Mainstreaming social participation into assessing resilience to climatic hazards for land use management in Taiwan

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Outlines

- Background and purposes
- Related studies
- Methods
- Results of the case study
- Conclusions

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Background and purposes

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Background – 1/2

Metropolitan areas are vulnerable and risky to climate-related hazards in parallel with a high agglomeration of population

Building resilience is critical for metropolitan land use planning to strengthen the ability to cope with and minimize climatic disaster risks

There are challenges in the identification and development of the components and metrics for measuring resilience

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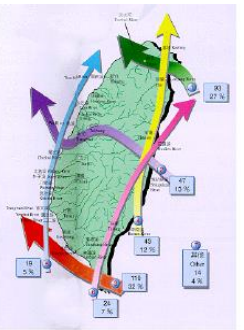
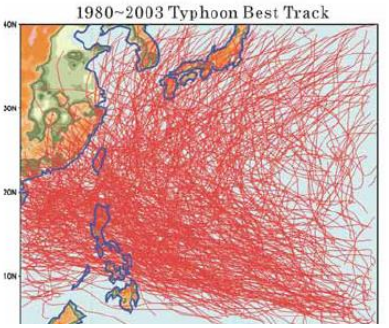
Background – 2/2

- Major portions of Taiwan are highly exposed to the threat from typhoon and flood





The Purpose of the Study

- To propose a novel method for resilience assessment that combines a GIS-based fuzzy multicriteria decision approach with multivariate analysis
- We create resilience maps using an PGIS approach to encompass active participation of stakeholders
- We examine the determinants of the concept of resilience using a multivariate and cluster analysis

Related studies

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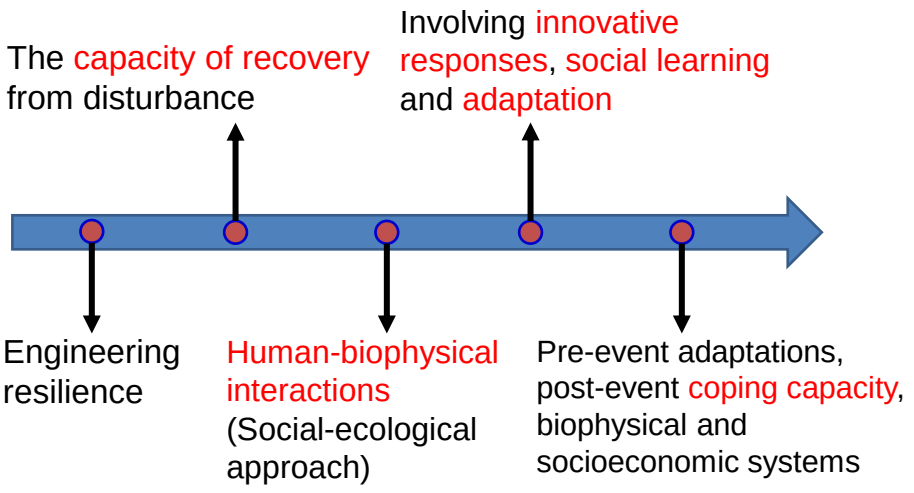
Evolution of the Concept of Resilience



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Resilience Assessment and Land Use Planning

Resilience assessment

- To help land-use planners understand which sectors, regions, or communities are the least resilient

Social-ecological approach

- Incorporating disturbances (hazards), institutional structure, governmental actions, knowledge, social capital into assessment

Contemporary resilience assessment

- Involve land-use factors
- GIS tools (e.g., PGIS) enhance the integration of stakeholders' knowledge and participations into the process of assessment

