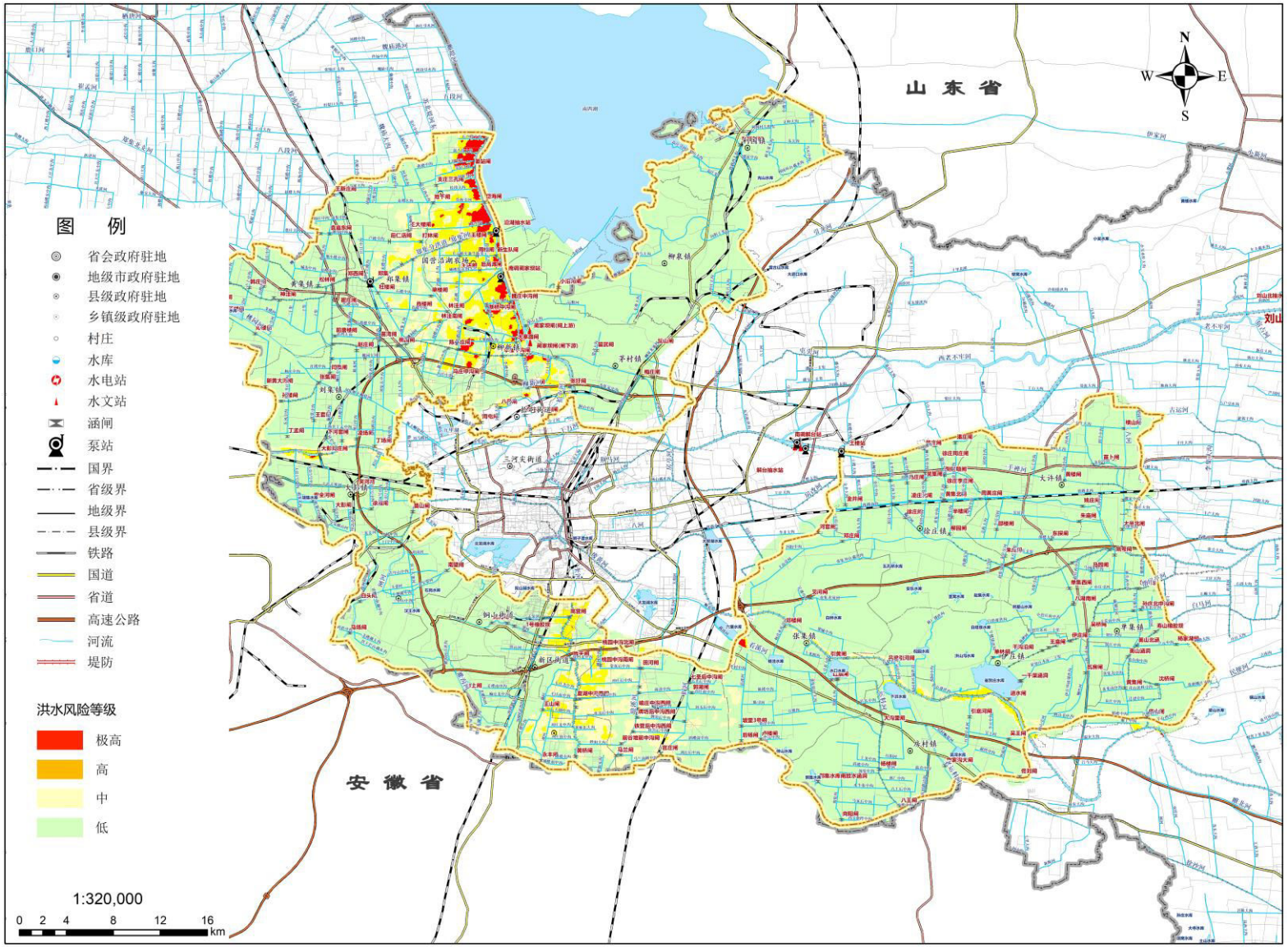
FRI value distribution

3. Results & Discussion

3.2 Risk zoning results & map

- the extremely high-risk area is 12.96 km2, accounting for 1%;
- The high-risk area is 58.88 km2, accounting for 3%;
- The medium risk area is 124.29 km2, accounting for 6%;
- The low risk area is 1703.86 km2, accounting for 90%.

