Natural Disaster and Road Network

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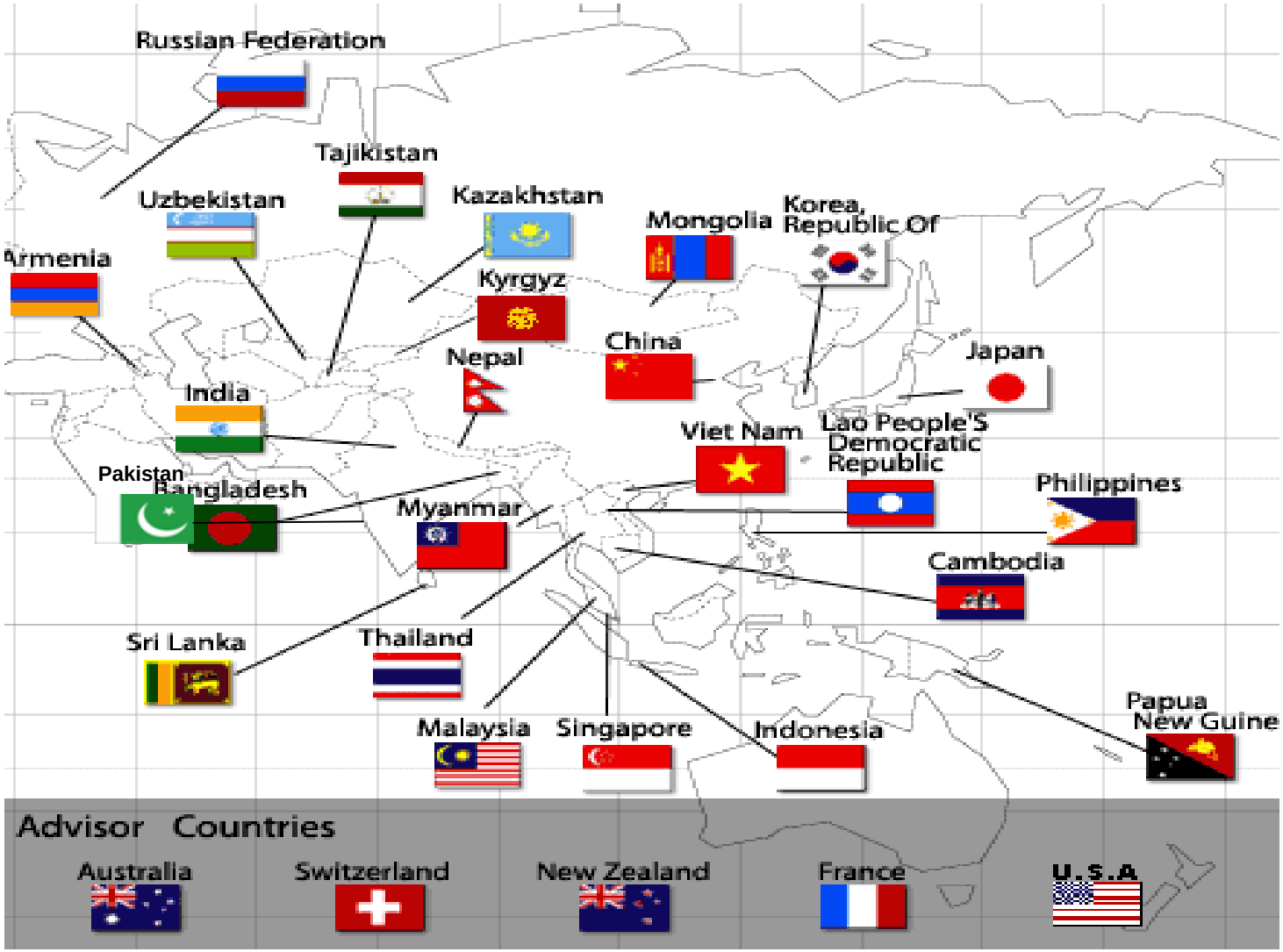
Contents

Promoting Disaster Reduction through Multi-National Cooperation in Asia region

Founded; 1998

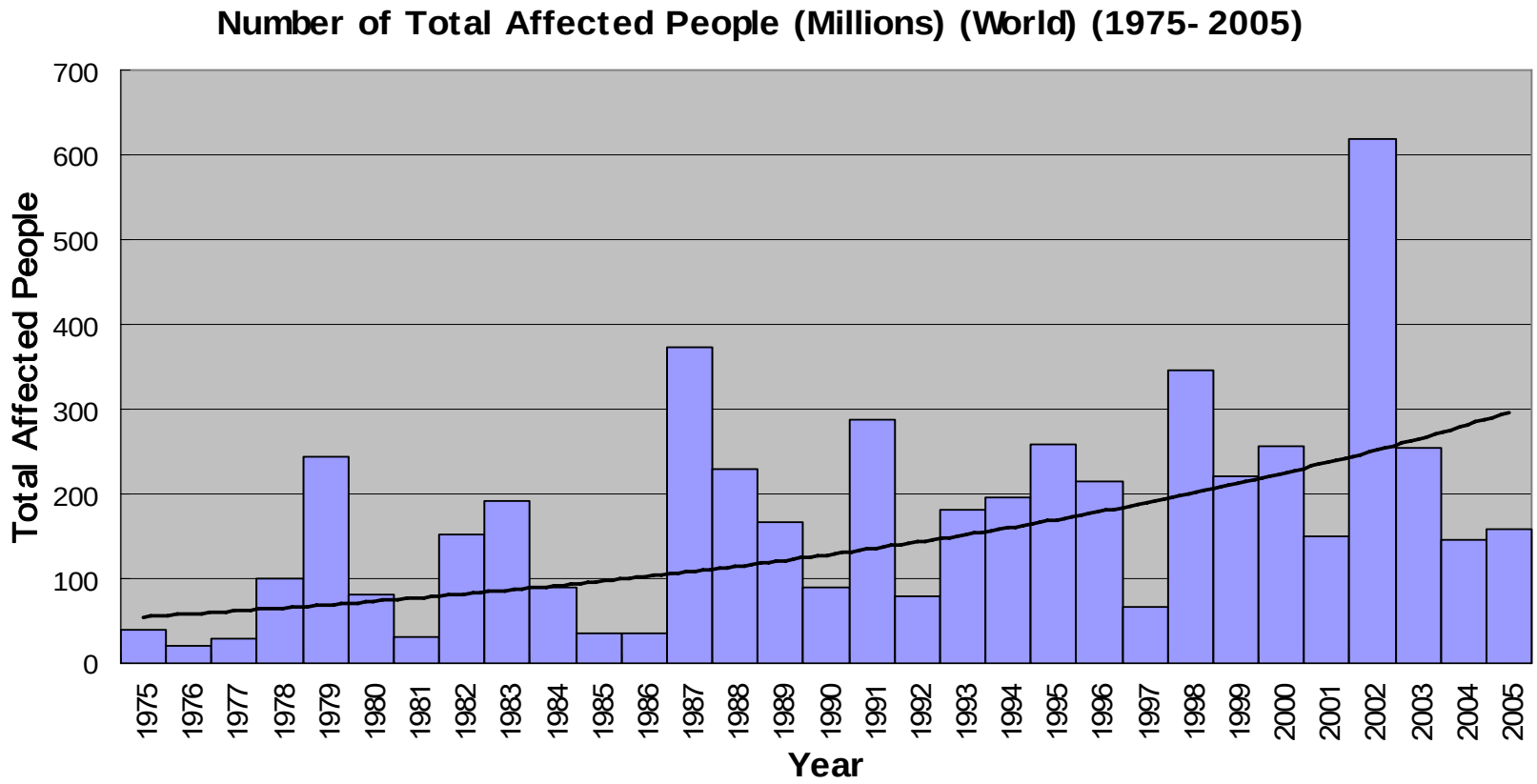
Asian Disaster Reduction Center (ADRC)

