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

UNIVERSITÉ CÔTE D'AZUR

FFP1: Seminar on Flash Flood Risk Management

Flash Flood Risk Assessment Based on FFIA in China

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China Institute of Water Resources and Hydropower Research (IWHR)

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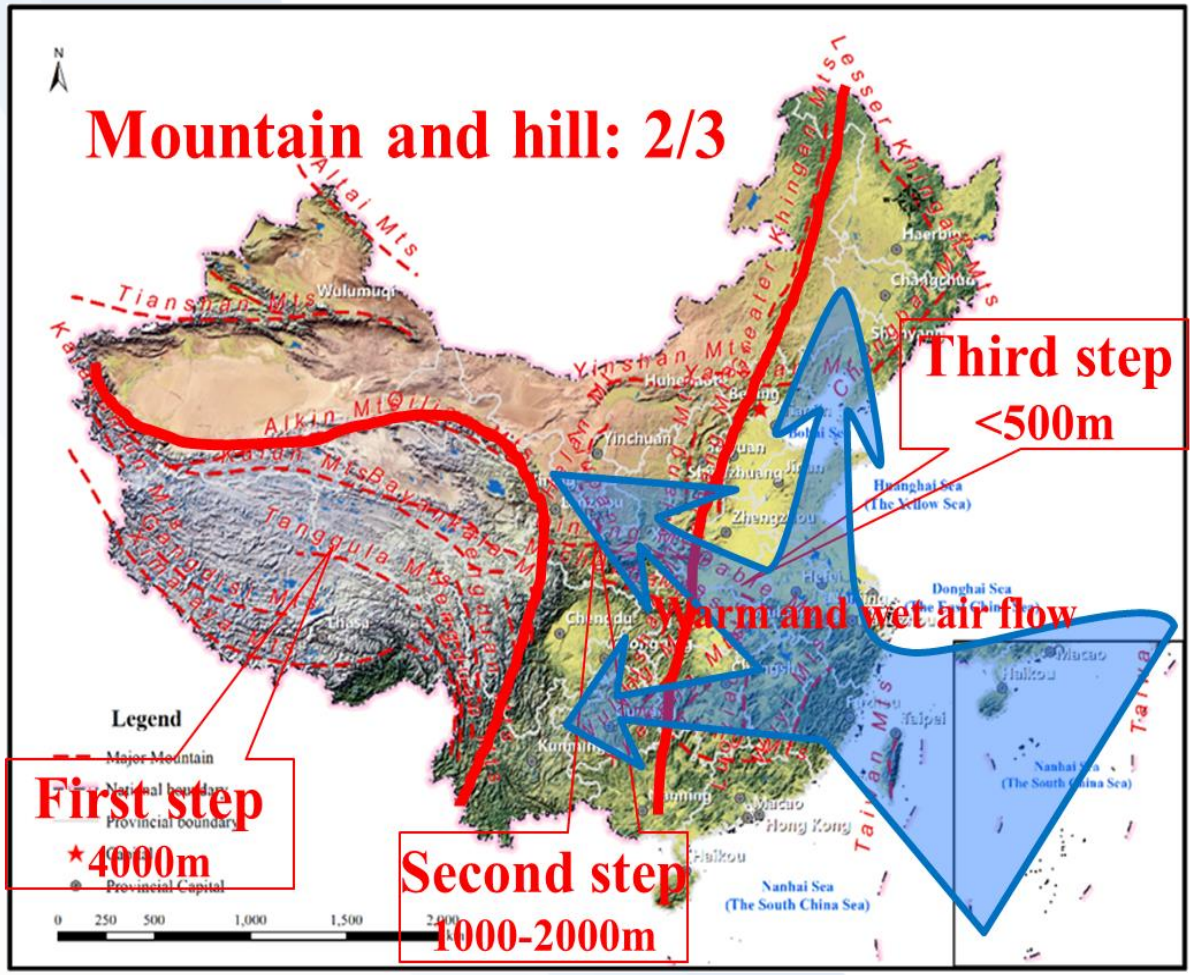
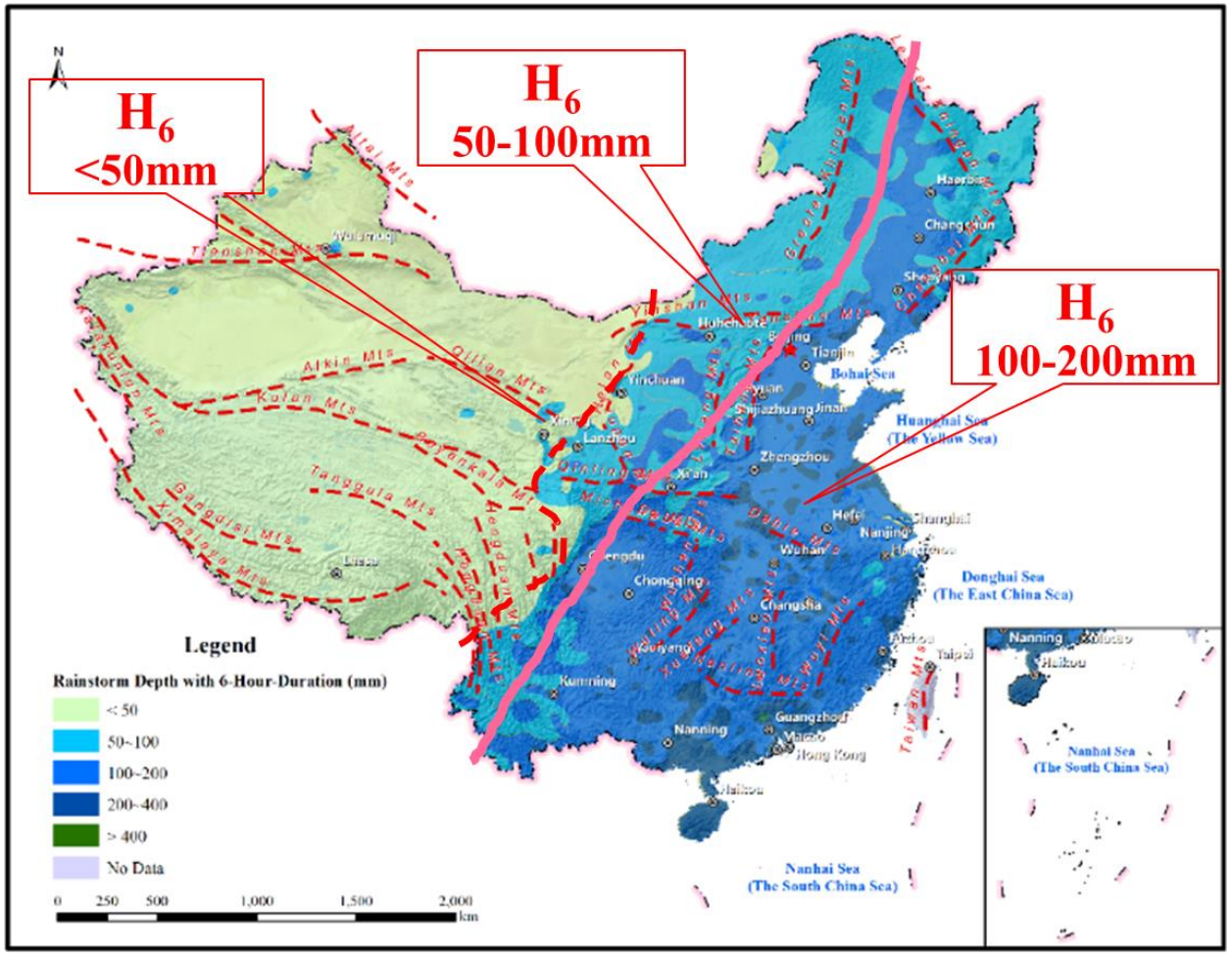
Content

