中国水利水电科学研究院
China Institute of Water Resources and Hydropower Research

China National Flash Flood Disaster Prevention Project

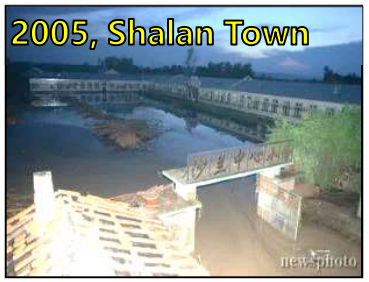
China Institute of Water Resources and Hydropower Research (IWHR)

Outline

- General Introduction
- Main Achievements of Flash Flood Investigation and Assessment
- Monitoring and Warning System for Flash Flood Prevention
- State-level Monitoring and Warning Platform and its Services
- Community-based Flash Flood Prevention
- Existing Challenges

1. General Introduction

- Flash flood prevention is extremely difficult and the weak aspect in flood control and disaster reduction work in China. Death toll of flash floods take 70% of that caused by all flood disasters.
- In 2010, National Flash Flood Project was launched, 30 billions RMB have been invested in recent 7 years.
- Main contents of the project include:
  - ✓ Flash flood investigation and assessment
  - ✓ Monitoring and warning system
  - ✓ Community-based prevention system



1. General Introduction

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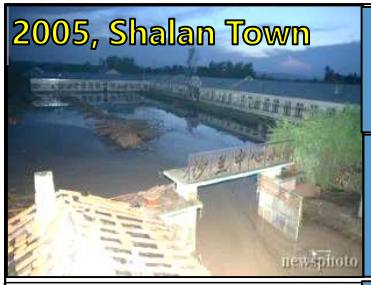
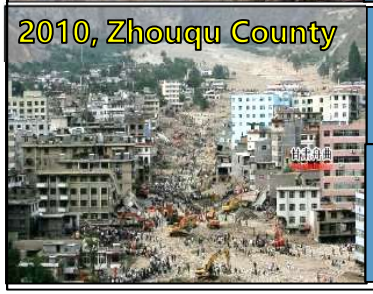


117 death

105 student death

346 death

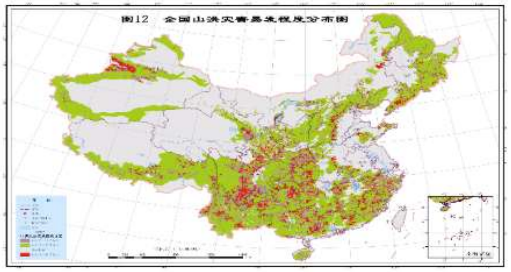
89 losing



1501 death

264 losing

Disaster Events



Densely distributed in all mountain areas, Frequently happened with many disastrous events

In definite season and region

Happen in very short time with catastrophic results

Casualties take 70% of that caused by all flood disasters

Extremely difficult to forecast and prevent

Characteristics

National Flash Flood Prevention Planning was approved in 2006

General Planning on Medium- and Small sized River Training, rehabilitation of dams with defects, flash flood and geological disaster prevention in 2011

Implementation Plan of National Flash Flood Prevention Project (2013-2015) 30 Province, 305 cities, 2058 counties

National Flash Flood Prevention Project (2010-2016), Total investment 29 billion RMB

- Monitor and Warning 16.7 billion
- Investigation and assessment, 3.3 billion
- Community-based prevention system, 5.2 billions
- Structural measures 3.9 billions

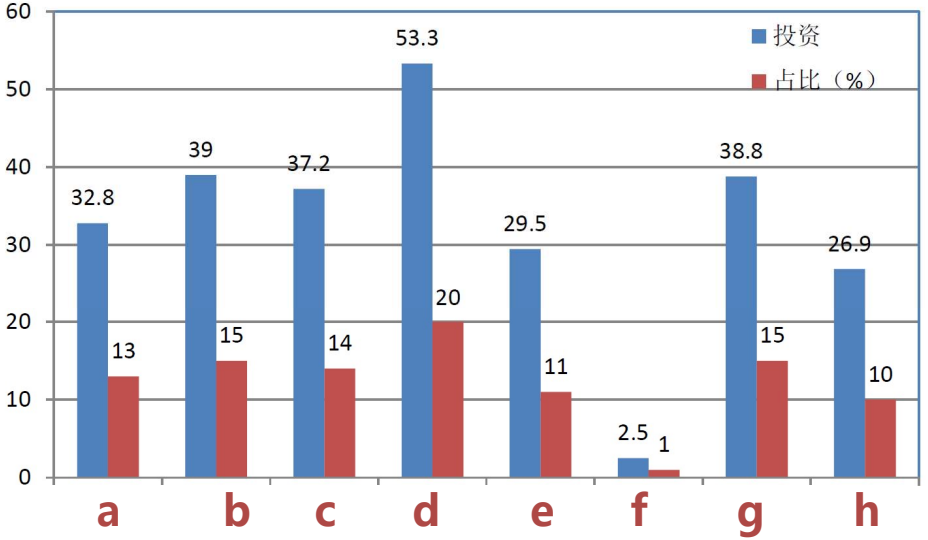
Prevention work

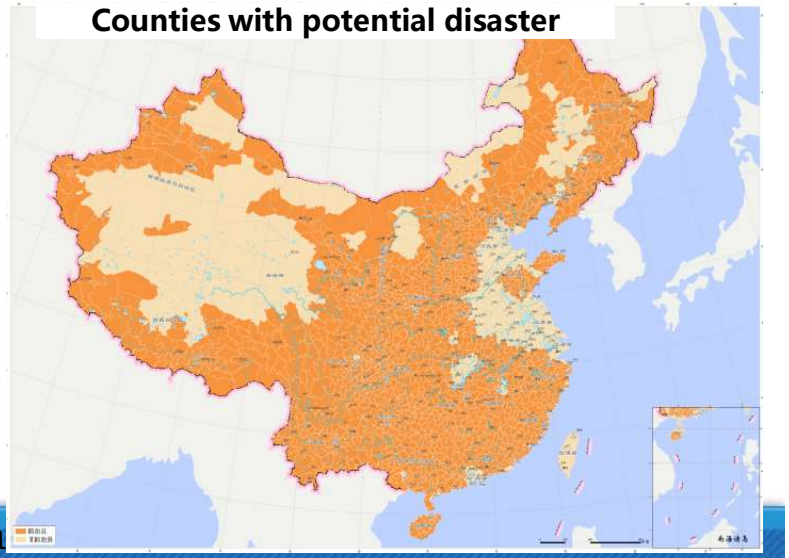
National Flash Flood Prevention Project is being continued……

1. General Introduction

2010-2015, Project Contents and Investments

	Invest. (billion)	Ratio (%)
Total	26	100
Investigation and assessment (a)	3.28	13
Monitoring (b)	3.9	15
Warning system (c)	3.72	14
Operation platform (d)	5.33	20
Community-based system (e)	2.95	11
Emergency rescuing (f)	0.25	1
Structural measure (g)	3.88	15
Others (h)	2.69	10





- Preliminarily understand the basic situations
- Fundamentally establish monitoring and warning system
- Gradually establish community-based prevention system
- Conduct structural measures for demonstration

2. Main Achievements of flash flood investigation and assessment work

Preliminarily clarify the disastrous areas, population distribution and underlying surface conditions

Counties	2138
Administrative areas (million km^2)	7.55
Towns (thousand)	32
Villages (thousands)	470
Sub-villages (millions)	1.57
Total population(billions)	0.9
Areas with risk (million km^2)	3.86
Areas with high risk(million km^2)	1.2
Villages in risk area (millions)	0.197
Sub-village in risk area (millions)	0.564
Enterprise (millions)	0.15
Threatened zone (millions)	0.52
Population in threatened region (millions)	58.36

Past flash flood events	53433
Investigated past flood	13014
Projects in stream channel	25
Automatic monitoring station	88969
Simple rain gauge	235890
Simple water stage gauge	47087
Wireless alert broadcast	201057
Streams need structural measures	31383
Investigated and assessed villages	157183
Channel section group	171762
Village with rainfall threshold for warning	142026
Village with water stage threshold for warning	33481
Map with threatened zone	102969

2. Main Achievements of flash flood investigation and assessment

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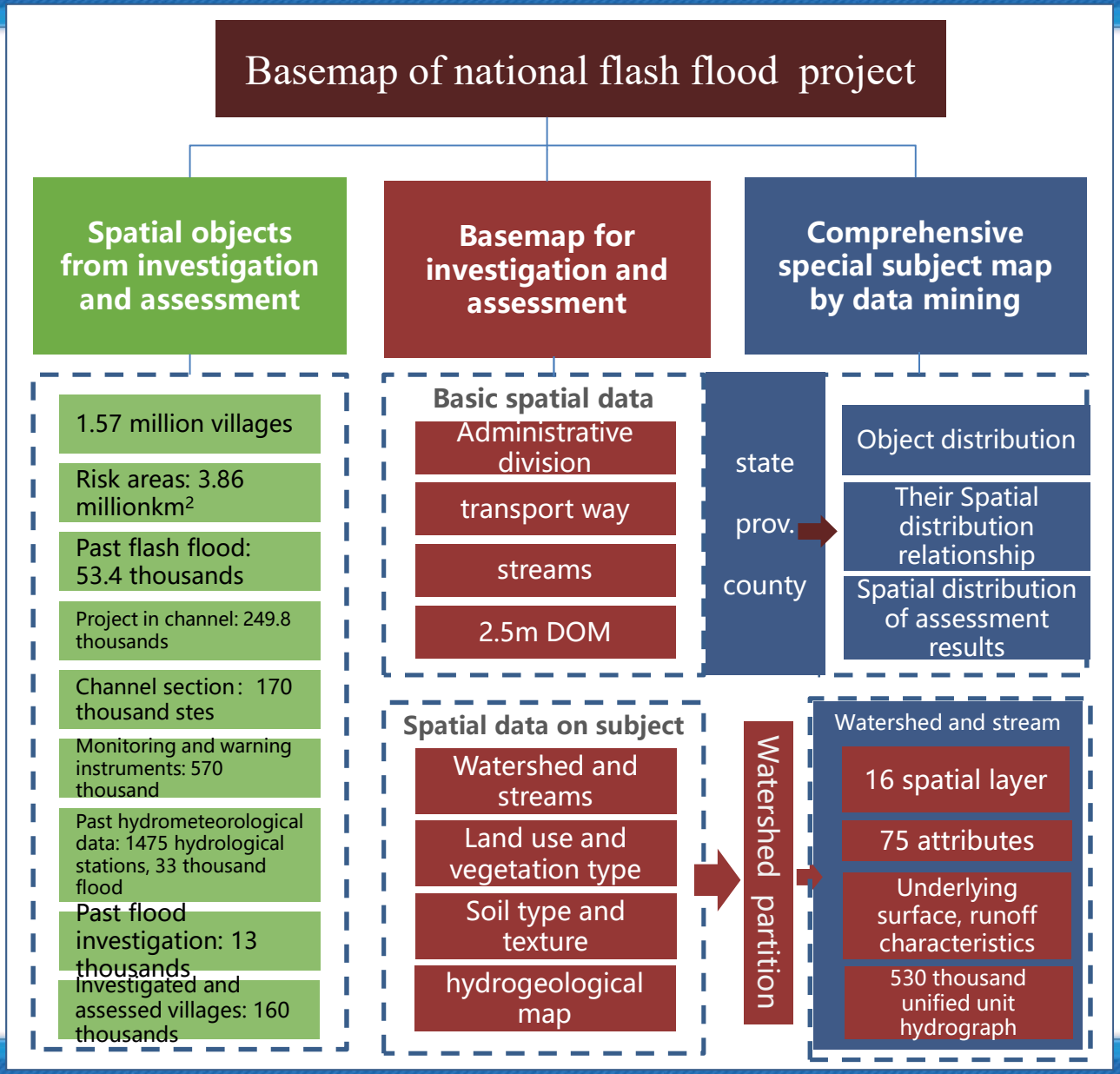

