

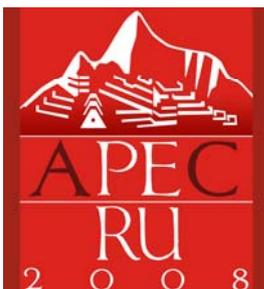


**Asia-Pacific
Economic Cooperation**

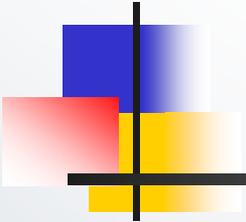
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A Summary Report on the Recovery Issues Following 921 Chi-Chi Earthquake

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**Workshop on Large-Scale Disaster Recovery in
APEC
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A Summary Report on the Recovery Issues Following 921 Chi-Chi Earthquake

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*** Keynote speech 1 presented at the Workshop on
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After this sound from the underground.....

Recorded at Long Valley Caldera

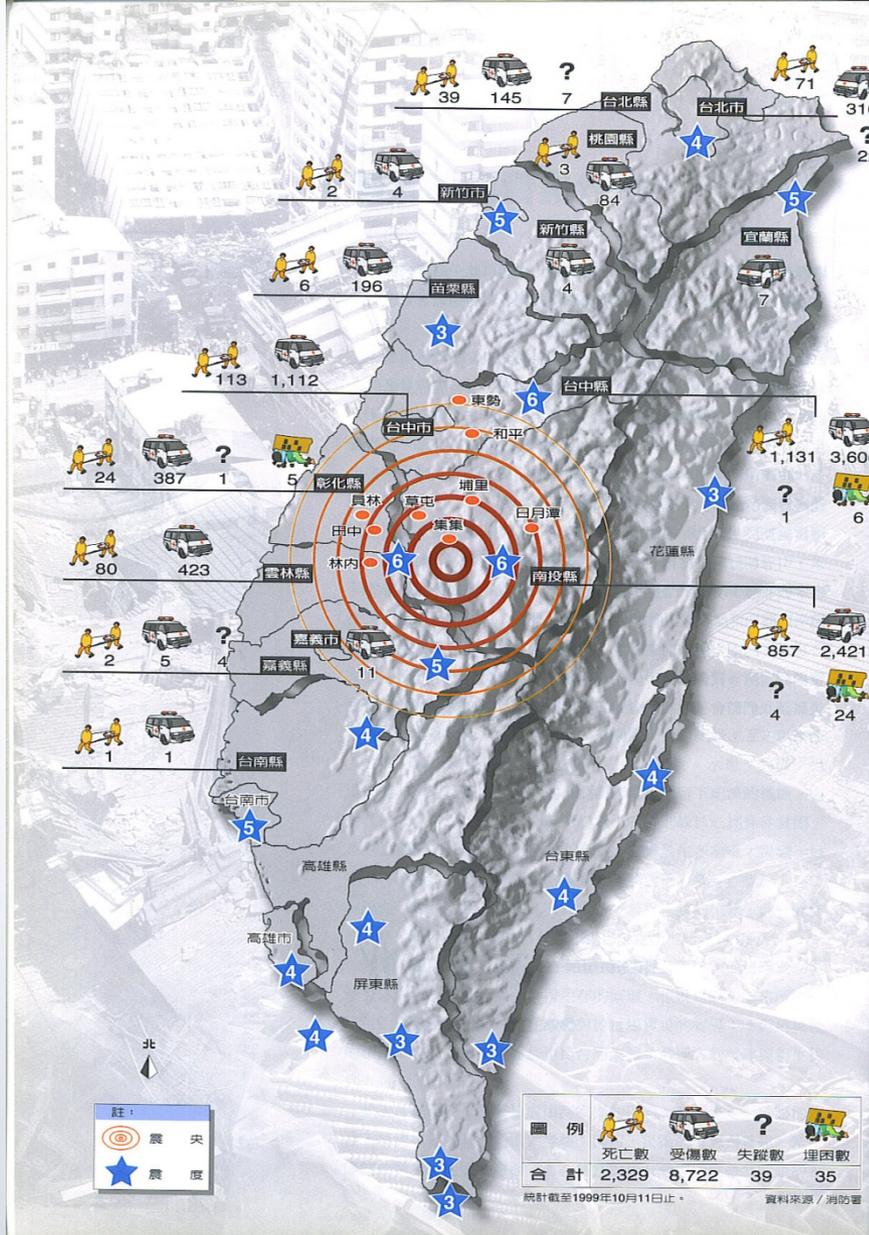


Recorded at Parkfield



< A comparable sound in 1992 7.3 Landers Earthquake ; USGS >

Then came a 100 km rupture of Chelungpu fault with the epicenter in mid-Chinese Taipei and an impact area of 10,000 square kilometers . For reference , it's a 350 km rupture of Longmenshan fault in Sichuan Earthquake with an impact area of 100,000 strong square kilometers .