ADRC Member Countries



25 Member Countries, **5** Advisor Countries, **1** Observer

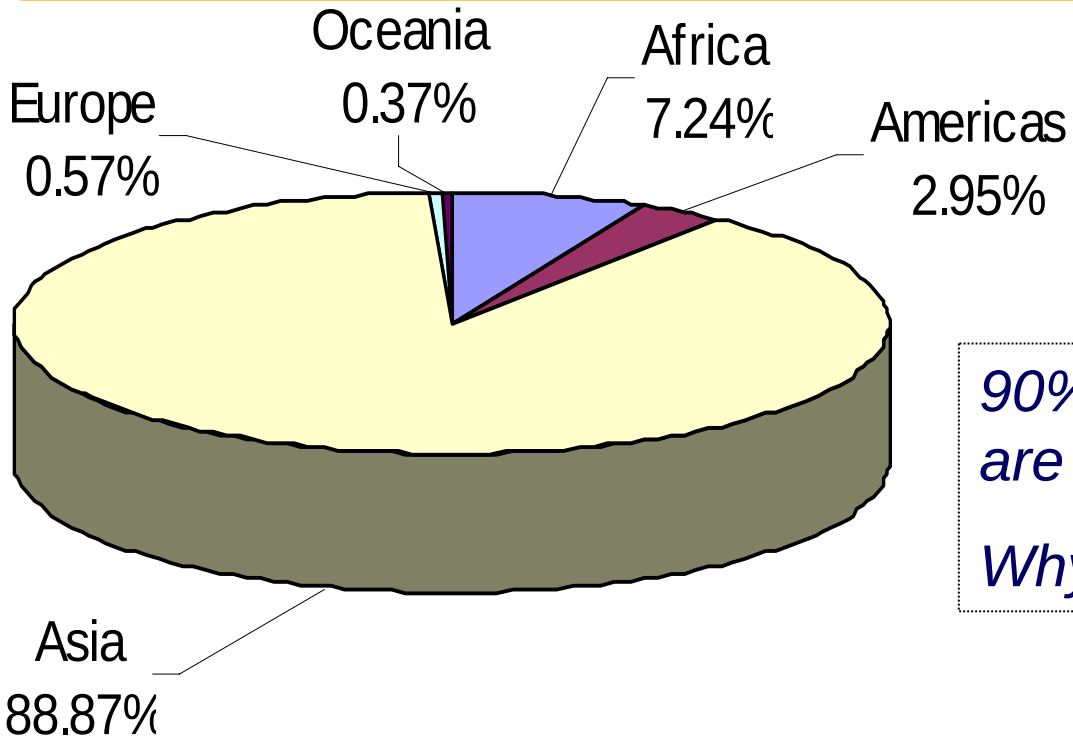
Time Trend on Number of Affected People



1. Number of affected people constantly increase.
2. 10yrs-ave., 1994-03, 40,000 killed, 260mio. affected each year
3. Recent, Hurricane and Pakistan EQ. Upward trend is accelerating

Note 1. Source: CRED EM-DAT
2. Affected People include killed, missing, injured, as well as the people who lost their houses.

Total Number of Affected People by Natural Disaster in the World (1975-2005)



90% of disaster victims are in Asia region.

Why in Asia?

① Geographical condition,

② Rapid increase of population, Rapid urbanization

③ Poverty

Note 1. Source: CRED EM-DAT
2. Affected People include killed, missing, injured, as well as the people who lost their houses.

Economic Loss by Natural Disasters in Asia (1960 - 2004)

Country	Year	Disaster Type	Damage (USD M$)	GDP (USD M$)	Damage /GDP
Armenia	1988	Earthquake	20,500	2,257	908%
Mongolia	1996	Forest fire	1,713	893	192%
Mongolia	2000	Cold wave	875	907	96%
Maldives	2004	Tsunami	470	753	62%
Lao PDR	1992	Typhoon	302	1,128	27%
Nepal	1987	Flood	728	2,851	26%
Georgia	1990	Earthquake	1,700	7,738	22%

Note 1. Source: CRED
2. GDP is before year of the disaster. Armenia's GDP is in 1990 after the independence.

Necessity of Disaster Reduction

- A single disaster can wipe out annual GDP of a country, also social stability and national security
- Natural disaster can be the biggest impediment to social development of a country

Disaster Reduction is a MUST for Sustainable Development in Asia

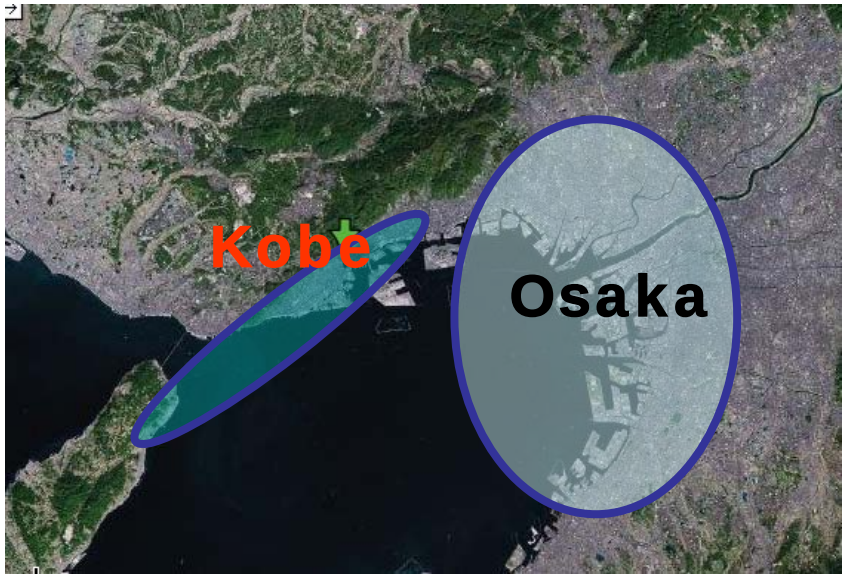
ADRC's Activities

1. **Information Sharing**
   - Through the Organizing Int'l Meetings and Workshop
   - Disaster Information Updated Through the Web (http://adrc.or.jp)
   - Good Practice from the Member Countries

2. **Human Resource Development**
   - Workshop and Trainings
   - Visiting Researcher Programs

3. **Building Community Capabilities**
   - Development of Community Hazard Mapping ("CBHM") & Town Watching Method,
   - Tsunami Risk Awareness Projects

Lesson Learned from Hansin Awaji EQ



Overview of the Hansin Awaji Earthquake

- Jan.17,1995 5:07AM
- Magnitude;7.4
- Human Losses;6000
- 2nd EQ Disaster affected to the modern highway system after the Northridge EQ in California.

Hanshin Awaji EQ - Problems

- Immediate after the Heavy Ground shaking, over 100,000 houses are collapsed.
- After the earthquake, so many fire occurred in Kobe.

The Problems (Overall)

- Non Engineered Building Easily Collapsed by Shaking
- Dense Populated Area
- Wooden Structured Bldg (Fire)
- In Winter season, Fire Heater
- Collapsed houses stop the access of the fireman and fire track
- Simultaneously Fire Occurred, insufficient fire track, fireman, water supply

Hansin-Awaji EQ - Sociao-Economic Problem

- Kobe Port is a major port in the West part of Japan
- Major Highway connects bet. Kansai and Cyuugoku Area.
- EQ affected to the local economy, and also to the regional economy.
- 4 highways collapsed made a stop of transportation between east and west (geographical reason)
- After 21month, fully recovery to the Original Level

Lesson Learned from Hansin Awaji EQ

Hanshin Awaji EQ

After EQ

After few days

Problems on the Road in Disaster

- For Local Area;
  - Timely Evacuate and Rescue
  - Fire Fighting due to the Access
  - **Delaying Recovery (logistic Problem)**

- For a Region;
  - **Socio-Economic Problem**

  No EQ affected area was suffered negative economic impact due to the disturbance of the transportation as well as Kobe City.

→ *Redundancy on the network for the Natural Disaster*

Old Dhaka Situation ~ Importance of “Road”

Dense Populated Area, Old Mid High Buildings,

Narrow Road Access

What will be happened in Dhaka after the earthquake ?

Easily Imagine the Situation of after the EQ !