1. China, a flash flood prone country

Geomorphology

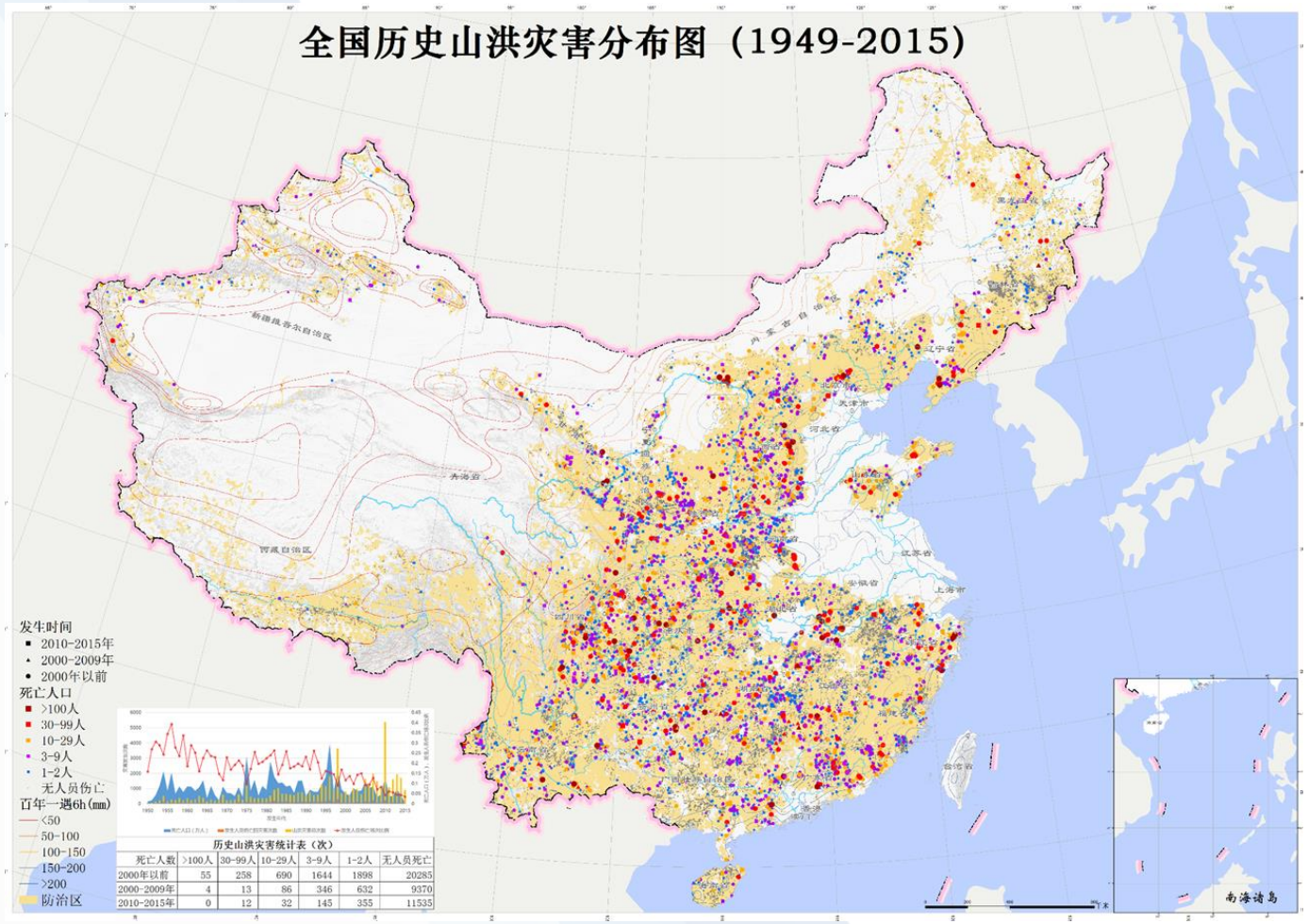


Rainstorm

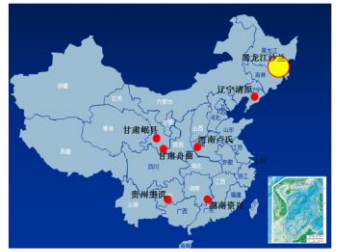


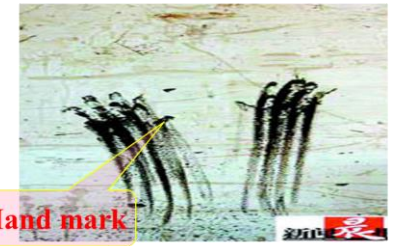
1.1 Flash flood events in China

Flash flood events in China since 1950



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



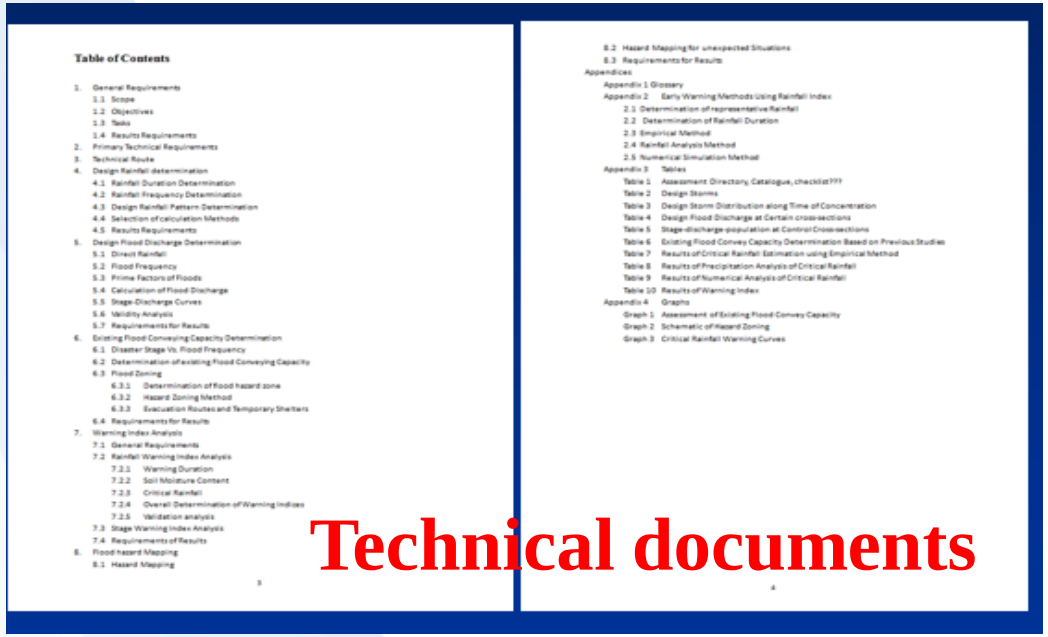


Event 2. Zhouqu County, Gansu, Aug., 7th, 2010