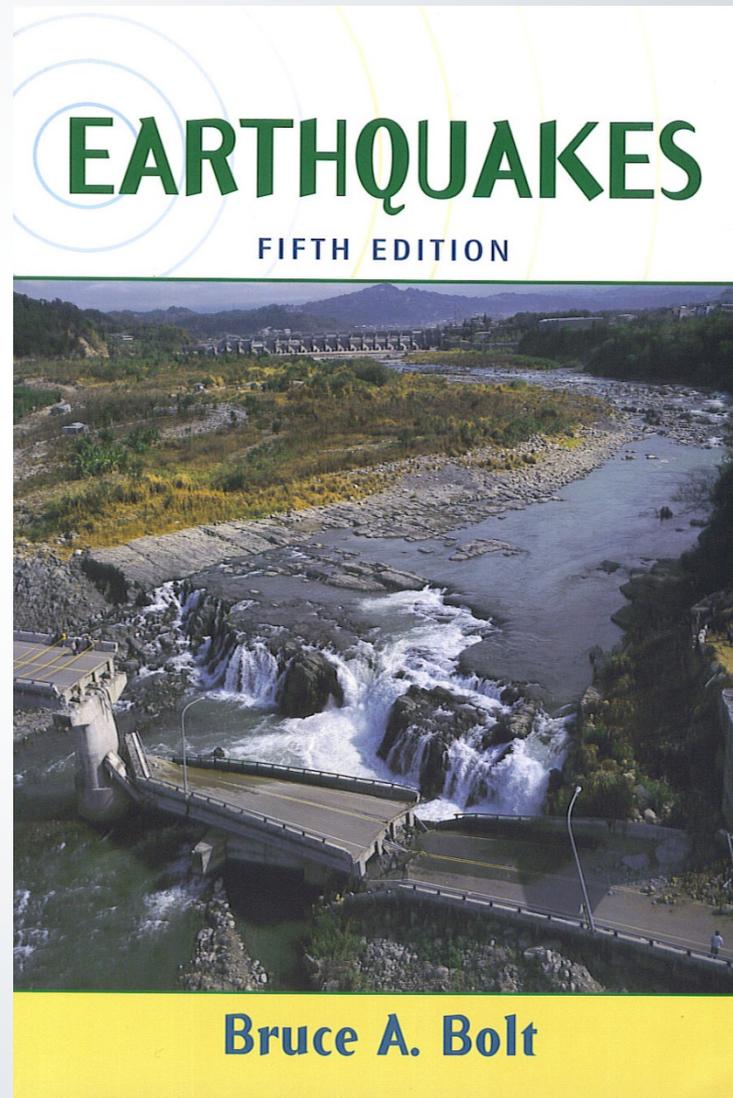
The epicenter of 921 Earthquake around central Chinese Taipei with island-wide impact
Source : United Daily News, 1999



The Fall of Golden Paris High-Rise Buildings in Taichung County
Source : United Daily News, 1999



**Rail deformation in Kobe City
(Similar in Nantou County, Central Chinese Taipei)
Source : Michiko Igarashi, Asahi Shinbun; Bolt (2004)**



Chelungpu fault crosses the Tachiahsi River, producing a 6-meter-high waterfall and destroying the road bridge. The damaged Shihkang dam is in the distance.

Source : Front page of Bruce A. Bolt (2004) . Earthquakes. New York : W. H. Freeman.

Statistics of 921 Chi-Chi Earthquake (1999)

Magnitude : $M_W = 7.6$ ($M_L = 7.3$)

< $M_W = 8.0$, Sichuan Earthquake >

Death Toll : 2,505

< Hanshin-Awaji , 1995 : 5,470

South Asia Tsunami , 2004 : > 200,000

Hurricane Katrina , 2005 : > 1,836

Sichuan Earthquake , 2008 : >88,000 >

Duration for Rescue and Sheltering : 4 months

Duration for Recovery (mainly , reconstructions) : 6 yrs.

