Resilience for Landslide Geohazards and Promoting Strategies in the Three Gorges Reservoir Area

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Introduction

Landslide Geohazards will lead to **serious environmental problems**. Studies on **disaster resilience** provides research breadth and depth for resilience research methods, disaster background, data processing and resilience enhancement strategies.

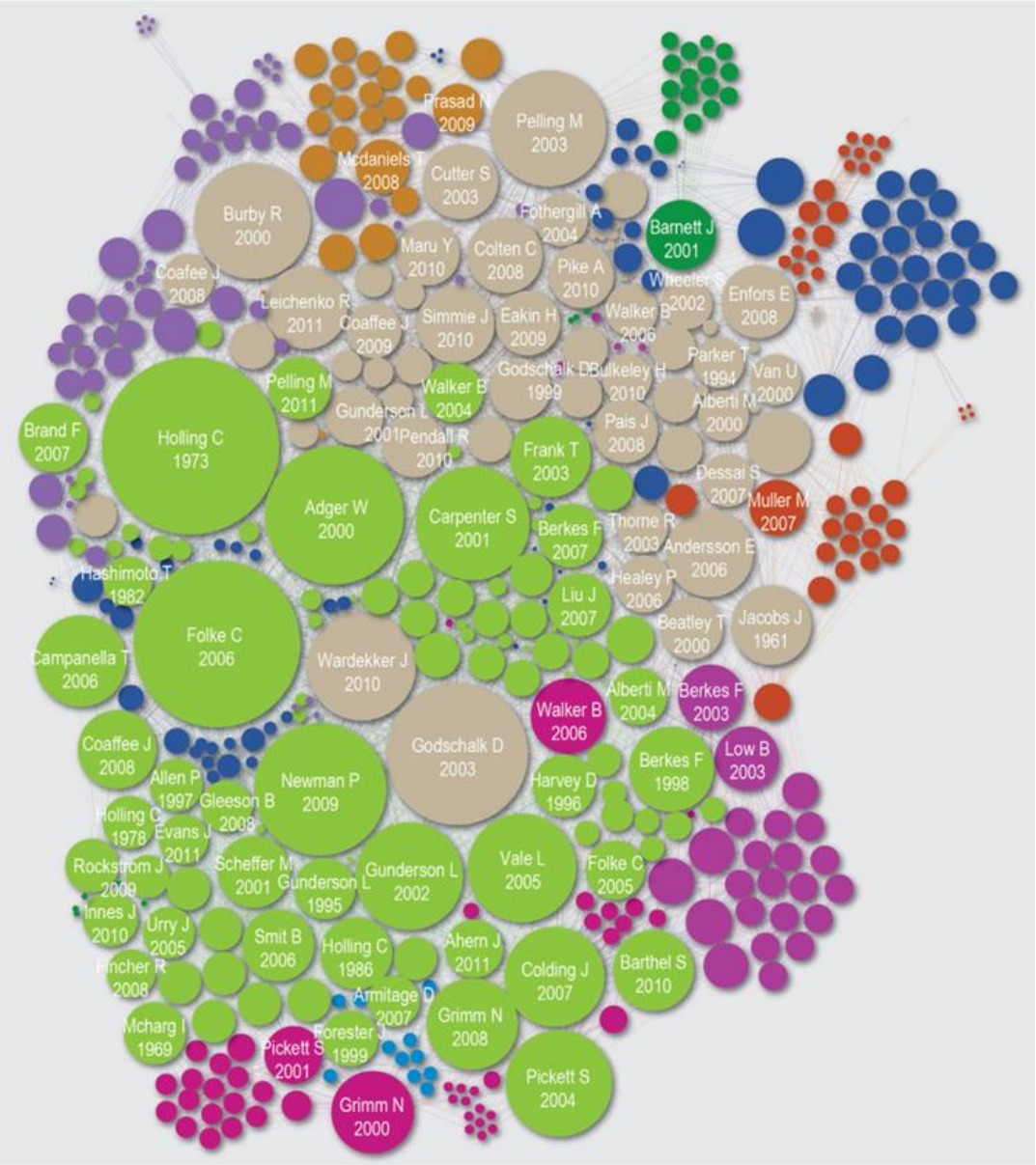
Introduction

Billion Dollar（measured in 2023 dollars）	**2023**	**2022**	Average of the last 10 years
Economic Loss (Total)	291	295	235
natural disasters	**280**	**286**	223
man-made disasters	11	9	12

