



Tsinghua Community, Earthquake Resilience Evaluation

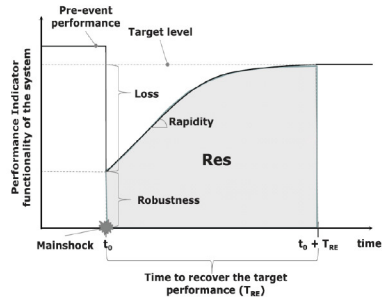
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Earthquake Resilience (Theoretical)

The ability of social units to mitigate disasters, absorb the impacts of disasters and take measures to recover in time, so as to reduce social disturbances and mitigate the effects of future earthquakes.

—Michel Bruneau et al



Framework from Mayunga

- Mayunga J S. Measuring the Measure: A Multi-dimensional Scale Model to Measure Community Disaster Resilience in the U.S. Gulf Coast Region[J]. Dissertations & Theses - Gradworks, 2010.
- We assess earthquake resilience from 5 dimensions of capital and 4 disaster phases
- Index selected based on various literature
- Index adjustment based on Chinese literature

Table 1. Mayunga's Framework

5 dimensions	4 disaster phases			
	Mitigation	Preparedness	Response	Recovery
	Social	...		
	Economic		...	
	Institutional			...
	Environmental			...
	Infrastructural			...

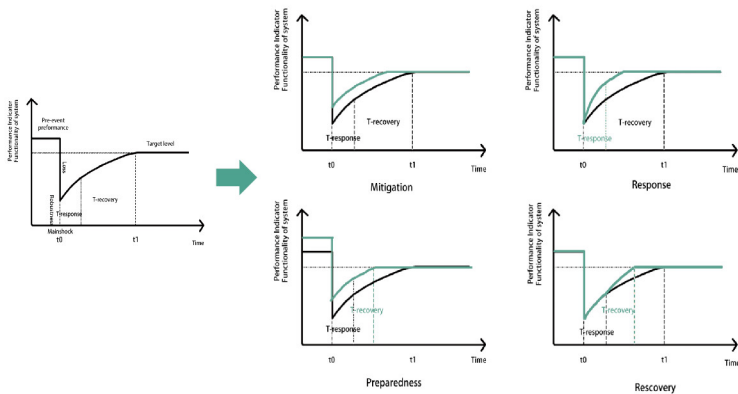
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Explanation of four phases

Table 2. Explanation of four phases

Disaster Phases	General definition	Example of activities
Hazard Mitigation	Advance actions taken to reduce or eliminate the long term risk.	<ul style="list-style-type: none">Building dams, levees, dikes, and floodwallsStrengthening buildings through building standardsProtecting natural environment e.g., wetlands
Disaster Preparedness	Activities undertaken to protect human lives and property in conjunction with threats that cannot be controlled by means of mitigation.	<ul style="list-style-type: none">Design and installation of warning systemsDeveloping plans for evacuationTraining of emergency personnel
Emergency Response	Activities that are conducted between the detection of the event and the stabilization of the situation following the impact.	<ul style="list-style-type: none">EvacuationSearch & RescueProvision of medical care
Disaster Recovery	Actions taken to repair, rebuild, and reconstruct damaged properties and to restore disrupted social routines and economic activities	<ul style="list-style-type: none">Re-establishment of economic activitiesProvision of housing, clothing, and foodRebuilding of major structure

Figure 1. Improved Resilience model



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Earthquake Resilience Index: Infrastructure

Infrastructure					Quantitative index	Mitigation	Preparedness	Response	Recovery
Level 1	Level 2	Level 3	Quantitative index	Mitigation	Preparedness	Response	Recovery		
Building system	Stability	Structure status	Structure type	1	1	0	0		
	Flexibility	Degradation of building function	Wall around the entrance and exit	1	1	0	0		
		Access restriction		1	1	0	0		
				1	1	0	0		
Water supply and drainage system	Stability	Water pipe parameters	Water pipe diameter	1	1	1	0		
	Flexibility	Emergency shut-down	Water pipe breakage level off valve	0	0	1	0		
		Water supply method	Water supply method	0	0	1	1		
		Reserve drinking water	Reserve drinking water	0	0	1	1		
Supply and distribution system	Stability	Component stability	Temporary storage tank capacity	1	1	0	0		
	Flexibility	Intelligent control ability	Power supply equipment resistance	1	1	1	0		
		Remote access status	Intelligent measurement system	1	1	1	1		
		Distributed power generation equipment	Feeder conduct switch control	1	1	1	1		
Communication system	Stability	Component stability	Telecommunication equipment seismic fortification level	1	1	0	0		
	Functional degree	Emergency preparedness	Is there an emergency backup system	0	0	1	0		
	Flexibility	Emergency preparedness	Is the communication line multi-path	0	0	1	1		
		Gas system seismic rating	Gas system seismic rating	1	1	1	0		
Gas system	Stability	Emergency preparedness	Emergency preparedness system	0	0	1	1		
	Flexibility	Emergency preparedness	Energy reserve such as liquefied gas tank	0	0	0	1		
				0	0	0	1		
				0	0	0	1		

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Earthquake Resilience Index: Environment