Spatial objects：
45.76 million

Watersheds：
530 thousand

Gullies and streams
3 millions

Basemap
2168 sets

Comprehensive special subject map
29246 sets

120 TB

2. Main Achievements of flash flood investigation and assessment

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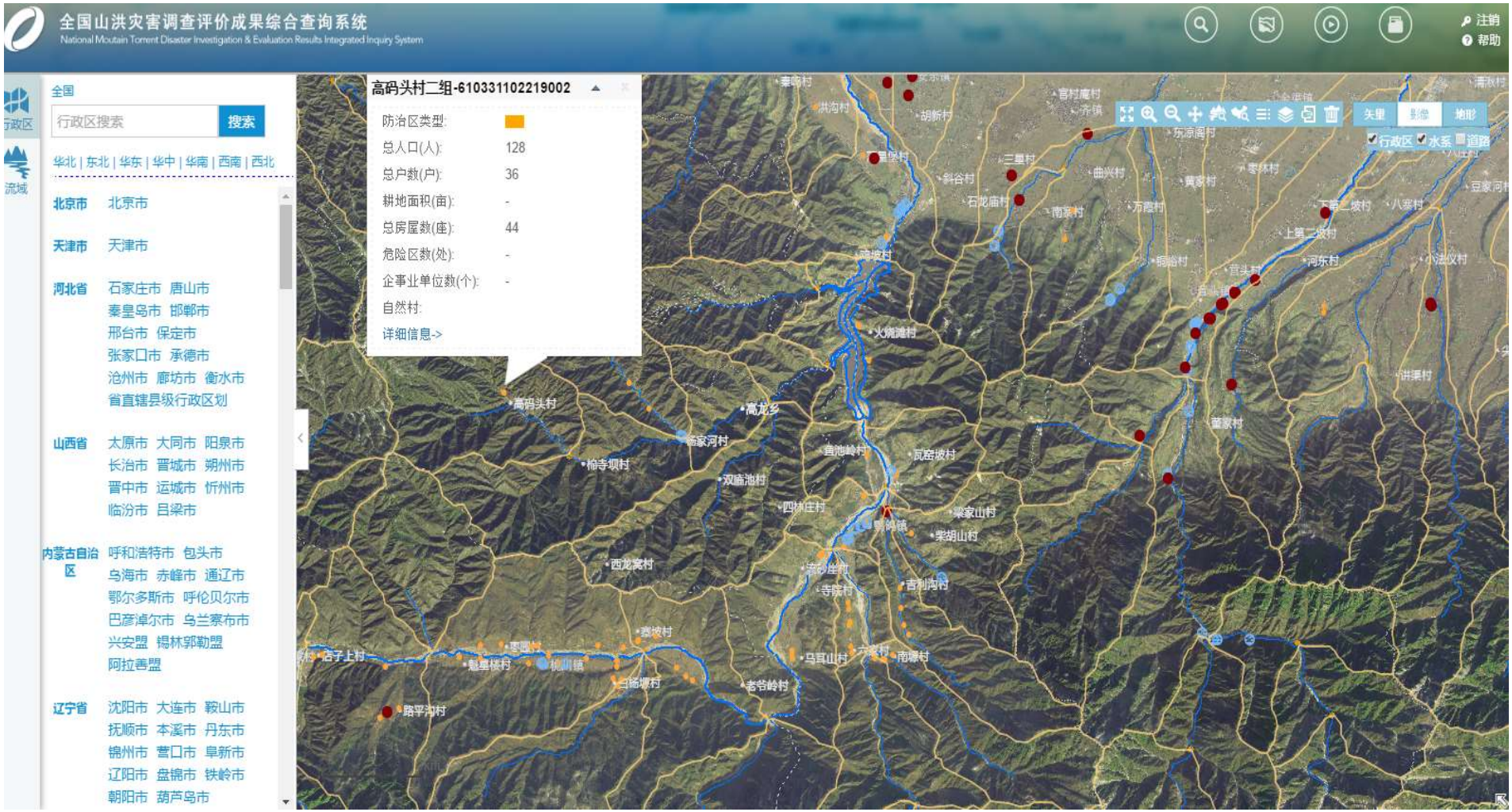
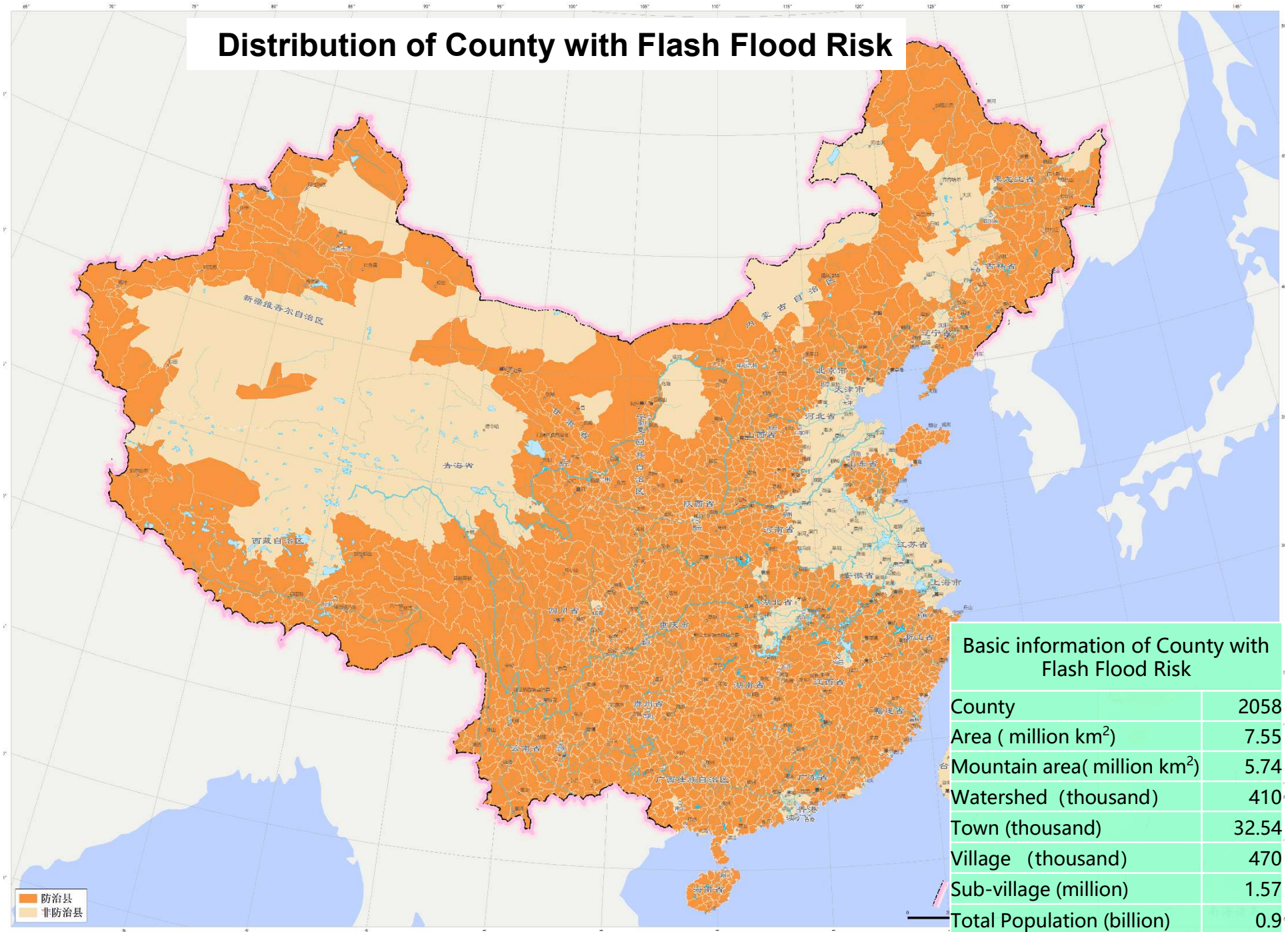
A result inquiry system is developed

