



A Mesh-based Earthquake Impact Assessment Tool and its Application on Disaster Preparedness and Policy Support

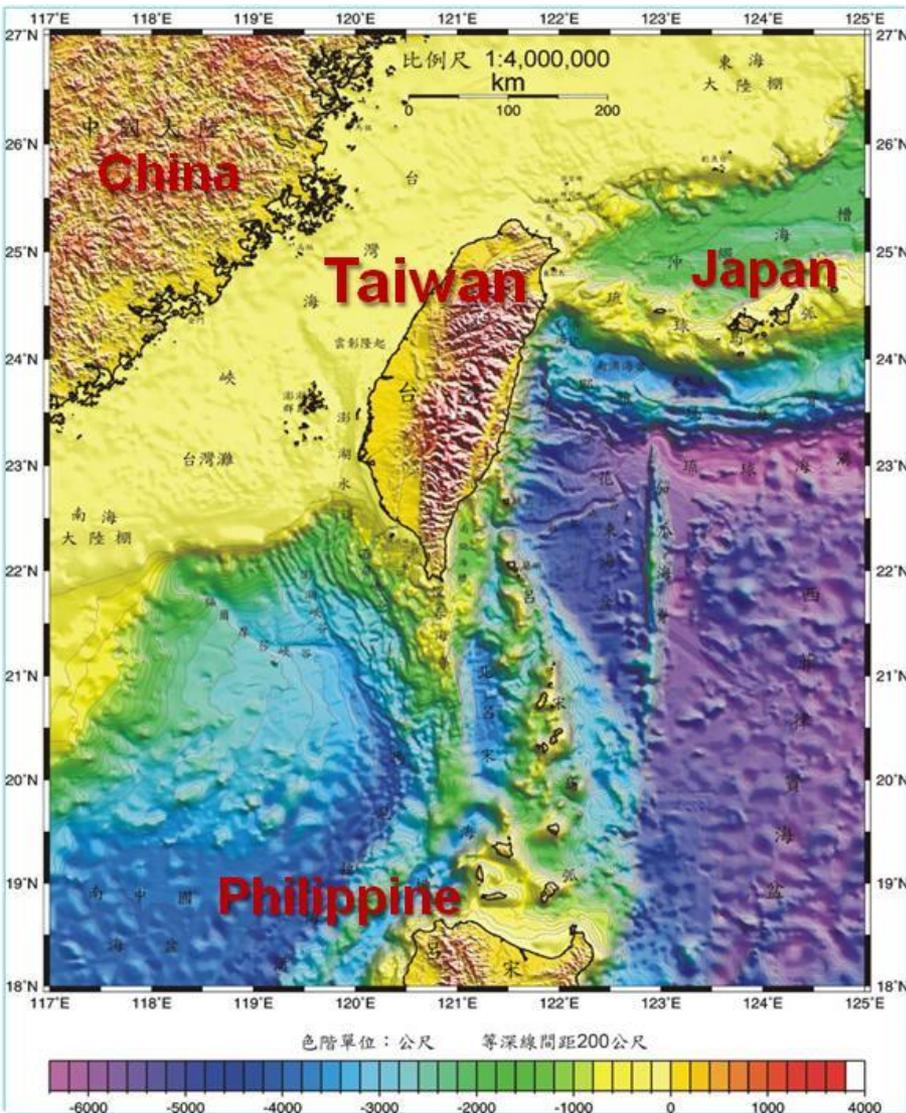
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2016/9/26

- | Background
 - ◆ Major earthquake disasters in Taiwan
 - ◆ Requirements on disaster prevention
- | Taiwan Earthquake Impact Information Platform, TERIA
- | Application
 - ◆ Scenario simulation for the National Earthquake Drill
 - ◆ Impact analysis for policy suggestion on disaster management system

Basic Information of Taiwan



• **Geographic features**

- **400 km from north to south**
- **145 km from east to west**
- **Area: 36,000 Km² over 70% in slope land**

• **Population (August, 2016)**

- **23,516,841 in total, 67.70% in urban areas**
- **Density: 647/ Km²**

Urban-type vulnerabilities

• **Tectonic Conjunctions:**

- **Philippine Sea plate**
- **Eurasian Plate**

Geo-hazards

• **High risk of tropical cyclones**

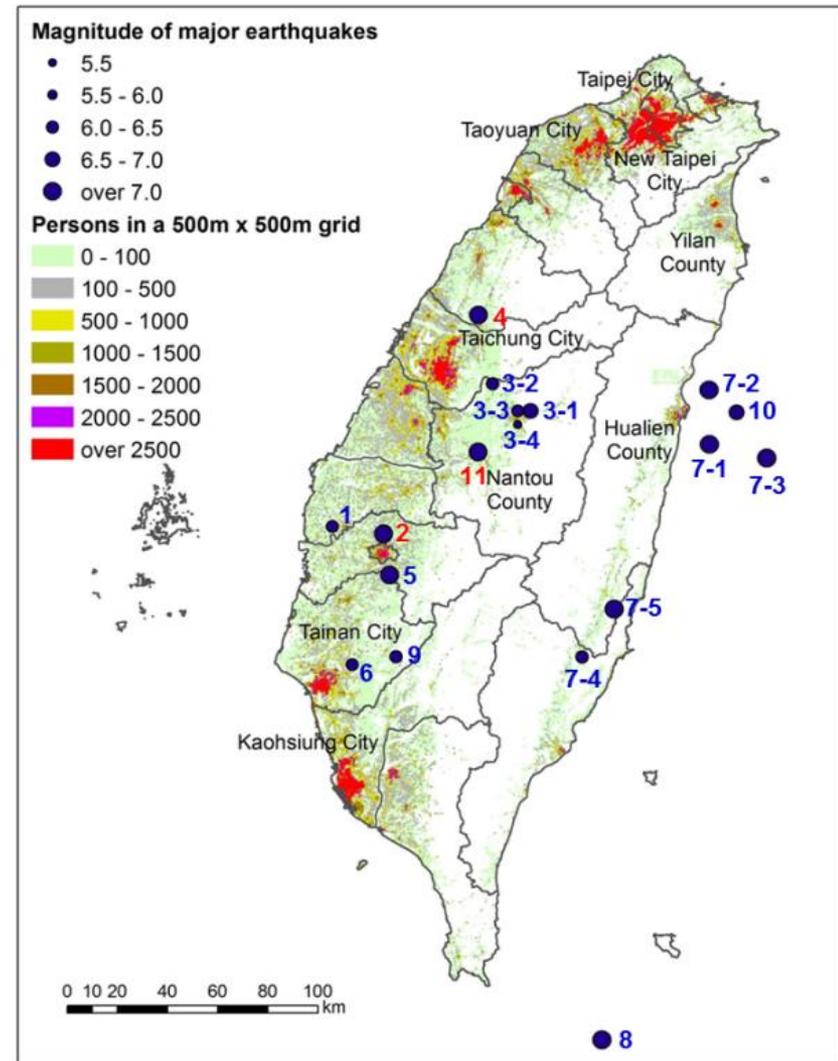
- **3.6 typhoons/year**

Hydro-meteorological hazards

Major earthquake disasters in Taiwan

- Meishan earthquake(1906): $M_L=7.1$, 1,258 death
- Hsinchu-Taichung(1935): $M_L=7.1$, 3,276 death
- Ch-Chi earthquake(1999): $M_L=7.3$, 2,405 death