Old Dhaka Situation

[Current Situation]

- Moderate EQ Area; Over 100 years ago EQ was happened
- Populated Area; 12 Million People
- Vulnerable Building; Old Mid Stories Building with no compliance to the building Code (Seismic Code)
- Narrow Space, No Access Road

[EQ risk in the standpoint of “Road”]

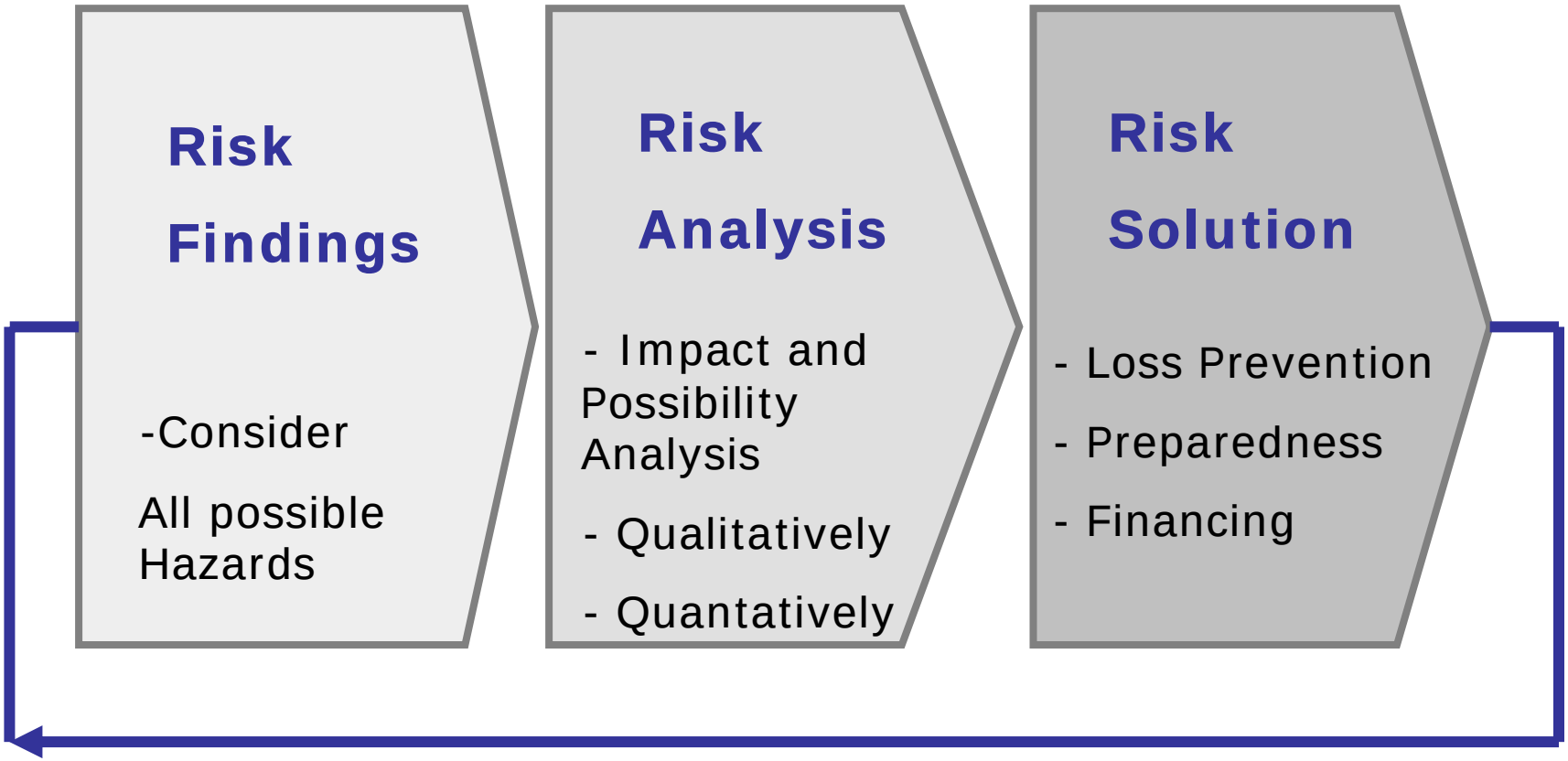
- Insufficient Evacuation Route for the Natural Disaster
- No Safely place to Evacuate
- No Available Rescue Service
- No Fire Tracks Access into the site after the fire following EQ
- No Smooth Debris Removal the collapsed building

[Solutions ???]

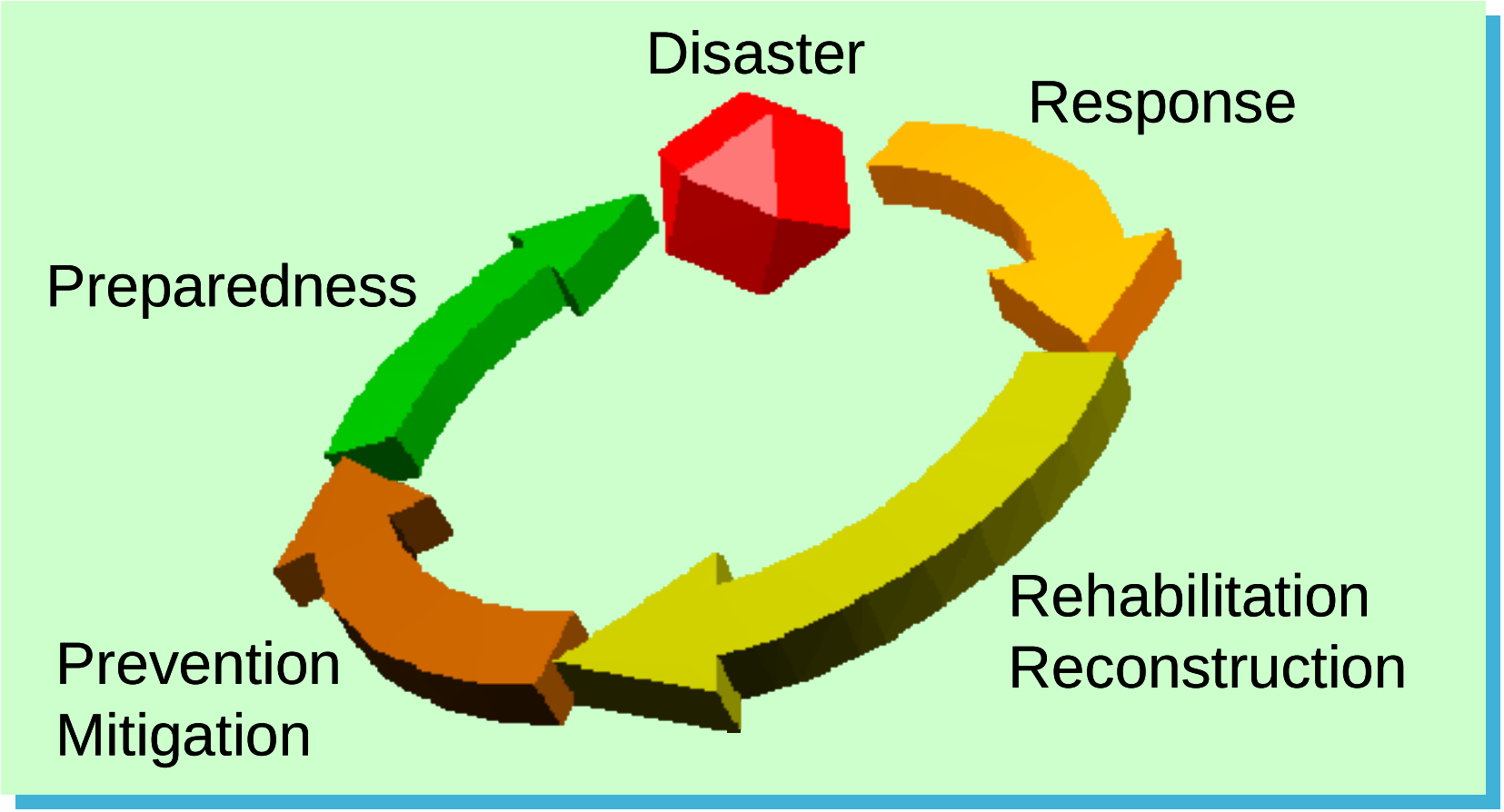
- Building Construction “No more build with no seismic code !”
- City Planning “No more reconstruction without permission !”

“Road” and Risk Management Cycle

General Risk Management Cycle



Disaster Risk Management Cycle



Disaster Management Cycle consists of 4 phases starting from the “Disaster”.