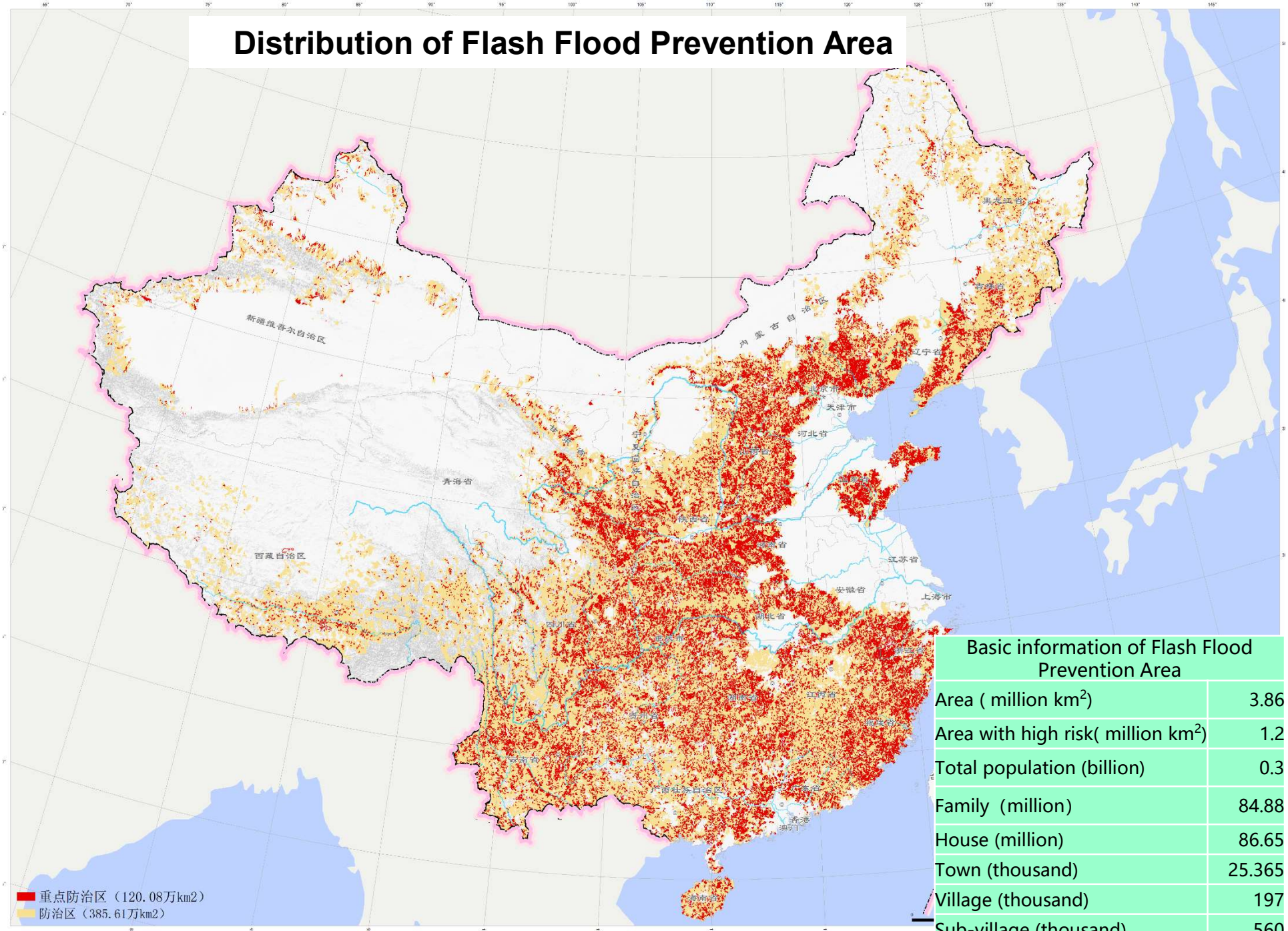


Distribution of County with Flash Flood Risk



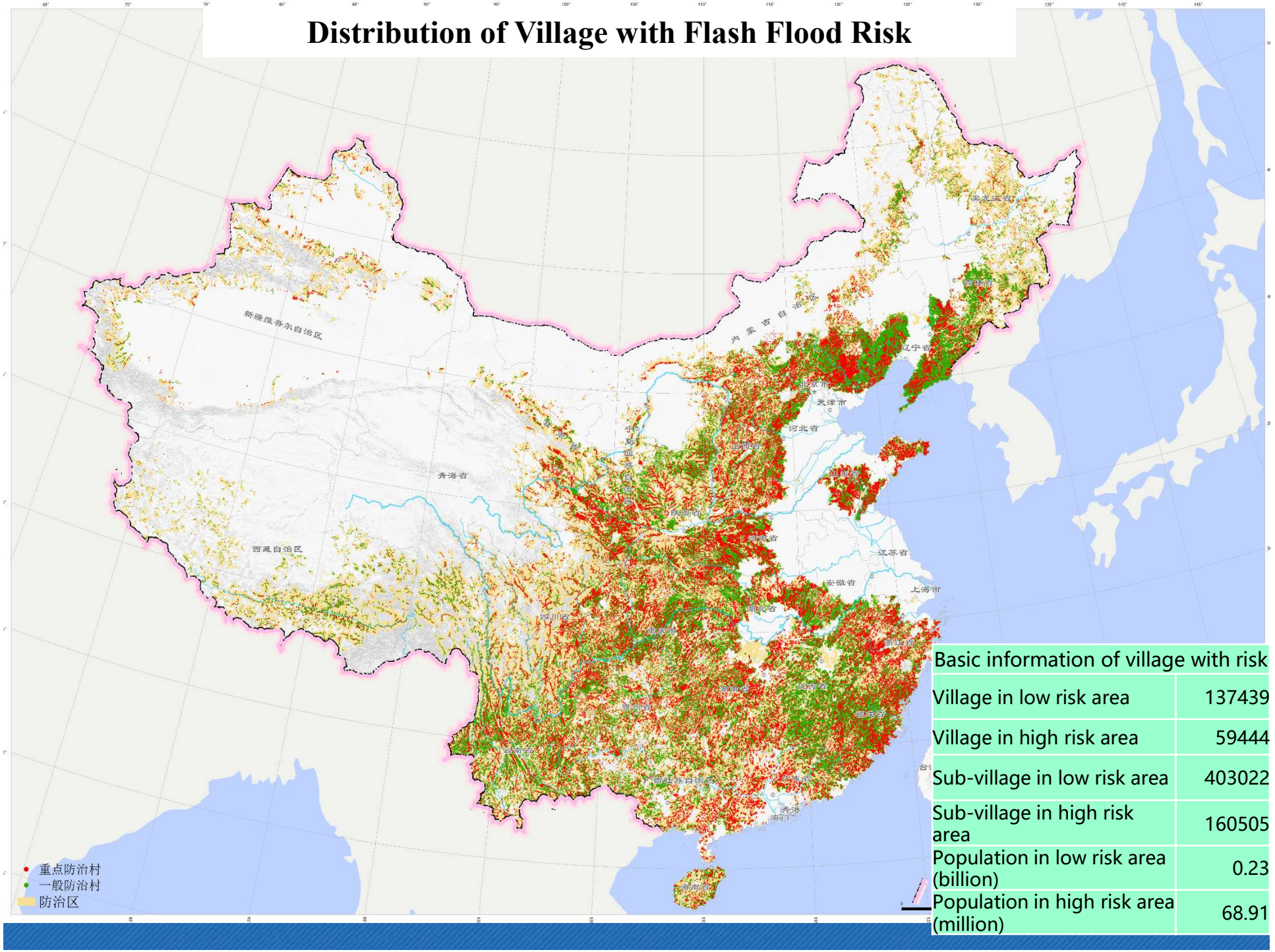
Basic information of County with Flash Flood Risk	
County	2058
Area (million km^2)	7.55
Mountain area(million km^2)	5.74
Watershed (thousand)	410
Town (thousand)	32.54
Village (thousand)	470
Sub-village (million)	1.57
Total Population (billion)	0.9

Distribution of Flash Flood Prevention Area



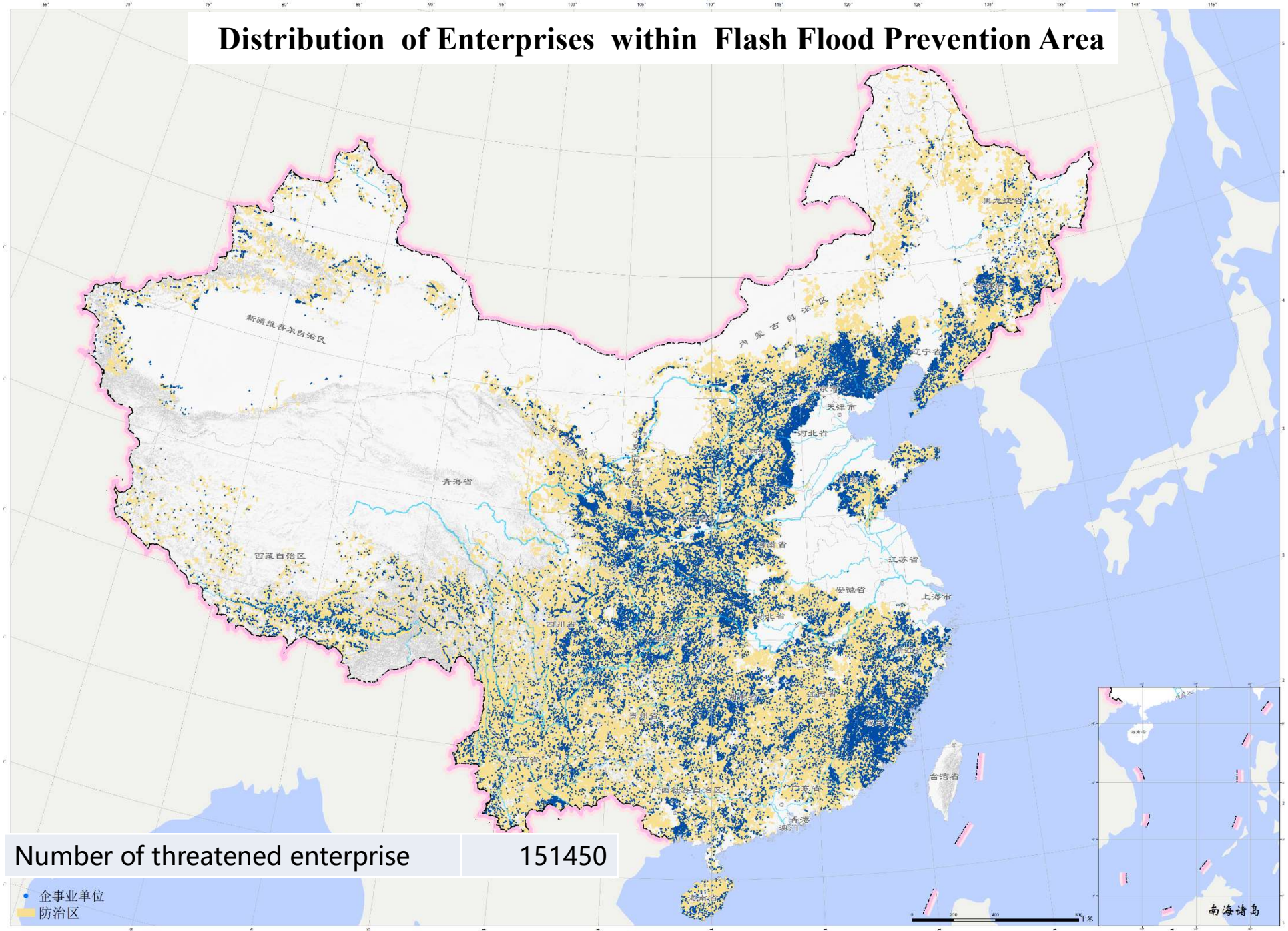
Basic information of Flash Flood Prevention Area	
Area (million km^2)	3.86
Area with high risk(million km^2)	1.2
Total population (billion)	0.3
Family (million)	84.88
House (million)	86.65
Town (thousand)	25.365
Village (thousand)	197
Sub-village (thousand)	560

