



中国水利水电科学研究院

China Institute of Water Resources and Hydropower Research



FFP1: Seminar on Flash Flood Risk Management

Flash Flood Risk Assessment Based on FFIA in China

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China, a flash flood prone country

2

Flash flood investigation and assessment (FFIA)

3

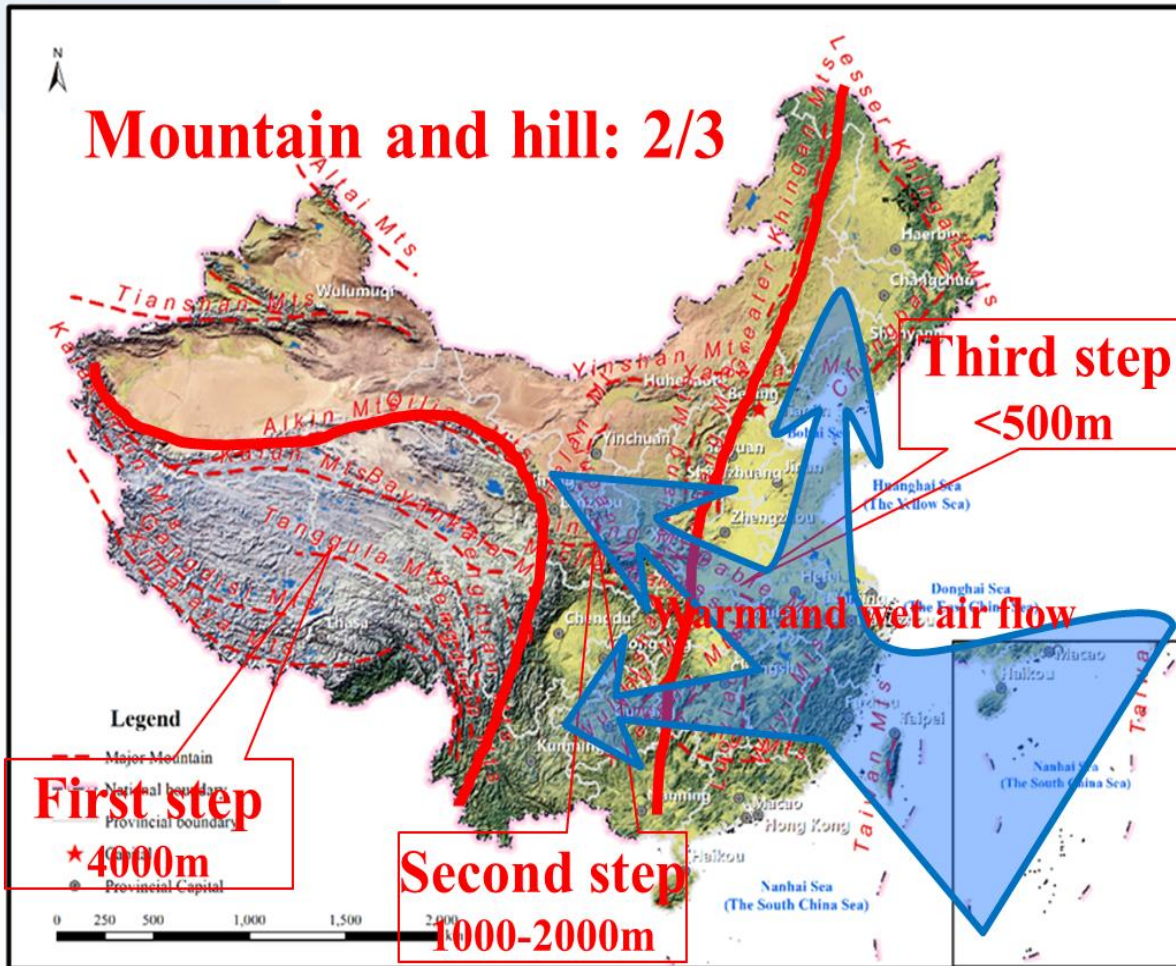
Flash flood risk assessment

4

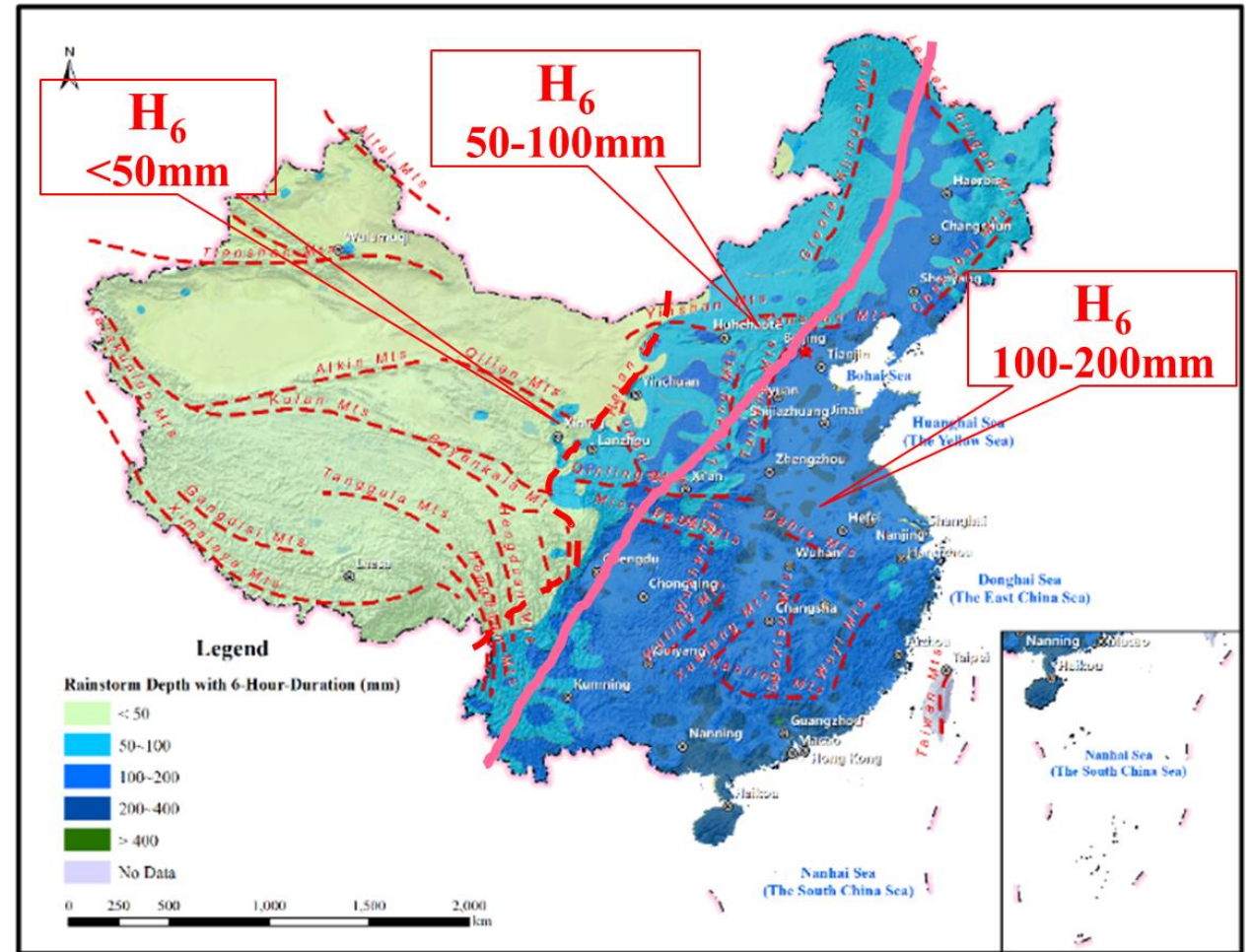
Summary and conclusions

1. China, a flash flood prone country

Geomorphology

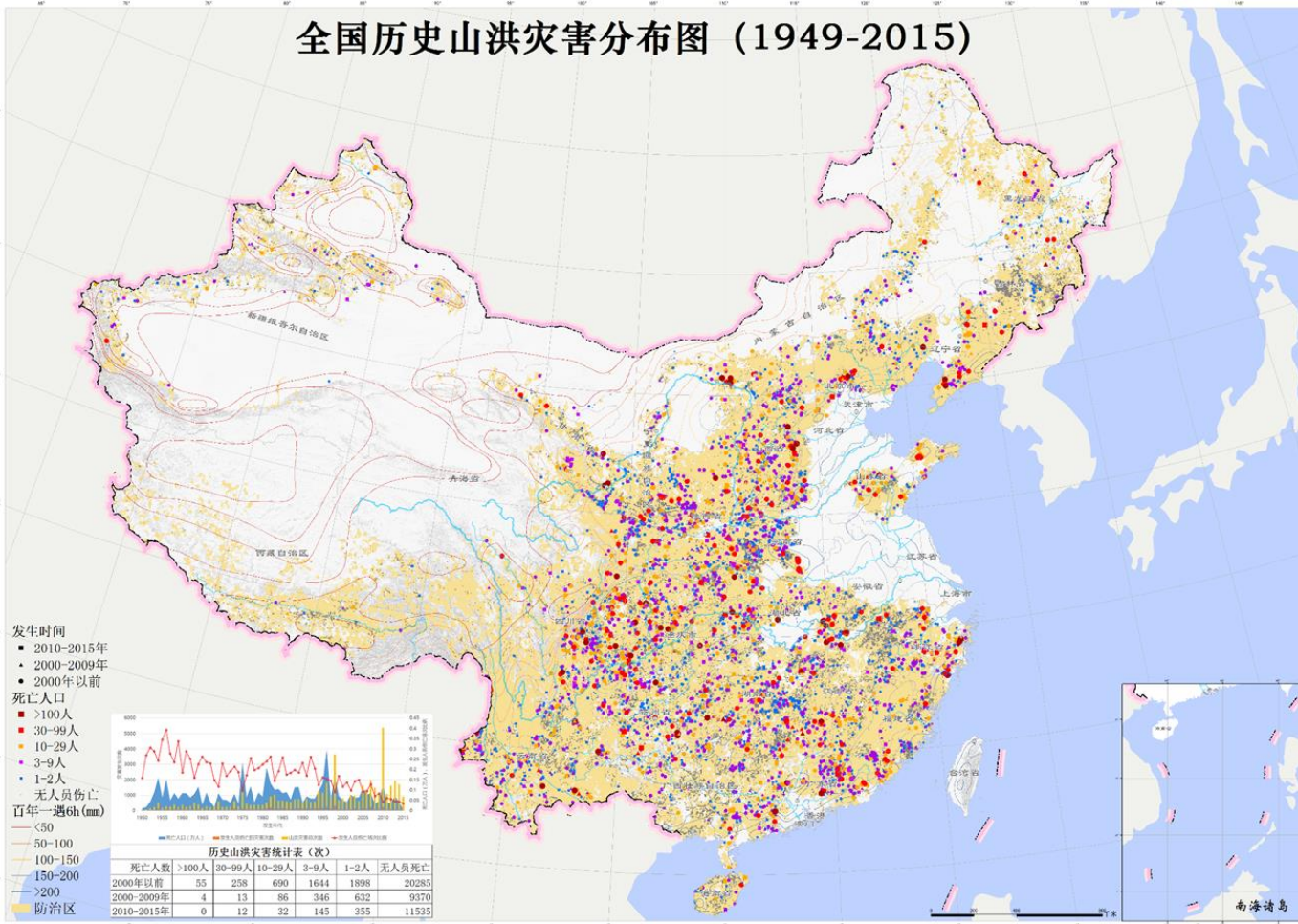


Rainstorm