Country	Event	Year	Unit	Economic Loss
Australia	Canberra Hailstorm	2020	Million USD	1,543
Japan	Typhoon Hagibis	2019	Million USD	13,000
United States	Hurricane Irma	2017	Million USD	67,000
Germany	Hail Disaster	2013	Million USD	4,823
China	Yangtze River Flood	2020	Million USD	27,418
China	Henan Flood	2021	Billion RMB	1,200

Data from **Swiss Re Institute 2024**

Introduction

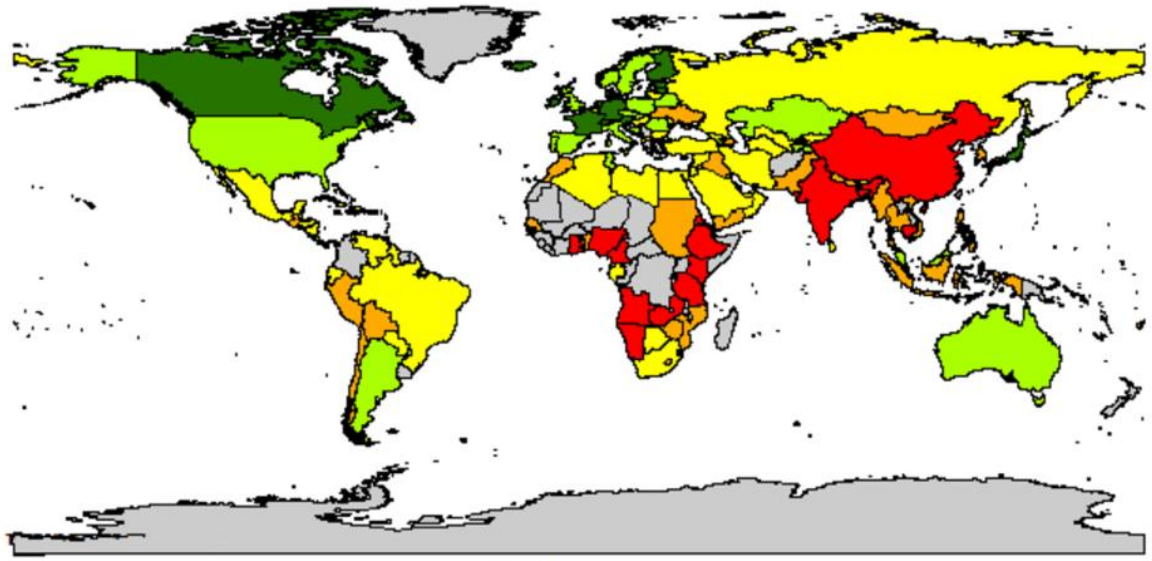


Influential publications in the urban resilience literature

Resilience:

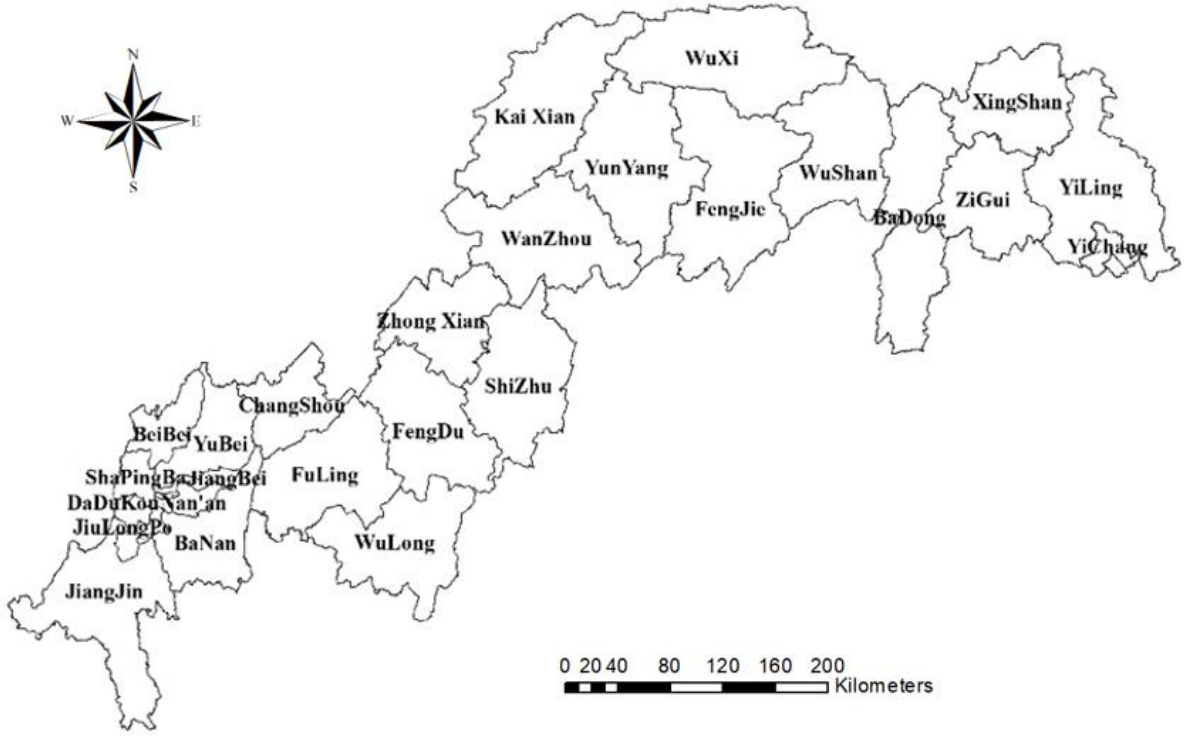
Ability to absorb, adapt and respond to changes in urban systems (Desouza and Flanery, 2013).

