

# Urban flood disaster resilience evaluation based on disaster response process: a case study of the middle and lower reaches of the Yangtze River

吴华清<sup>1, 2</sup>, 张朝<sup>1</sup>

## Background

**Resilience**, the ability of the system to absorb, recover and adapt from disturbances, plays an important role in improving urban disaster prevention and reduction.

- ◆ Building resilient cities has been written into the 14th five-year plan by the Chinese government.
- ◆ The middle and lower reaches of the Yangtze River (MLYR) is the area with the most frequent floods in China, which has become a prominent problem for China's urban public security.
- ◆ Model calculation lacks a comprehensive consideration of urban socio-economic and the data requirement is relatively high which is not conducive to tracking the variation of urban disaster resilience (UDR) for a long time.
- ◆ The index system always lacks the consideration of UDR variation in the process of urban response.

Taking MLYR as an example, we divided the urban response process into four stages and established the evaluation index system for urban flood disaster resilience (UFDR) including 21 indicators.

## Calculation Method

① Data normalization

Positive:  $x'_{i,j} = x_{i,j} - x_j^{\min} / x_j^{\max} - x_j^{\min}$ ; Negative:  $x'_{i,j} = x_j^{\max} - x_{i,j} / x_j^{\max} - x_j^{\min}$

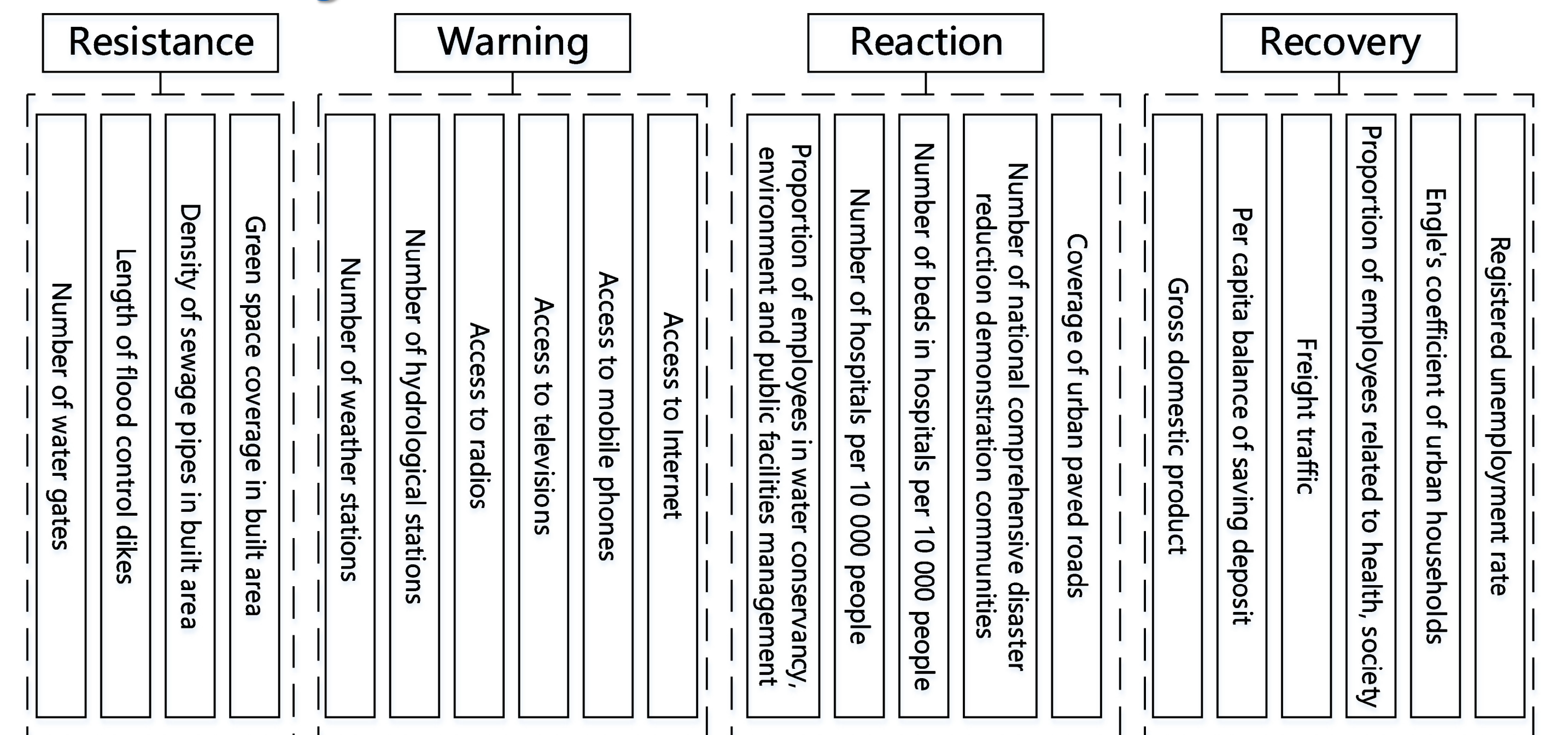
② Entropy weight calculation

Proportion	Entropy	Redundancy	Weight
$y_{i,j} = x'_{i,j} / \sum_{i=1}^n x'_{i,j}$	$e_j = -1 / \ln(n) \sum_{i=1}^n y_{i,j} \cdot \ln y_{i,j}$	$d_j = 1 - e_j$	$w_j = d_j / \sum_{j=1}^m d_j$

③ Scores calculation

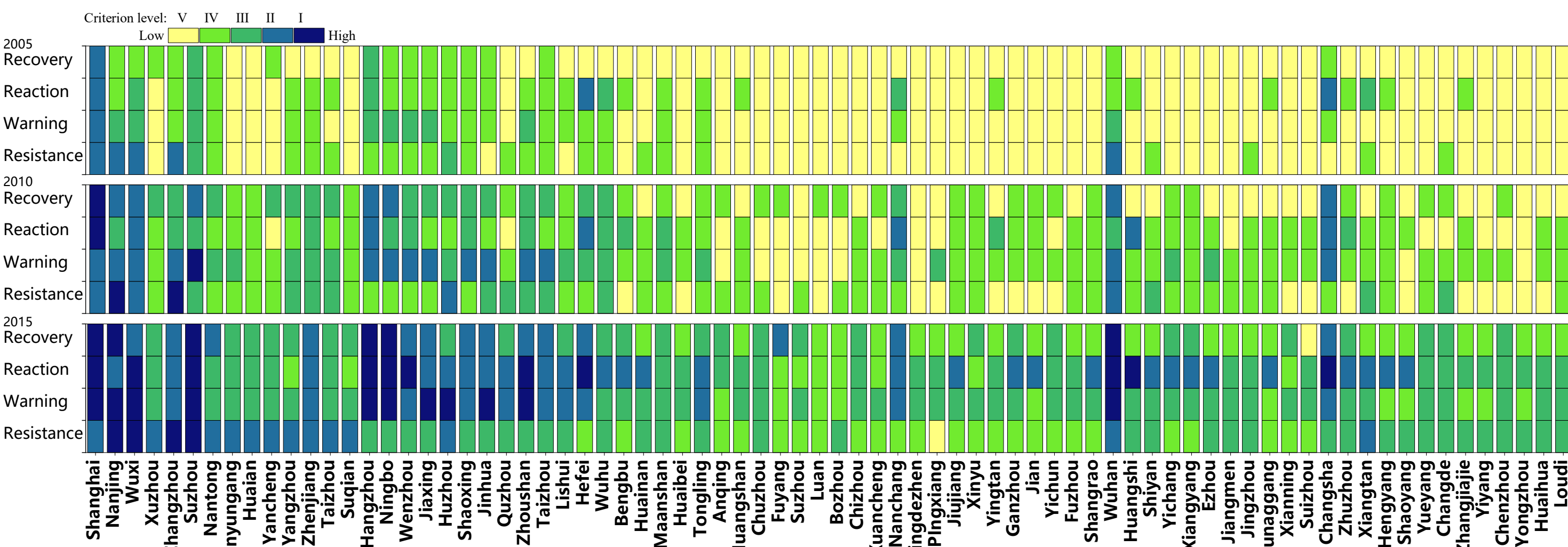
Criterion	Resilience	Classification
$S_{i,j} = w_j \cdot x'_{i,j}$ $S_{i,c} = \sum_{j=1}^q S_{i,j}$	$R_i = \sum_{c=1}^4 S_{i,c}$	Natural breakpoint