It is consistent with the actual situation in Tongshan District, and also indicates the flooding risk zoning results are reasonable

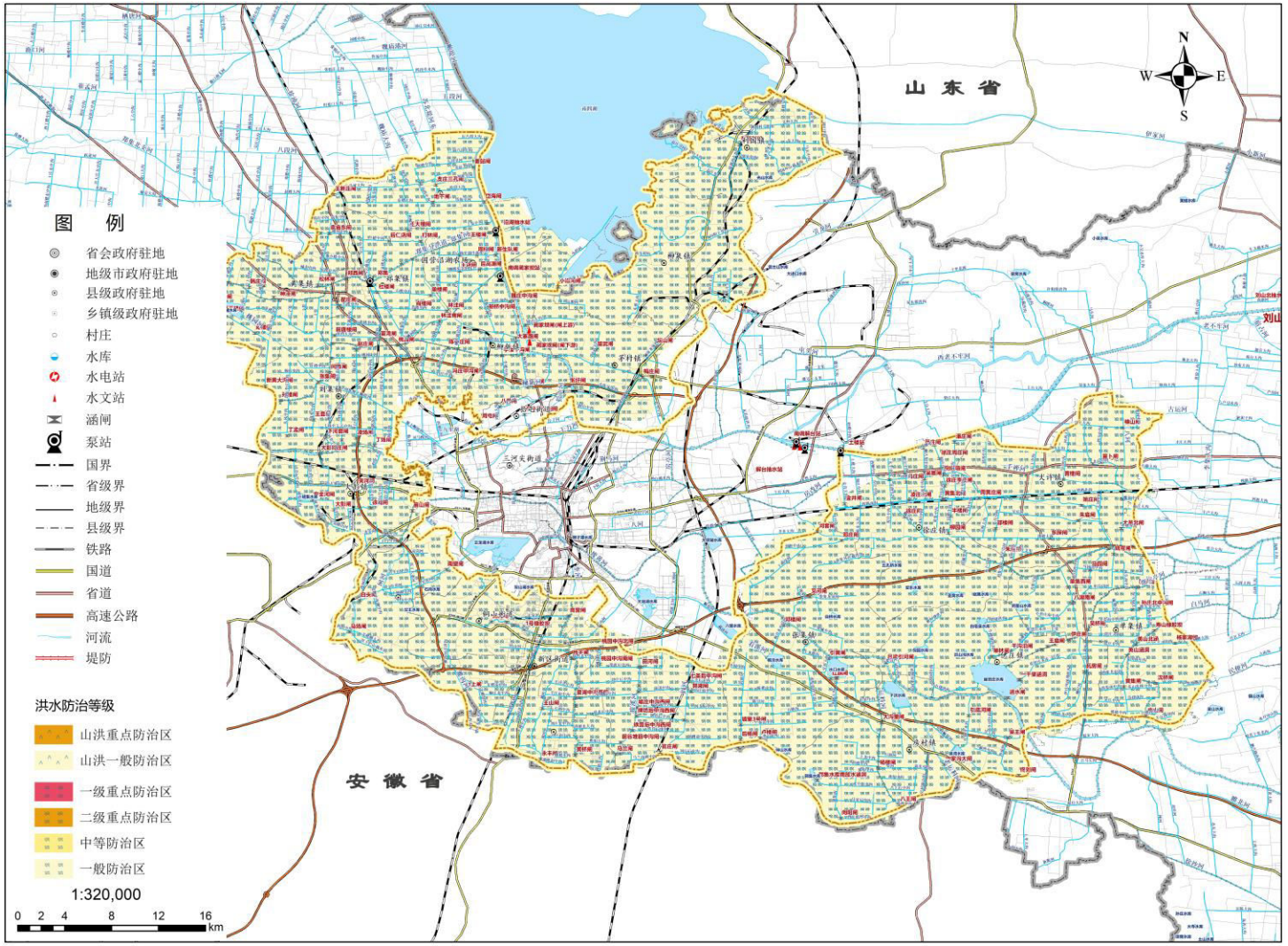


3. Results & Discussion

3.3 Prevention zoning results & map

- the whole area of Tongshan District belongs to the general prevention zone.

It is consistent with the key flood control engineering projects arranged in the flood control planning of Huai River and Yishusi River, and also indicates that the prevention zoning results are reasonable



4. Conclusion

(a). When considering the regional landform, watershed, river embankment and other linear infrastructures, **Tongshan District is divided into four main river/lake flood zoning units**: Nansi Lake west unit, Middle Canal south unit, Old Yellow River unit and Kui River unit, this zoning division is acceptable.

(b). According to the flooding simulation results of **two different frequency flood scenarios (P=0.01 & P=0.02)**, the calculated flood risk factors, mainly inundated water depth indicator, and the flooding risk grades are carried out, so as to the flood risk zone map is drawn based on the FRI, which **conforms to the actual spatial distribution of flooding risk in Tongshan District**.

(c). According to the current flood control standards in the four zoning units, the flood disaster prevention zoning grades of each unit are analyzed and determined, and the flood disaster prevention zone map is drawn integrated with flooding risk zoning, which is **consistent with the key flood control engineering projects planning in Tongshan District**.

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Q & A