Introduction



Sources: Moghim, S., & Garna, R. K. (2019). Countries' classification by environmental resilience. Journal of environmental management, 230, 345-354.

Introduction



The three gorges reservoir area is a typical ecological fragile area as well as a frequent occurrence area of environmental geological disasters in China, which characterized by steep topography, poor stability of riparian stratum, large number of people and less land along the reservoir area, and frequent human activities (Zhou , 2010; Ma, 2015). The quantification of urban resilience can reflect the situation of urban resilience in different areas scientifically and objectively, which is helpful to guide the formulation of resilience improvement policies. Obviously, it is significant for the three gorges reservoir area to strengthen disaster risk management by building resilient cities.

Research Background

About resilience index system

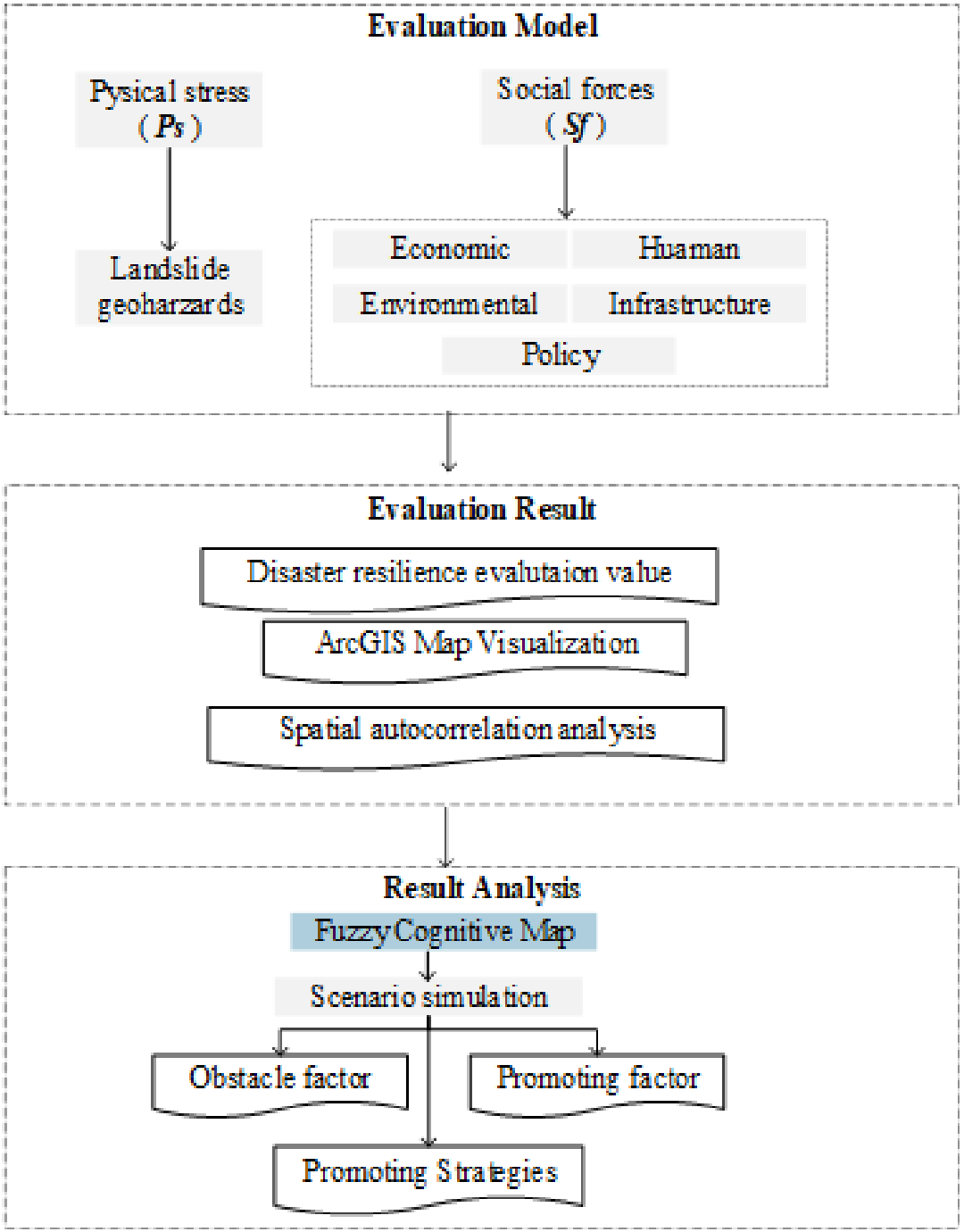
Although the domestic and foreign theoretical research and construction practice of resilience have been carried out, however, there is no recognized resilience evaluation index system, and there are few researches on domestic toughness quantitative evaluation, and there is no index system suitable for China city or regional resilience evaluation.