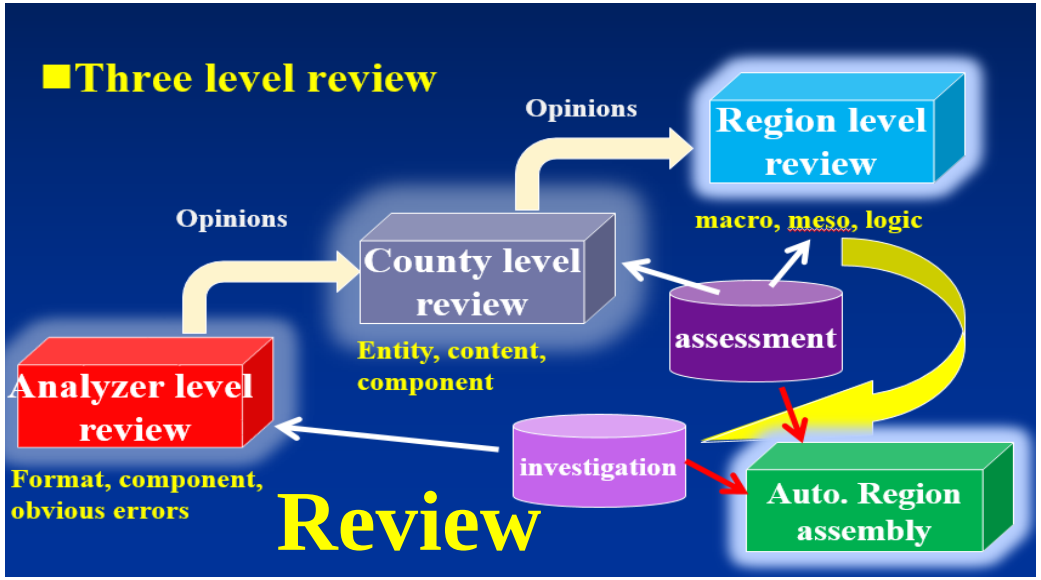
Buildings ruined

County city inundated

2. Flash flood investigation and assessment (FFIA)



- **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, …

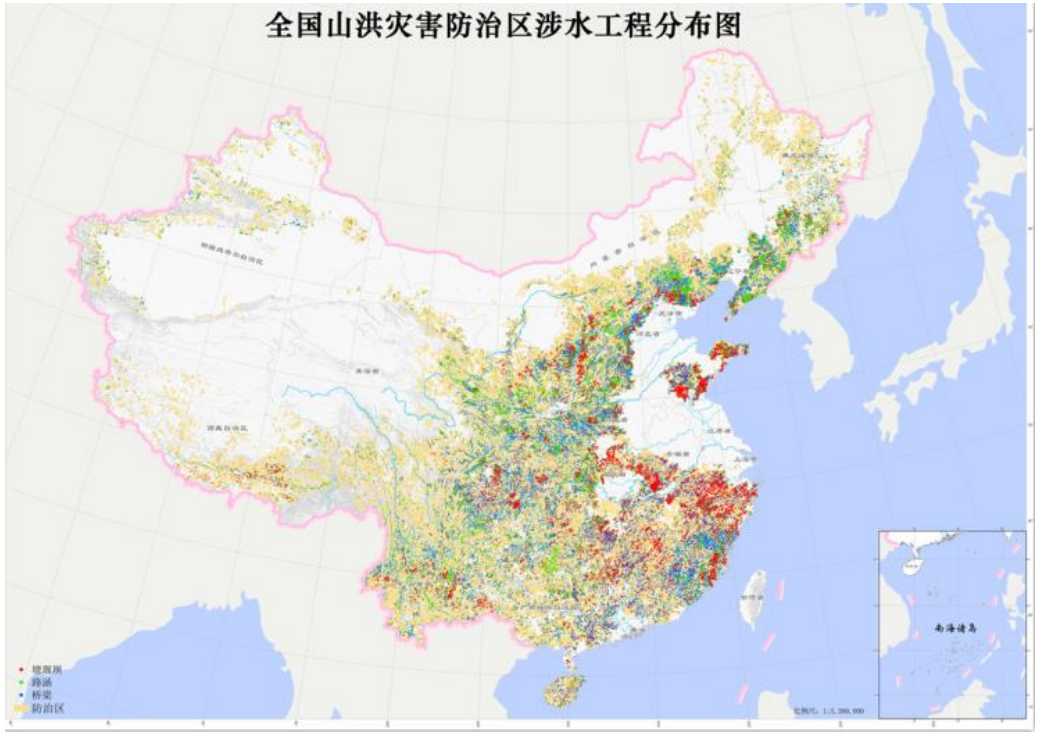


2.1 Exposures

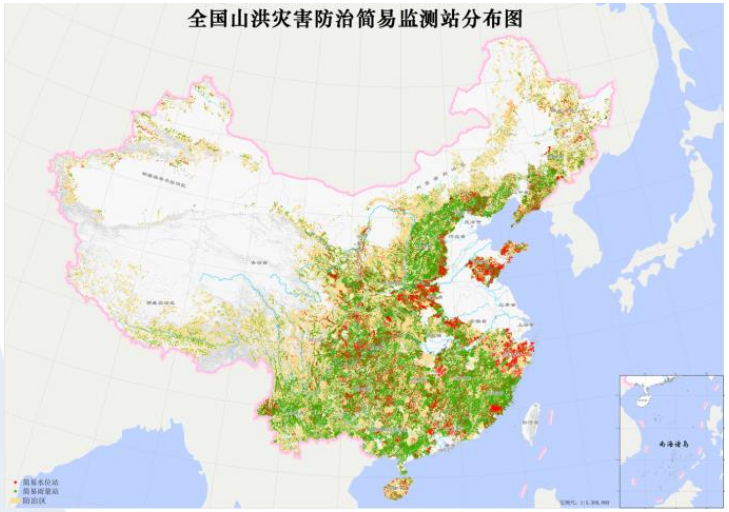
Exposures

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

- Detected structural measures involved in potential flash flood events