Distribution of Village with Flash Flood Risk



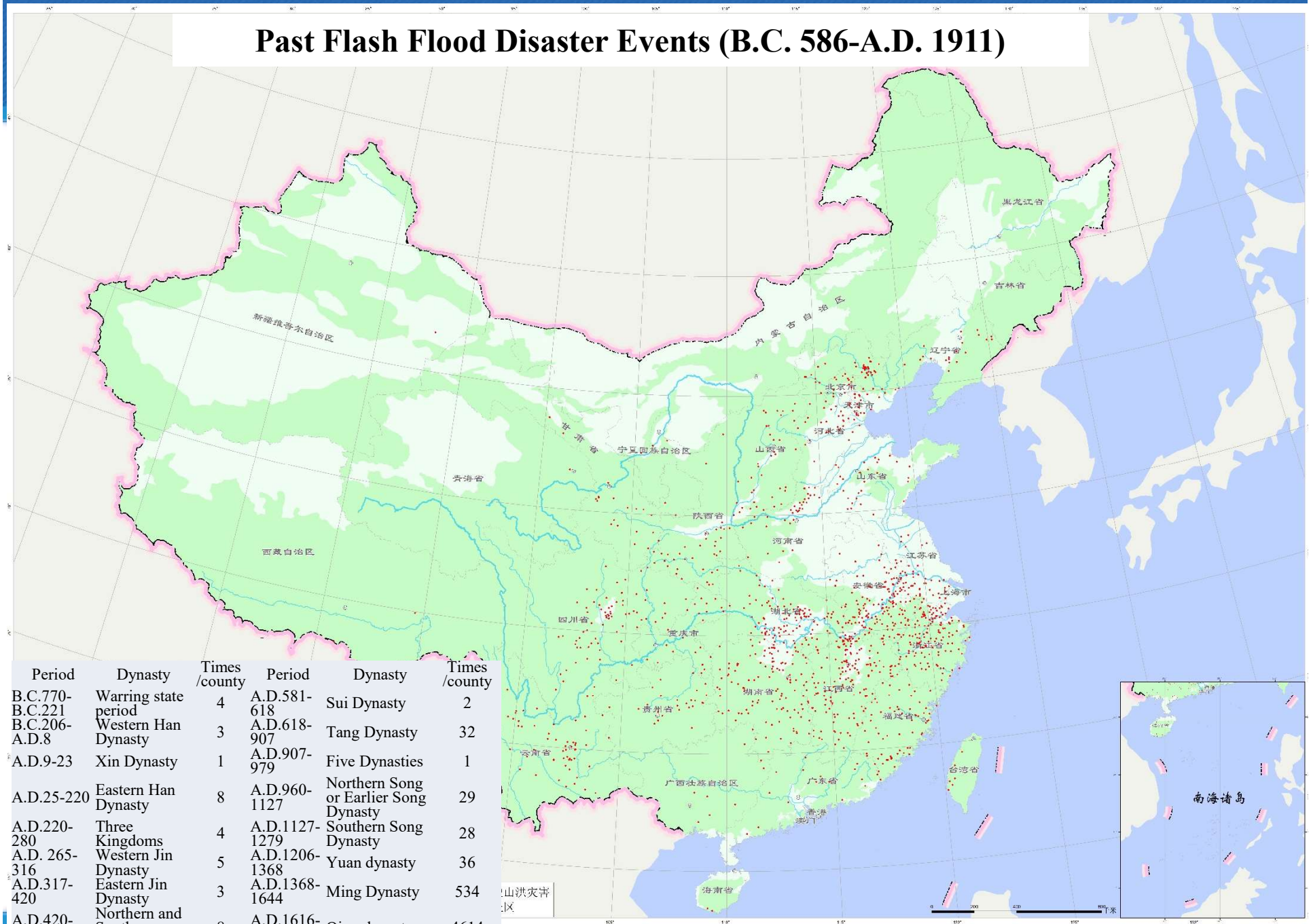
Basic information of village with risk	
Village in low risk area	137439
Village in high risk area	59444
Sub-village in low risk area	403022
Sub-village in high risk area	160505
Population in low risk area (billion)	0.23
Population in high risk area (million)	68.91

Distribution of Enterprises within Flash Flood Prevention Area



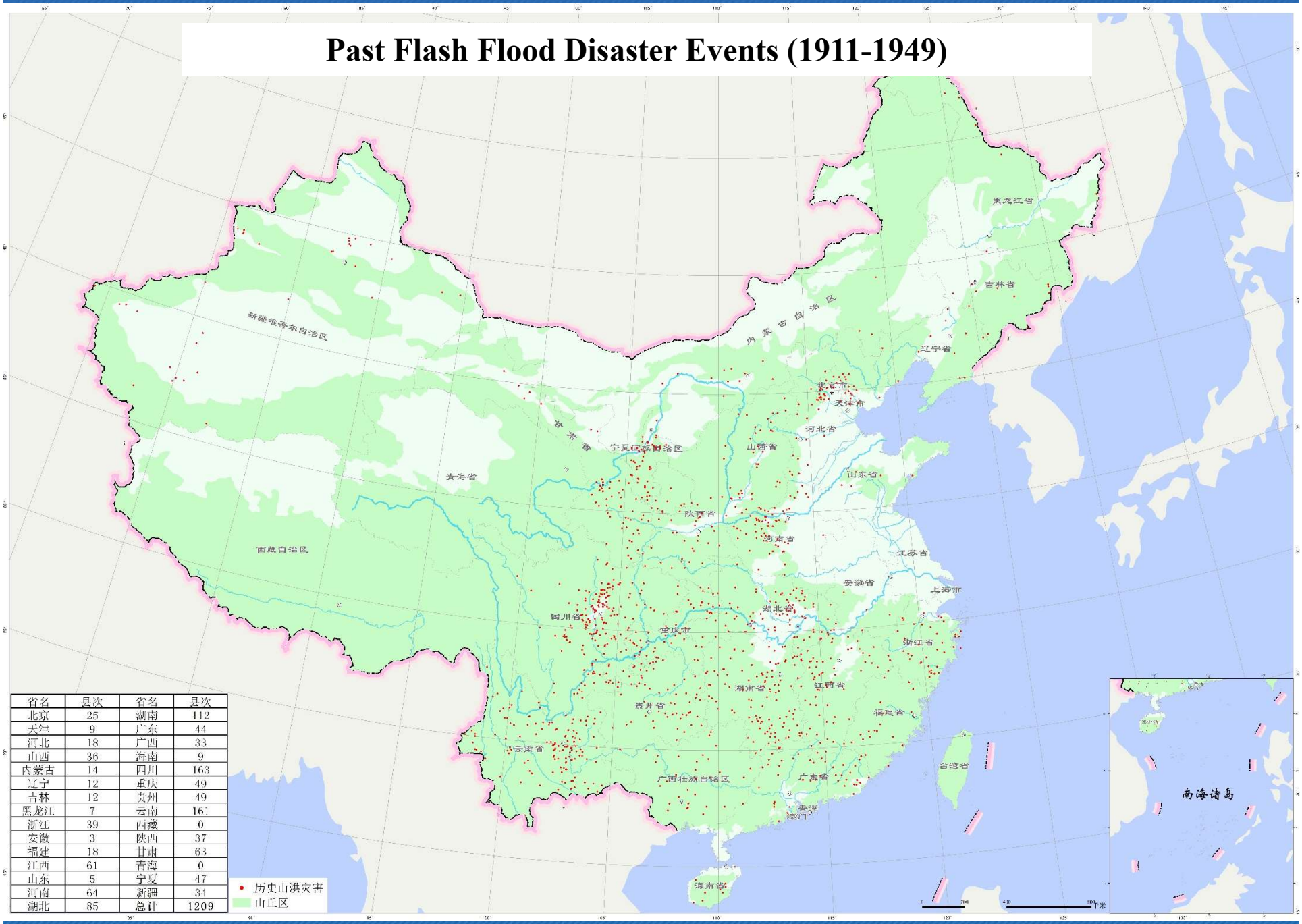
Number of threatened enterprise	151450

Past Flash Flood Disaster Events (B.C. 586-A.D. 1911)



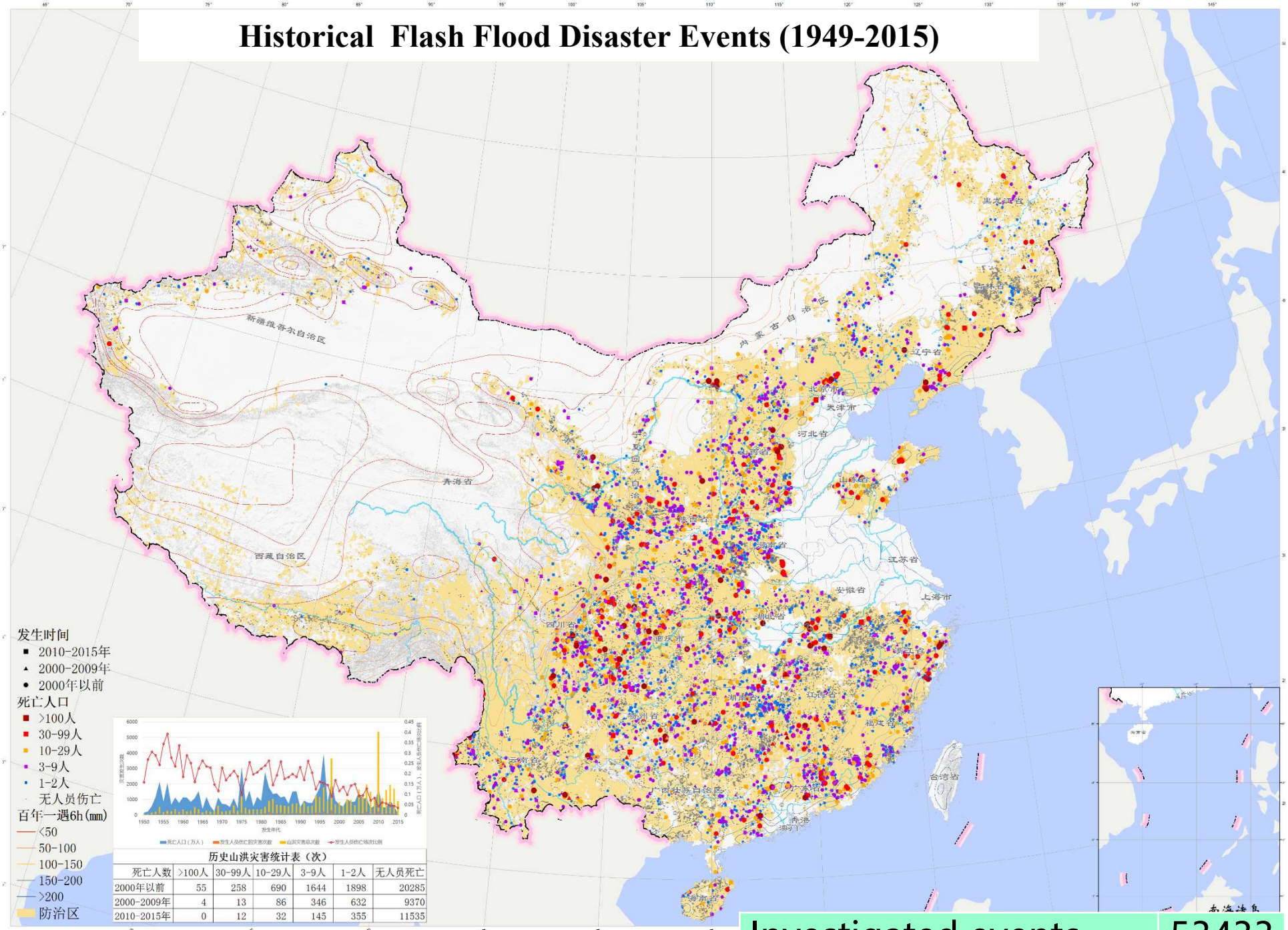
Period	Dynasty	Times /county	Period	Dynasty	Times /county
B.C.770-B.C.221	Warring state period	4	A.D.581-618	Sui Dynasty	2
B.C.206-A.D.8	Western Han Dynasty	3	A.D.618-907	Tang Dynasty	32
A.D.9-23	Xin Dynasty	1	A.D.907-979	Five Dynasties	1
A.D.25-220	Eastern Han Dynasty	8	A.D.960-1127	Northern Song or Earlier Song Dynasty	29
A.D.220-280	Three Kingdoms	4	A.D.1127-1279	Southern Song Dynasty	28
A.D. 265-316	Western Jin Dynasty	5	A.D.1206-1368	Yuan dynasty	36
A.D.317-420	Eastern Jin Dynasty	3	A.D.1368-1644	Ming Dynasty	534
A.D.420-581	Northern and Southern Dynasties	8	A.D.1616-1911	Qing dynasty	4614

Past Flash Flood Disaster Events (1911-1949)