No.	Earthquake	Date	Magnitude (M_L)	Depth (km)	Casulties	
					Decease	Injured
1	Douliou	1904/11/06	6.1	7.0	145	158
2	Meishan	1906/03/17	7.1	6.0	1,258	2,385
3	Nantou Series	1916/08/28	6.8	45.0	71	285
		1916/11/15	6.2	3.0		
		1917/01/05	6.2	0.0		
		1917/01/07	5.5	0.0		
4	Hsinchu-Taichung	1935/04/21	7.1	5.0	3,276	12,053
5	Chungpu	1941/12/17	7.1	12.0	358	766
6	Hsinhua	1946/12/05	6.1	5.0	74	182
7	Longitudinal Valley Series	1951/10/22	7.3	4.0	>85	>1,000
		1951/10/22	7.1	1.0		
		1951/10/22	7.1	18.0		
		1951/11/25	6.1	16.0		
		1951/11/25	7.3	36.0		
8	Hengchun	1959/08/15	7.1	20.0	17	85
9	Paiho	1964/01/18	6.3	18.0	106	653
10	Hualien	1986/11/15	6.5	15.0	13	45
11	Chi-Chi	1999/09/21	7.3	8.0	2,405	11,305



Are we ready for the next major earthquake?



Requirement on preparedness and management



Emergency preparedness

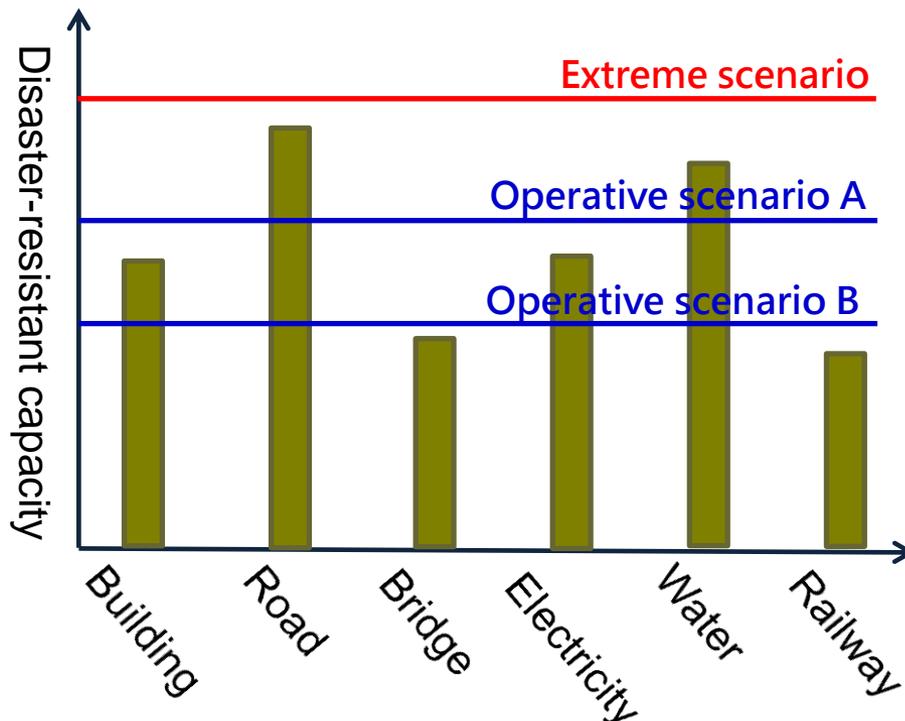
- ◆ The results of **scenario simulation** have not been properly applied on the Emergency preparedness in the Local Disaster Prevention and Response Plan
- ◆ The practical **disaster scenario** of large-scale earthquakes has not been fully considered in the planning of earthquake drills

Disaster management

- ◆ Subjected to an large-scale earthquake, the **disaster resilience** of organizations should be examined

Concept of this study

- Impact analysis in various levels of excitations
 - Mesh-based scenario simulation
 - Scan the weak point and its spacial distribution
 - Examine the disaster-resistant capacity of each item