< Hanshin-Awaji : 5 yrs.

Hurricane Katrina : 8-11 yrs. (estimated) >

**What should we have learned from 921
Chi-Chi Earthquake to counteract a
second-coming ?**

1. Effective implementation for the prompt response towards rescue and recovery

- (1) Emergency Order issued by the President ;
Sep. 25 , 1999.**
- (2) Special Act for 921 Earthquake Post-
Disaster Recovery ; Feb. 3 , 2000
(effective for 6 yrs.) .**
- (3) Master and Action Plans for Recovery ;
Nov. 9 , 1999 and May 15 , 2000.**

(4) Launching an integrative Commission for 921 Earthquake Post-Disaster Recovery in the Cabinet (stationed in Nan-Tou County with 300 full-time coordinating officers and staffs working for 5 yrs.) .

2. Gov't Budget allocation for recovery

(1) 1.7 % GDP

(2) Hanshin-Awaji : 1.25 % GDP

Hurricane Katrina : 1.1 % GDP

3. Civic donation

(1) $1/7$ of Gov't input

(2) $1/25$ for Hanshin-Awaji or Hurricane Katrina

(3) Civic donation was largely allocated to the reconstruction of schools and shelters. It is worth noting that civic donation , due to its flexibility and the exemption from strict government accounting restrictions , should better be allocated for timely victim-based personal assistance . The logic is simply that government budget should take larger responsibility in school reconstructions.

4. Collapsed constructions produced more than 10 million cubic-meter solid wastes . Half were recycled and the other half were dumped along the riversides or other ecologically-sensitive areas . A well-thought management plan should be worked out beforehand .

5. 5,844 temporal-housing were built together with sufficient social (welfare) support . It is recommended to accommodate at least for two years and wait for future housing assistance .

6. School rebuilds should be kicked off in 6 months . More than 1,500 schools (mostly , primary and junior-high schools) were damaged and 293 were collapsed . The rebuilds were upgraded to stay on the safe location , raise the seismically-safer standard (0.23g → 0.33g plus an extra 25 % enhancement , i.e., 0.41g) , improve the whole structure of school layout from fragile straight-line to resilient U or L shape , and create an unprecedented architectural aesthetics .



The Fall of Buddha Temple and Tzu-Ming Technical School
Source : Journal of Civil Engineering Technology, January 2000.



The Fall of Tzao-Tun Technical School
Source : Sino-Geotechnics Research and Development Foundation, 1999



Ruins of Kuang-Fu Junior High School
Source : Sino-Geotechnics Research and Development Foundation, 1999