The Concept of Total Disaster Risk Management (“TDRM”) approach

Risk Analysis #1 Possible Scenarios EQ/Road

Network System of the road under Emergency Condition

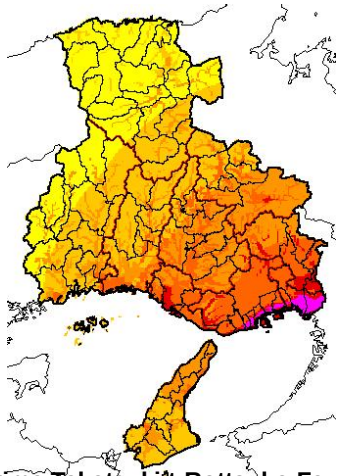


Fig 3-1 Arima Takatsuki-Rottsuko Fault(M7.7)

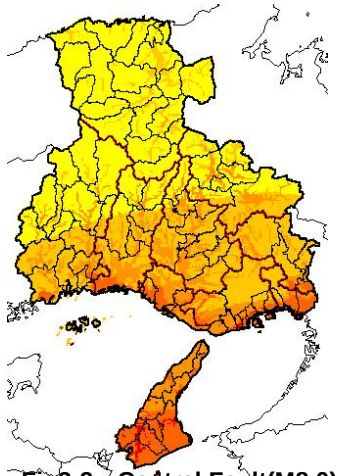


Fig3-2 Central Fault(M8.0)

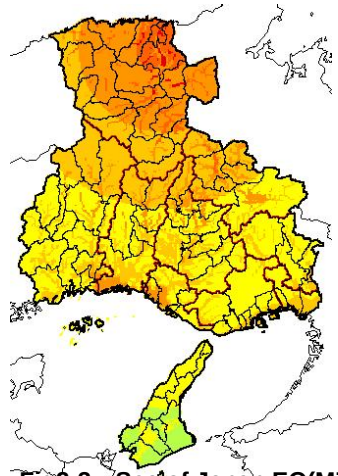


Fig3-3 Sea of Japan EQ(M7. 3)

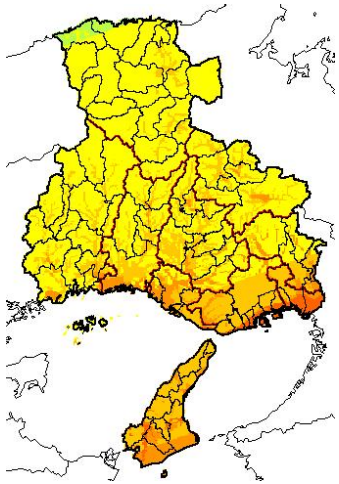


Fig3-4 Nankai (M8.4)

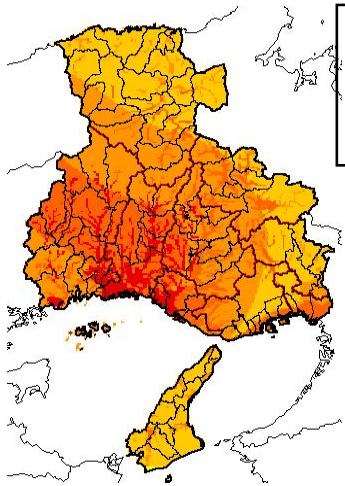
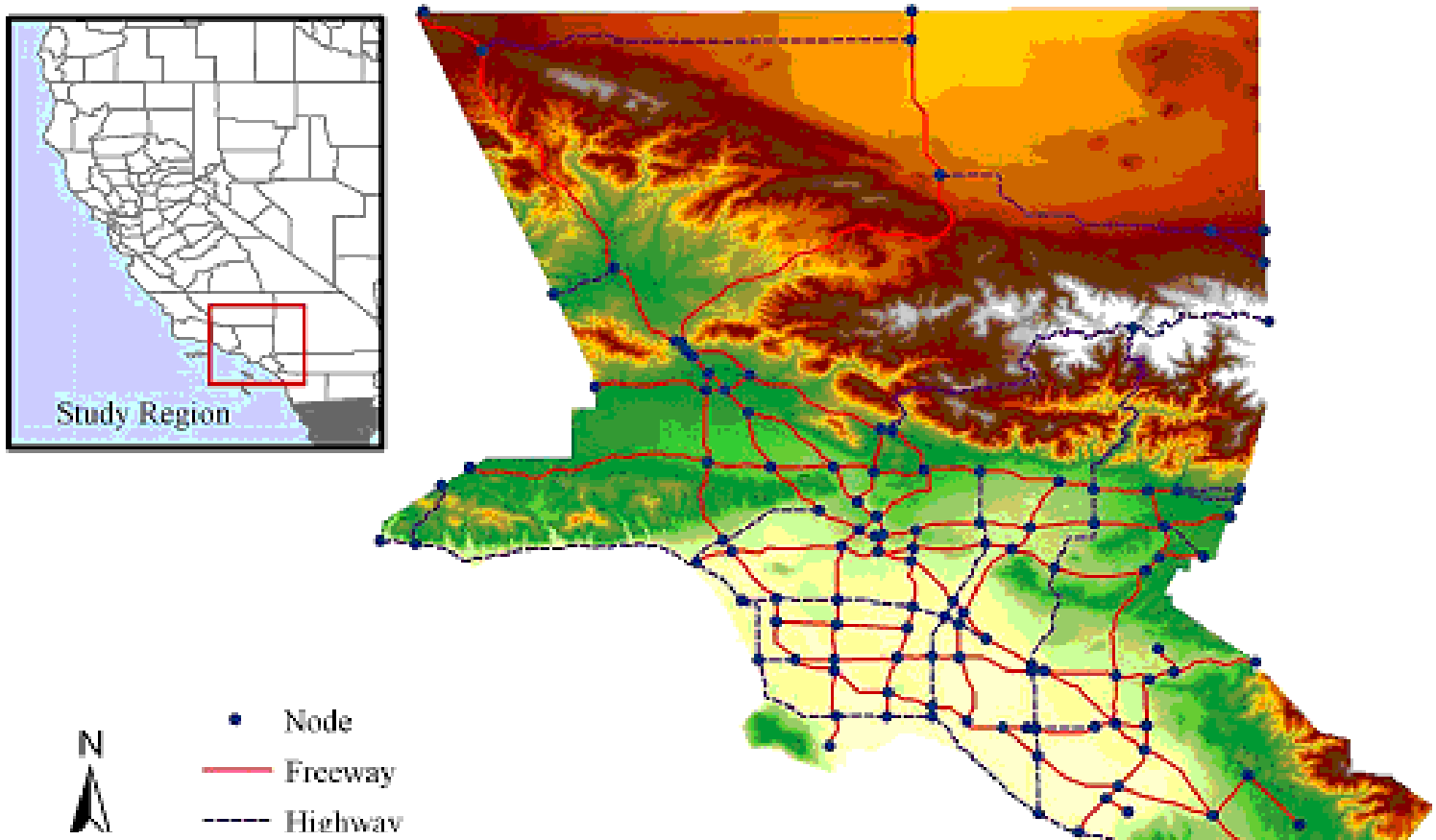


Fig3-5 Yamazaki Fault (M7.7)

Five Highly Potential Occurrence of Earthquakes

Cited from the document from Hyogo Prefecture

Risk Analysis #2 CALTRAN in California



No Service Time is a Critical Problem,
How to effectively Retrofit of the Network ?

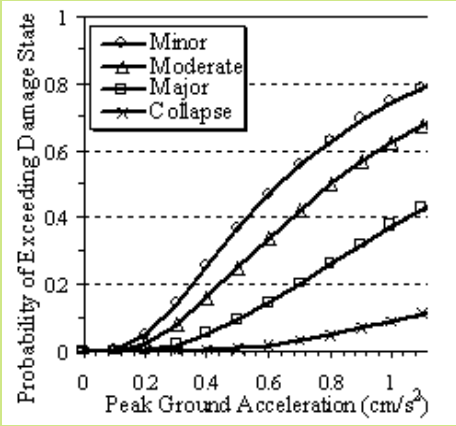
- Unknown EQ? Probabilistic Approach

- How to analyze complex system ?

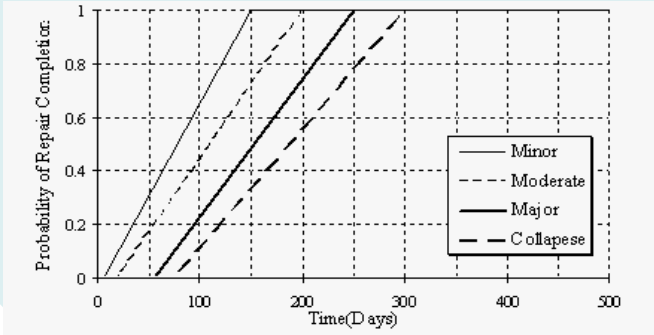
Cited from the research Paper
of Prof.Shinozuka of UCLA