1. Extreme scenario

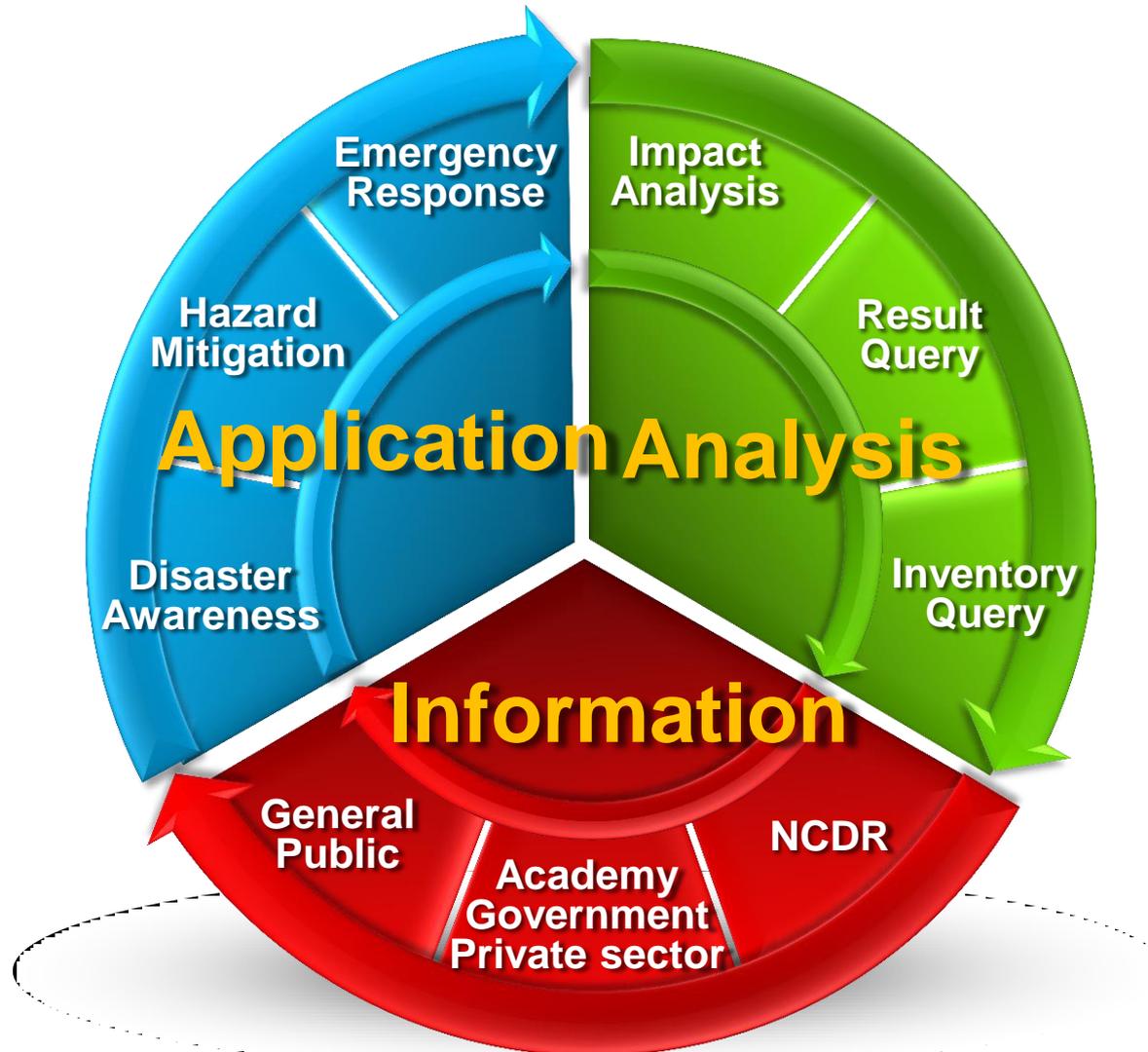
Quantitative analysis in an extreme scenario allows the **disaster resilience** of organizations to be examined

2. Operative scenario

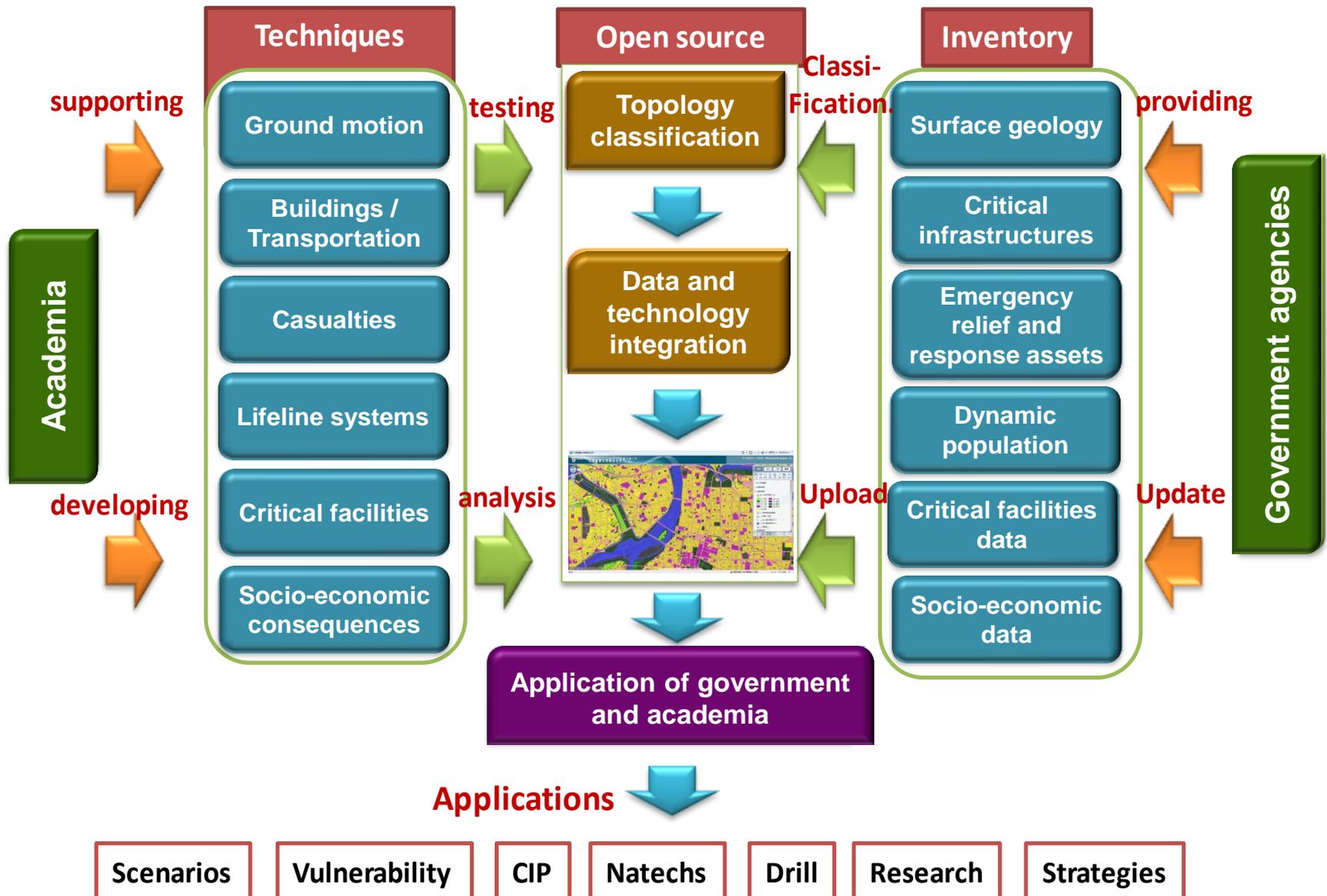
Scenario simulation in **various levels** of excitations can be applied on the local plan to enhance the **capacity**