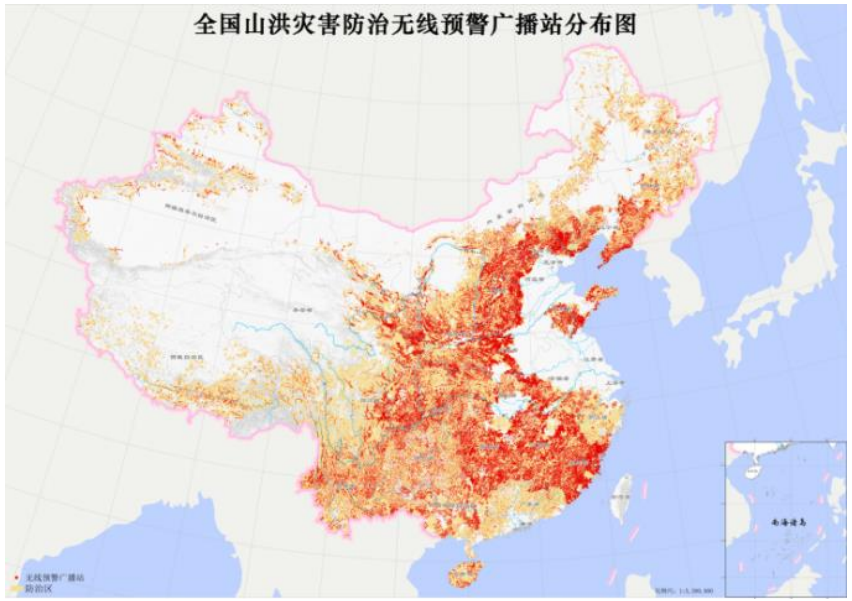


2.2 Monitoring and warning networks



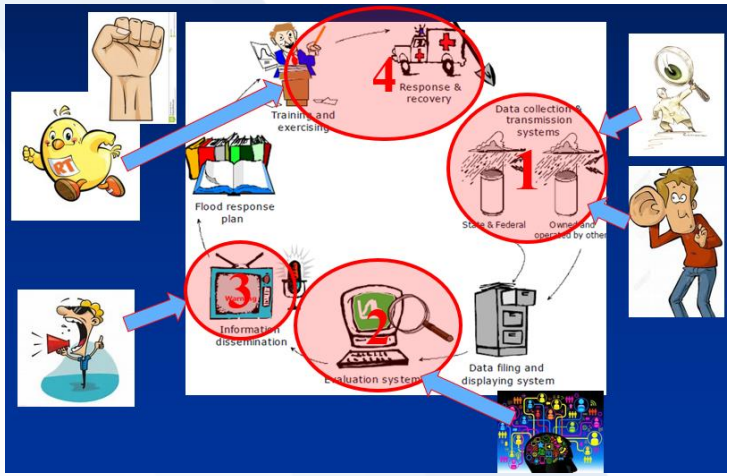
rain gauges and stage gauges:

- **360,000 manual**
- **75,000 automatic**



Wireless broadcast for warning

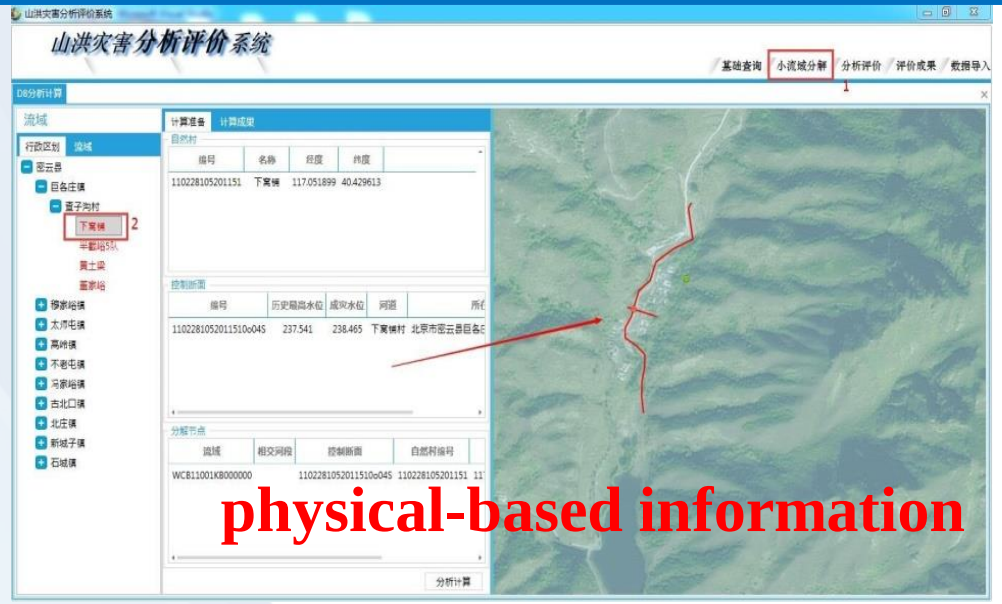
- **1.4 mil. for early warning**

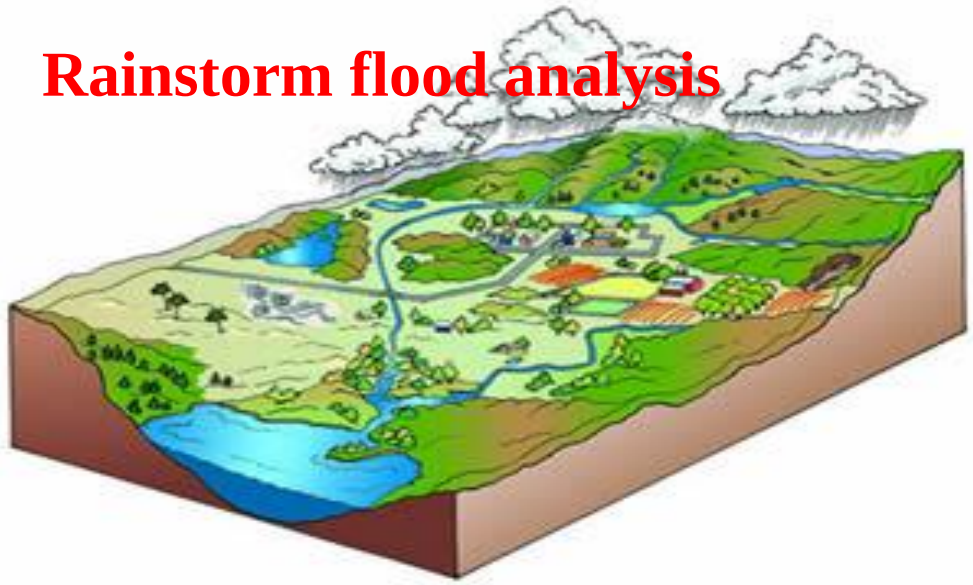


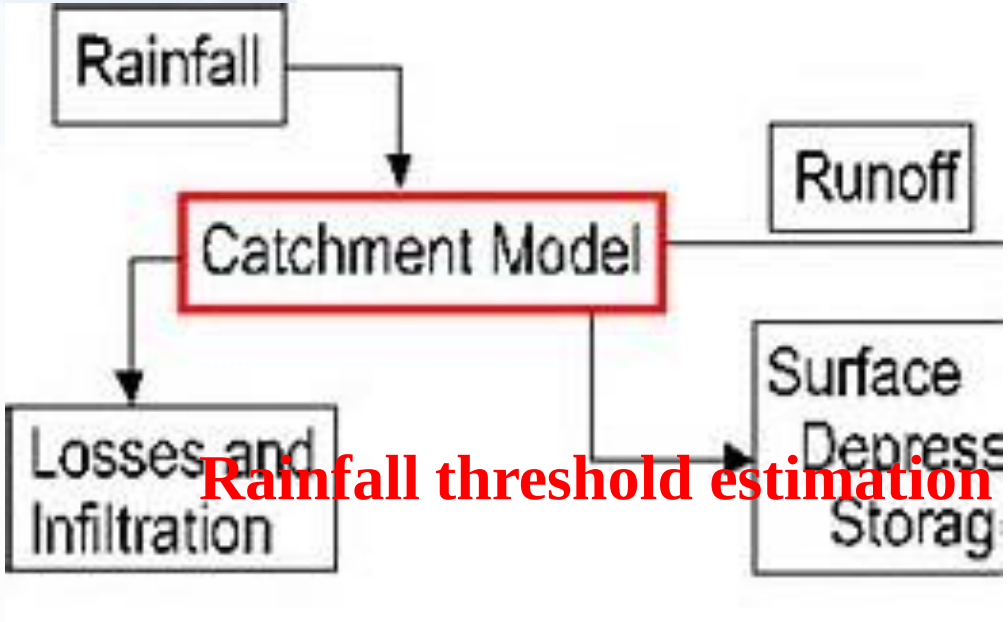
flash flood response and emergency management system