Research Background

About research method

Current approaches to disaster resilience evaluation are usually limited either by the qualitative method or properties of different disaster.

The Resilience Evaluation System



The Evaluation System

Indicators used to construct disaster resilience index

Destination layer	Subsystem layer	Element layer	Basic index layer	Effect on resilience
Physical stress	Stress of landslide geohazards	Disaster	Distribution density of hidden landslide	Negative
			Earthquake frequency	Negative
			Soil erosion degree	Negative
			Distribution density of landslide hidden danger points	Negative

The Evaluation System

Indicators used to construct disaster resilience index

Destination layer	Subsystem layer	Element layer	Basic index layer	Effect on resilience
Social forces	Human	Population	Proportion of population under 18 and over 60	Negative
			Population density	Negative
			Natural population growth rate	Negative
		Social Security	Minimum subsistence ratio	Positive
			Number of organizations per 10,000 citizens (village committees)	Positive
			Proportion of people insured in medical insurance	Positive
			Number of doctors per 10,000 population	Positive
			Per capita main food production (grain, vegetables, fruit)	Positive
			Government disaster relief experience	Positive
		Education	Public libraries for every 10,000 people	Positive
			Number of full-time teachers per 10,000 students	Positive
		Traffic	Vehicle ownership per 10,000 population	Positive
	Economy	Comprehensive Economy	Per capita GDP	Positive
			Proportion of added value in primary industry	Negative
			Jobless rate	Negative
			Proportion of non-agricultural population	Positive
			Energy efficiency	Positive
			Economic loss threatened by per unit volume landslide	Negative
		Government Finance	Local financial expenditure	Positive
		Individual Economy	Per capita savings	Positive
			Per capita loan	Positive
			Income equity (coefficient of income disparity between urban and rural areas)	Positive