TERIA platform

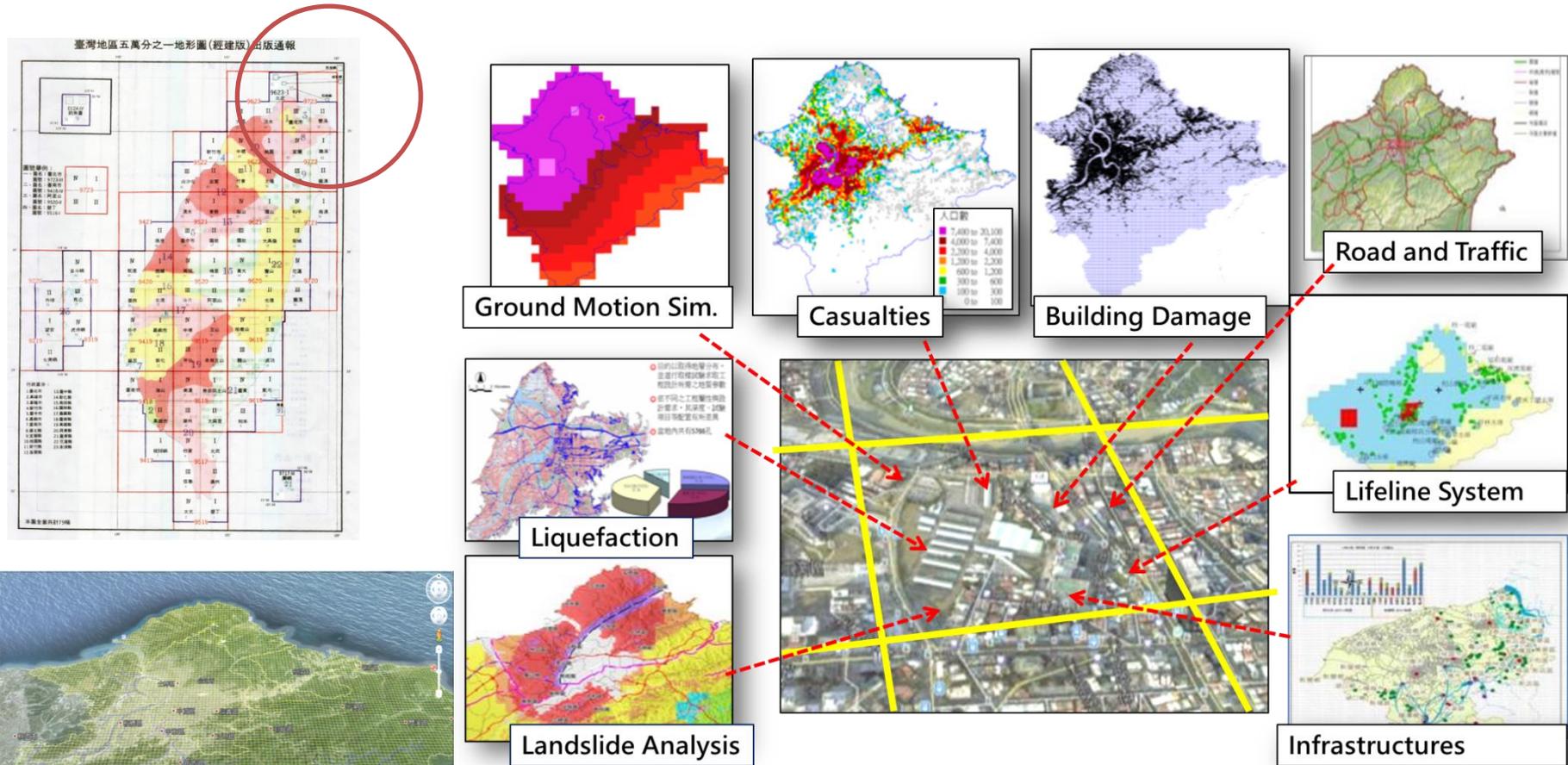
Taiwan Earthquake Impact Information Platform