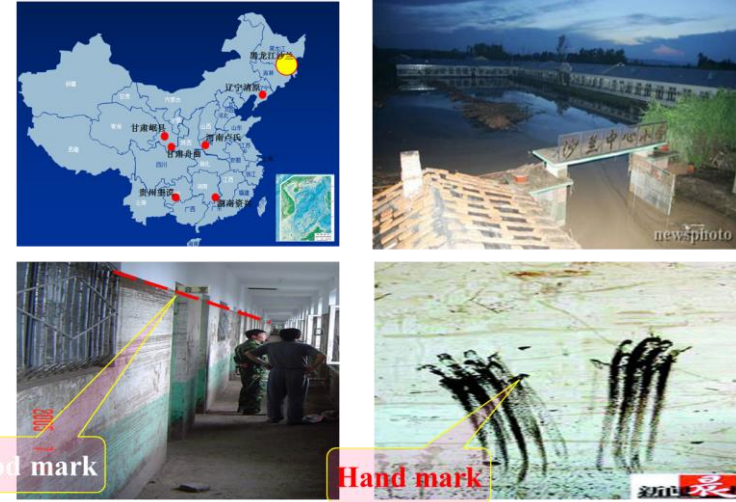


1.1 Flash flood events in China

Flash flood events in China since 1950



Event 1. Shalan Town, Heilongjiang, June 10th, 2005



Event 2. Zhouqu County, Gansu, Aug., 7th, 2010



2. Flash flood investigation and assessment (FFIA)

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8.1. Hazard Mapping	

Technical documents



Training

- **Hazard:** rainstorm, structural failure, mountainous rivers, historic flood events, catchment and river channel geomorphy, ...