Risk Analysis #2 Quantitative Risk Analysis

Property Damage

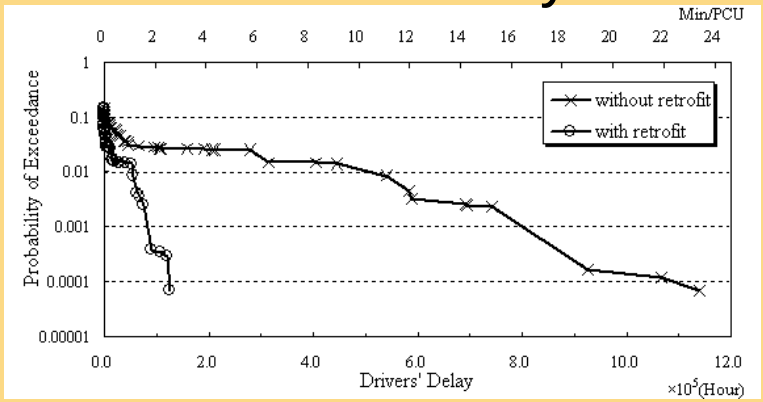


Interruption Loss



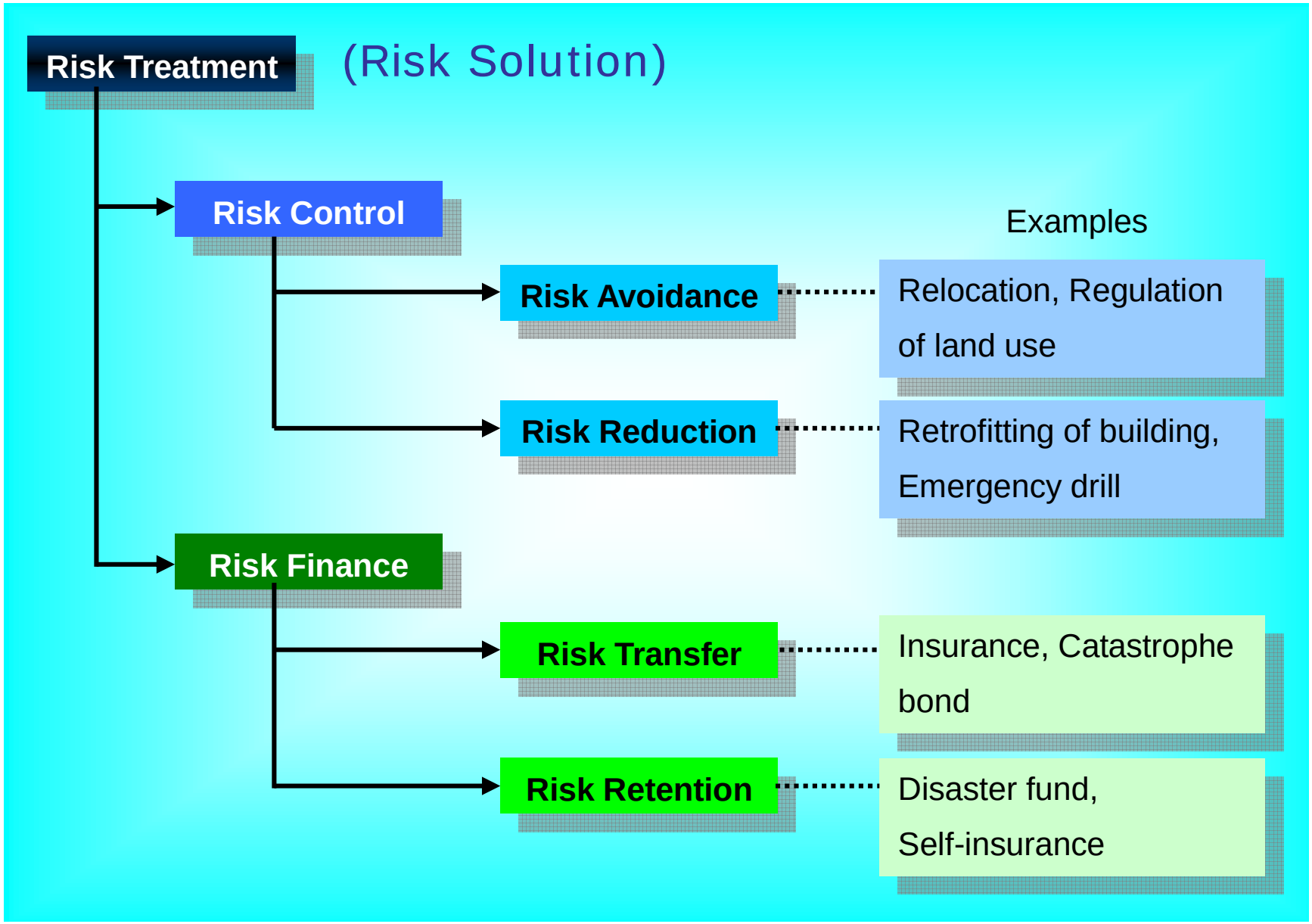
EQ Hazard

Driver's Delay

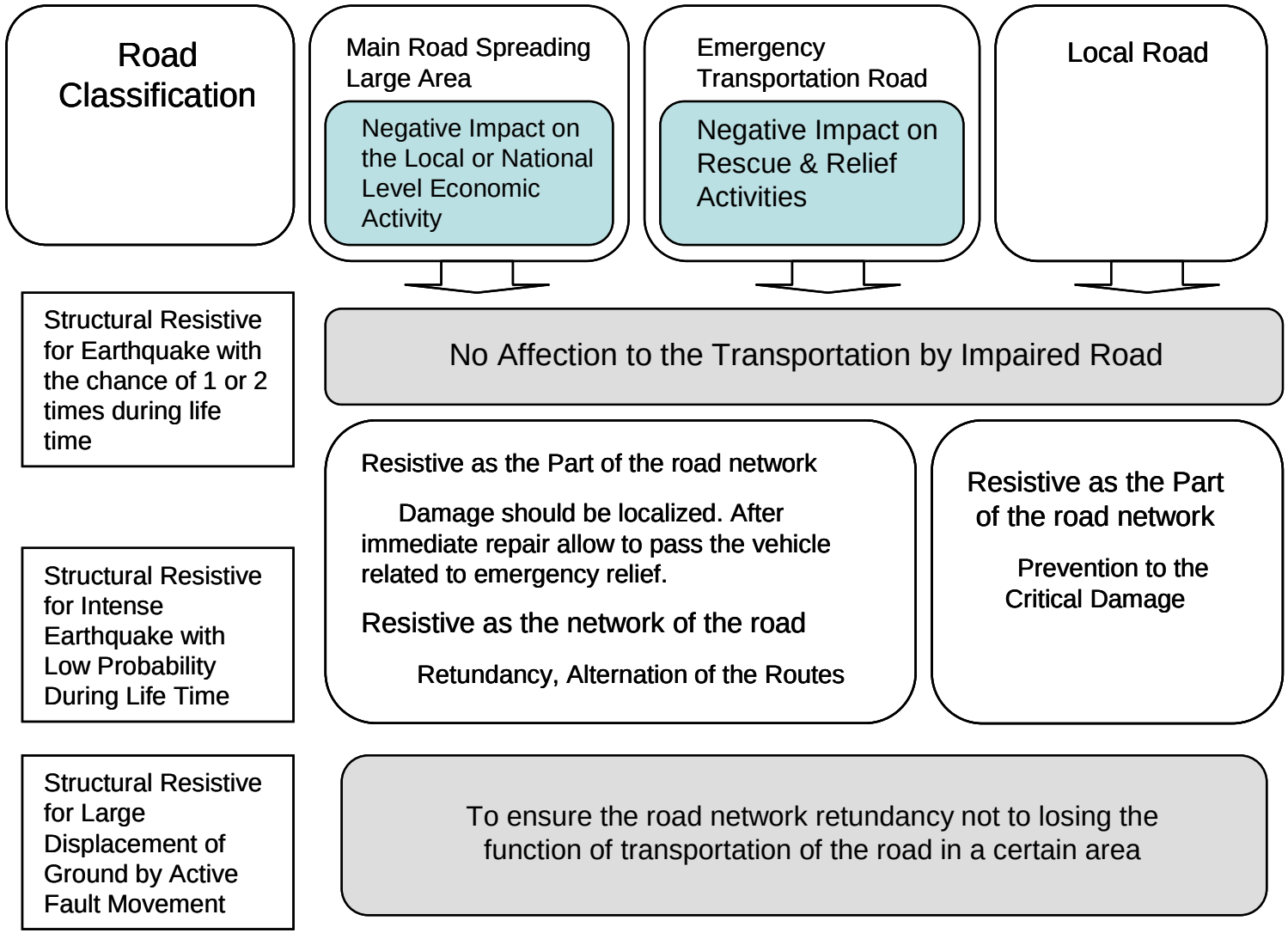


- Advanced Prob. Method
- Cost Benefit Analysis for Retrofit

Cited from the research Paper of Prof.Shinozuka of UCLA


Risk Treatment
(Risk Solution)
Risk Control
Risk Avoidance
Risk Reduction
Risk Finance
Risk Transfer
Risk Retention
Examples
Relocation, Regulation of land use
Retrofitting of building, Emergency drill
Insurance, Catastrophe bond
Disaster fund, Self-insurance

Risk Solutions; Hardware



Risk Solutions;

Seismic Intensity	Type “A” Bridge	Type “B” Bridge
(Level 1)	No impairment of the Bridge by Earthquake	
Type I (Level 2)	Remaining damaged bridge condition after the earthquake is a no critical condition	Remaining damaged bridge condition after the earthquake is a just a localized and immediately recover the function as a bridge.
Type II (Level 2)		