TERIA Platform Framework



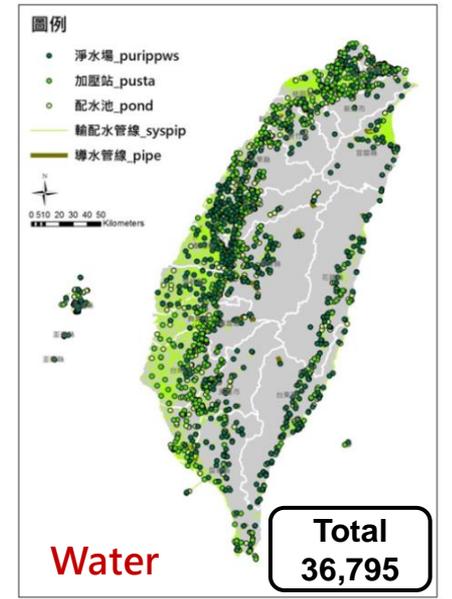
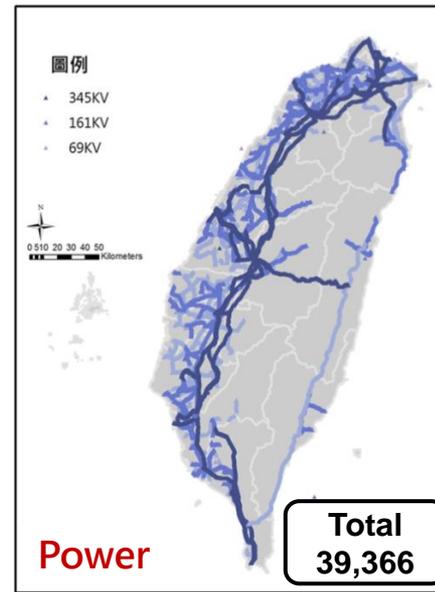
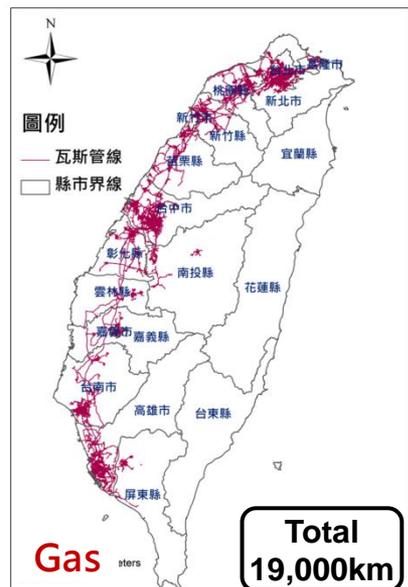
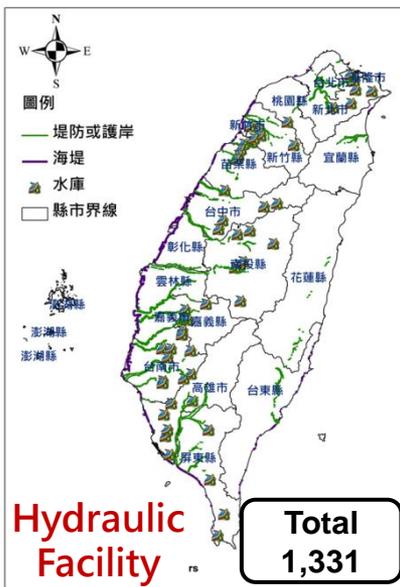
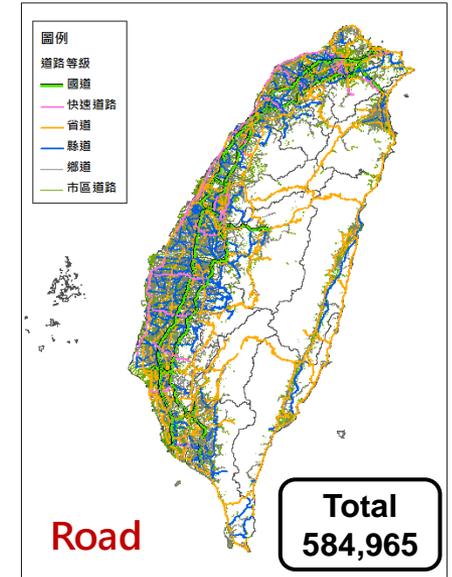
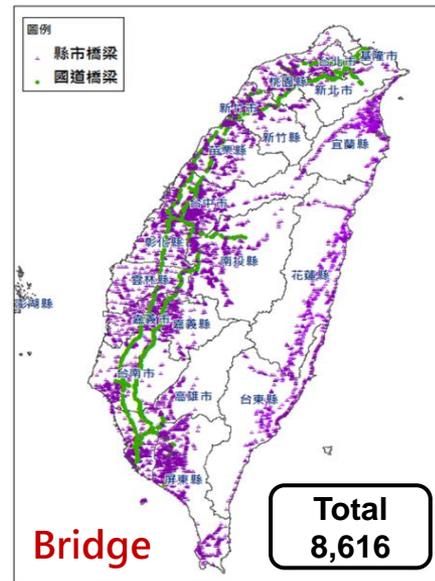
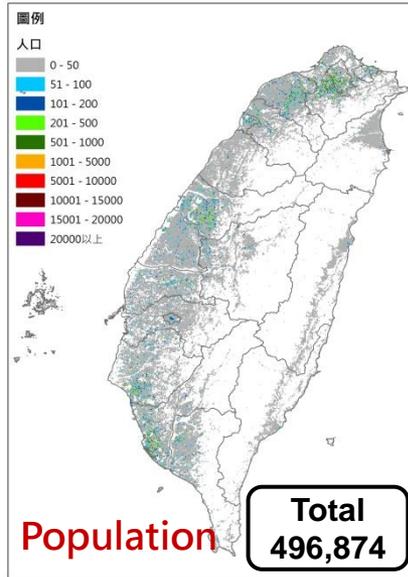
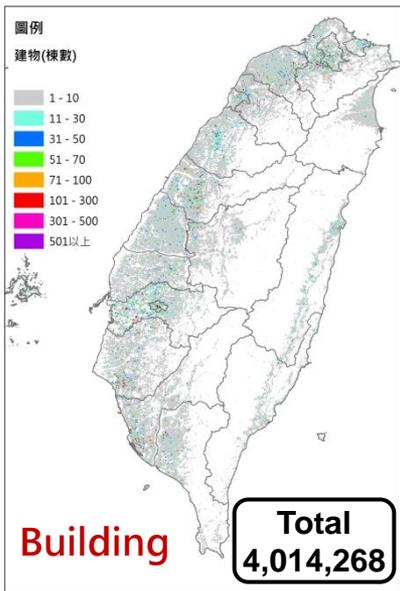
Geospatial meshed Data



500m x 500m Meshed Map Sheet

Number of Meshes :13,2712

Inventory database



Analytical items and output

Item		Unit	Output
Ground motion			
• Response of ground motion		500m mesh	Peak ground acceleration, velocity, and displacement
• Soil liquefaction and induced settlement		500m mesh	Liquefaction potential (P_L), settlement
• Landslide potential		500m mesh	Landslide potential induced by an earthquake
Impact analysis			
• Building	1. General building	500m mesh	No. of damaged general buildings
	2. Old building	500m mesh	No. of damaged old buildings
• Casualty		500m mesh	Casualty induced by building damage in 4 time slots
• Traffic	1. Road	500m mesh	Interruption probability of plane roads
	2. Bridge	point, line segment	Interruption probability of bridges (including elevated roads)
• Electricity	1. Electric facility	point	Damage probability of generation plants and substations
	2. Distribution circuit	500m mesh	Damage state of power supply
• Water	1. Water-supply facility	point	Damage probability of wells, treatment plants, and pumping plants
	2. Distribution pipeline	500m mesh	Damage state of water supply

Create an event for simulation

- Line source: Fault name, magnitude, depth
- Point source: Longitude and latitude of epicenter
- User-defined distribution of ground motion



分析結果查詢 **新增衝擊分析** 基本資料查詢

新增分析
排程清單

事件關鍵字:

地震規模(ML): ~

震源深度(KM): ~

震央、斷層、震央縣市3選1輸入

震央 東經: 度 北緯: 度

斷層 下拉選擇斷層:

震央縣市 全臺

查詢

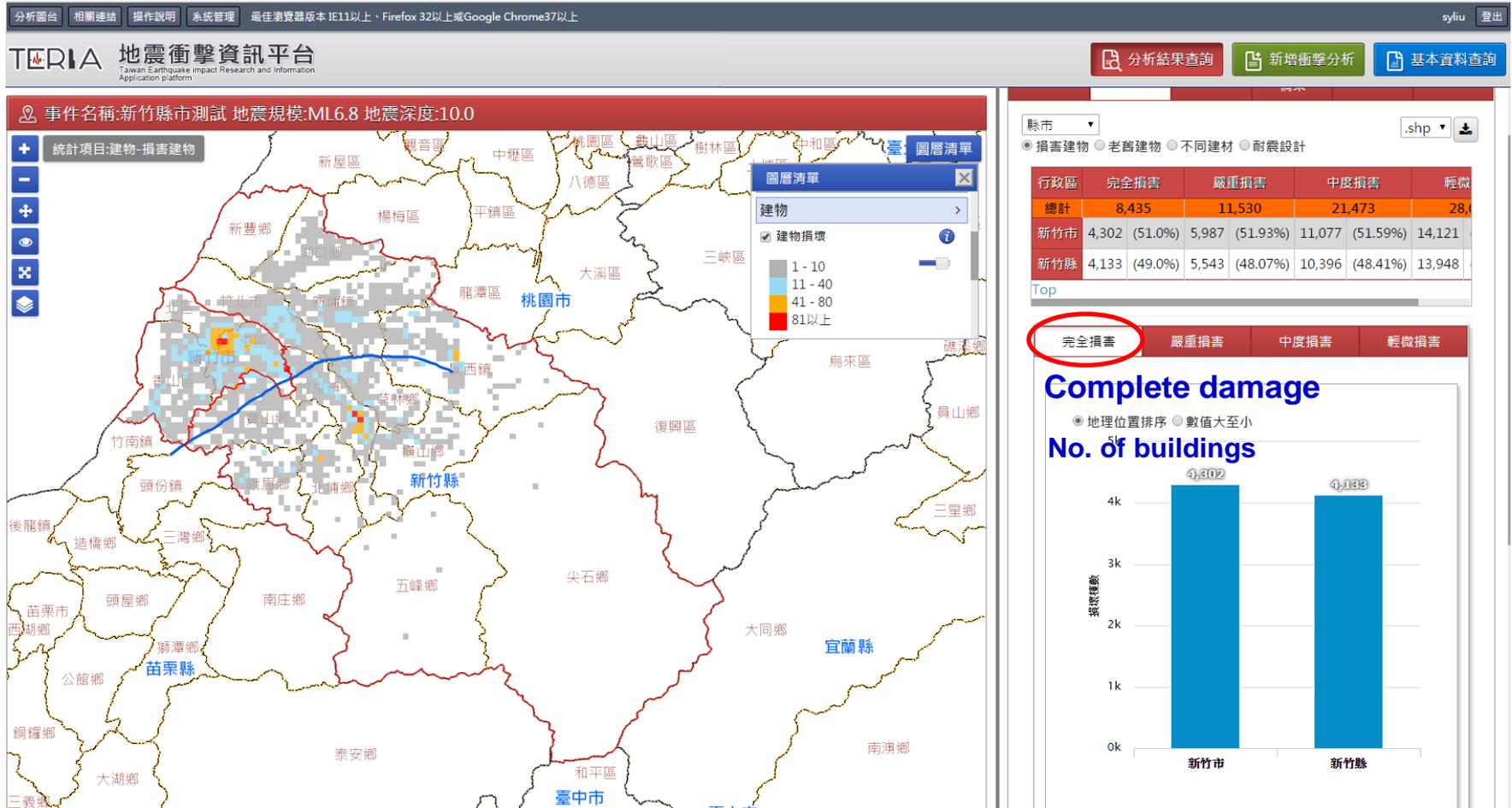
歷史分析清單

日期	事件名稱	地震規模	地震深度
2016/6/4	組4新竹地區	6.2	9.0
2016/5/2	高雄美濃地震	6.6	14.6
2016/2/23	宜蘭7.0第二次跑	7.0	5.0
2016/2/22	宜蘭點震源7.0	7.0	5.0
2016/2/9	0206美濃地震看液化	6.4	16.7
2015/11/18	花蓮點震源M7.0	7.0	10.0
2015/9/15	台中市M6.3	6.3	7.0