省名	县次	省名	县次
北京	25	湖南	112
天津	9	广东	44
河北	18	广西	33
山西	36	海南	9
内蒙古	14	四川	163
辽宁	12	重庆	49
吉林	12	贵州	49
黑龙江	7	云南	161
浙江	39	西藏	0
安徽	3	陕西	37
福建	18	甘肃	63
江西	61	青海	0
山东	5	宁夏	47
河南	64	新疆	34
湖北	85	总计	1209

Historical Flash Flood Disaster Events (1949-2015)

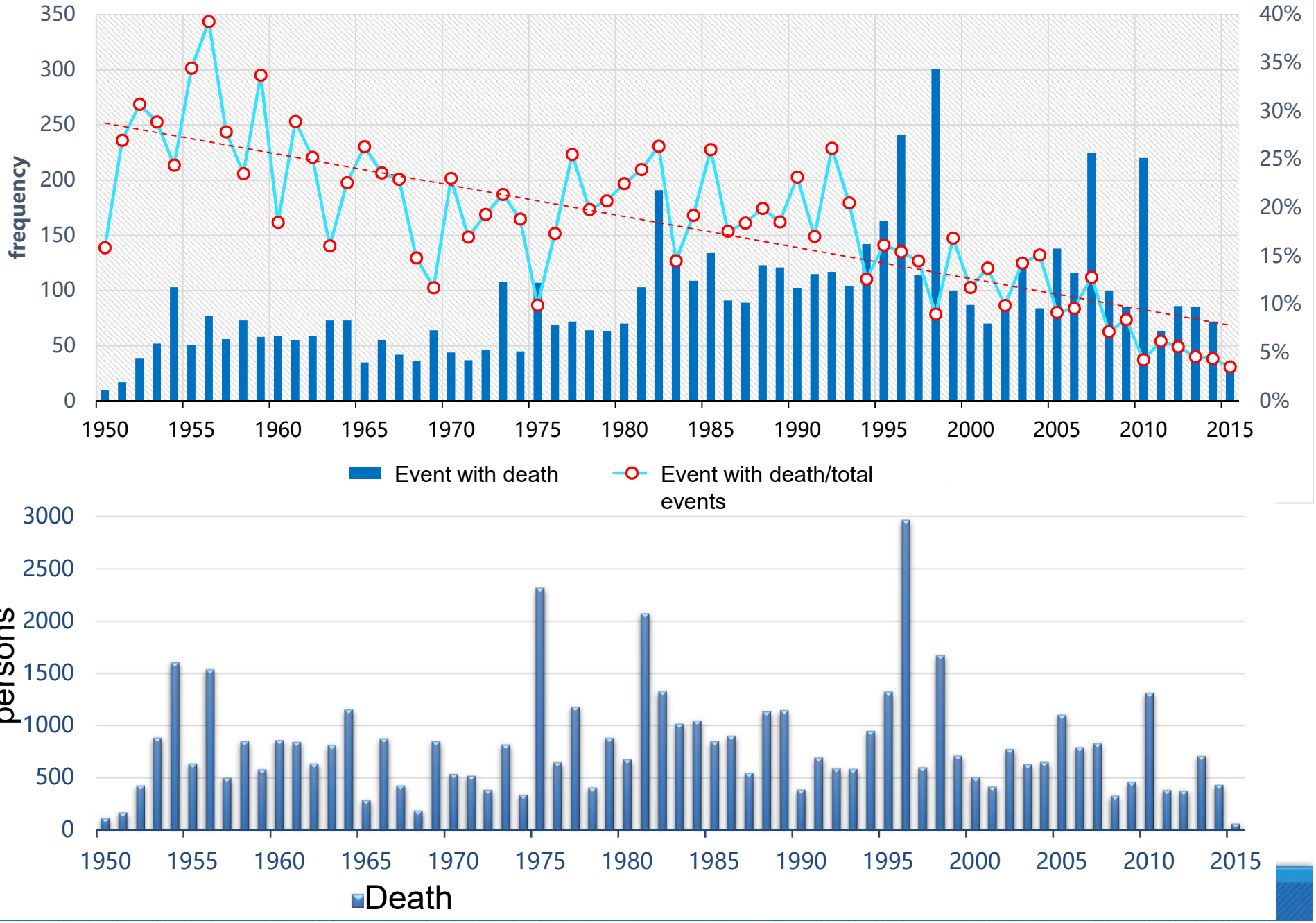


历史山洪灾害统计表（次）

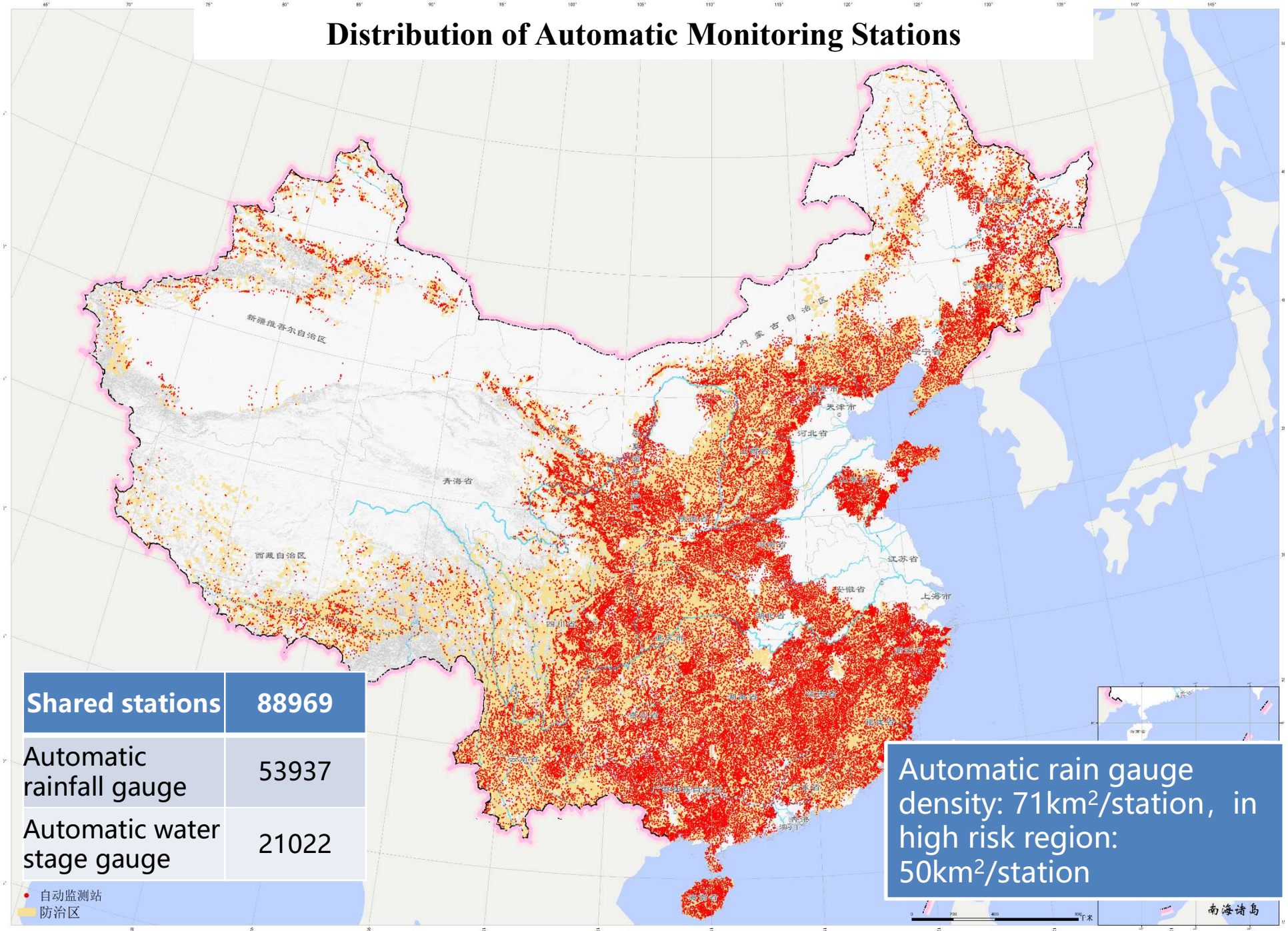
死亡人数	>100人	30-99人	10-29人	3-9人	1-2人	无人员死亡
2000年以前	55	258	690	1644	1898	20285
2000-2009年	4	13	86	346	632	9370
2010-2015年	0	12	32	145	355	11535

Investigated events 53433

Historical Flash Flood Disaster Events



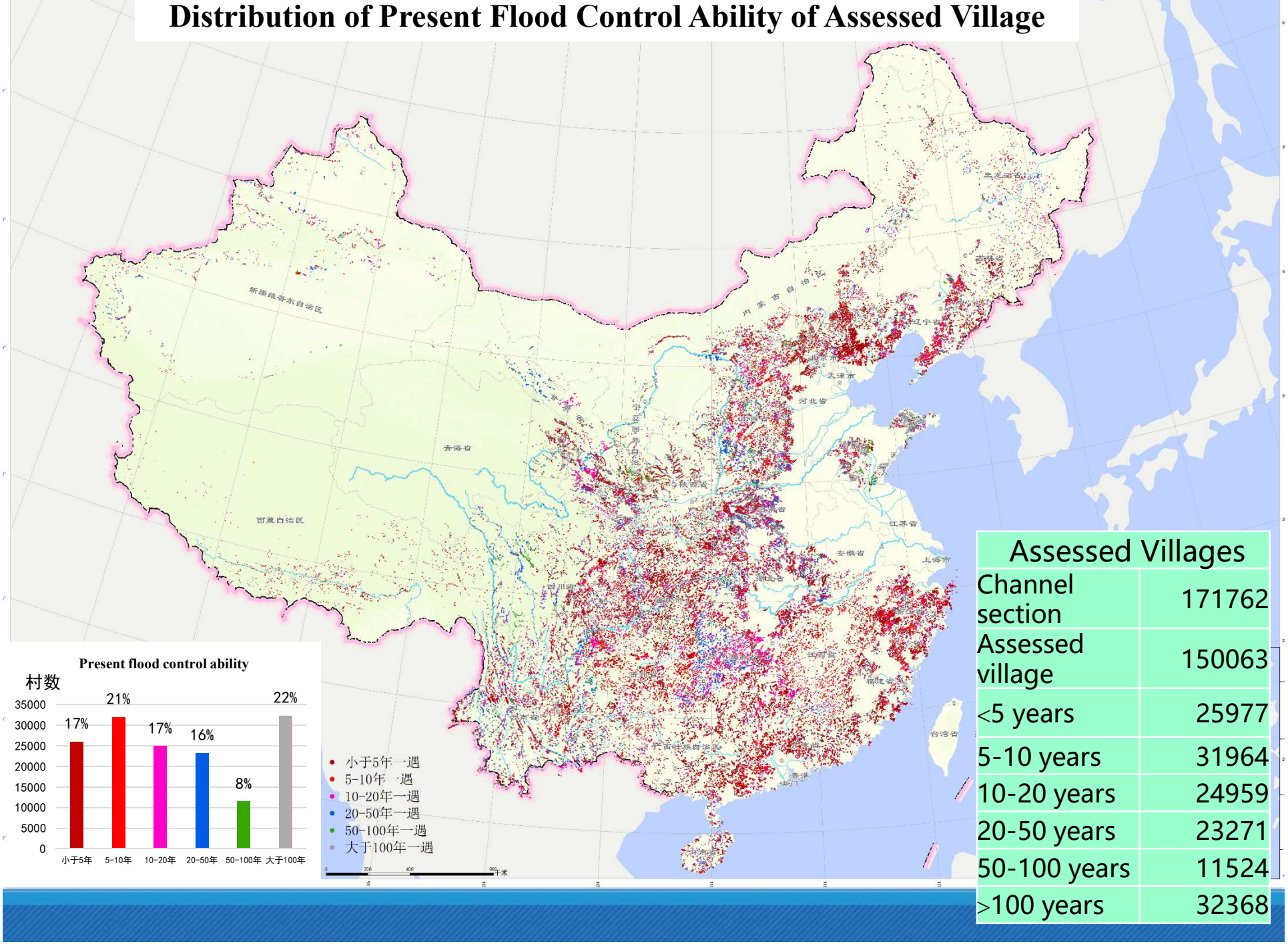
Distribution of Automatic Monitoring Stations