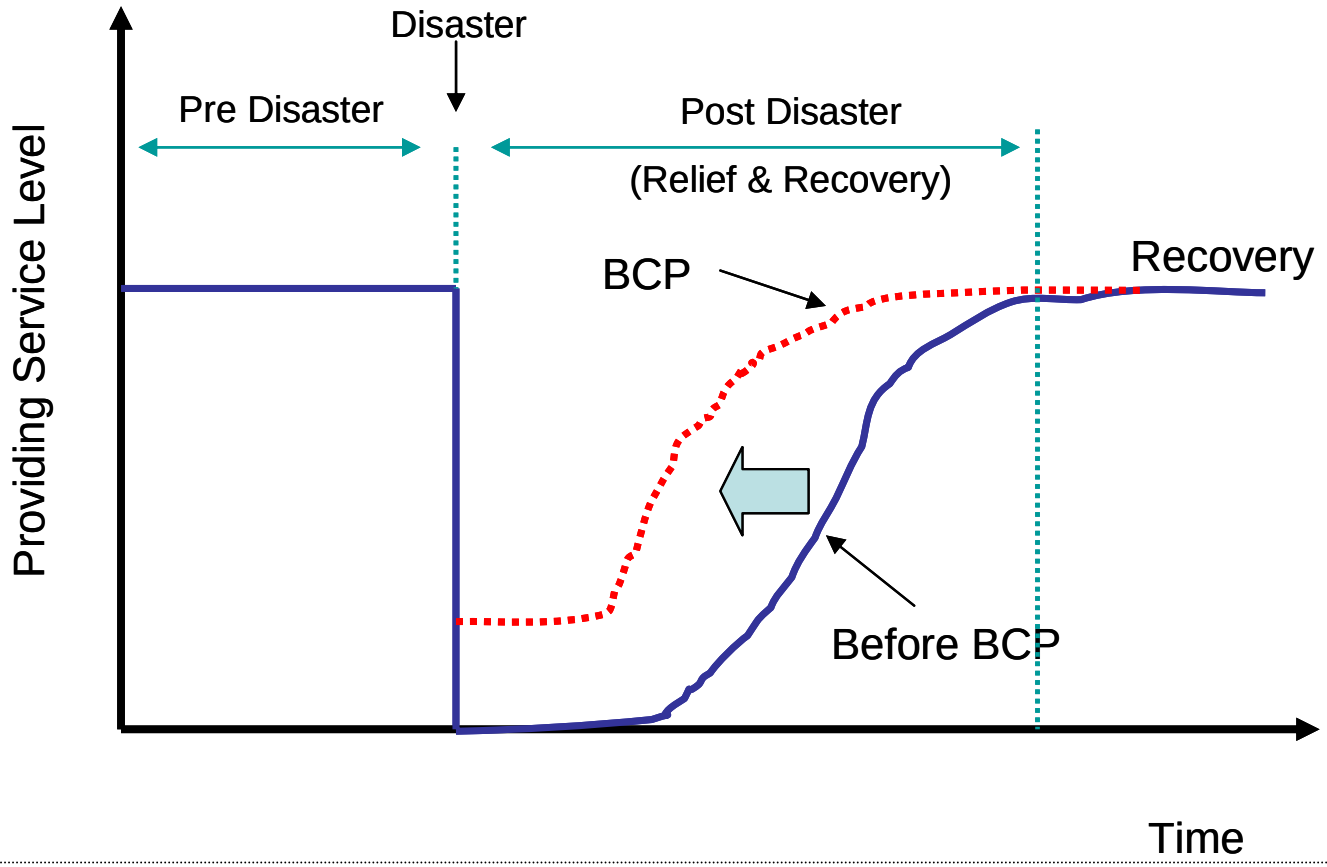
Prevention ; Retrofitting after the EQ

During the retrofitting work

Column Reinforced

An example of the prevention method on keeping the integrity of the road network

Business Continuity Planning (Software Aspects)



- **BCP**; Reducing Redundancy in Normal Operation, however quick recovery necessary in Emergency for Private Company.
- **Public-Private- Partnership ("PPP")** on DRR (Disaster Risk Reduction)
- Mitigate the natural disaster impact
- Public's measures on the enhancement of the integrity level on network system, Private Company recovery speed up the local economy.

Preparedness; Route for the Rescue and Recovery

Case: Yamazaki Fault Earthquake (M7.7)

(Immediately after quake hits)

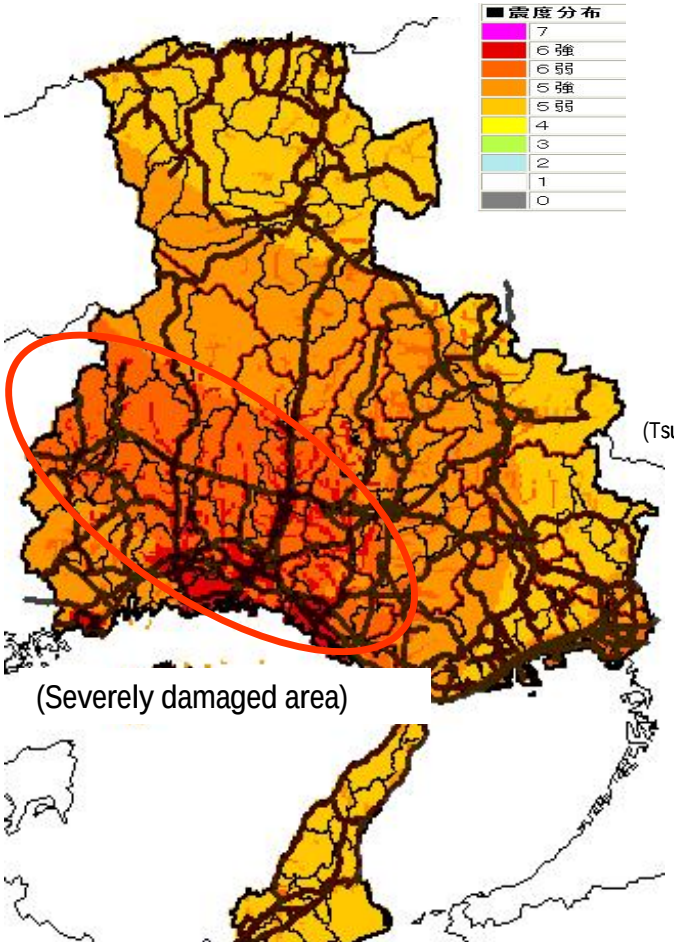
First stage: Setting wide-area detours

<Estimated situation/problems>

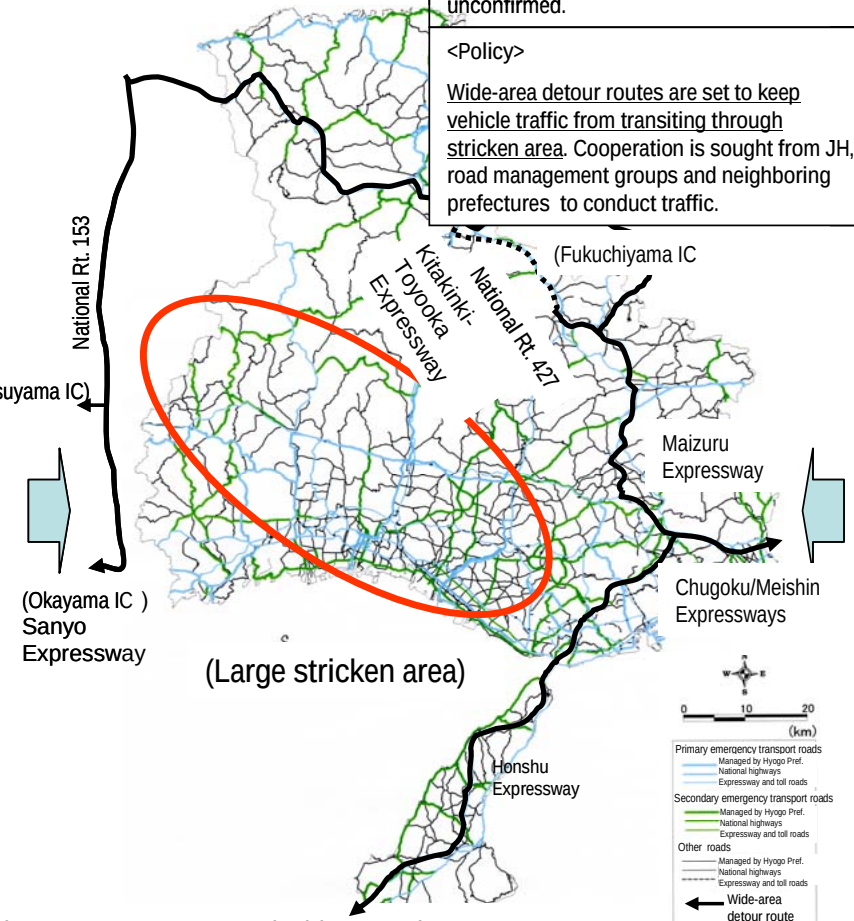
Earthquake size and magnitude distribution are known. Damage information is unconfirmed.