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Methods

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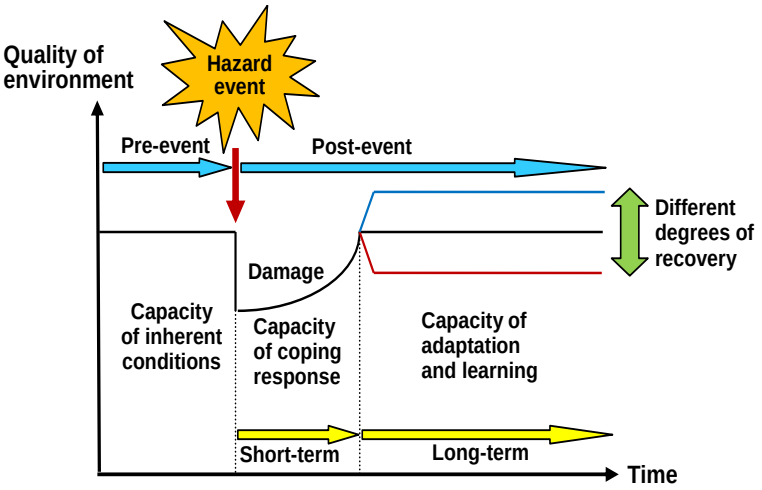
Conceptual framework of resilience assessment to climatic hazards



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Resilience indicators to climatic hazards

Dimension	Category	Indicator	Relationship with resilience
Inherent biophysical conditions	**Hazard potential**	Rainfall	Linear (-)
		Debris flow torrents	Binary-Linear(-)
	Exposure	Proximity to river	Linear (+)
		Elevation	Linear (+)
Inherent Socio-economic conditions	**Demography**	Population	Linear (-)
		Elderly	Linear (-)
		Native	Linear (-)
		Social dependence	Linear (-)
	Income	Income	Linear (+)
		Saving	Linear (+)
	Industries	Unemployment	Linear (-)
		Industry and service	Linear (-)
		Primary industries	Linear (+)
Institutional, coping, and infrastructure capacity	**Land uses**	Urban development	Linear (-)
		Agricultural land	Linear (+)
		Informal settlements	Linear (-)

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Resilience indicators to climatic hazards

Dimension	Category	Indicator	Relationship with resilience
Institutional, coping, and infrastructure capacity	**Politics**	Vote turnout	Linear (+)
	Infrastructure	Public infrastructure	Linear (-)
		Shelters	Linear (-)
		Police and fire facilities	Linear (+)
		Medical services	Linear (+)
Adaptive capacity and learning	**Perceived risk and self-efficacy**	Risk perceptions	Nominal (+)
		Access to resources	Nominal (+)
		Adaptation appraisal	Nominal (+)
	Adaptation and learning	Adaptive strategies	Binary and linear(+)
		Education	Linear (+)

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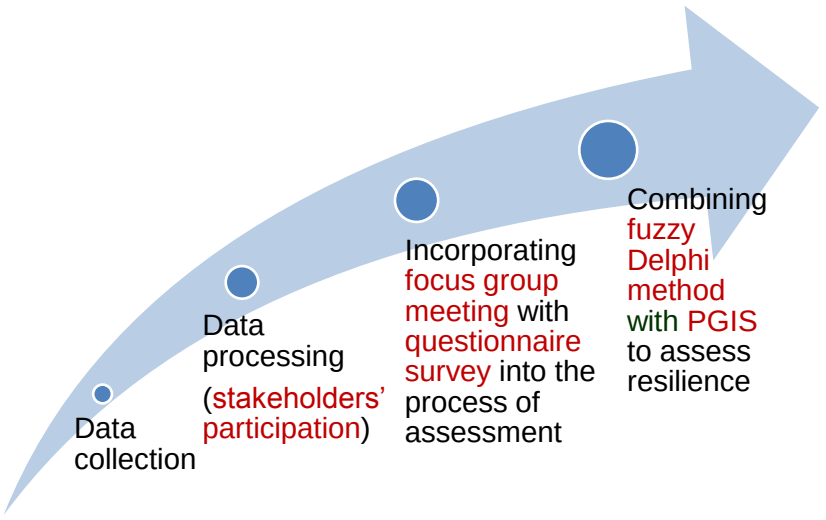
Process of assessing resilience



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Results of the case study

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Case study areas

Taichung City is the largest metropolis and the most rapidly urbanizing area in central Taiwan

The population of Taichung increased by 30% from 2 million in 1990 to 2.7 million in 2013