- **Exposures:** flash flood prone areas, population threatened by flash flood, socioeconomic conditions, riverside villages, key traffic and communication lines,...
- **Vulnerability:** monitoring, warning, community-based training, emergency response planning and exercises, ...



investigation & analysis



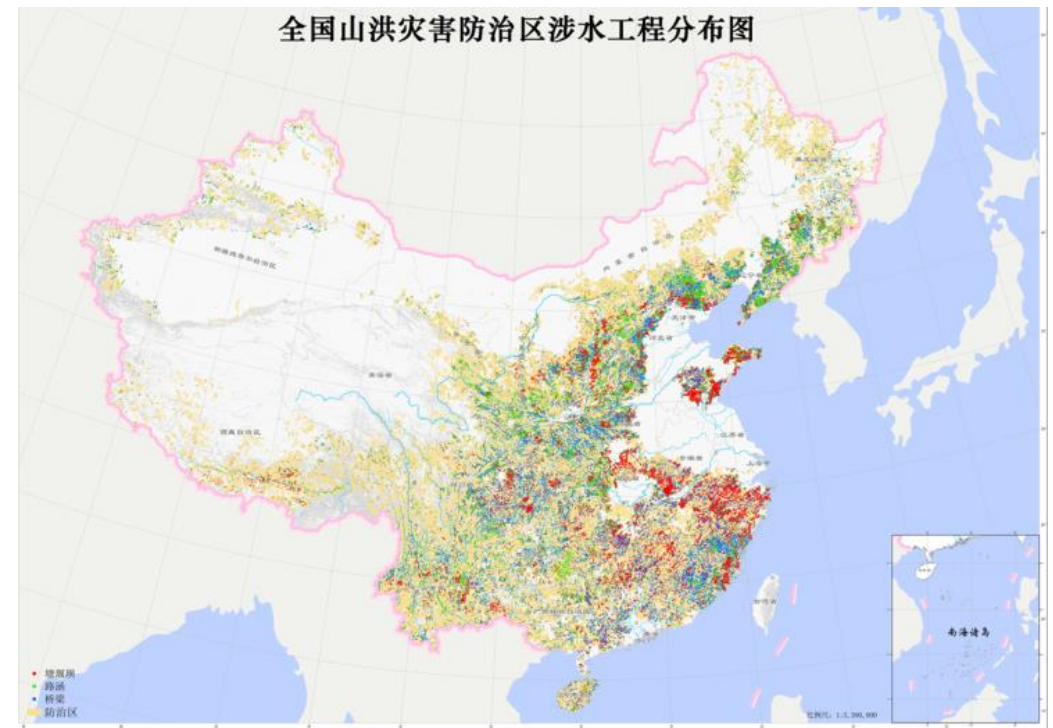
2.1 Exposures



- Detected structural measures involved in potential flash flood events

Exposures

- Flash flood prone area
- Population and property
- Social and economic status
- Historical events





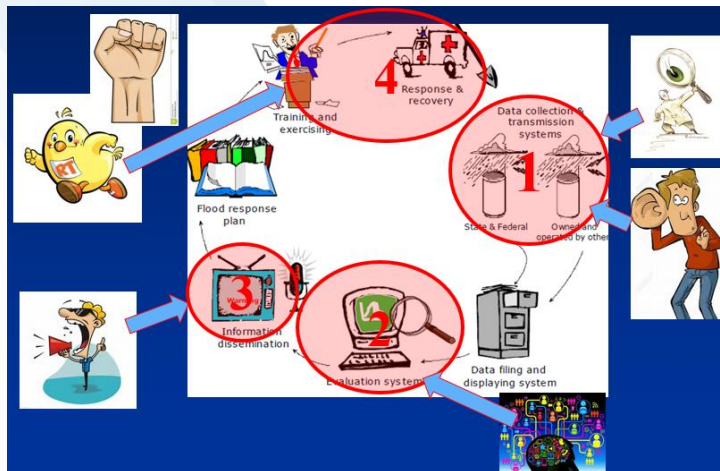
rain gauges and stage gauges:

- 360,000 manual
- 75,000 automatic



Wireless broadcast for warning

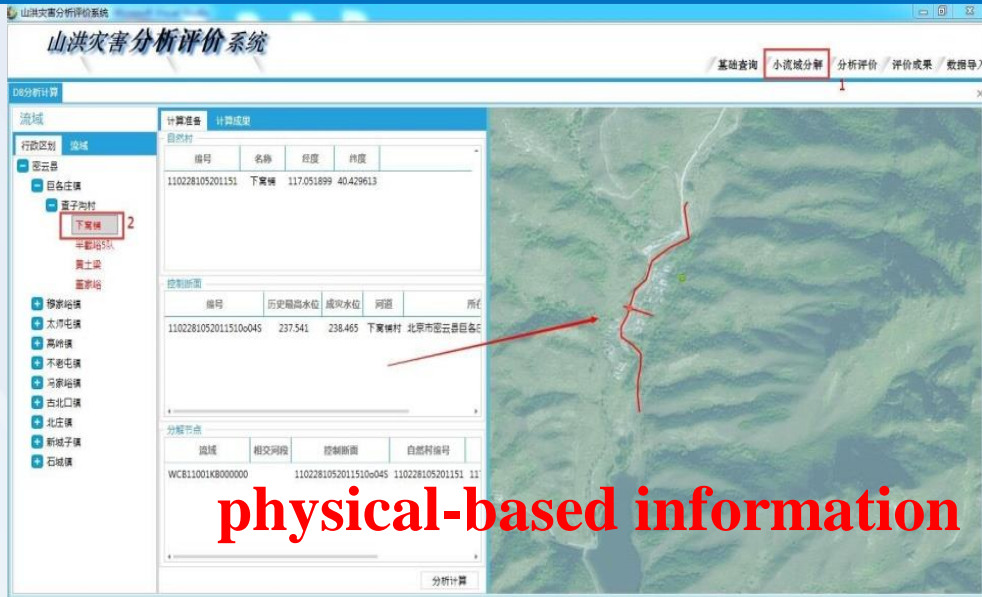
- 1.4 mil. for early warning



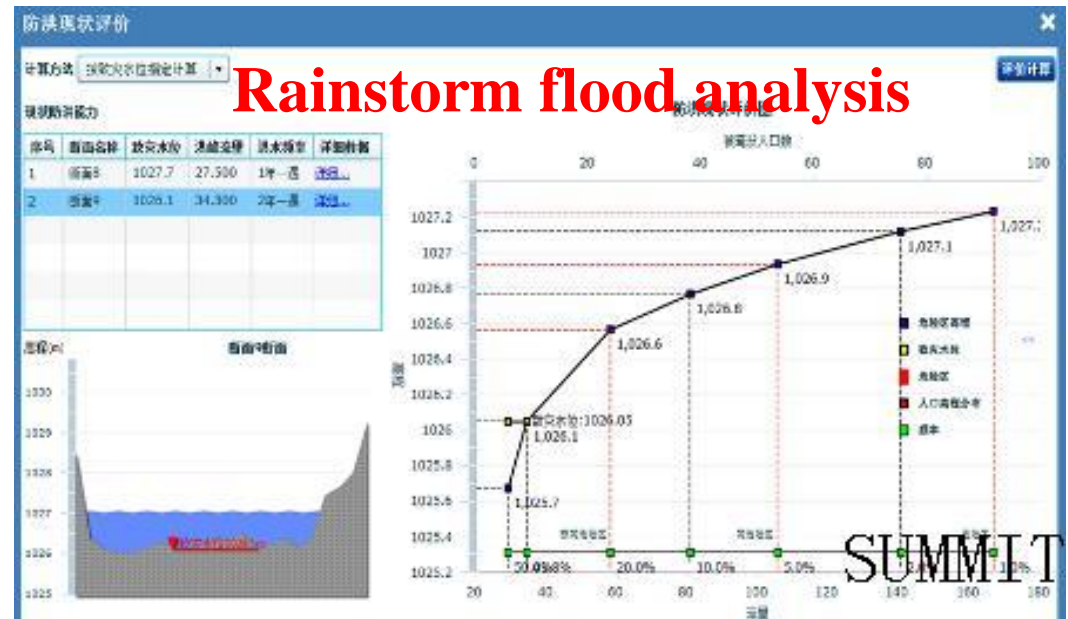
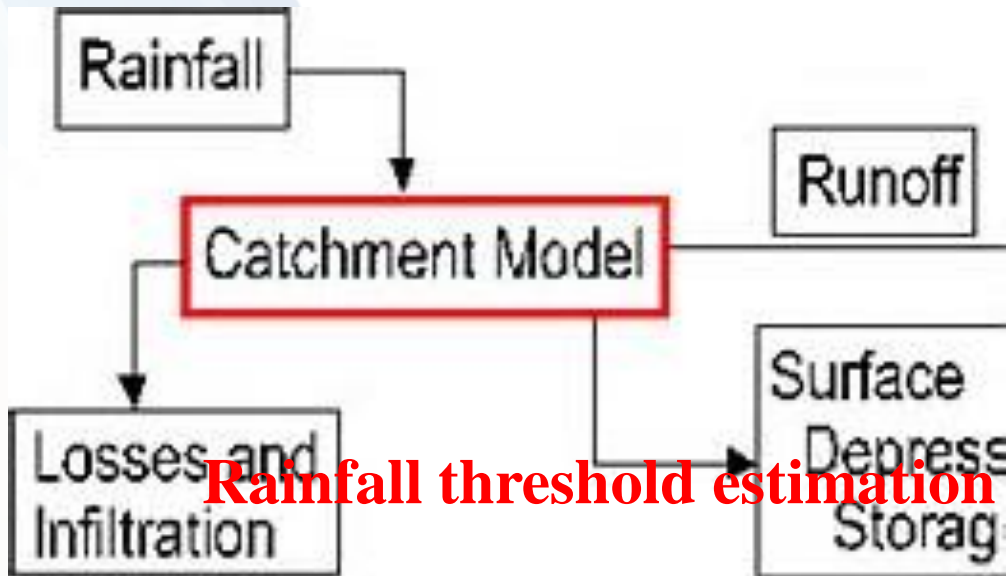
flash flood response and emergency management system