Shared stations	88969
Automatic rainfall gauge	53937
Automatic water stage gauge	21022

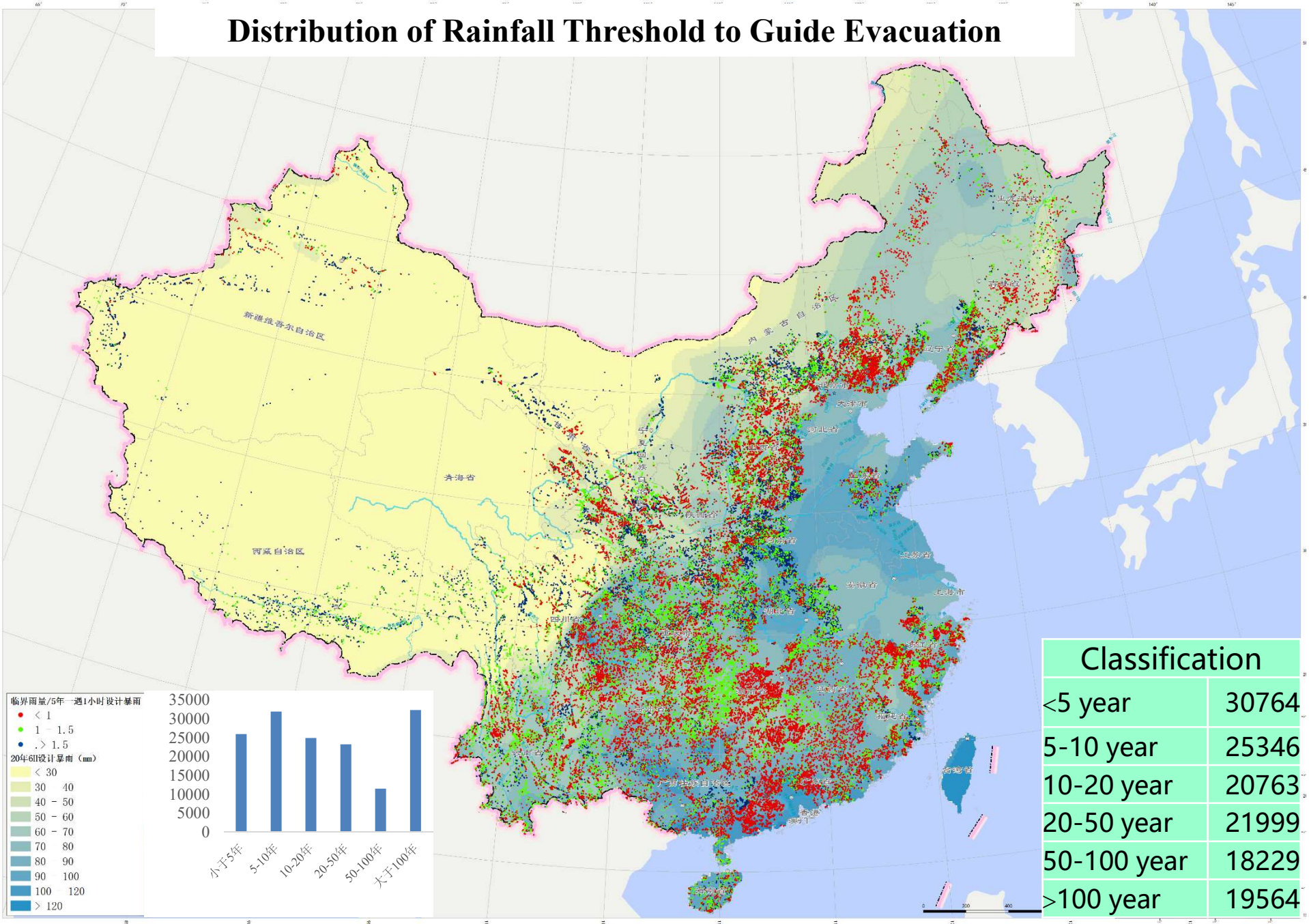
Automatic rain gauge density: 71km^2/station，in high risk region: 50km^2/station

Distribution of Present Flood Control Ability of Assessed Village



Assessed Villages	
Channel section	171762
Assessed village	150063
<5 years	25977
5-10 years	31964
10-20 years	24959
20-50 years	23271
50-100 years	11524
>100 years	32368

Distribution of Rainfall Threshold to Guide Evacuation



Classification	
<5 year	30764
5-10 year	25346
10-20 year	20763
20-50 year	21999
50-100 year	18229
>100 year	19564

3. Monitoring and Warning System for Flash Flood Prevention

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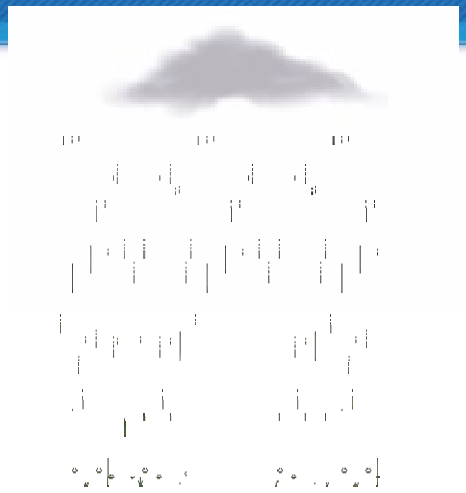
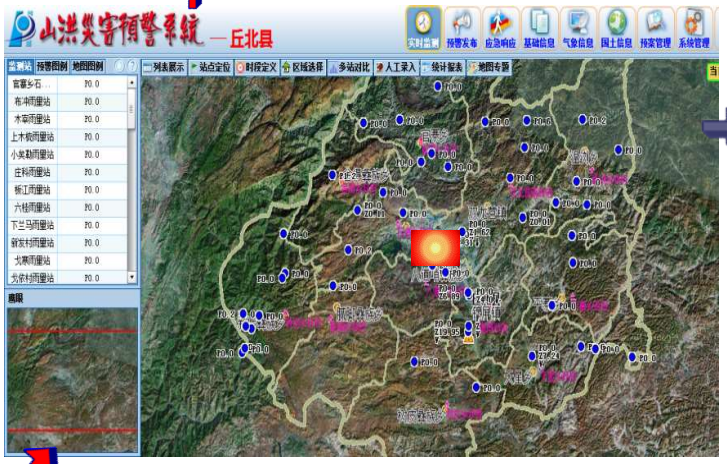


Monitoring and warning information management system at state, province and city level



Automatic Monitoring (46000 Rain gauge and 20000 stage gauge)

County-level monitoring and warning operation platform

Alert system

Warning message transfer, evacuation

- Monitoring and warning operating platforms are established in 2058 counties, 30 provinces, 305 cities and the state, extended to 18924 towns.
- The State flood control and drought command system is expanded. Local flood prevention decision-making and command ability are greatly improved.

Alert facilities

Simple rainfall gauge and warning devices: 296320 sets, Simple water stage gauge: 64078 sets, Wireless alert broadcast 245743 sets, Manual operated alert devices: 394520 sets, Gong: 760837 sets。

4. State-level Monitoring and Warning Platform and its Services

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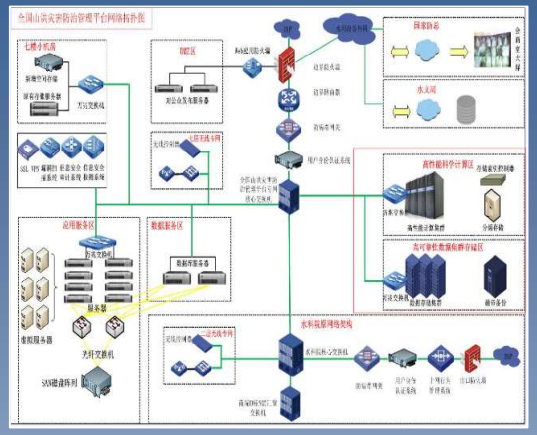
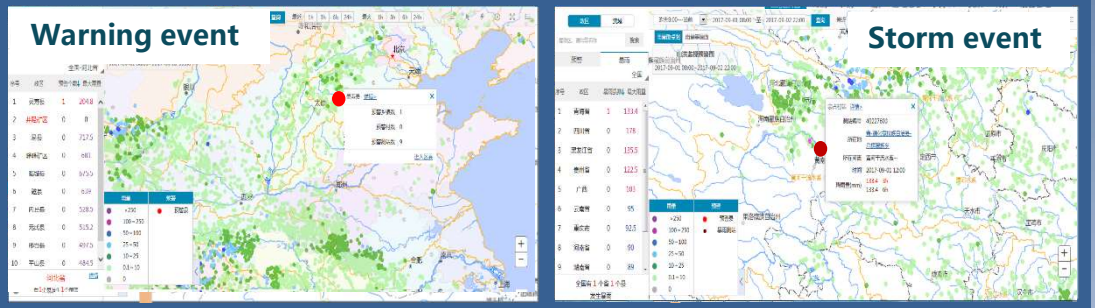
Hardware and Network



- High-performance computer cluster. Flop operating speed 12.9 trillion times/s
- High-reliability storage cluster, capacity 668TB
- Special Network connection with water, weather, satellite sectors

Application Software

Four typical level, to supply information service in different scale



Two type of events, to drive around central tasks

Two Principle path, to organize disaster prevention information

National Flash Flood Monitoring and Warning Information Management System

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◆Nation-wide Precipitation distribution

— point precipitation, isosurface

—1h/3h/6h/24h point precipitation, isosurface and point rainfall frequency

◆Dynamically displayed

Point precipitation
Isosurface
Point rainfall frequency

Point precipitation display of 70 thousand rainfall monitoring station

Information Inquiry on Mobile Devices

Mobile device

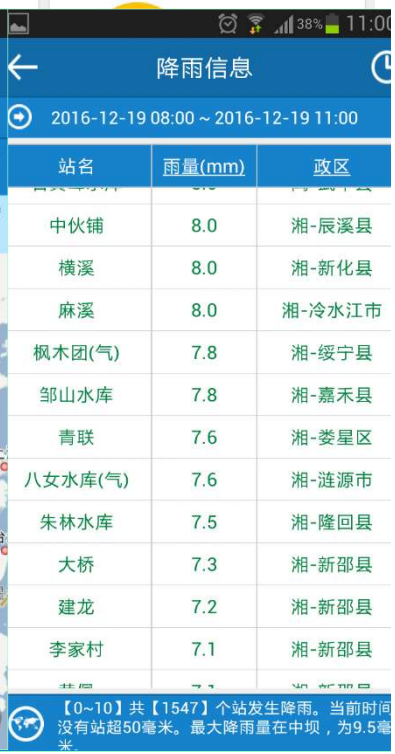
Information receiving

service

Flash flood (Android、iOS)