Three cases were selected from Taichung City including the villages in Dongshih (hillside), Longjing (coastline) district and downtown areas

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Taichung Metropolis

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Weights of indicators

Dimension	Weight	Category	Weight	Indicator	Weight
Inherent biophysical conditions	0.205	**Hazard potential**	0.081	Rainfall	0.035
				Debris flow torrents	0.038
		Exposure	0.112	Proximity to river	0.036
				Elevation	**0.039**
Inherent Socio-economic conditions	**0.351**	**Demography**	0.110	Population	0.028
				Elderly	0.037
				Native	0.029
				Social dependence	0.076
		Income	**0.121**	**Income**	**0.039**
				Saving	**0.039**
		Industries	**0.120**	Unemployment	0.036
				Industry and service	**0.041**
				Primary industries	0.033
Institutional, coping, and infrastructure capacity	**0.232**	**Land uses**	**0.121**	**Urban development**	**0.068**
				Agricultural land	0.032

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Weights of indicators

Dimension	Weight	Category	Weight	Indicator	Weight
Institutional, coping, and infrastructure capacity		Infrastructure	0.110	Informal settlements	0.035
				Public infrastructure	0.032
				Shelters	0.036
				Police and fire facilities	0.039
				Medical services	0.041
Adaptive capacity and learning	0.212	Perceived risk and self-efficacy	0.115	Risk perceptions	0.039
				Access to resources	0.040
				Adaptation appraisal	0.042
		Adaptation and learning	0.110	Adaptive strategies	0.058
				Education	0.032

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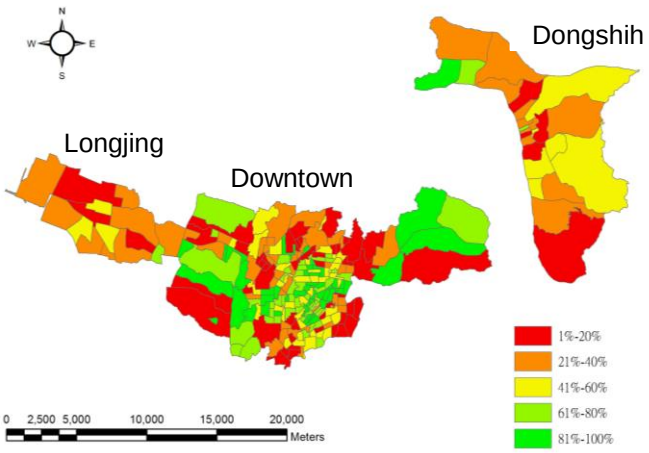
The Distribution of estimated integrated resilience indices



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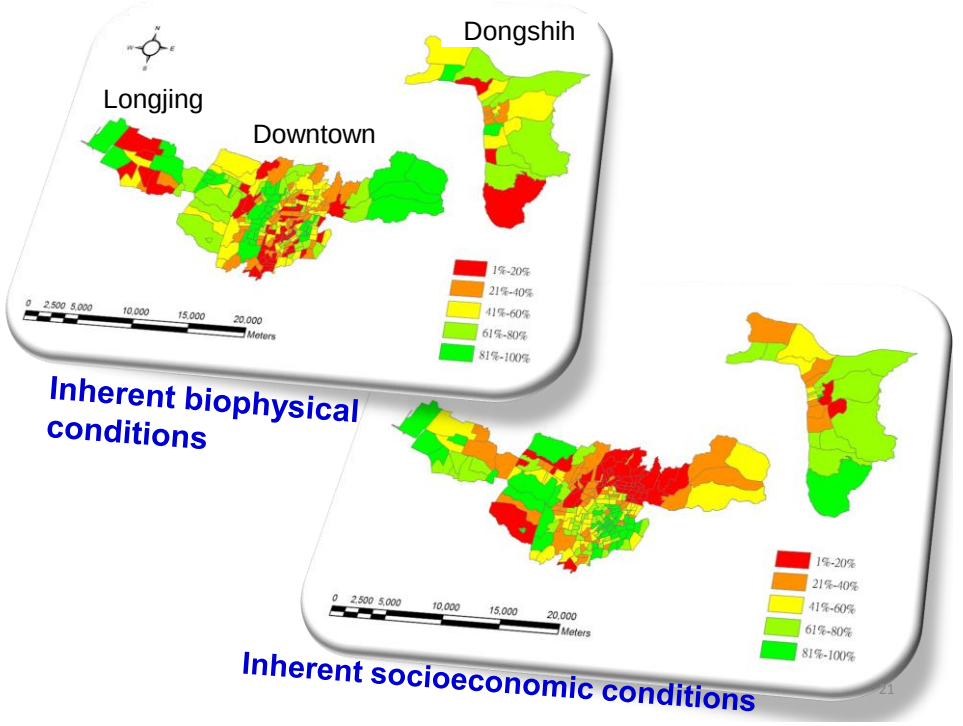