- 2,058 county level subsystems
- 305 prefectural cities
- 29 provinces

2.3 Watershed information



Rainstorm flood analysis

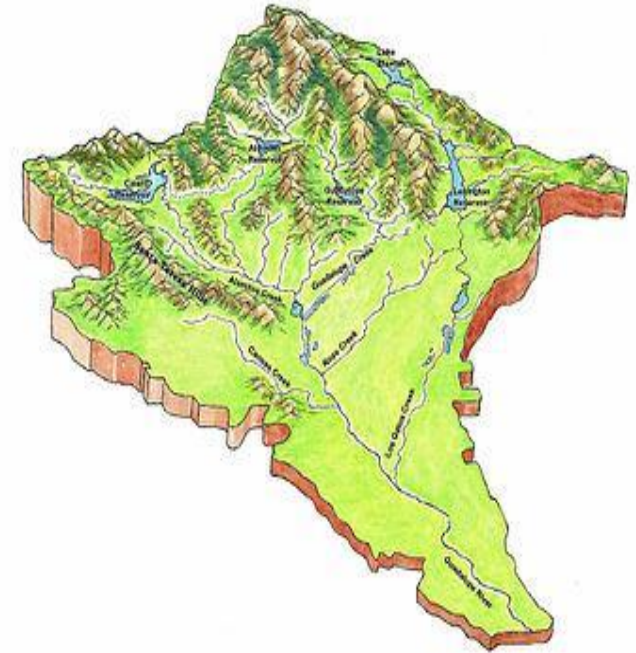


Rainstorm flood analysis

SUMMIT

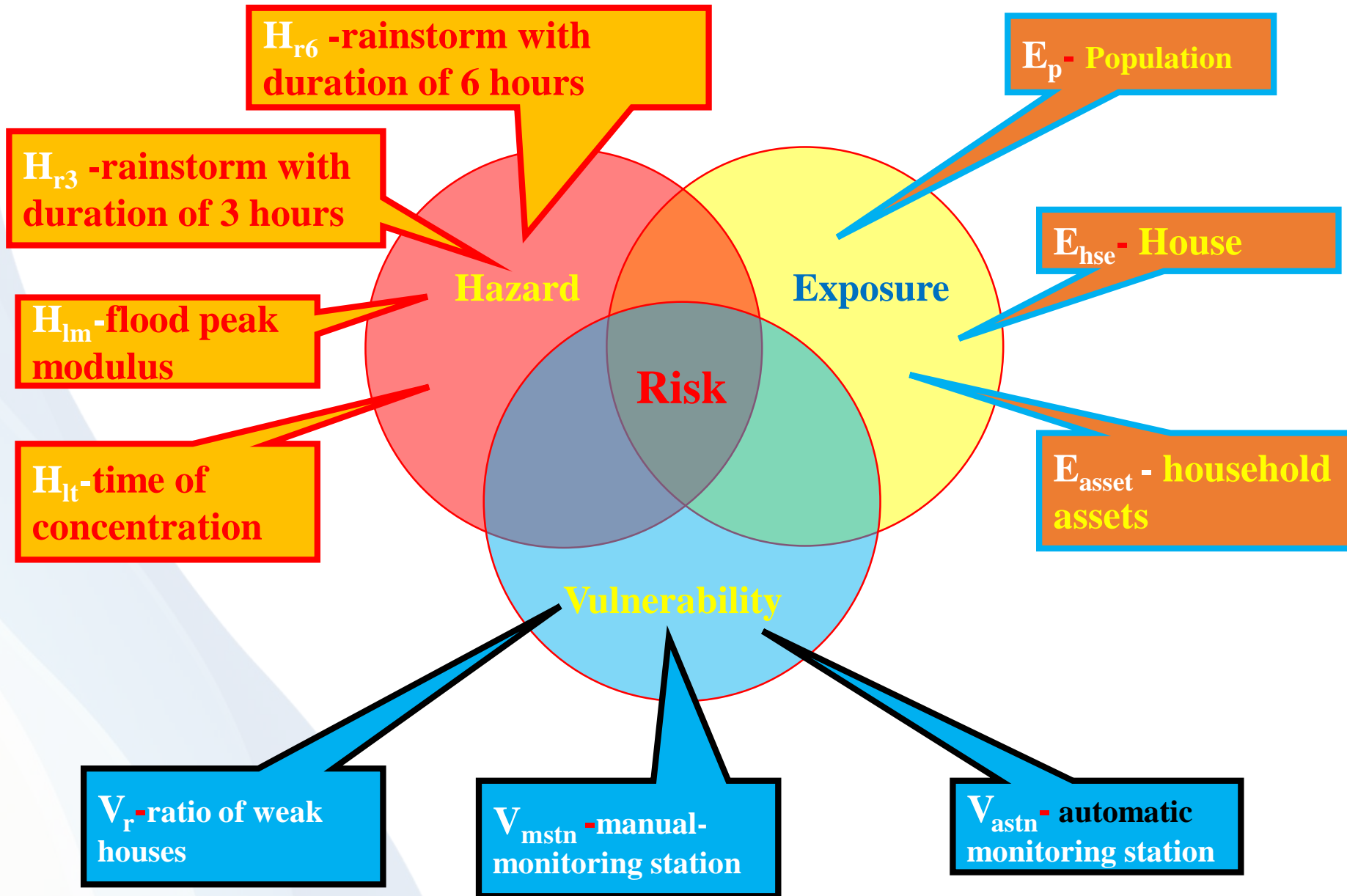
3. Flash flood risk assessment

- **Step 1: Index system development**
- **Step 2: Index normalization**
- **Step 3: Weights assignment**
- **Step 4: Computation of risk components**
- **Step 5: Flood risk level classification**