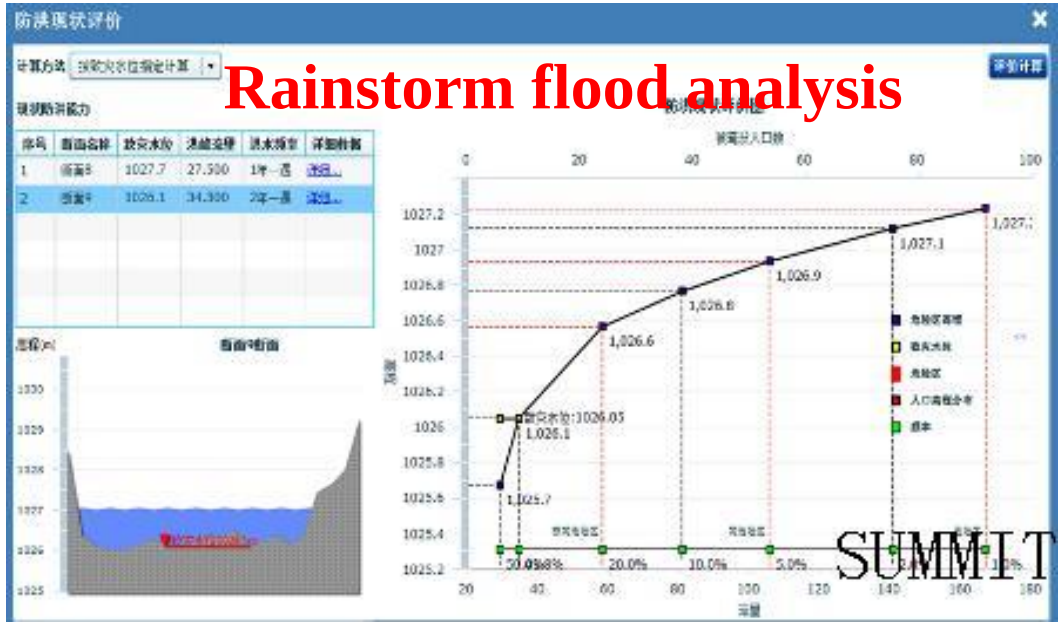
- **2,058 county level subsystems**
- **305 prefectural cities**
- **29 provinces**