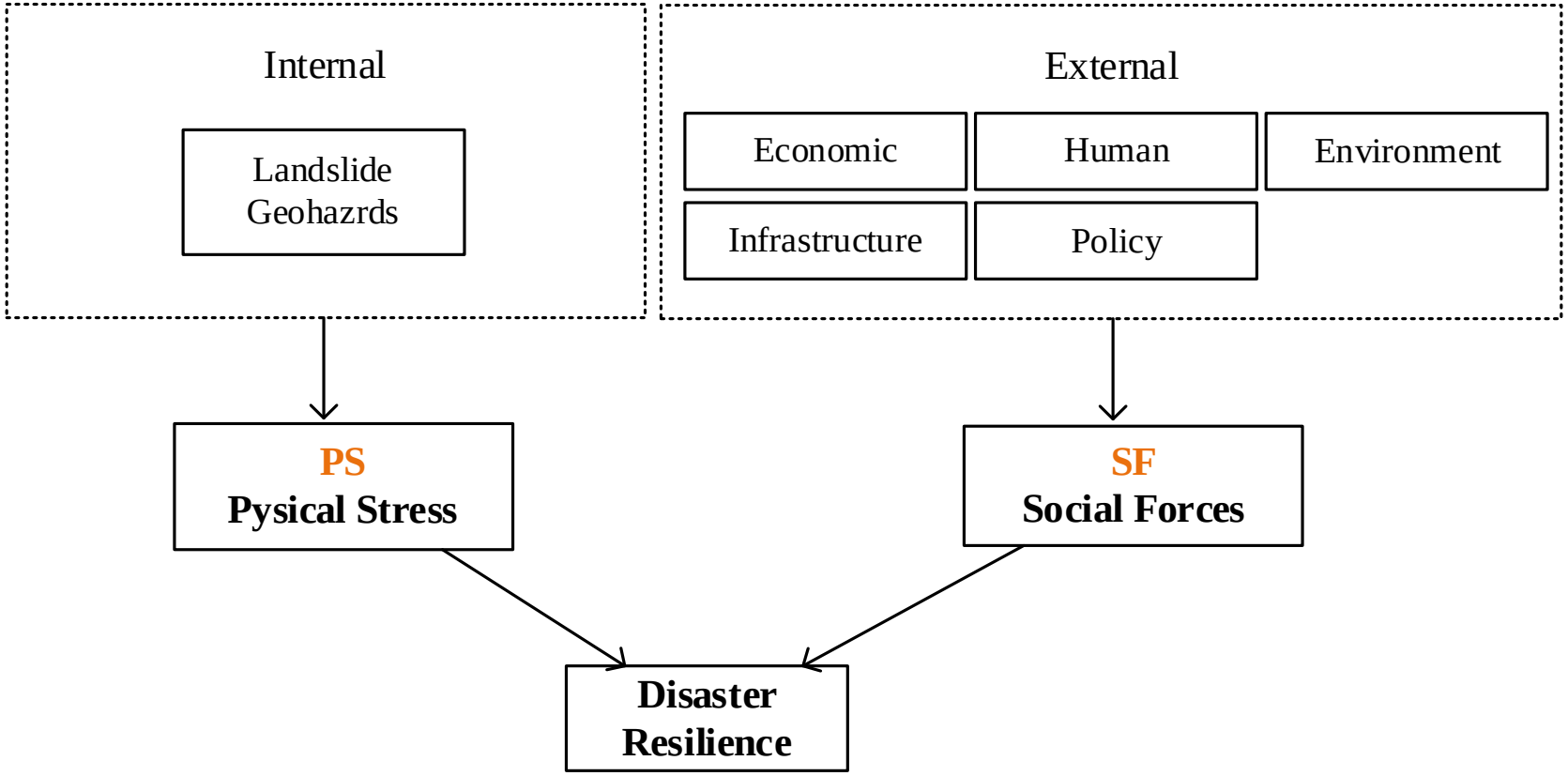
The Evaluation System

Indicators used to construct disaster resilience index

Destination layer	Subsystem layer	Element layer	Basic index layer	Effect on resilience
Social forces	Infrastructure	Social Infrastructure	Number of residential units per 10,000 persons	Positive
			Number of schools per 10,000 population	Positive
			Number of beds per 10,000 social welfare adoption units	Positive
			Number of hospitals per 10,000 population	Positive
			Number of beds per 10,000 population	Positive
			Per capita housing area	Positive
		Economic Infrastructure	Rural per capita electricity consumption	Negative
			Per capita water consumption	Positive
			Per capita road ownership length	Positive
			Highway density	Positive
			Internet broadband coverage	Positive
			Number of mobile phones per 10,000 population	Positive
	Environment	Ecological Condition	Forest coverage rate	Positive
		Climate	Annual rainfall	Negative
	Policy	Insurance	The proportion of unemployment insurance population	Positive
			Medical insurance coverage	Positive
			Total Assets of Soil and Water Conservation	Positive
			Investment Completion of Urban Fixed Assets	Positive

Method

$$DisasterResilience = Ps * Sf$$



The method system of resilience evaluation.