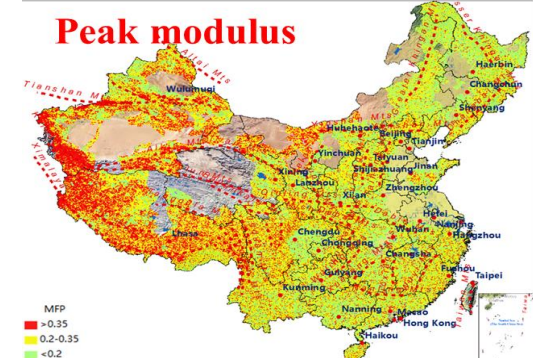
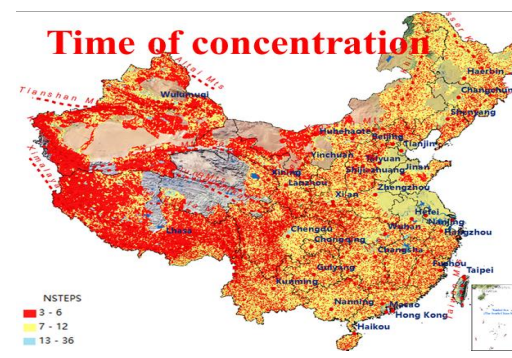
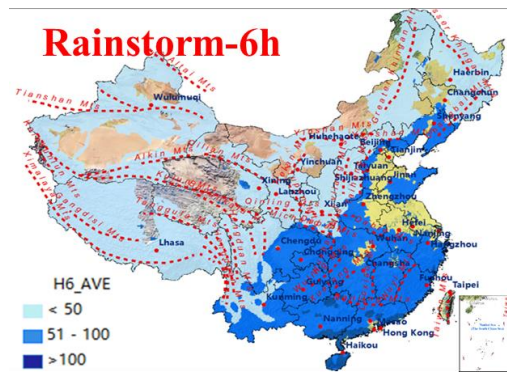
Computed entity
– **watershed**
530,000

3.1 Step 1: Index system development

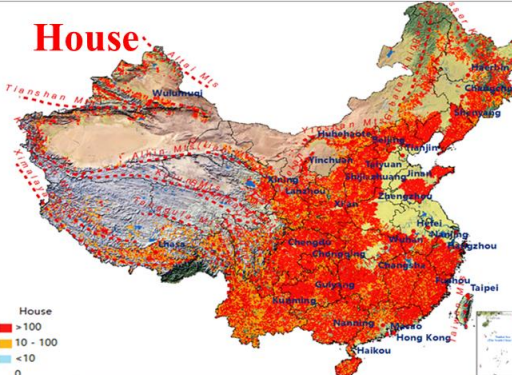
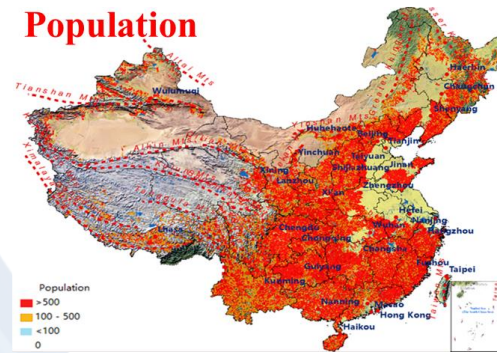


3.2 Hazard, exposure and vulnerability

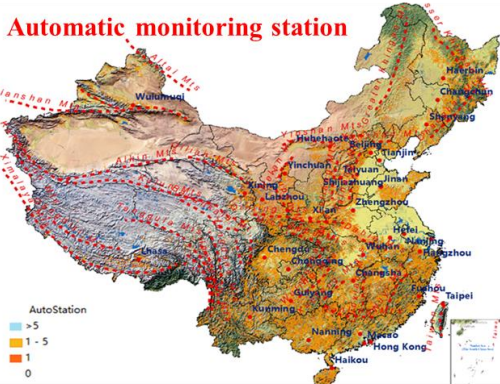
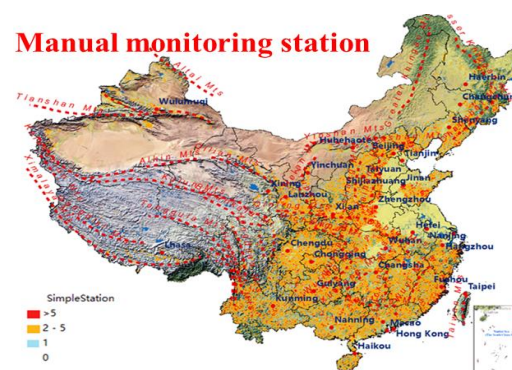
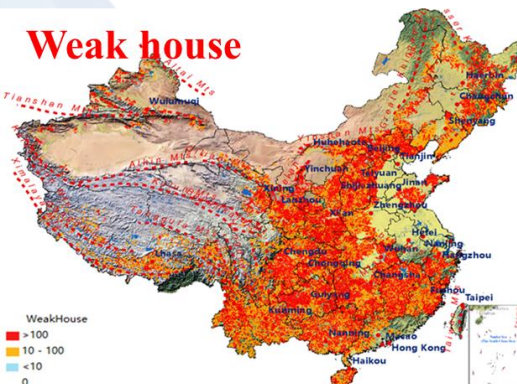
Hazard



Exposure



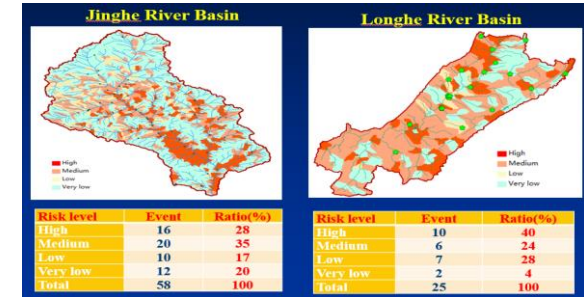
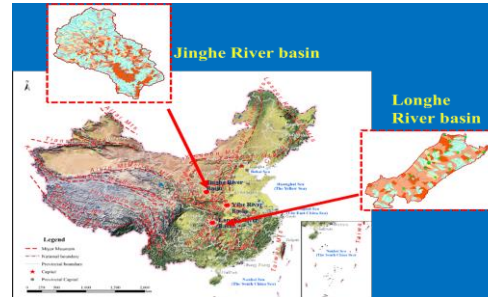
Vulnerability