http://61.56.4.195/Teria/home/CreatAnalysis

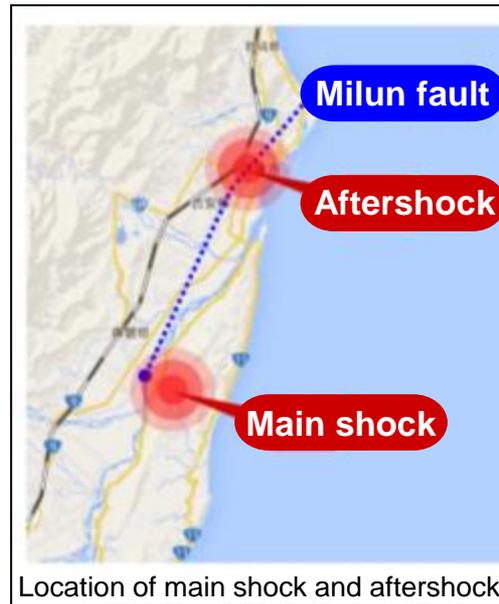
Interpret the analytical results

Display detailed results



Scenario simulation for the National Earthquake Drill

Line source: Milun Fault



Scenario

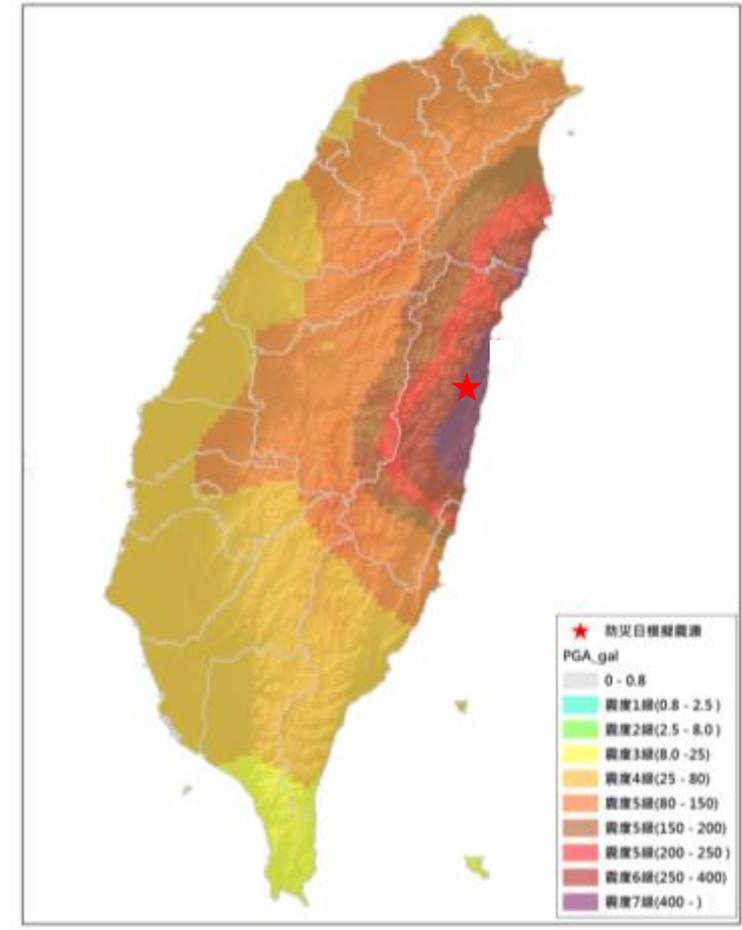
Time: am9:21 Sep. 21, 2014

Weather: sunny, 31°C

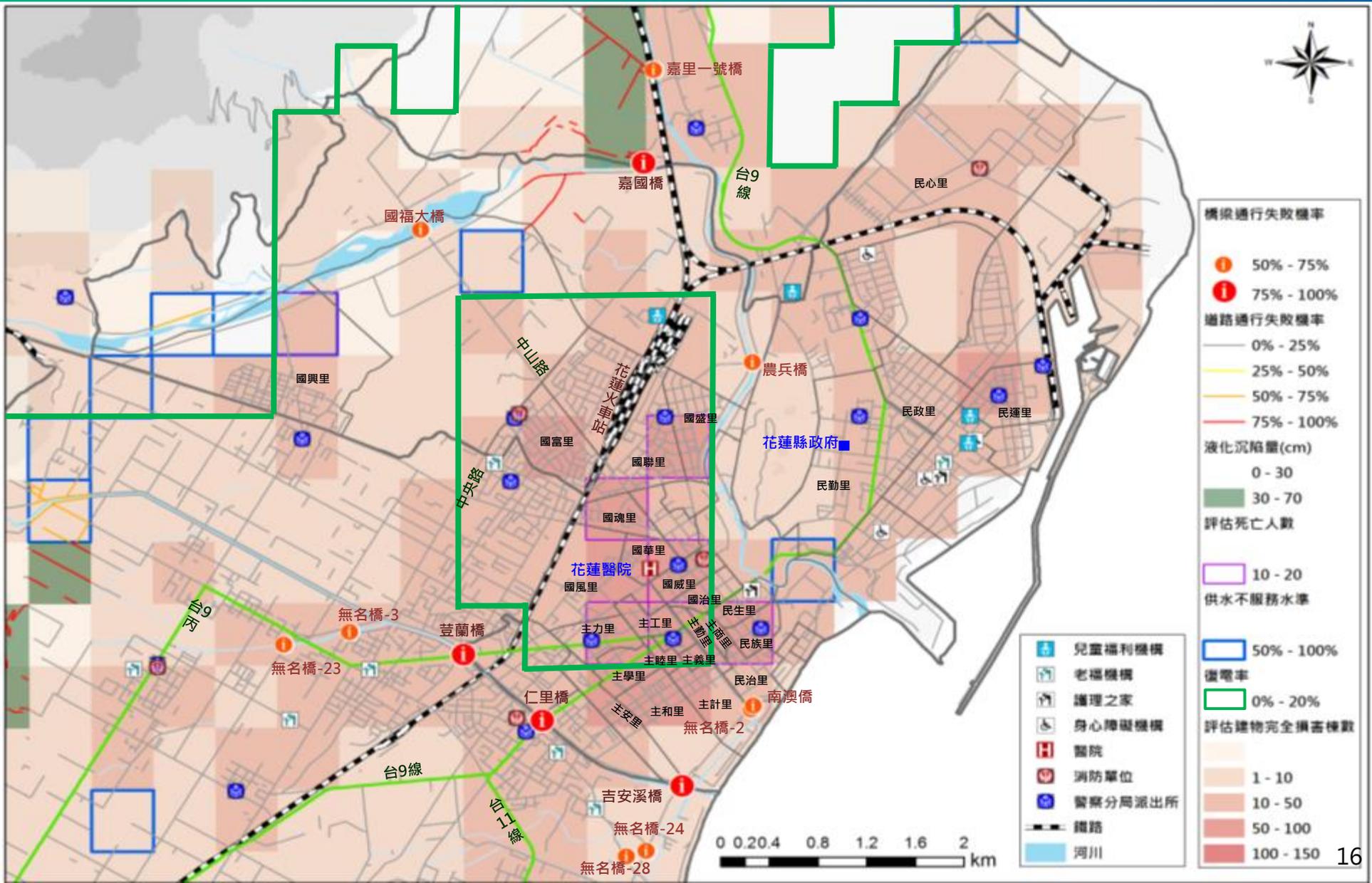
Epicenter: Shoufeng township, Hualien county

Event: $M_L=7.0$, depth=10km, intensity exceeds Level 7 in some areas

Ground motion distribution

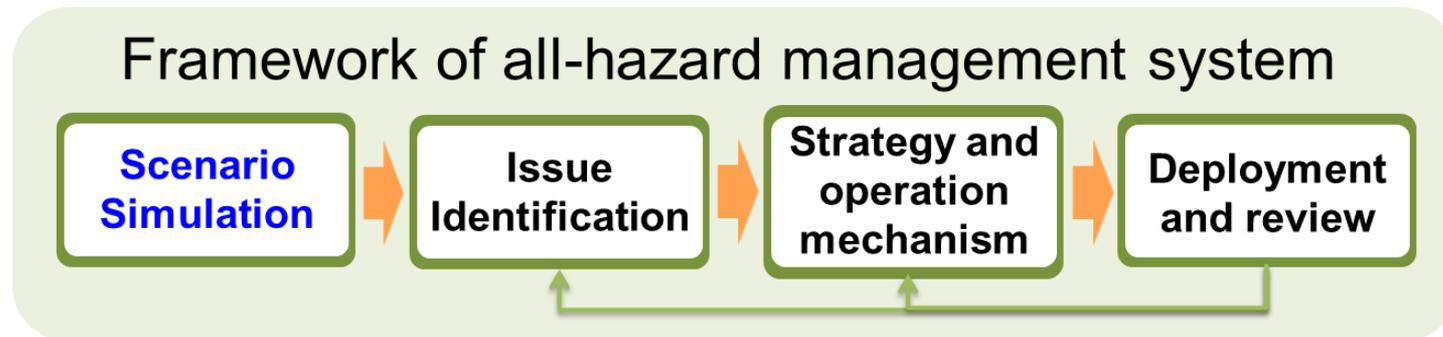


Integration of analysis results in Hualien



Impact analysis for disaster management

- The expert consultation committee* requested a scenario, **an urban city subjected to large-scale earthquakes**, to disclose the challenges in the disaster management system



Simulation items

- ◆ Soil liquefaction
- ◆ Building
- ◆ Casualty
- ◆ Sheltering
- ◆ Transportation
- ◆ Mass medical care
- ◆ Lifeline system