Rebuild of Pei-Mei Junior High School
Source : Ministry of Education, 2003

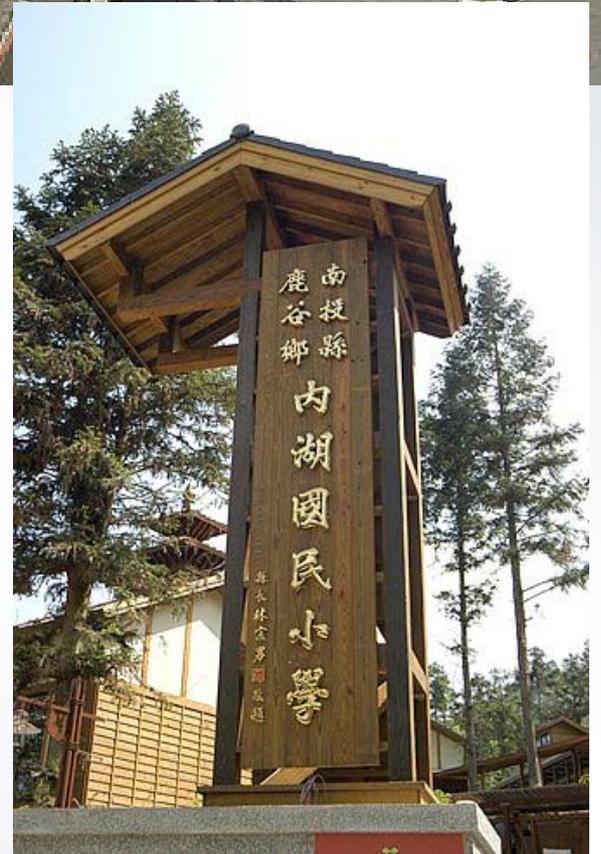
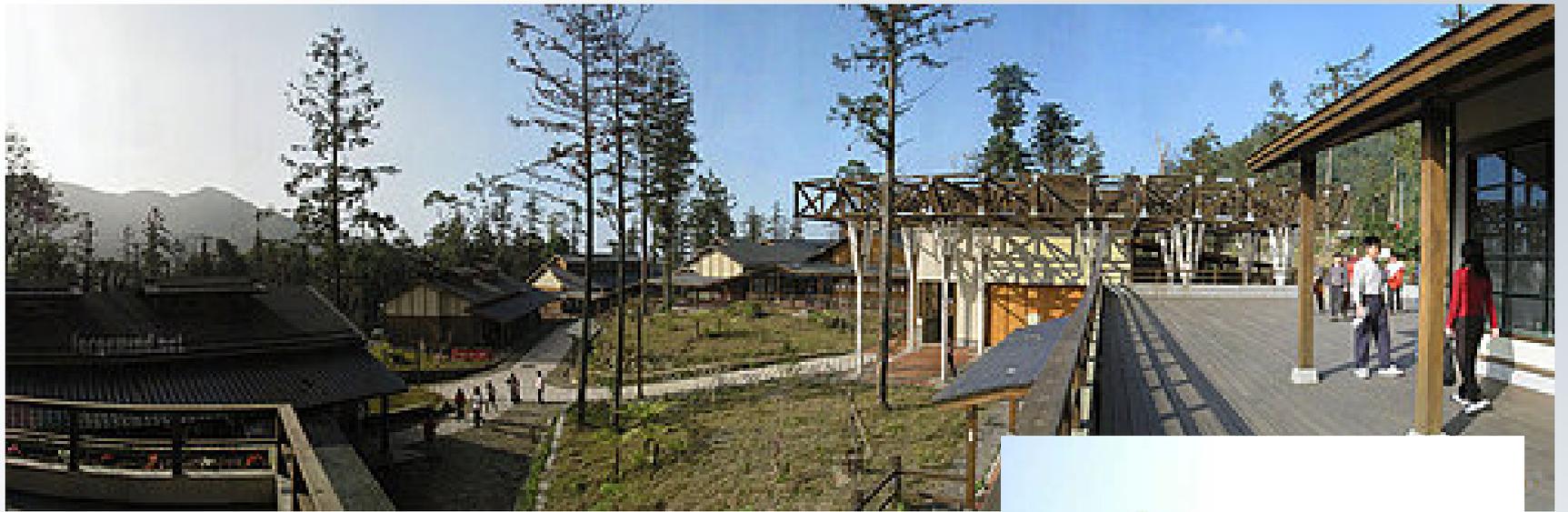


Rebuild of Tan-Nan Primary School (No. of Students = 72)
Source : Ministry of Education, 2003



However , an exceptional and unwarranted case did still happen . Sometimes , local politics prevails .





7. The most difficult recovery issue was the retrofitting and rebuilt of the amenable and collapsed houses . There were 27,723 vs. 27,635 collapsed and amenable individual housings . For apartment compounds of collective housing , it's 172 vs. 148 , respectively .

A lot of difficulties were incurred in the realignment of property land boundaries , financial subsidies , and willingness to rebuild (especially for collective housing cases). The authority should take the most cautious steps and provide sufficient support for dealing with these issues effectively .

8. Socio-economic support is a must in :

- (1) Employment , medication , nusergy of the aged , and continued schooling .**
- (2) The support helped reduce the suicide rate , PTSD , and other complications . It also enhanced the resilience among the under-priviledged .**

- (3) Victims were 1.46 times more likely than non-victims to commit suicide following the earthquake (Chou et al., 2003) . In the first 10 months , suicide rate in the impacted area rised up to an increase of 42.3 % , then back to base-line (Yang et al., 2005) .**
- (4) Prevalence rate of full PTSD (by DSM-IV) dropped from 9 % to 3 % in three years (Chen , Wu , & Hung , 2004) .**

9. A total number of 20,000 public engineering projects with a budget of 3 billions had to be completed in three years . It's a heavy additional burden to the existing national capacity and capability in conducting public constructions . It is thus a formidable challenge to assure quality , efficiency , and legitimate management . Inefficient and corruptive behaviors could be partly prevented through a well-coordinated monitoring network .