Compression of multi-media data

Mobile System for National Flash Flood Monitoring and Warning Information Management



National Flash Flood Simulation System

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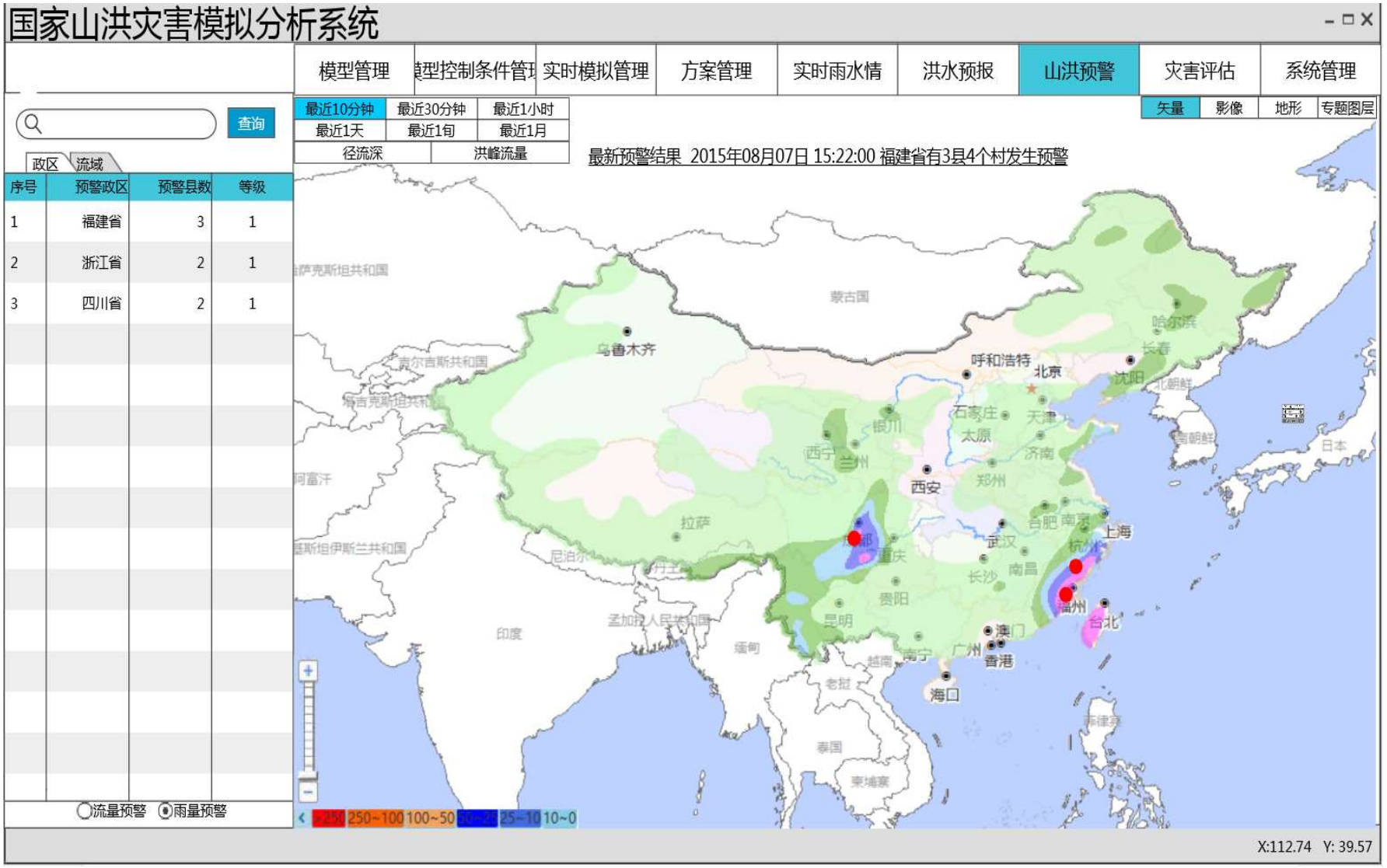

Rainfall character analysis

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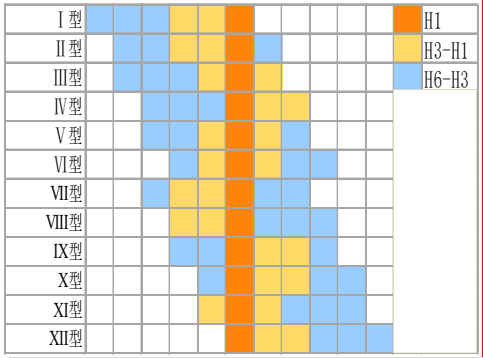
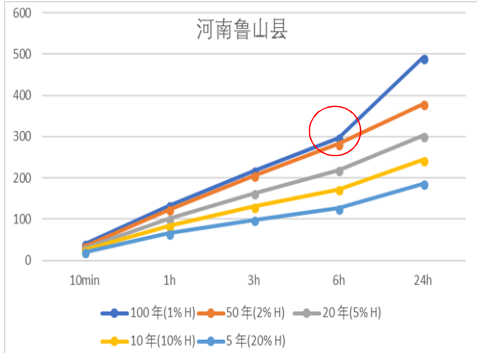
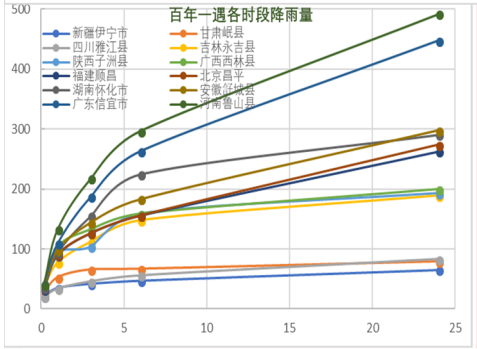
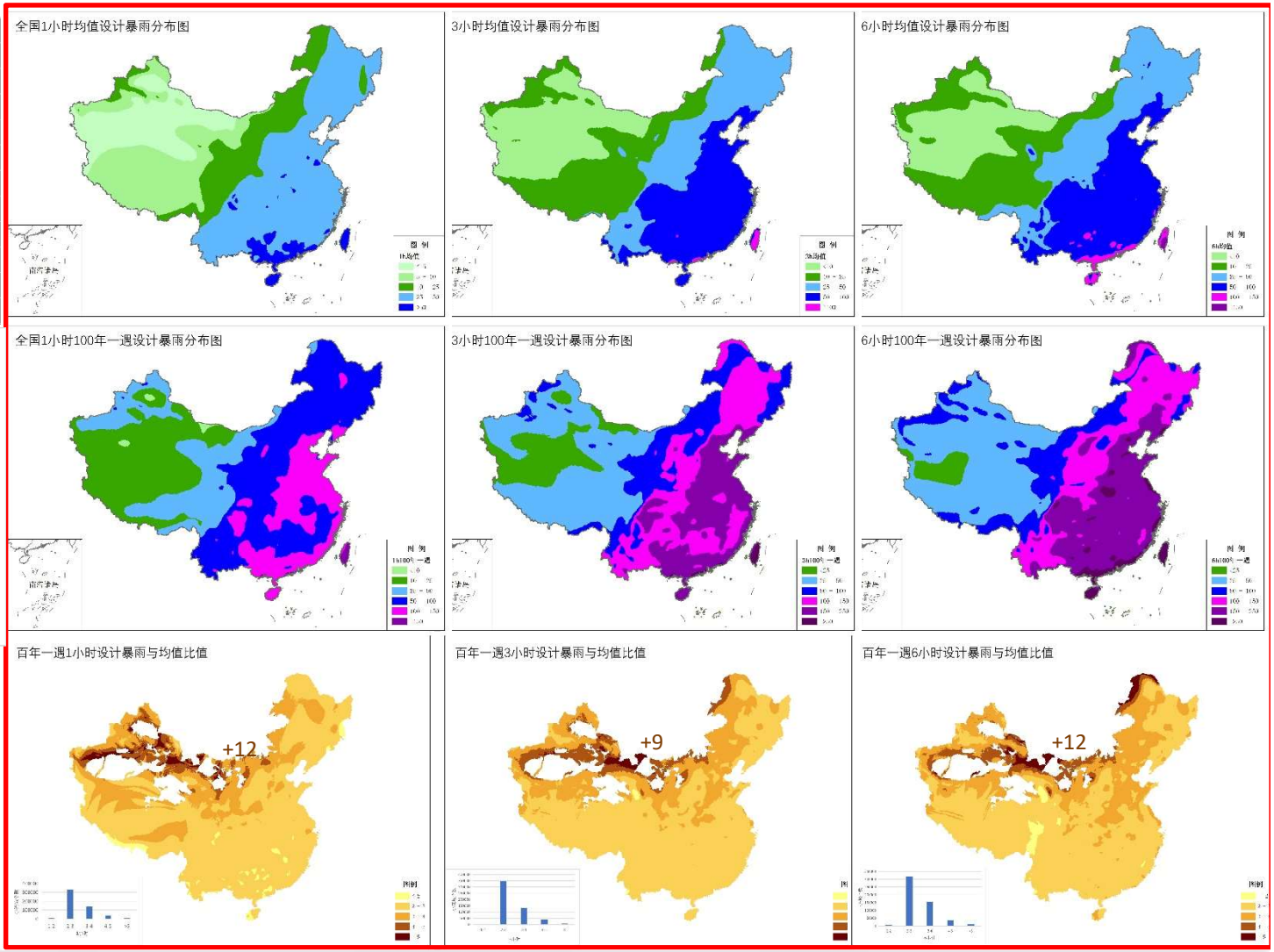
Types of designed rainfall in 6h of each provinces





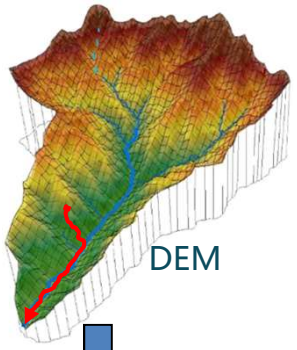




Runoff generation and confluence characteristics

Methods are put forward to extract runoff generation and confluence parameters by synthesizing rainfall and underlying surface condition. Nonlinear unified unit hydrographs of watersheds were established.