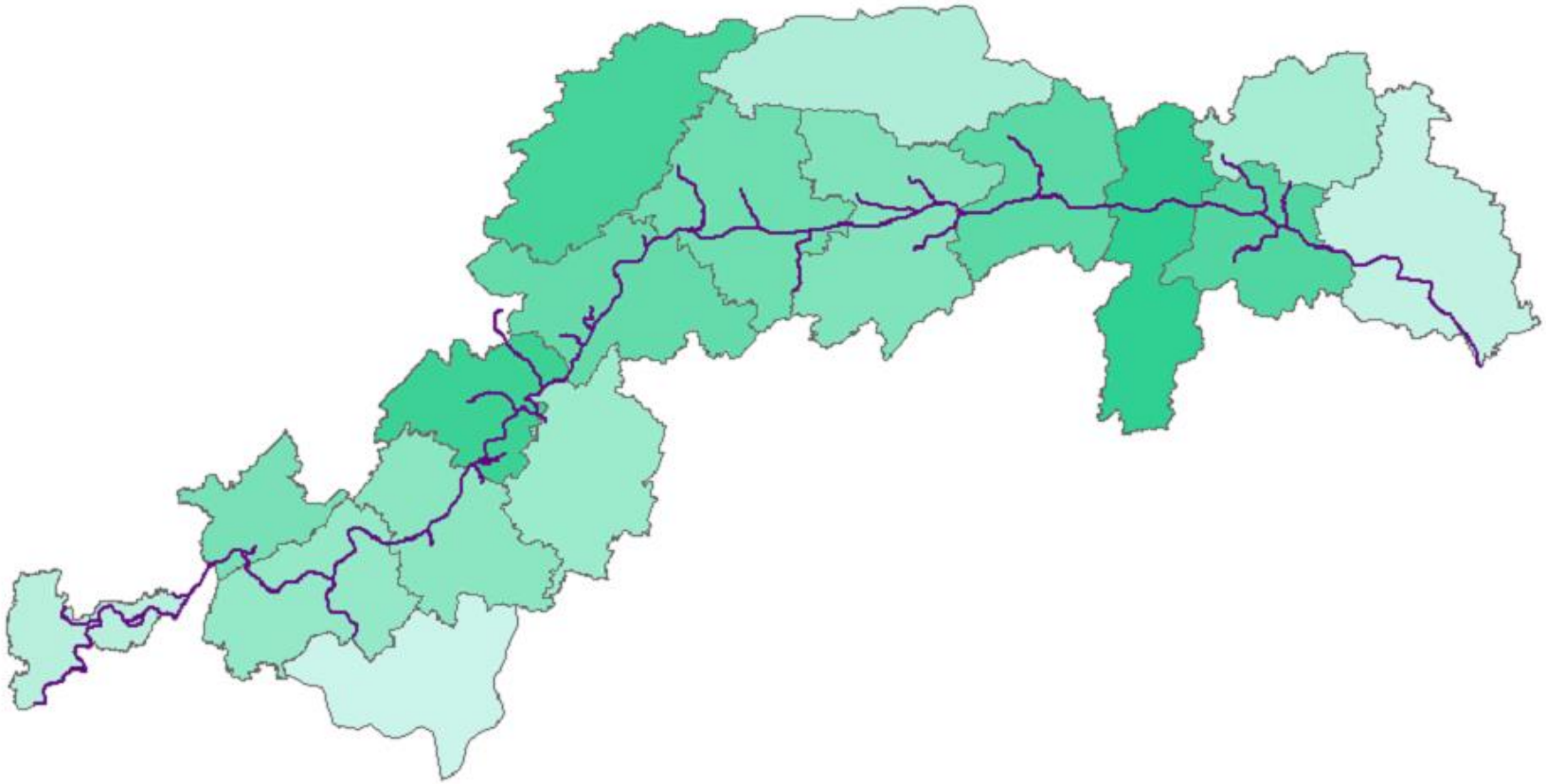
Results and analysis

The final result

NO.	County	Resilience score
1	Fuling	24.23
2	Yunyang	15.80
3	Badong	13.43
4	Wanzhou	12.35
5	Wushan	10.35
6	Wuxi	5.00
7	Fengjie	3.86
8	Kai	-0.15
9	Yiling	-2.30
10	Changshou	-4.18
11	Shizhu	-6.13
12	Fengdu	-6.52
13	Wulong	-8.13
14	Xingshan	-11.65
15	Zhong	-11.79
16	Zigui	-13.84
17	Dudukou	-17.32