<Policy>

Wide-area detour routes are set to keep vehicle traffic from transiting through stricken area. Cooperation is sought from JH, road management groups and neighboring prefectures to conduct traffic.



Magnitude distribution and emergency transport roads



Proposed wide-area detour routes

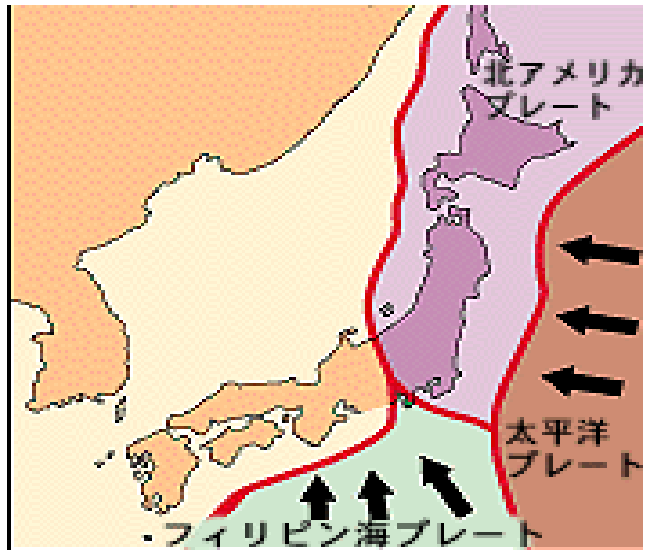
Cited from the document from Hyogo Prefecture

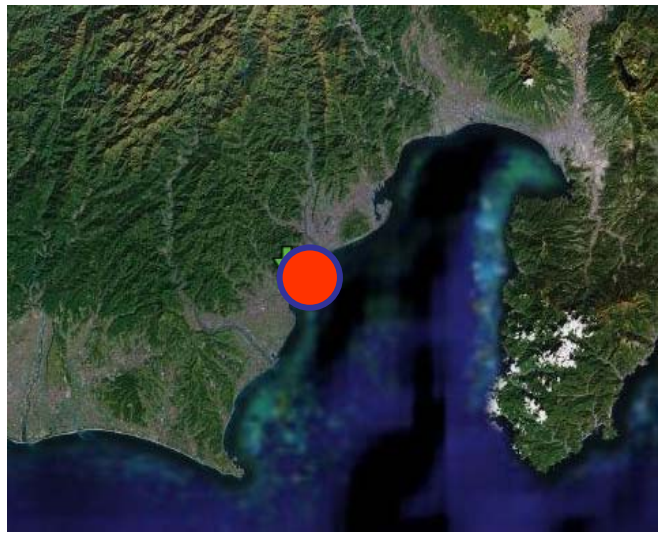
Case #1 Pharmaceutical Industry

- Location:
  Shizuoka, highly earthquake prone area, every 100-150 years M8 earthquake off Shizuoka. The past earthquake was happened 144 years ago !

- Geographic:
  Between large consumption areas such as Tokyo and Nagoya. Delivery route is limited by the mountainous area behind Shizuoka. Main route is located between the narrow space between the sea and mountain.

- The main responsibility;
  Deliver medicine to the patient during 24hrs in a year “Never stopping” (in spite of EQ)





Case #1 Pharmaceutical Industry

- Problem:

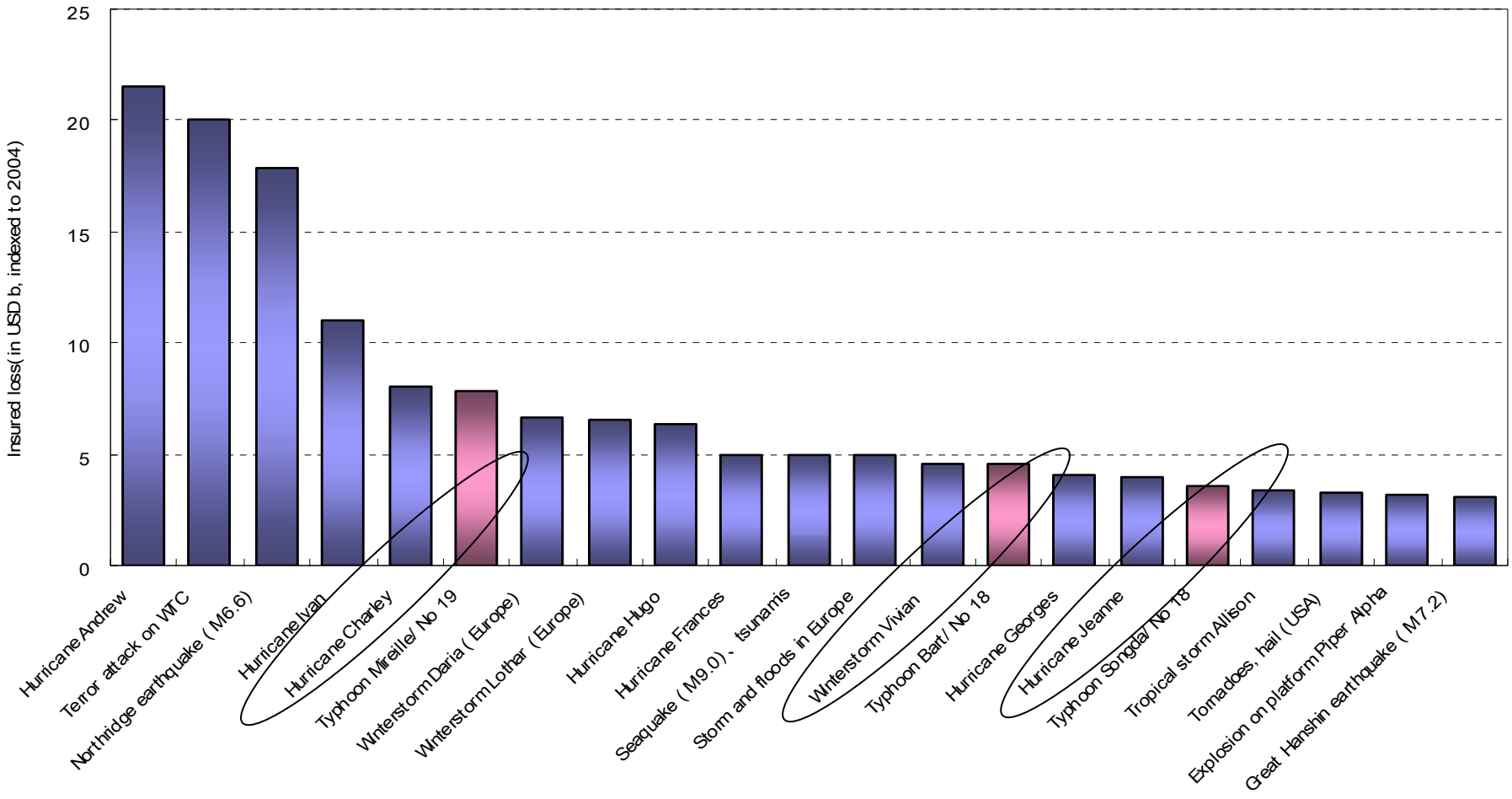
  For the future EQ, after the risk analysis, they reinforced their facility for the EQ, however the route of the stock delivery is a critical factor for their business continuity. No detour route !

- Risk Solution;

  - Sufficient Spare Stocks were stocked for the no EQ locations in Japan.