## Index System



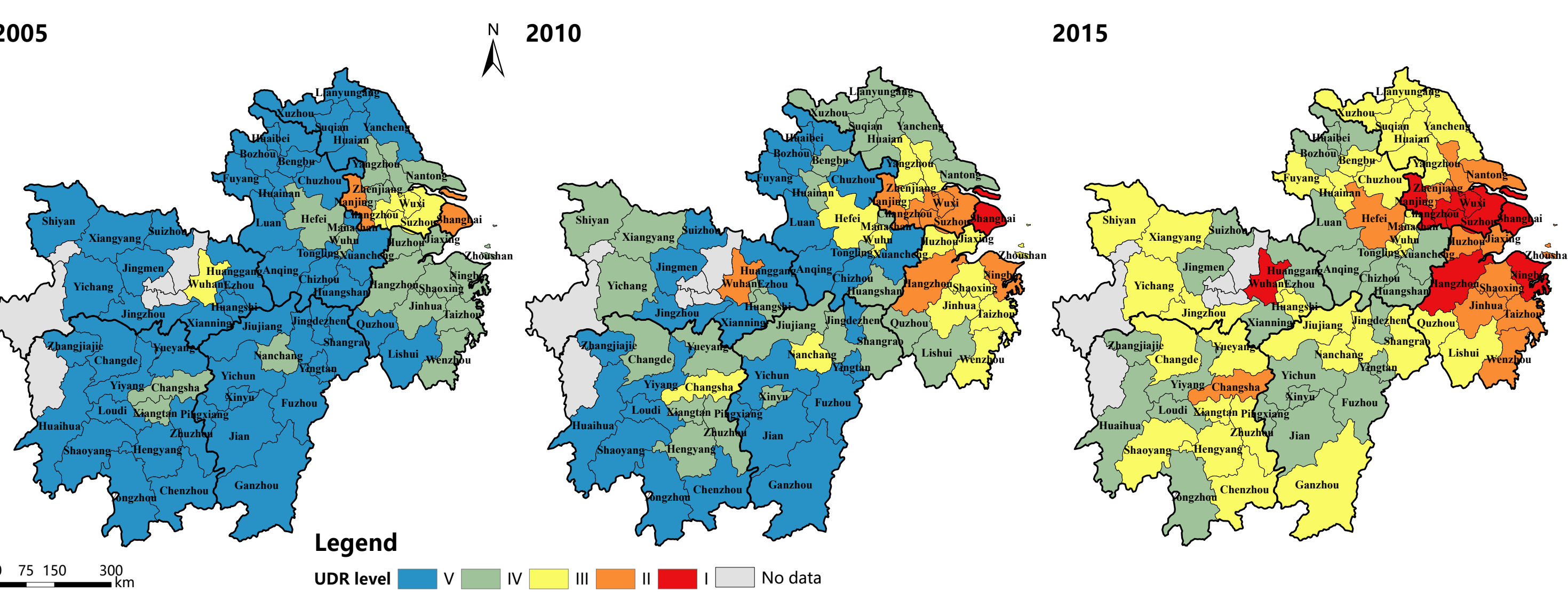
## Results

### ① Criterion level



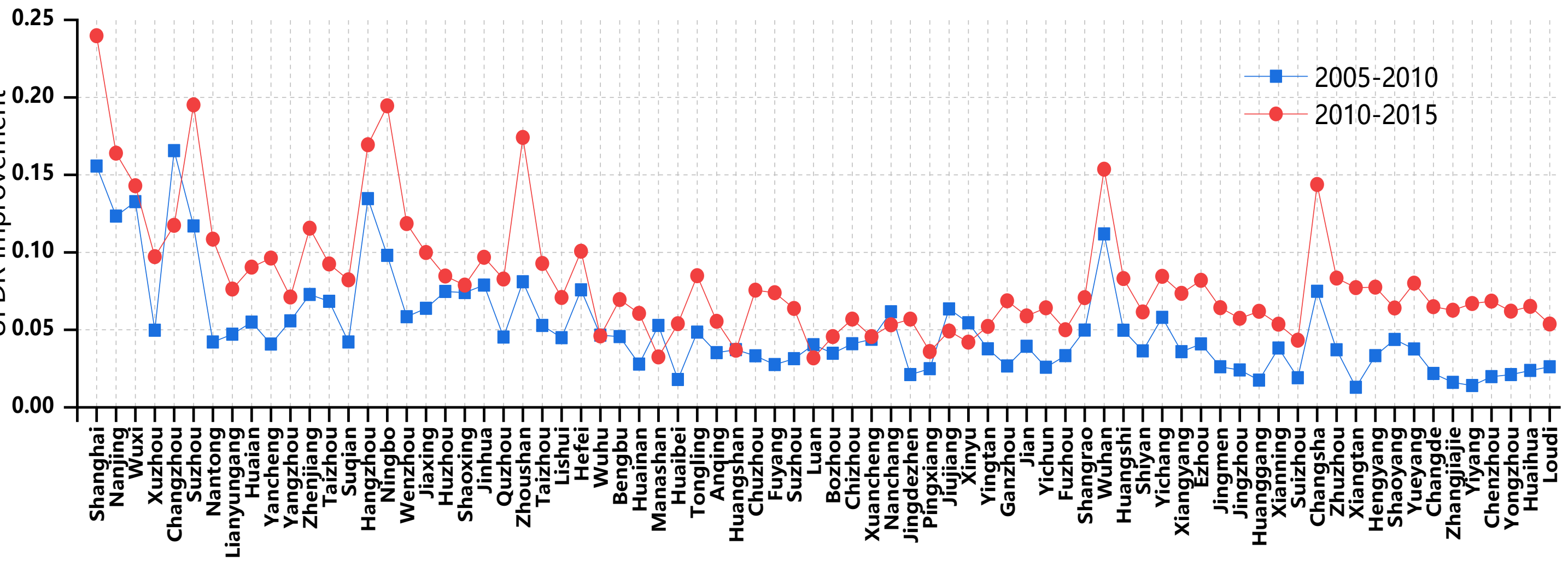
The level of the four stages of UFDR showed an increased trend from 2005 to 2015. The maximum scores are mostly concentrated in Shanghai and Jiangsu Provinces, while the minimum scores are mostly in Anhui, Hubei, Jiangxi and Hunan Provinces.

### ② Resilience level



UFDR has increased from 2005 to 2015, and UFDR of Shanghai is higher than that of other cities. Moreover, UFDR of Shanghai, Jiangsu and Zhejiang Provinces is significantly higher than that of Anhui, Jiangxi, Hubei and Hunan Provinces.

### ③ Resilience variation



The average improvement from 2010 to 2015 is higher than that from 2005 to 2010. The UFDR improvement the provincial capitals of Hubei and Hunan Provinces is higher than other cities in the provinces while the improvement of cities in Anhui and Jiangxi Province is relatively similar.

## Conclusion

- The criterion level of cities in Shanghai, Jiangsu and Zhejiang are higher and provincial capital cities are often higher than that of other cities in the province.
- UFDR of Shanghai is ahead of other cities. The average improvement from 2010 to 2015 is higher than that from 2005 to 2010.
- Considering the urban disaster response process, our index system provides a new perspective for UFDR evaluation and is of great significance for urban disaster management system.