2.3 Watershed information



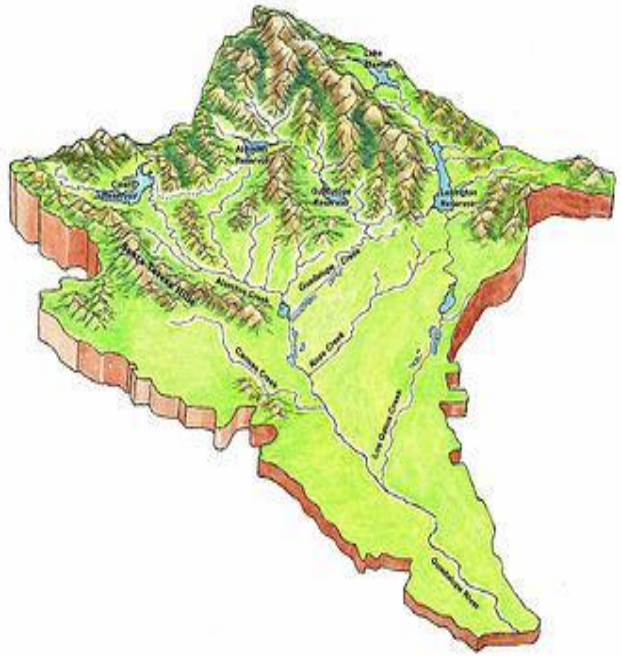






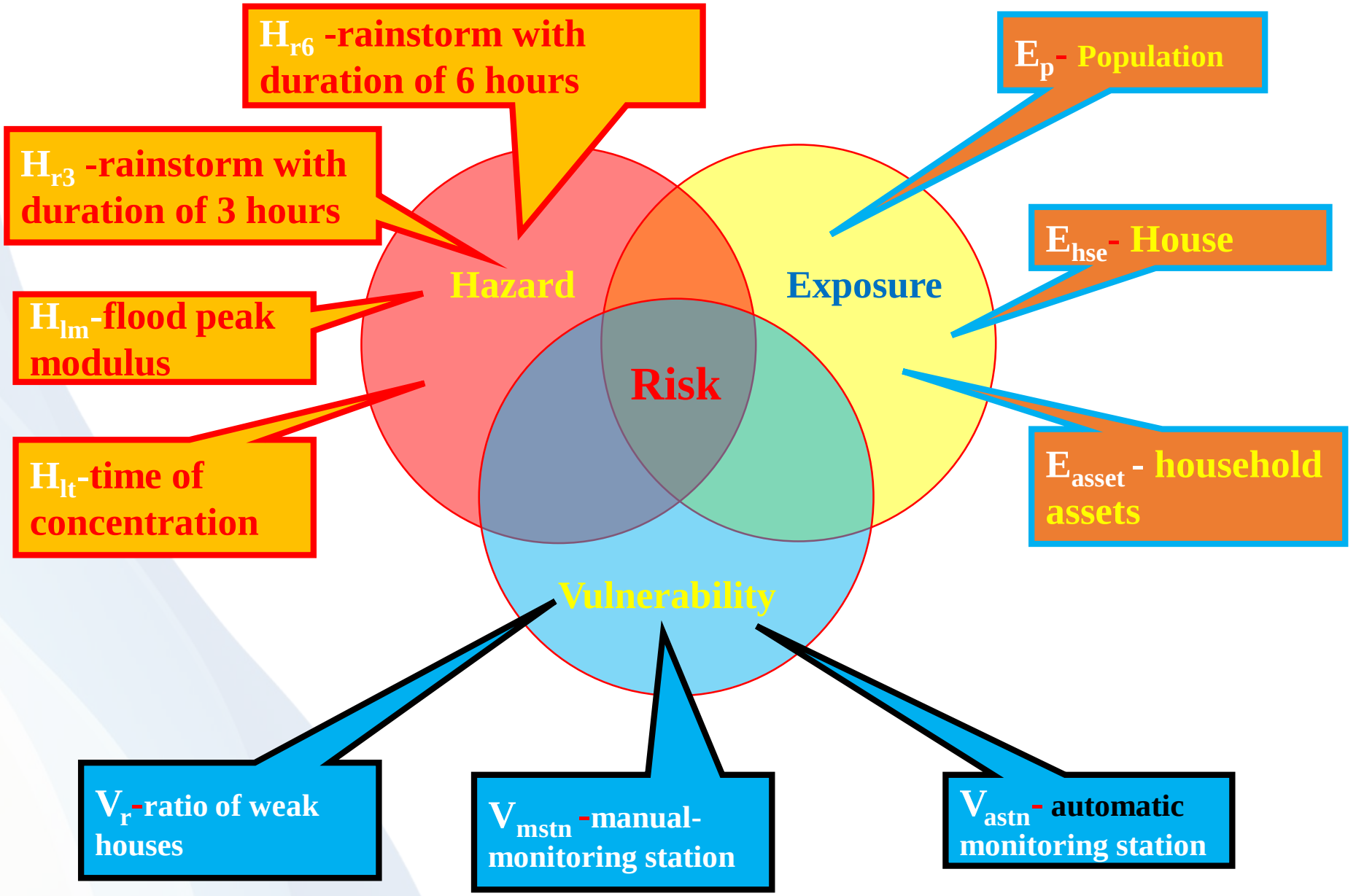
3. Flash flood risk assessment

- **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**



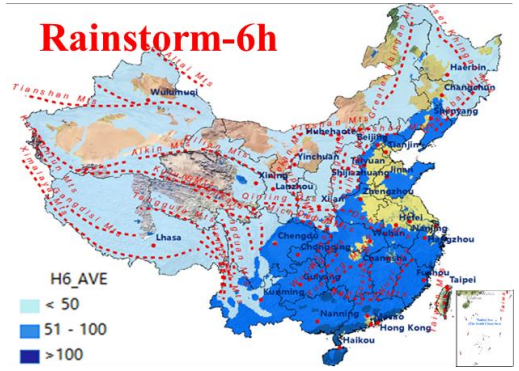
Computed entity – watershed 530,000

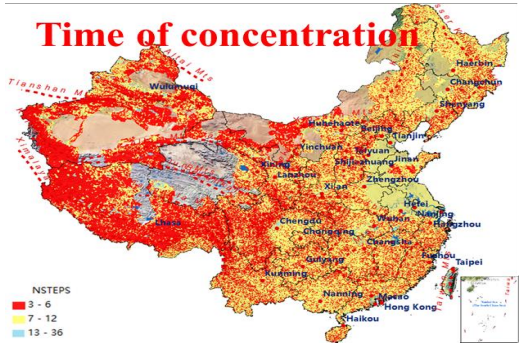
3.1 Step 1: Index system development

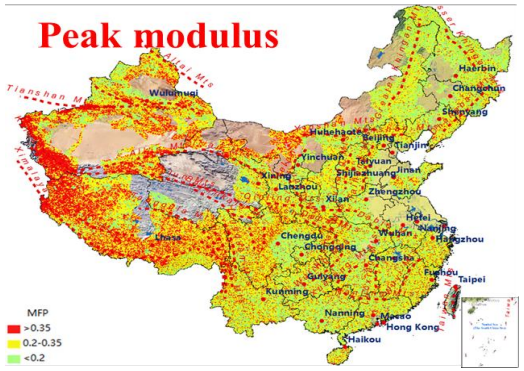


3.2 Hazard, exposure and vulnerability

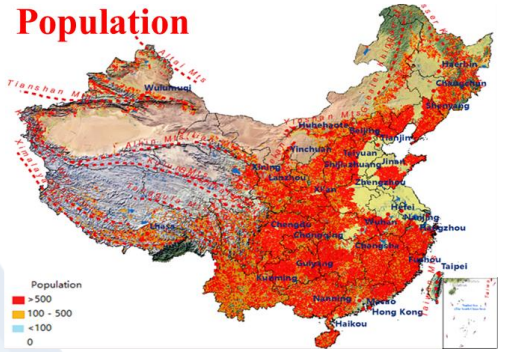
Hazard

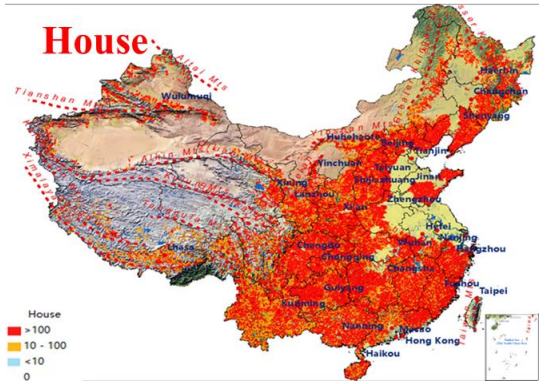




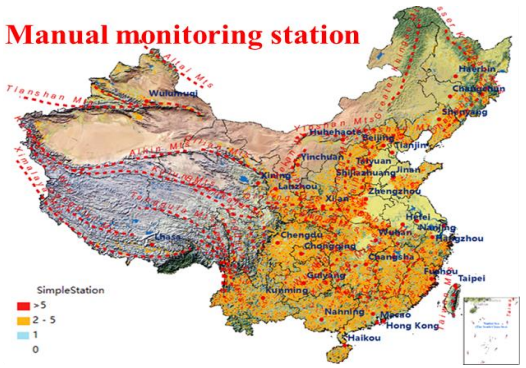


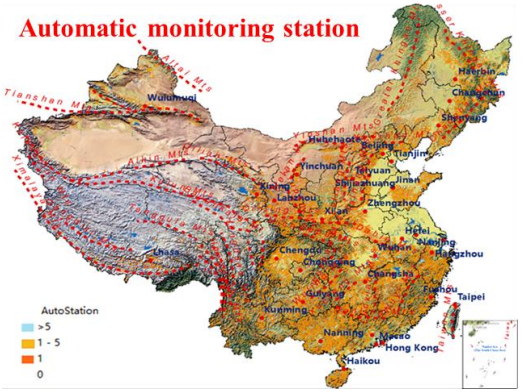
Exposure





Vulnerability

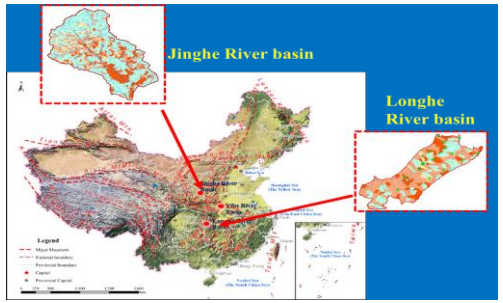


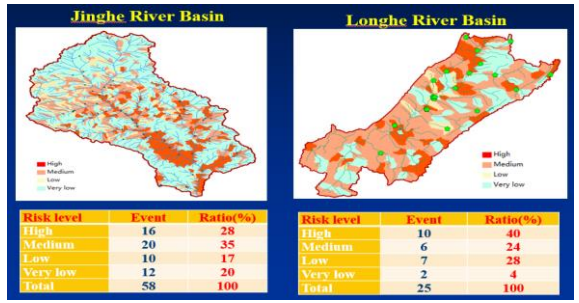


3.3 Steps of risk assessment

Step 2: Normalization

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





Risk level	Event	Ratio(%)
High	16	28
Medium	20	35
Low	10	17
Very low	12	20
Total	58	100

Risk level	Event	Ratio(%)
High	10	40
Medium	6	24
Low	7	28
Very low	2	4
Total	25	100