  (The road integrity and ensuring is a key factor for their business, however they could not do by themselves)

Catastrophic Event List (Swiss Re)



Case Study #2 - Risk Financing; Amuement Park

- Location;
  Reclaimed Land close to Tokyo Bay
  (Single Location in Japan)

- Annual Visitors;
  25 Million (70 Thou/Day, USD 3 Million/day)

- EQ Exposure;
  Highly Liquefaction, Ground Shaking

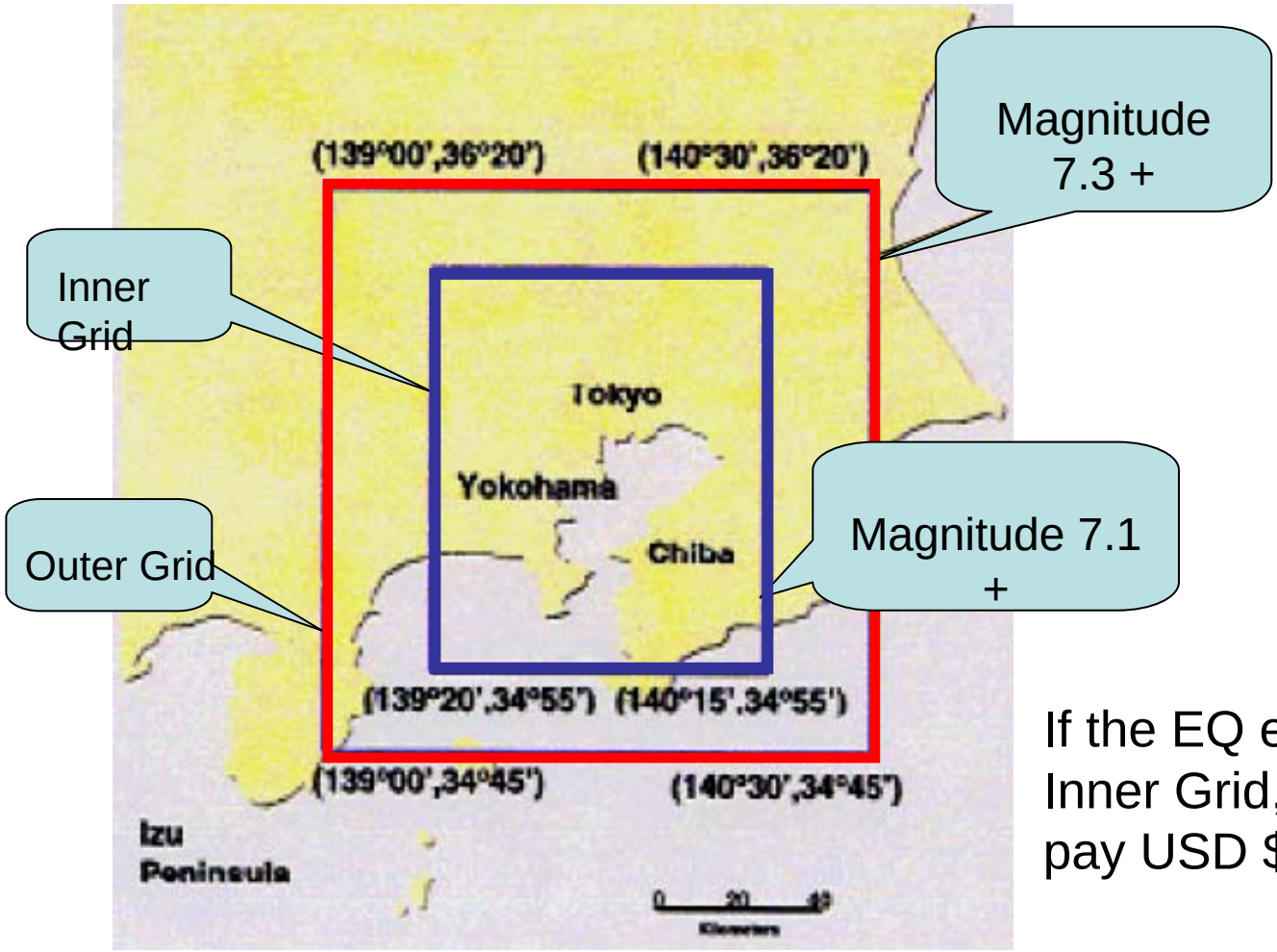
- Protection;
  Compliance with Bldg Code for their facility

Case Study #2 Risk Finance ~ Amusement

- Problem;
  - The major problem is the visitors' accessibility to the Site. Major access route as bridged type highway and railroad will be collapsed by the EQ (Liquefaction etc), nobody could not access the site.
  - Amusement business itself could not continue after the EQ, however, financially supported make continued their business.

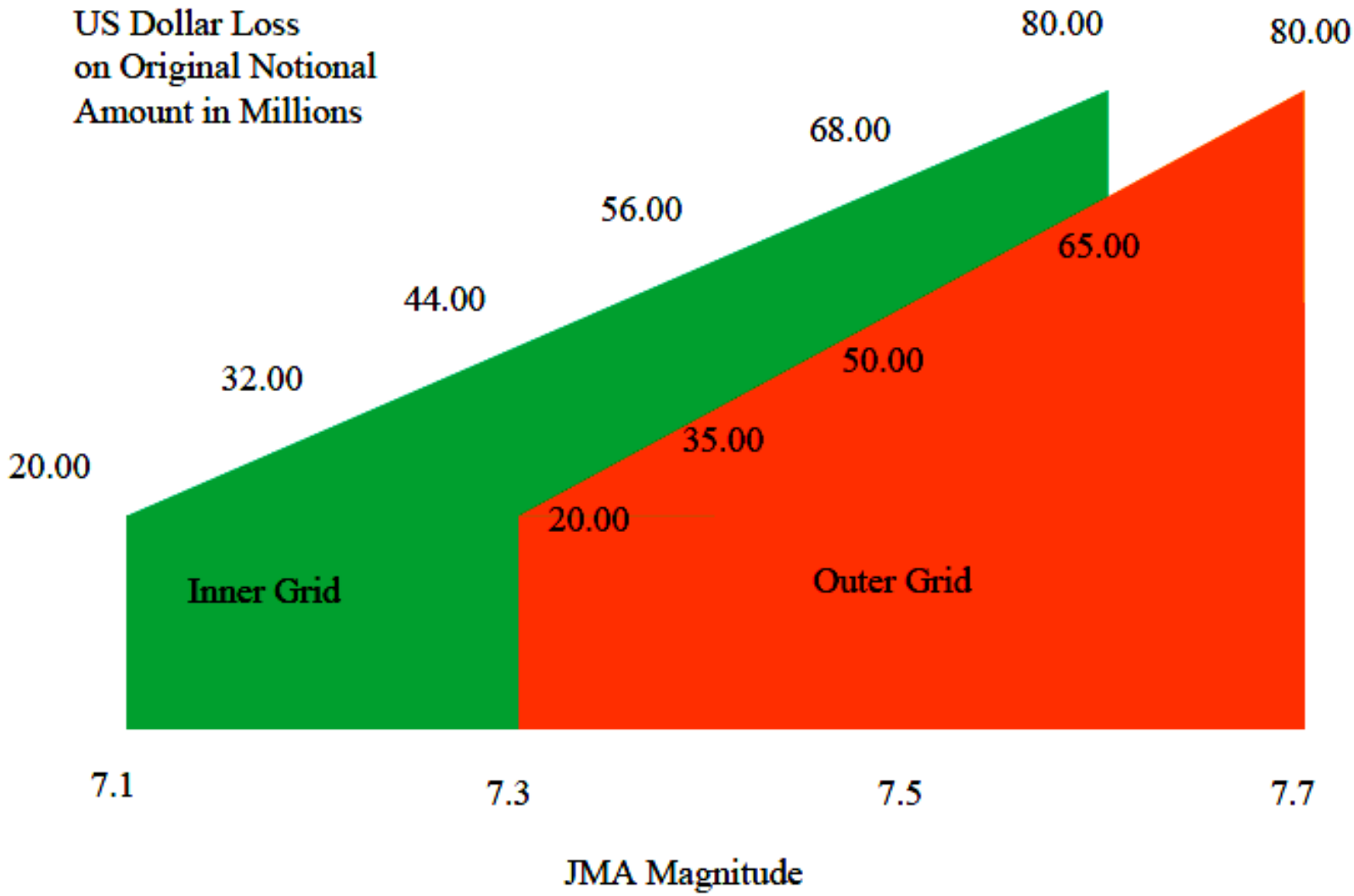
- Solution;
  - Since they could not directly reinforce the highway, they issued the CAT bond (USD$200) to recover the income loss by the decreasing of the visitors after EQ.

An Example of Parametric Trigger of CAT Bond



If the EQ exceed M7.1 in Inner Grid, Investor will pay USD $200M.

Recovery Rate(%) of Principal Amount from Investor After EQ (JMA Magnitude Trigger)



Conclusion

- The importance of function of the road network was described based on past experience of earthquake.
- The method of the risk assessment for the road disturbance by the earthquake was introduced, and the countermeasures were also reviewed on the risk management processes.
- In econo-social activity, recent business minimizes the redundancy to introduce the supply chain management, these activity cause the increasing of vulnerability to the disaster situation. For the problem, it is important to have a suitable redundancy to the road network system preparing for the future natural disaster.