3.3 Steps of risk assessment

Step 2: Normalization

$$x_i^* = \frac{x_i - x_{min}}{x_{max} - x_{min}}$$



Step 3: Weights set

Step 4: Computation

①

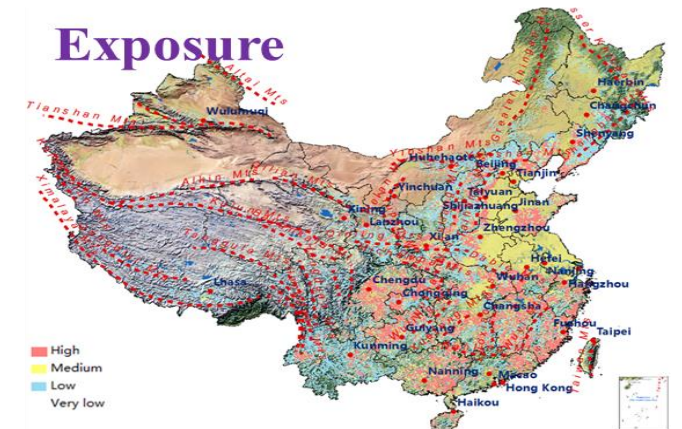
$$\text{Risk} = H \cap E \cap V$$

②

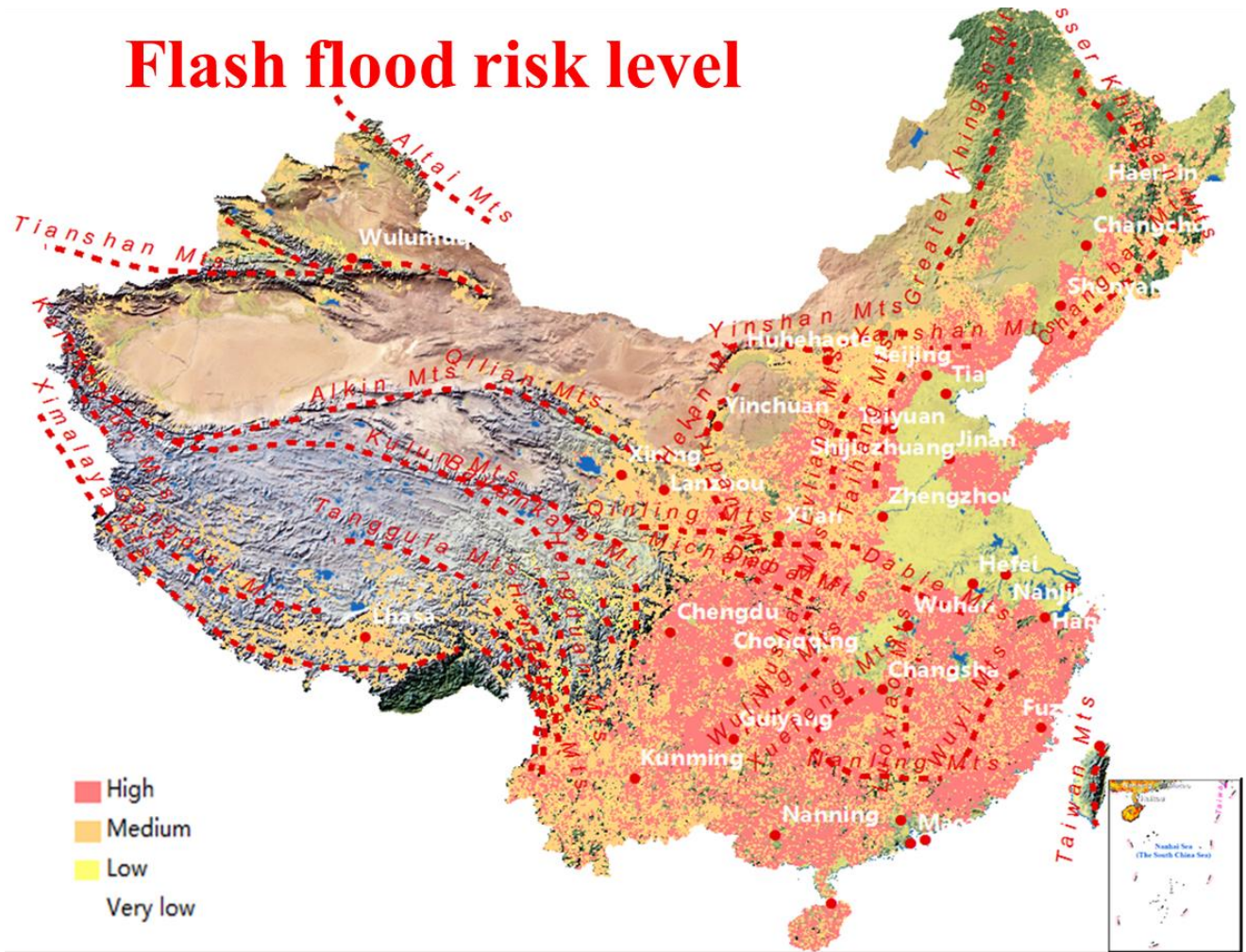
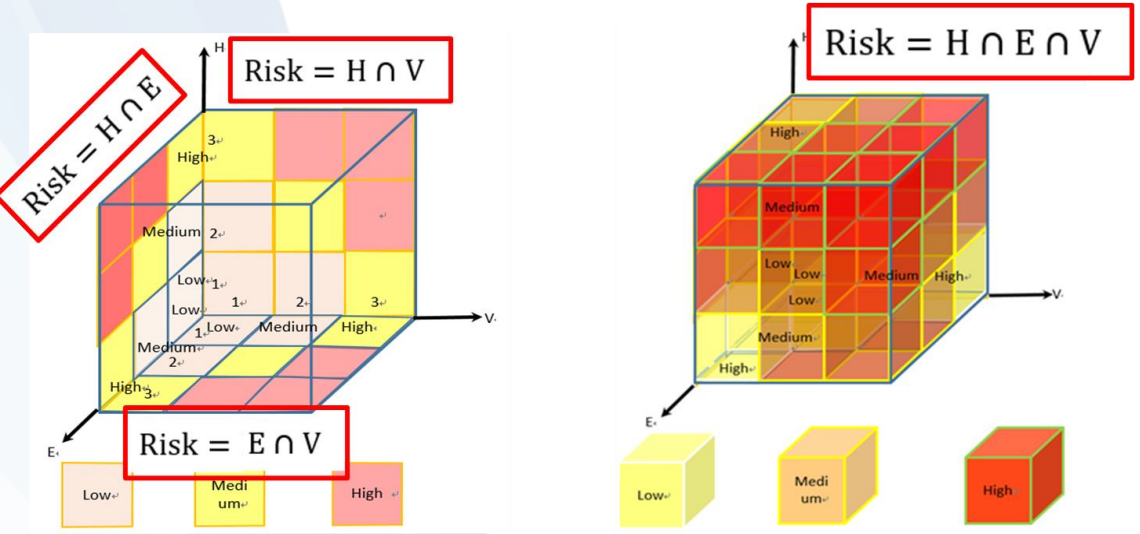
$$H = \sum_{i=1}^m W_i H_i = \sum_{i=1}^m w_i (\sum_{k=1}^{m'} w_{ik} H_{ik})$$