Step 3: Weights set

Step 4: Computation

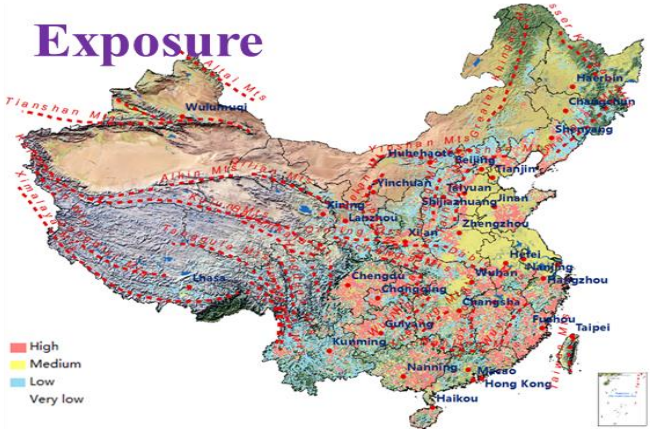
① $\text{Risk} = H \cap E \cap V$

②

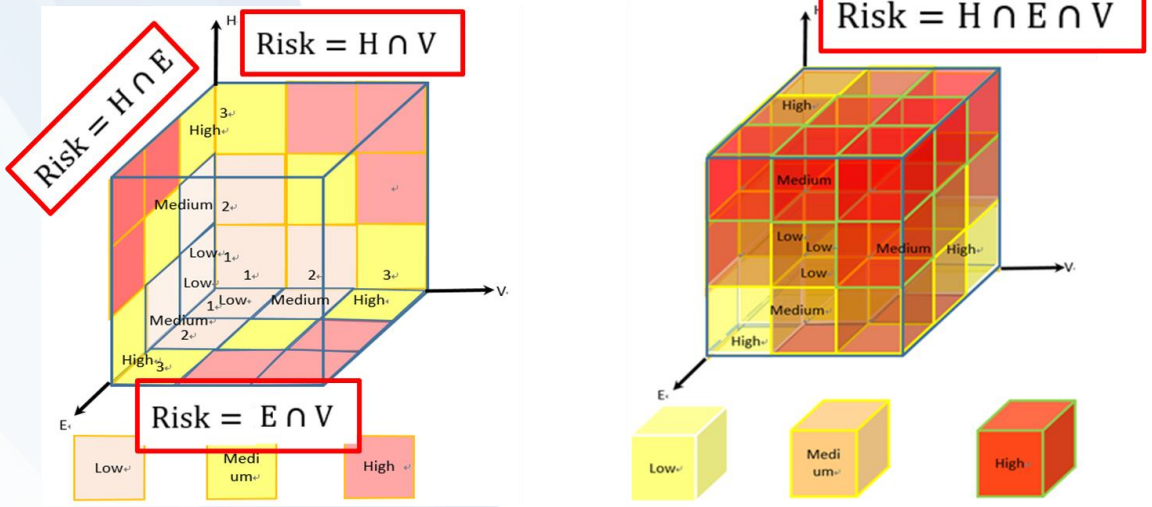
$$H = \sum_{i=1}^{m} W_i H_i = \sum_{i=1}^{m} w_i \left(\sum_{k=1}^{m'} w_{ik} H_{ik}\right)$$

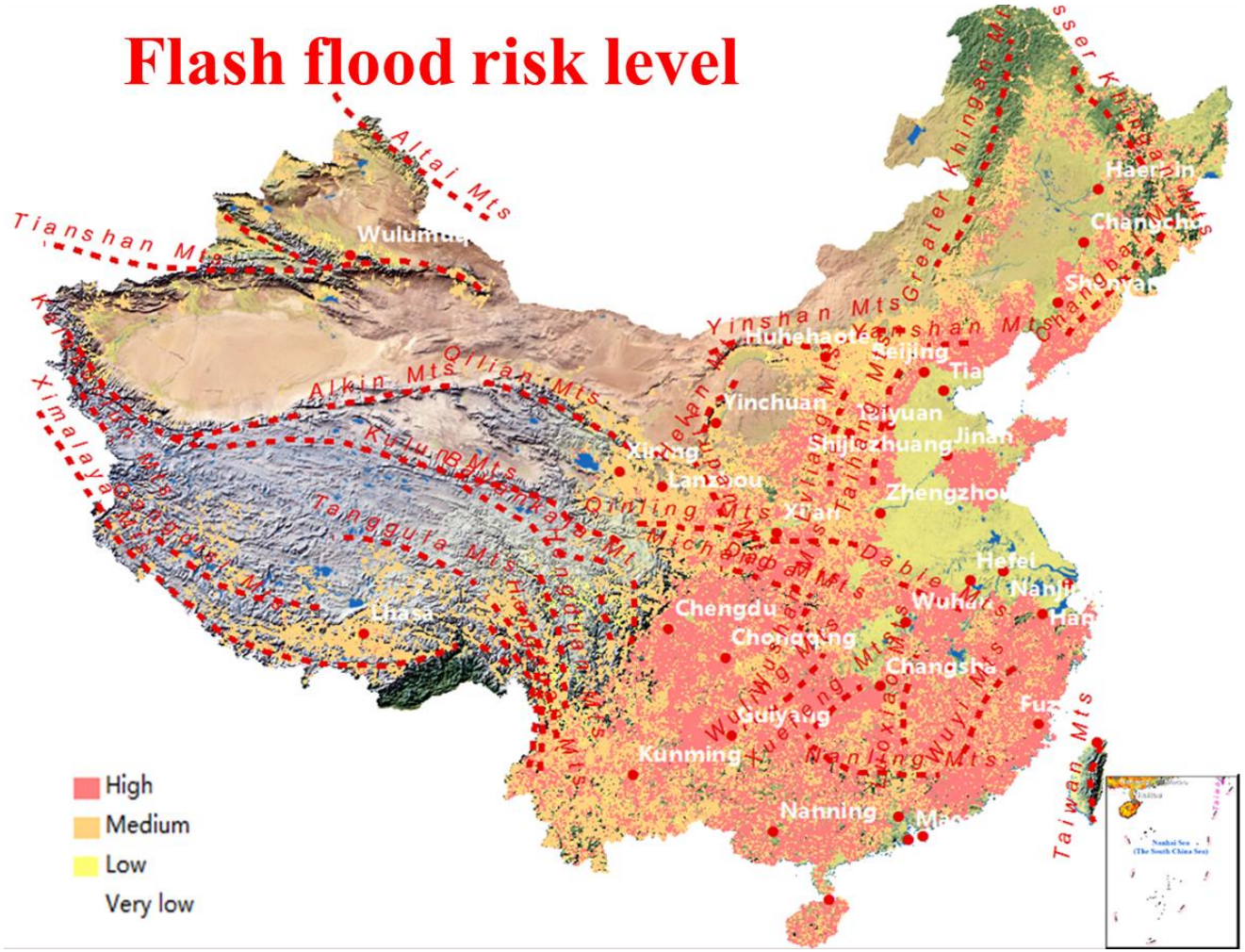
$$E = \sum_{j=1}^{n} W_j E_j = \sum_{j=1}^{n} w_j \left(\sum_{k=1}^{n'} w_{jk} E_{jk}\right)$$