Environment					Quantitative index	Mitigation	Preparedness	Response	Recovery
Level 1	Level 2	Level 3	Quantitative index	Mitigation	Preparedness	Response	Recovery		
Community surroundings	Community-to-city Connectivity	Building density	Volume rate	0	0	1	1		
		Emergency evacuation site area in the emergency site	Per capita evacuation site area in the emergency site	0	1	1	0		
		Per capita road area	Per capita road area	0	0	1	1		
		Unoccupied evacuation channel ratio	Unoccupied evacuation channel ratio	0	0	1	1		
Internal environment	Layout	Internal traffic	Out-of-building evacuation mark coverage	0	1	1	1		
		Medical service facility	Medical service facility	0	1	1	1		
		Public Welfare Facility	Child care facility	0	0	1	1		
			Elderly welfare facility	0	1	1	1		
Alternative	Shelter	Hotel/hospital capacity	Hotel/hospital capacity	0	0	1	1		
		Harmful chemical storage station	Harmful chemical storage station	0	0	1	1		
		Security situation	Is there a radius of 1 km?	0	0	1	1		
		Health and Safety	Number of beds per capita within 1 km radius	0	1	1	1		

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Earthquake Resilience Index: Society

Examining population attribute, the participation and involvement in social groups and civic engagement

Society					Quantitative index	Mitigation	Preparedness	Response	Recovery
Level 1	Level 2	Level 3	Quantitative index	Mitigation	Preparedness	Response	Recovery		
Population level	Age	Age pyramid	Population share of all ages	1	1	1	1		
	Gender	Male to female ratio	Female share	1	1	1	1		
	Marital status	Proportion of all types of married population marriage	Average lifetime	1	1	1	1		
	Health status	Per capita health level	Incidence of disease such as tuberculosis	1	1	1	1		
Education level	Senior talent level	Ratio of college students	Percentage of permanent housing	1	1	1	1		
	Fixed housing	Migration	Resident population	1	1	1	1		
	Mobility	A accommodation charity	Number of student apartment volunteers (Zijing volunteers)	1	1	1	1		
		Voluntary Activities Traffic charity	Number of campus buses	1	1	1	1		
Social connection	Community connection	Community charity	Neighborhood committee, community medical	1	1	1	1		
	Community Entertainment	Scale of community activities	Number of club participants	1	1	1	1		
	Community activity	Community activity	Number of participants	1	1	1	1		
	Influence	Community activity	Push reading	1	1	1	1		
Social Worker Activities	election participation	Social worker cadre	Number of votes per thousand	1	1	1	1		
	Participation	Participation	Number of associations per thousand people	1	1	1	1		
	Participation	Participation	Number of volunteers per 1,000 people	1	1	1	1		
	Participation	Participation	Special strengths (medical, engineering) (for the whole community) frequency of safety disaster reduction education and training	1	1	1	1		
Disaster response potential	Professional Training	Value	Number of professional training participants per thousand people	1	1	1	1		
	Training results	Value	Number of relevant certifications per thousand people	1	1	1	1		
	Value	Value	Safety education and training frequency	1	1	1	1		
	General training	Training results	General public safety awareness and method mastery	1	1	1	1		

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Earthquake Resilience Index: Economy

Financial resources that people use to support their livelihoods

Economy					Quantitative index	Mitigation	Preparedness	Response	Recovery
Level 1	Level 2	Level 3	Quantitative index	Mitigation	Preparedness	Response	Recovery		
Income Situation	Average community income / average urban income	Income level	Average community income / average urban income	0	0	1	1		
	Income difference	Income difference	Incomes variance	0	0	1	1		
	Participation in the proportion of social production	Employment status	Employment ratio	0	0	1	1		
	Career development	Land and housing ownership	Class of occupation	0	0	1	1		
Household economic situation	Property Situation	Vehicle ownership	Average family home value	0	0	1	1		
	Medical insurance	Medical insurance	Number of vehicles per capita	0	0	1	1		
	Property insurance	Property insurance	Medical insurance insurance ratio	0	0	0	1		
	Property insurance	Property insurance	Property insurance insurance ratio	0	0	0	1		
Community Income	Community Income	Community Income	Community Income	1	1	1	1		
	Community Income	Community Income	Community Income	1	1	1	1		
	Community Income	Community Income	Community Income	1	1	1	1		
	Community Income	Community Income	Community Income	1	1	1	1		
Community finance	Community finance	Community finance	Community finance	1	1	1	1		
	Community finance	Community finance	Community finance	1	1	1	1		
	Community finance	Community finance	Community finance	1	1	1	1		
	Community finance	Community finance	Community finance	1	1	1	1		

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Earthquake Resilience Index: Institution

Performance of community leaders and administration before earthquake strikes

Institution					Quantitative index	Mitigation	Preparedness	Response	Recovery
Level 1	Level 2	Level 3	Quantitative index	Mitigation	Preparedness	Response	Recovery		
Inspection & Maintenance	Inspection	Inspection attention	Infrastructure inspection frequency	1	1	0	0		
	Performance	Inspection input	Number of infrastructure inspection personnel	1	1	0	0		
	Maintenance	Maintenance attention	Infrastructure maintenance frequency	1	1	0	0		
	Performance	Maintenance input	Number of infrastructure maintenance personnel	1	1	1	1		
Emergency response capability	Emergency response capability	Emergency plan	Emergency plan detail level	0	0	1	1		
	Emergency response capability	Emergency plan	Emergency plan detail level	0	0	1	1		
	Emergency response capability	Emergency plan	Emergency plan detail level	0	0	1	1		
	Emergency response capability	Emergency plan	Emergency plan detail level	0	0	1	1		
Policy Development	Policy Development	Policy Development	Policy Development	0	0	1	1		
	Policy Development	Policy Development	Policy Development	0	0	1	1		
	Policy Development	Policy Development	Policy Development	0	0	1	1		
	Policy Development	Policy Development	Policy Development	0	0	1	1		

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