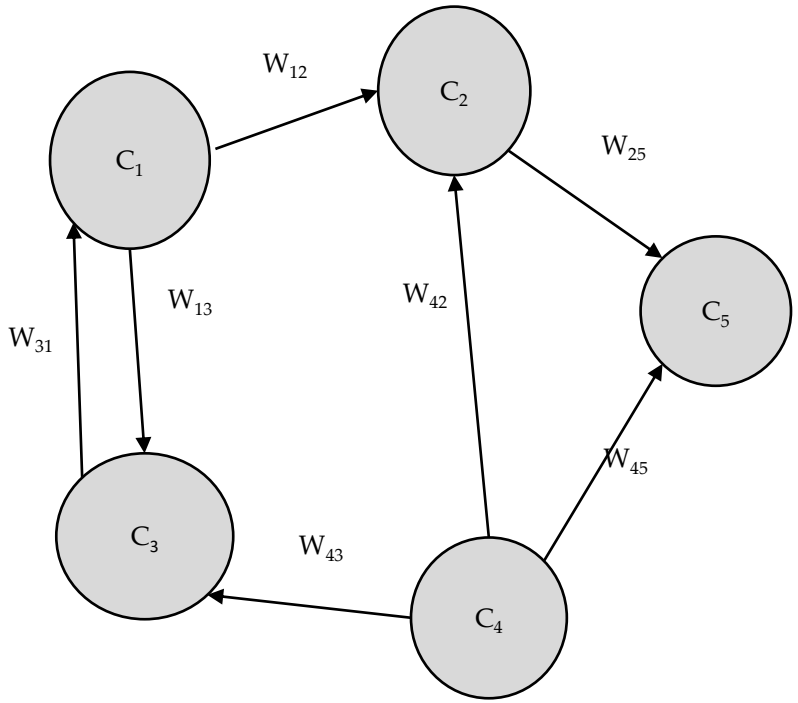
Results and analysis

The final result



Results and analysis

Simulation by Fuzzy Cognitive Map

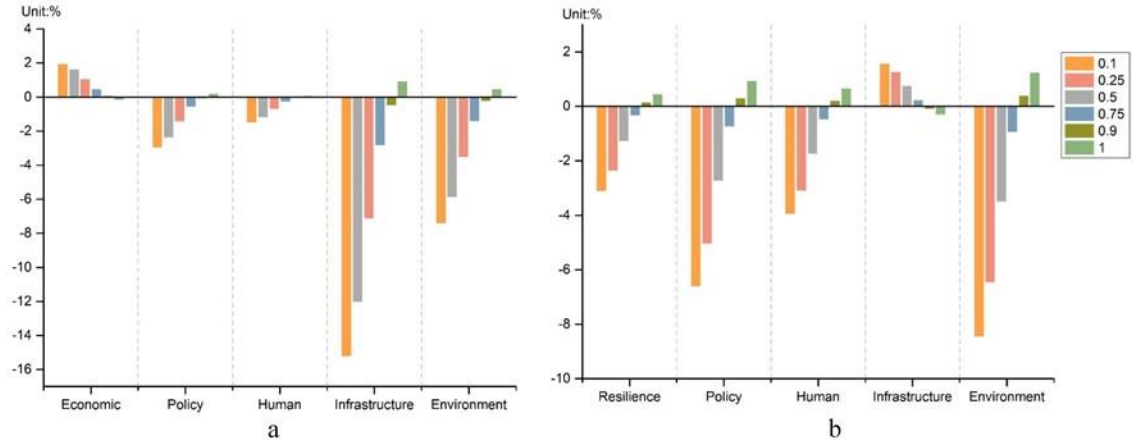


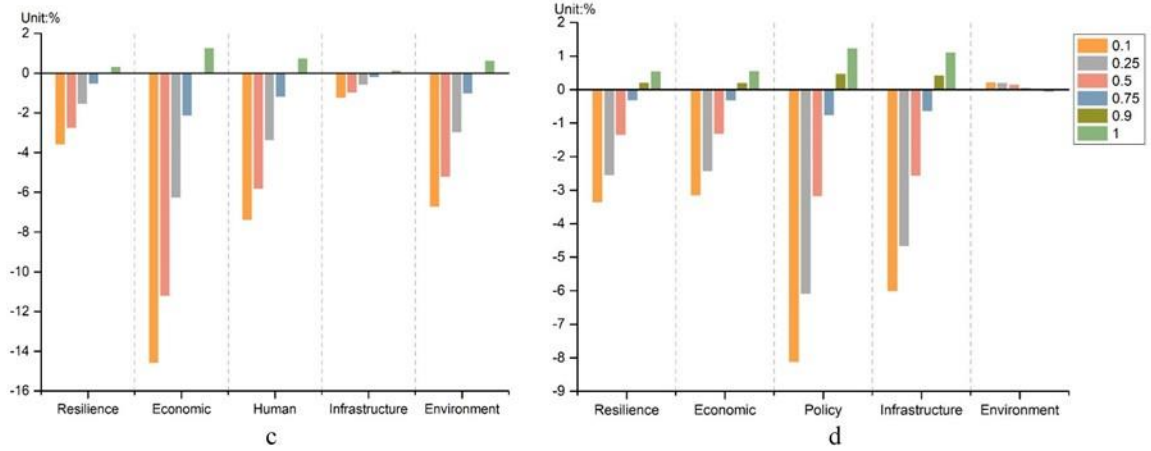
Results and analysis

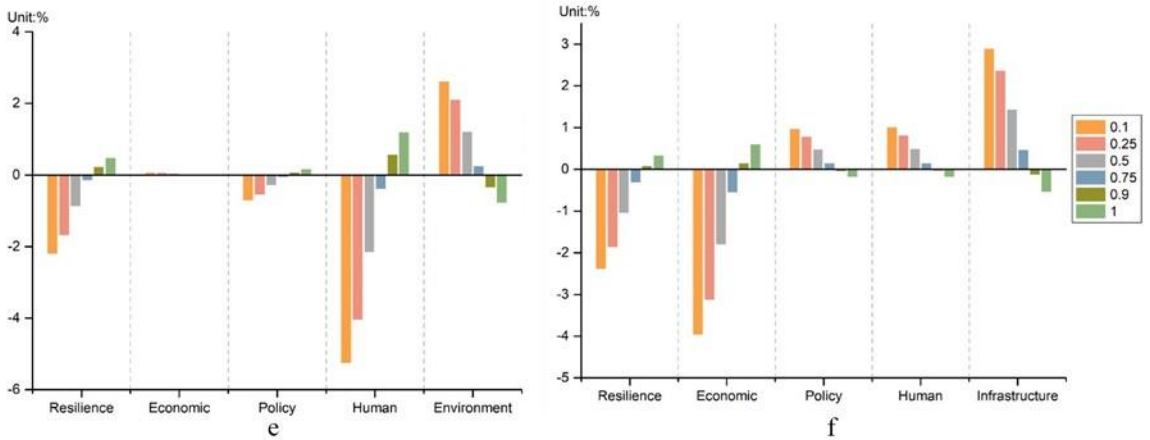
The crisp value of the connection matrix

	Disaster resilience	Economic	Policy	Human	Infrastructure	Environment
Disaster resilience	0	-0.2	0.301	0.04	0.66	0.53
Economic	0.41	0	0.61	0.24	-0.12	0.55
Policy	0.39	0.79	0	0.39	0.05	-0.37
Human	0.46	0.17	0.73	0	0.3	-0.08
Infrastructure	0.37	-0.01	0.032	0.35	0	-0.28
Environment	0.39	0.3	-0.15	-0.07	-0.19	0

Results and analysis







Conclusions

Conclusion 1

Conclusion 1: Disaster resilience are not completely random in the spatial distribution, but the spatial aggregation between the similar values.