10. Recovery of 250 cultural heritage and historic buildings was time-consuming . We got to be patient for the authentic recovery instead of treating it like an ordinary engineering project . It takes at least two times longer in restoration when compared with conventional engineering cases . The authority is usually eager to push harder for speedier recovery . It simply does'nt work.

11. Landmark memorials should be kept as minimum as possible . Tormenting collective memory needs to be transformed into a vision for brighter future . In the beginning , 17 memorials were forcefully proposed by local governments and concerned citizens . Five geological landscapes were finally agreed upon .

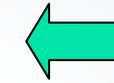
921 Earthquake Museum



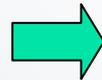
Geological Unfolding of the Active Fault



竹山車籠埔斷層槽溝
開挖及拓印

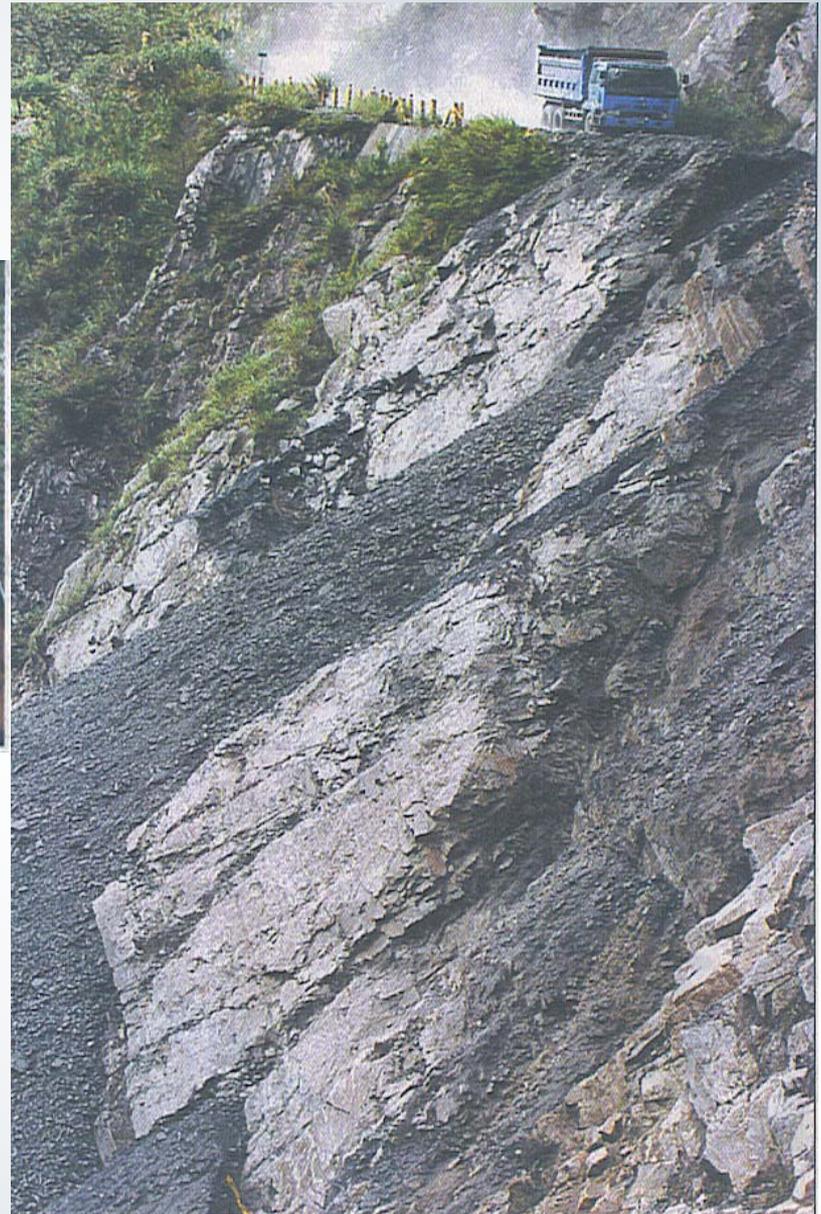
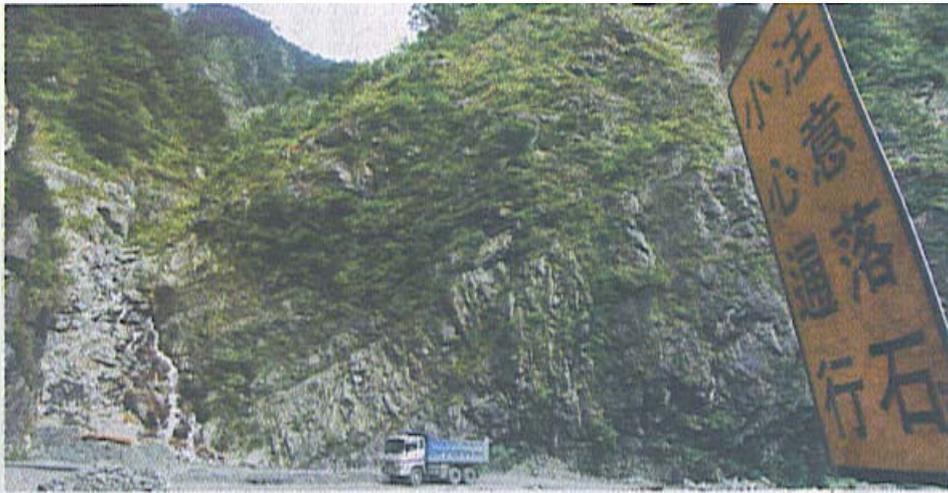