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



3.4 Step 5: Risk level classification-HEVOA method

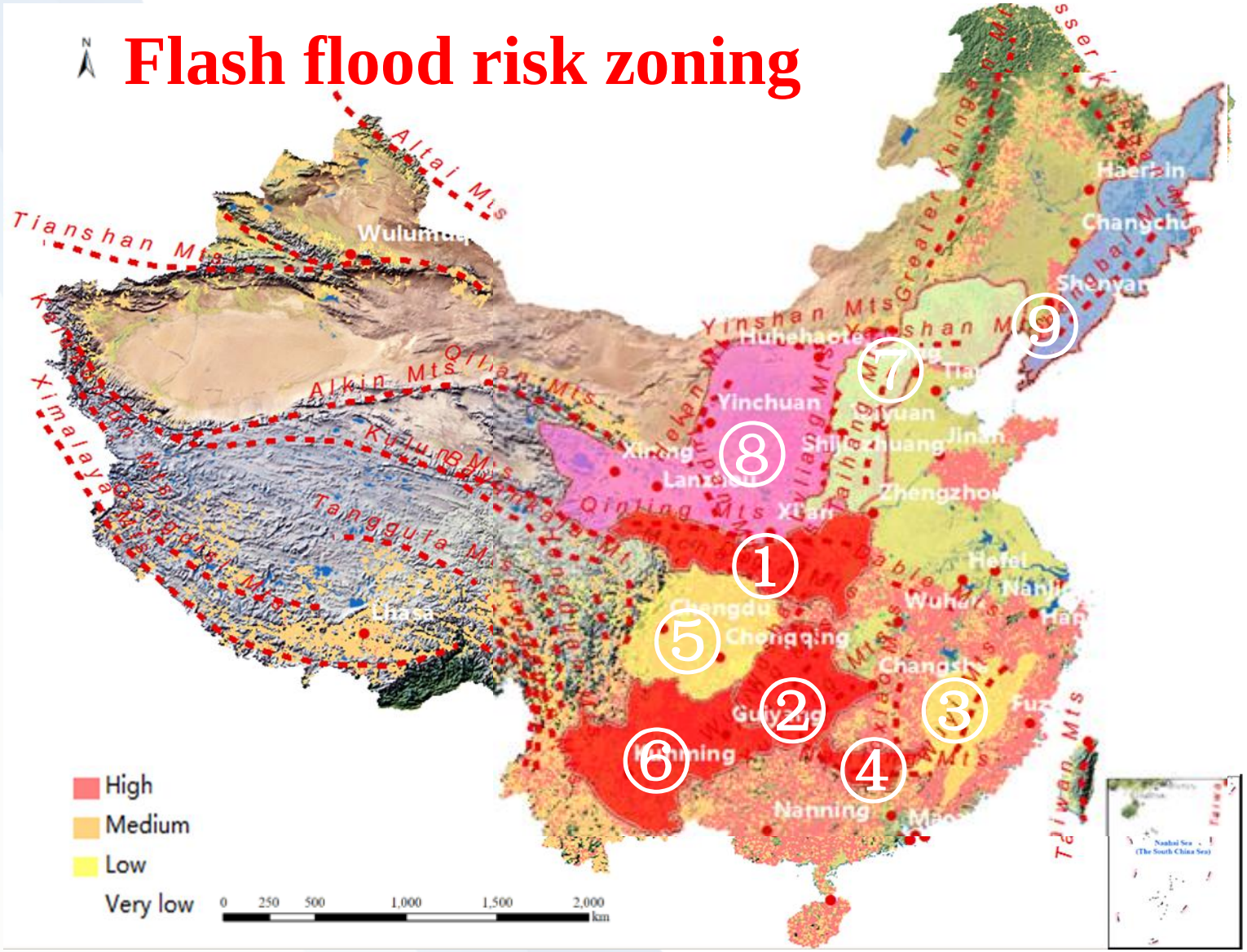




Overlaying effect of H-E-V and flash flood risk classification		
Risk level	**Number**	**Code of sub-cube**
High	**7**	**H1E3V3, H2E3V3, H3E1V3, H3E2V3, H3E3V1, H3E3V2, H3E3V3**
Medium	**13**	**H1E2V2, H1E2V3, H1E3V2, H2E1V2, H2E1V3, H2E2V1, H2E2V2, H2E2V3, H2E3V1, H2E3V2, H3E1V2, H3E2V1, H3E2V2**
Low	**7**	**H1E1V1, H1E1V2, H1E1V3, H1E2V1, H1E3V1, H2E1V1, H3E1V1**

4. Summary and conclusions

Flash flood risk zoning



①Qinba Mountains area

②Wuling-Xuefeng Mountains area

③Wuyi Mountains area

④Nanling area

⑤Sichuan Basin and surrounding

⑥Yun-Gui Plateau area

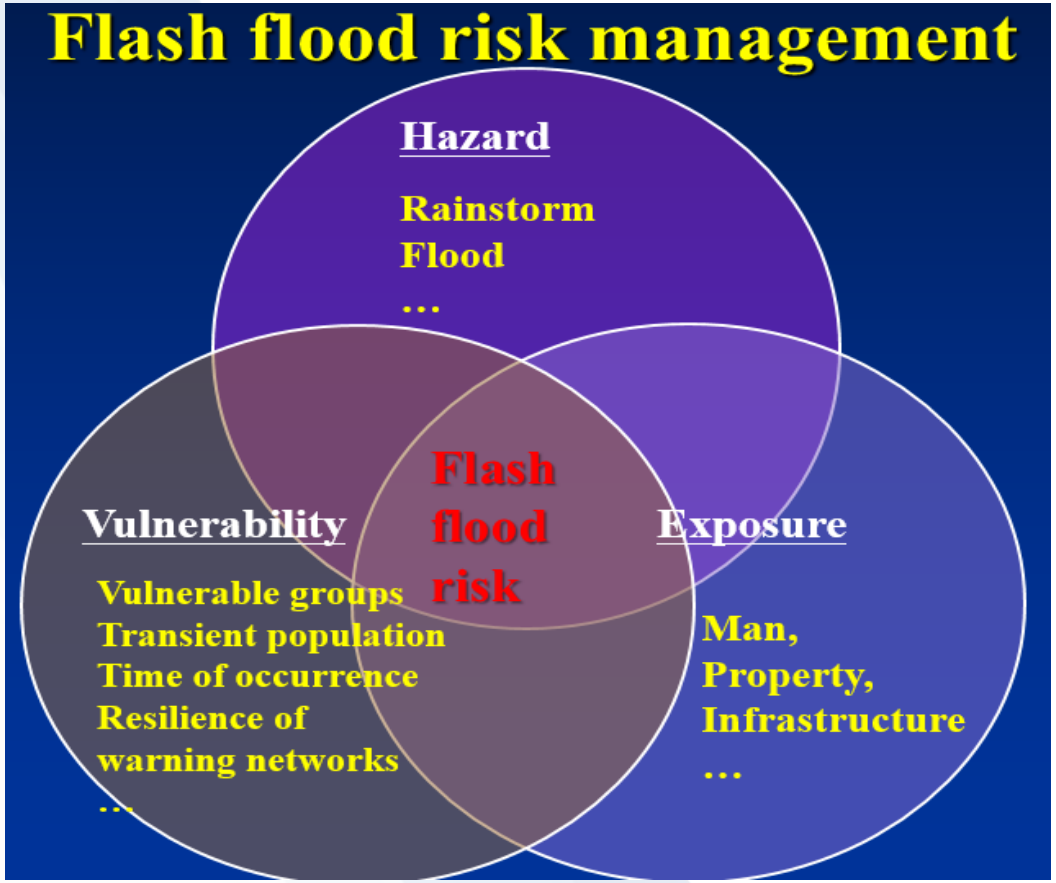
⑦Yanshan-Taihang Mountains area

⑧Loess Plateau area

⑨Changbai Mountains area

Potential - We are still on the way...

Flash flood risk management



Flash flood emergency management

Thank you!