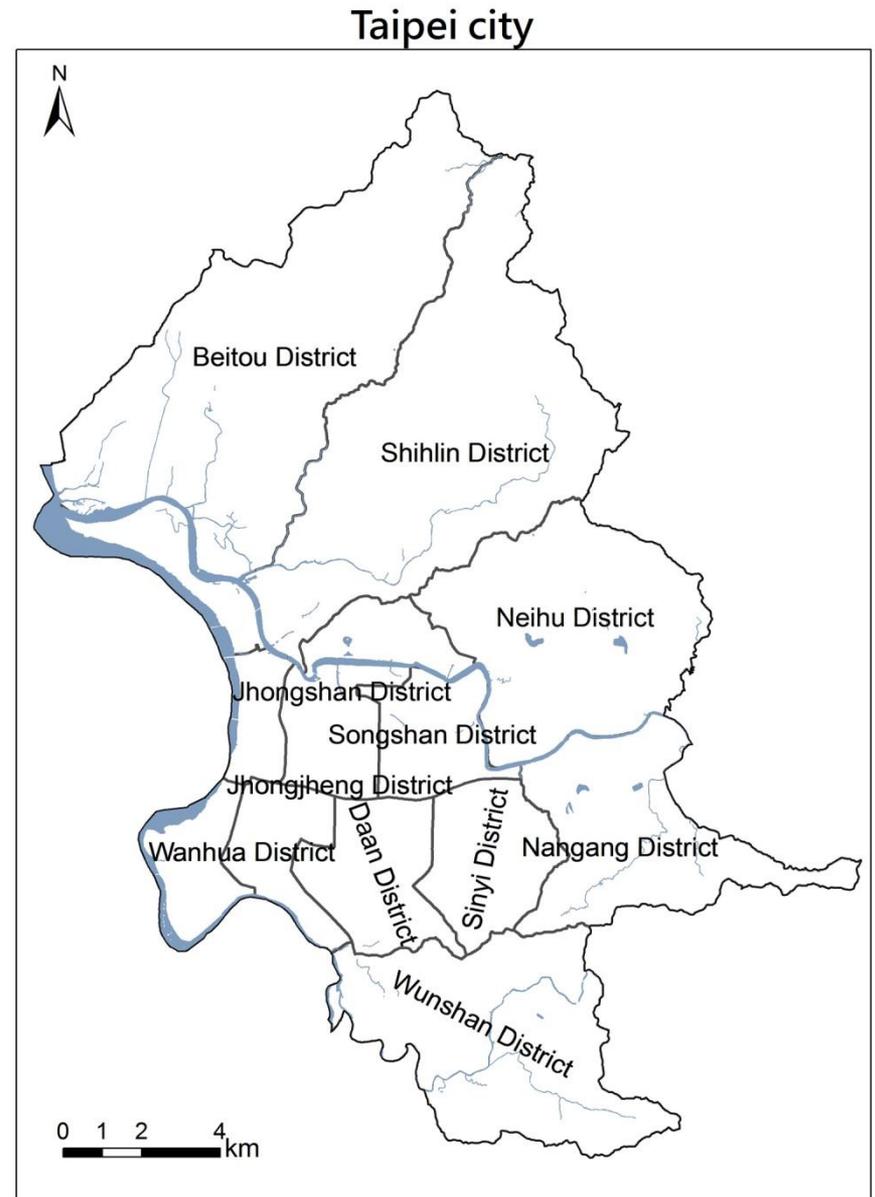
*Disaster Prevention and Protection Expert Consultation Committee, the Executive Yuan

Simulation in various shaking intensities

Intensity level	Acceleration range	Scenario setting
V	80~250gal	240gal*
VI	250~400gal	320gal*
VII	>400gal	450gal**

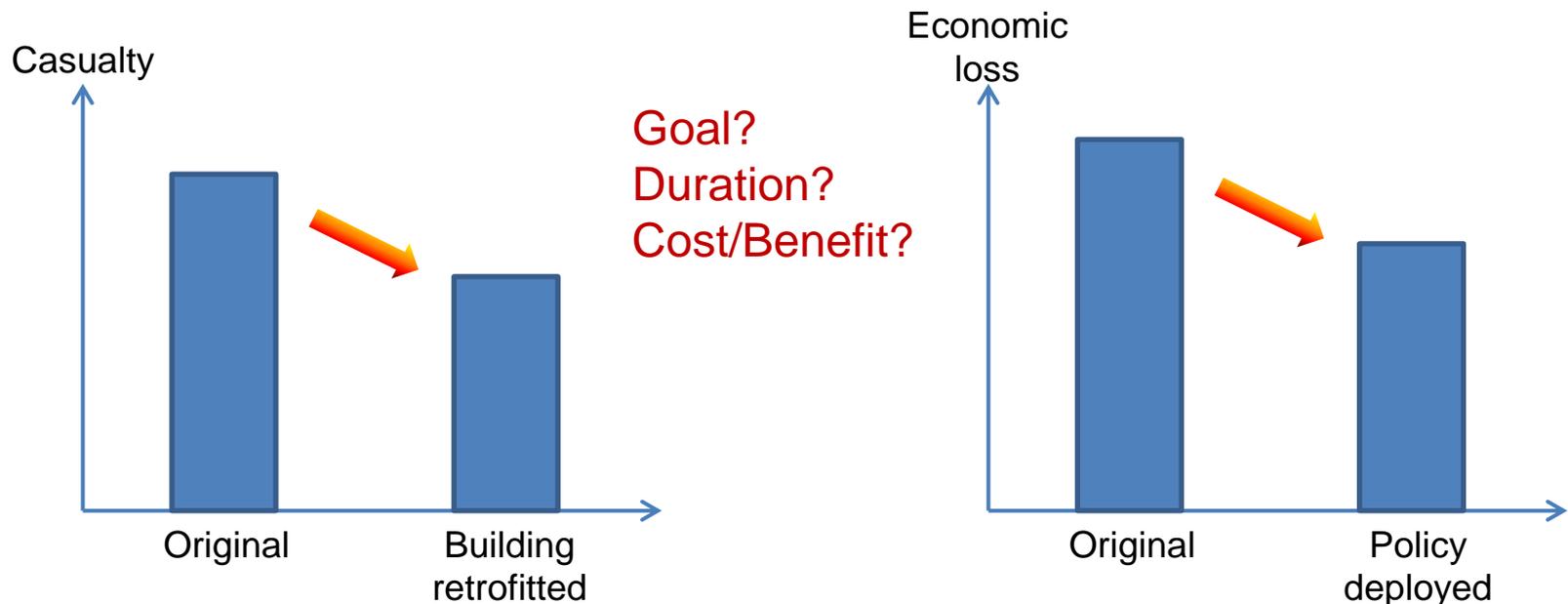
* Based on the building code in return periods of 475 and 2500 years

** According to the average PGA measured in the central Taiwan for the Chi-Chi earthquake



Future work

- Assessment of policy measures on disaster reduction
 - Performance of building retrofit on reduction of casualty
- Evaluation of economic loss
 - Consider direct and indirect losses
 - Cost/Benefit analysis of policy deployment





Thank you
for your attention