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

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



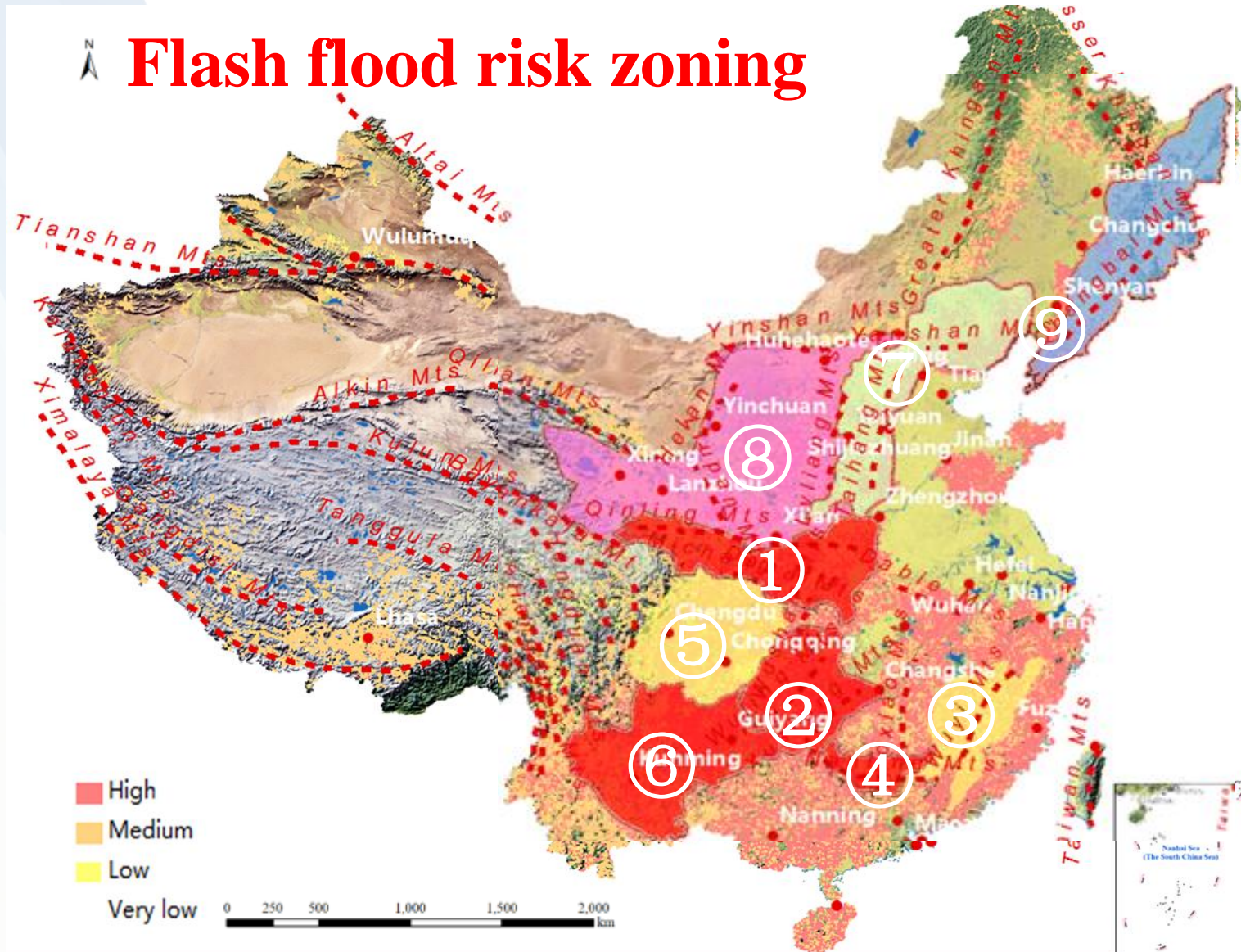
3.4 Step 5: Risk level classification-HEVOA method



Overlaying effect of H-E-V and flash flood risk classification

Risk level	Number	Code of sub-cube
High	7	H1E3V3, H2E3V3, H3E1V3, H3E2V3, H3E3V1, H3E3V2, H3E3V3
Medium	13	H1E2V2, H1E2V3, H1E3V2, H2E1V2, H2E1V3, H2E2V1, H2E2V2, H2E2V3, H2E3V1, H2E3V2, H3E1V2, H3E2V1, H3E2V2
Low	7	H1E1V1, H1E1V2, H1E1V3, H1E2V1, H1E3V1, H2E1V1, H3E1V1

4. Summary and conclusions



- ① Qinba Mountains area
- ② Wuling-Xuefeng Mountains area
- ③ Wuyi Mountains area
- ④ Nanling area
- ⑤ Sichuan Basin and surrounding
- ⑥ Yun-Gui Plateau area
- ⑦ Yanshan-Taihang Mountains area
- ⑧ Loess Plateau area
- ⑨ Changbai Mountains area

Potential - We are still on the way...

Flash flood risk management

Flash flood emergency management



Thank you!