竹山車籠埔斷層構造



12. Ecological or natural restoration is sometimes better than hasty engineering recovery . For example , an engineering project aiming for landslope stabilization and a reopening of a short segment of the Central Traverse Highway (CTH) will cost 1 billion . It's obviously an unwarranted proposal and also not a cost-effective action . Mother Nature will heal herself eventually . International experience , like in Japan , will recommend a time frame , say ten years , to secure genuine stabilization .

Upper and Lower Landslope of CTH



Mountain Restoration Near the Epicenter



← 九份二山植生復育前

九份二山植生復育後 →



13. The rock and soil were shaken loose and remained on mountain top . Rock-soil compound will be rushed to the rivers after major typhoon or heavy rainfalls , then a flash flood filled with debris or mud flow . Comprehensive mitigation projects of four river basins have been proposed and conducted since 2005 .

14. Active civic participation in community renewal can highlight a new set of reborn values . A consensus vision for broadening the future will reshape the community outlook to an amazing degree .





15. Policy decision issues . It's always difficult in making decision under uncertainty .

(1) Decision under risk (with knowledge of probability structure of the consequences ; in need of good judgment and efficiency)

A. School rebuilds : Remove the collapsed or leave it until the legal or liability investigation completed ?

Correct action : Remove the collapsed .

B. Who should be the responsible agents for identifying the status of “collapsed” or “amendable” among afflicted buildings ?

Wrong action : Professional on-site

evaluation was adopted only for reference to assist a final judgment by local administrative personnels , like township administrators . It might incur the following absurd case : the first-story “collapsed” and the upper-stories “amendable” in the same building .

(2) Decision under ambiguity (ignorant of probability structure and outcome of the proposed action ; in need of consensus under multiple criteria)

Example :

A good-intention proposal to evacuate and replace inhabitants from unstable villages is often failed . The problem lies in a failure to recognize the resident's attachment to the land and community . Sometimes , an uncertainty on the future life in an unfamiliar new placement also counts . A consensus can be worked out through a hard-working coordination under multiple criteria . Only has this consensus reached , the intended evacuation and replacement project can hopefully be implemented .

The recovery experience of 921 Chi-Chi Earthquake should have been integrated as an indispensable new dimension into current hazard mitigation and disaster management and also in the development of a comprehensive early warning system .

Although some influential thinkers didn't show their confidence on human capacity to learn from experiences , like

Georg W. F. Hegel

What experience and history teach is this : that people and governments never have learned anything from history , or acted on principles deduced from it .

George Bernard Shaw

Hegel was right when he said that we learn from history that man can never learn anything from history .

**However , we are still expecting
the contrary !**