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Cluster analysis

- To provide policy-makers with the core areas in which planning measures require to be adopted and which characteristics can be used to promote resilience
- A method of combining k-means cluster with discriminant analysis was used to identify unique grouping of villages

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Clusters of resilience types

Cluster 1

- A higher socioeconomic vulnerability to climatic hazards
- Distributed mostly surrounding the downtown cores

Cluster 2

- Containing the areas with the middle indicator values

Cluster 3

- The highest values for all of the biophysical conditions, learning and adaptive capacity
- Concentrated mostly in Dongshih

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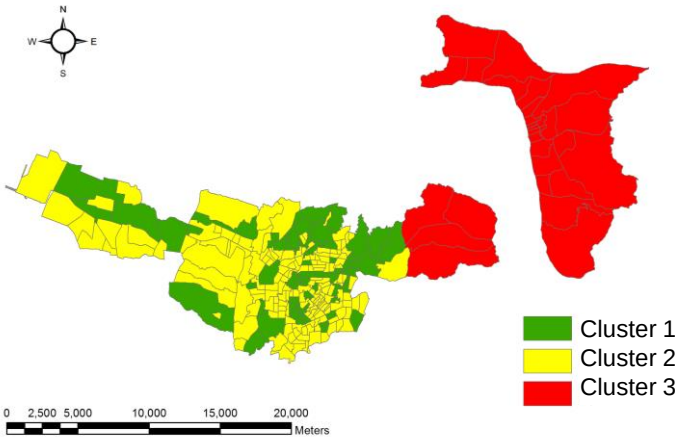
Results of cluster analysis



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Determinants of resilience to climatic hazards

- Logit regression analysis allows us to identify the key factors driving diversification of local resilience
- To compare the least resilience villages (20th percentile estimated IRI values) with the remaining ones

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The findings through Logit analysis

Category	Indicator	Relationship to resilience
Exposure	Proximity to river	+ ***
	Elevation	+ ***
Demography	**Population**	**— *** **
	Elderly	**— *** **
	Native	**— *** **
	Social dependence	**— *** **
Income	Income	+ ***
	Saving	+ ***
Industries	Unemployment	— ***
	Industry and service	+ **
Land uses	Urban development	— ***
	Informal settlements	— *

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

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The findings through Logit analysis

Category	Indicator	Relationship with resilience
Infrastructure	**Public infrastructure**	**+***
	Shelters	**+***
	Police and fire facilities	**+***
	Medical services	**+***
Perceived risk and self-efficacy	Risk perceptions	+***
	Access to resources	+***
	Adaptation appraisal	+***
Adaptation and learning	Adaptive strategies	+*
	Education	+***

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

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Conclusions

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Conclusions – 1/2

Building resilience	• Policy-makers focus more on building resilience and incorporating stakeholders' knowledge into decision-making
Novel approach	• We constructed an integrated index to characterize the resilience • To combine a fuzzy multicriteria decision analysis with an PGIS to assess resilience
Findings	• Various factors constitute different spatial patterns of resilience, and that tradeoffs may exist between some of these factors

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Conclusions – 2/2

Findings	• To provide policy-makers with a better governance structure to design appropriate patchworks of planning measures for different resilience cluster in metropolitan areas

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Thanks for your attention

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