Method to establish nonlinear unified unit hydrograph



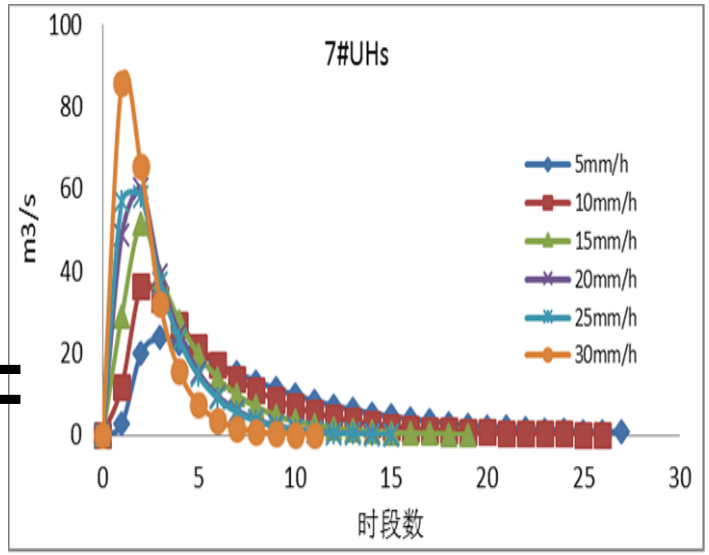
Design storm

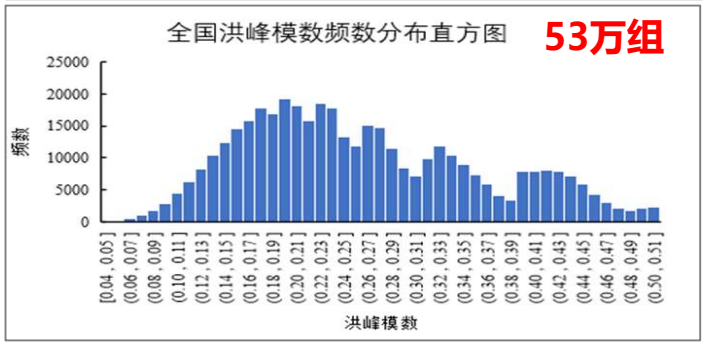
input

$$V = KS^{0.5} i^{a}$$

$$\Delta\tau = L / V$$
$$\Delta\tau = \sqrt{2}L / V$$
$$\tau = \sum \Delta\tau_i$$

$$q(\Delta t, t) = \frac{10F}{3.6\Delta t} \times \{S(t) - S(t - \Delta t)\}$$
$$uh_i = cI_i + (1-c)uh_{i-1}$$





Flash flood risk identification

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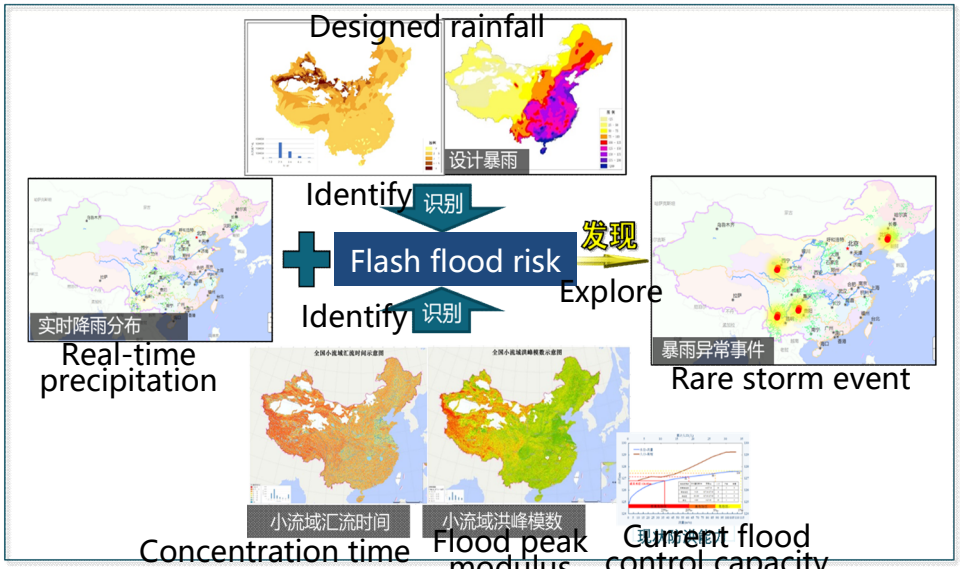
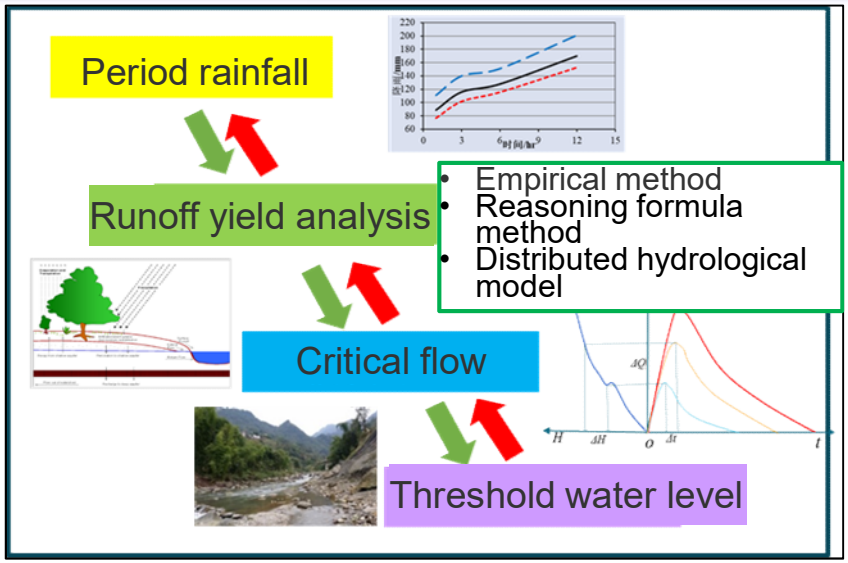
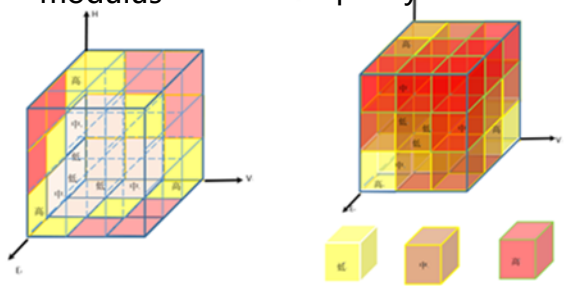




$$H = \sum_{i=1}^{m} W_i H_i = \sum_{i=1}^{m} w_i \left(\sum_{k=1}^{n} w_{ik} H_{ik} \right)$$

$$E = \sum_{j=1}^{n} W_j E_j = \sum_{j=1}^{n} w_j \left(\sum_{k=1}^{n} w_{jk} E_{jk} \right)$$

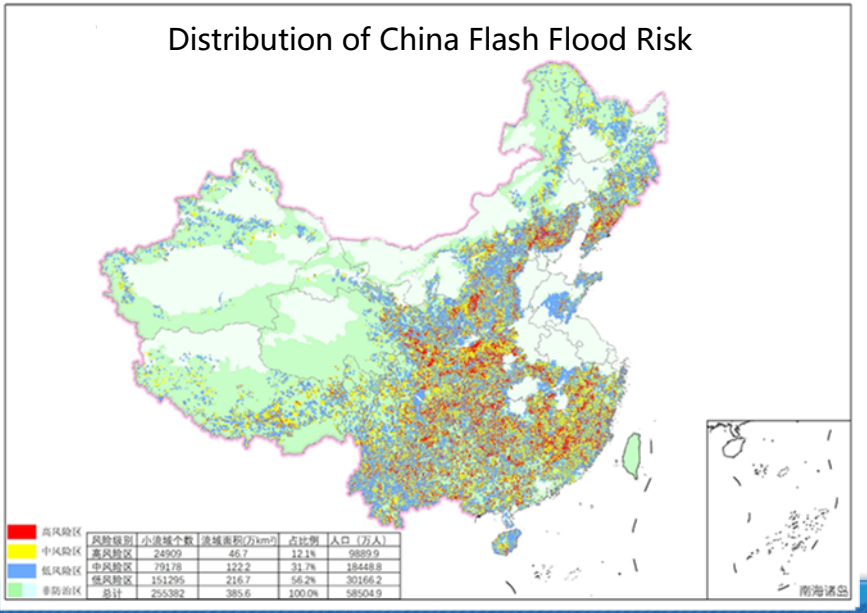
$$V = \sum_{k=1}^{l} W_k V_k = \sum_{k=1}^{l} w_k \left(\sum_{k=1}^{l} w_{kk'} V_{kk'} \right)$$



	High risk	Middle risk	Low risk
Area ($10^4 km^2$)	47	122	216
Frequency ($10^{-4} km^2$)	190	119	98

Testify: 53000 historical flash flood

Distribution of China Flash Flood Risk



5. Community-based Flash Flood Prevention

Preparedness Plan at county, town, village level. Alert plates. Propaganda board. Notice card, training and drills

One responsibility system

One preparedness plan

One simple rain gauge with alert devices

One set alert devices

One training per year

One drill

One temporal residence for each threatened zone

One propaganda board

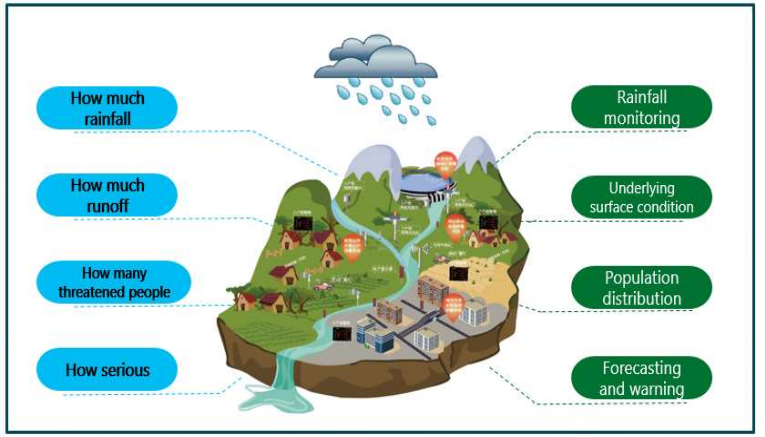
One set alert plates

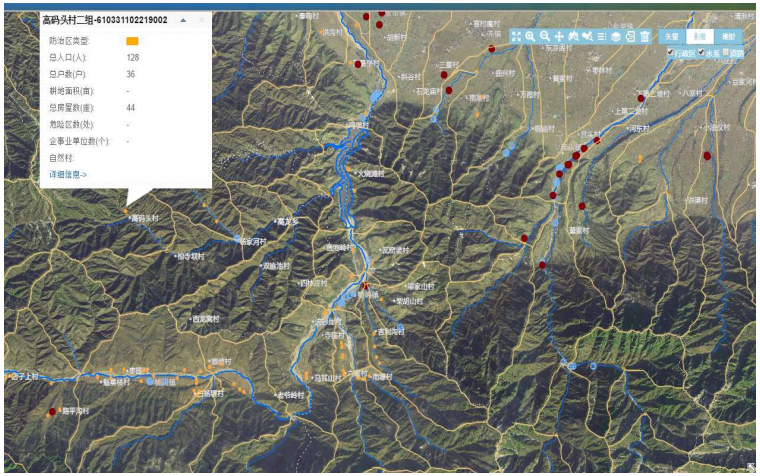
One must-know card

10 “one item” activities for each village

6. Exiting Challenges

- Warning accuracy: the enhancement of rainstorm analysis theory and technology, the rapid acquisition of real-time data, the improvement of calculation method, and the adjustment of monitoring facilities;
- Warning efficiency: the extension of warning lead-time, the improvement of warning method, and more accurate Radar, satellite and weather forecast data
- Risk and disaster: to better handle relationship between human and water.
- Warning message delivery: to better organize among government, associations and local communities





Thanks !