Conclusion 2

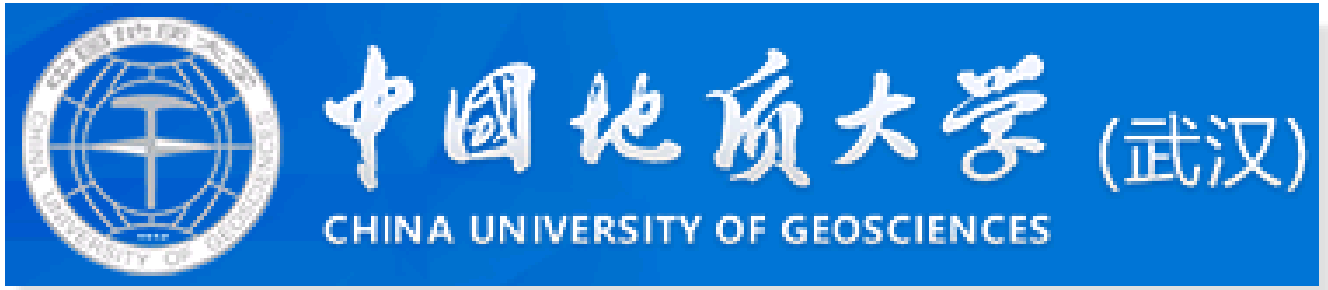
Conclusion 2: The simulation result reveals that disaster resilience has a significant influence on both the infrastructure and environment aspect.

Next step

Whether the geographical distribution of economic, social, environmental, and infrastructure resilience in the Three Gorges reservoir area has a certain distribution law, it is necessary to continue research.

Limitations and future study

Our study studied the resilience from a static perspective, so quantifying the change of resilience in the study area from a dynamic perspective should be considered in future studies. In addition, the existing methods are not strong in future prediction, so improving the effectiveness of prediction should also be considered in future research.



Thanks for Listening!